

CURED-IN-PLACE PIPE (CIPP) LINER

**\*\*From South Burlington IM SCRP(3)**

xx. DESCRIPTION. This work shall consist of lining an existing culvert(s) (pipe(s)) at the location(s) indicated in the Plans and as directed by the Engineer.

xx. MATERIALS. Materials for the Cured-In-Place Pipe (CIPP) system shall meet the following requirements:

(a) Tube. The sewn tube shall consist of one or more layers of absorbent non-woven felt fabric and shall meet the requirements of ASTM F 1216, Section 5.1 or ASTM F 1743, Section 5.2.1. The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe, and stretch to fit irregular pipe sections.

The wet out tube shall have a relatively uniform thickness that when compressed at installation pressures will equal or exceed the calculated minimum design thickness.

The tube shall be manufactured to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion. Overlapped layers of felt in longitudinal seams that cause lumps in the final product shall not be utilized.

The outside layer of the tube shall be coated with an impermeable, flexible membrane that will contain the resin and all the resin impregnation (wet out) procedure to be monitored.

The tube shall be homogeneous across the entire wall thickness, containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.

The wall color of the interior pipe surface of CIPP after installation shall be a relatively light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.

Seams in the tube shall be stronger than the non-seamed felt material.

The tube shall be marked for distance at regular intervals along its entire length, not to exceed 1.5 meters (5 feet). Such markings shall include the manufacturer's name or identifying symbol. The tube shall be manufactured in the United States.

(b) Resin. The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy system including all required catalysts, initiators, or hardeners that when

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cured within the tube create a composite that satisfies the requirements of ASTM F 1216 and ASTM F 1743, the physical properties herein, and those which are to be utilized in the design of the CIPP for this project. The resin shall produce a CIPP that will comply with the structural and chemical resistance requirements of this specification.

The following manufacturers are capable of supplying a pipe liner system that meets these specifications:

Inliner Technologies, LLC  
1468 West Hospital Road  
Paoli, IN 47454  
Tel.: 812-723-0704

Insituform Technologies, Inc.  
17988 Edison Avenue  
Chesterfield, MO 63005  
Tel.: 636-530-8000  
Fax: 636-519-8010

Premier-Pipe USA  
JWM Environmental, Inc.  
9855 West 78<sup>th</sup> Street, Suite 400  
Eden Prairie, MN 55344  
Tel.: 952-944-8093  
Fax: 952-944-4399

Requests for substitutions for the above shall be submitted to the Agency's Office of Contract Administration a minimum of 10 days in advance of the bid opening date. Substitutions for the above after award shall be approved by the Resident Engineer.

- xx. DESIGN, MANUFACTURE, SAMPLING, AND TESTING. The CIPP shall be designed in accordance with ASTM F 1216, Appendix X1. The CIPP design shall assume no bonding to the original pipe wall.

The manufacturer shall have performed long-term testing for flexural creep of the CIPP pipe material installed. Such testing results are to be used to determine the long-term, time-dependent flexural modulus to be utilized in the product design. This is a performance test of the materials (tube and resin) and general workmanship of the installation and curing. A percentage of the instantaneous flexural modulus value (as measured by ASTM D 790 testing) will be used in design calculations for external buckling. The percentage, or the long-term creep retention value utilized, will be verified by this testing. Retention values exceeding 50% of the short-term test results shall not be applied unless substantiated by qualified third party test data to the Owner's satisfaction. The materials utilized for the project shall be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in the CIPP design.

The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe

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or knife blade moves freely between the layers. If the layers separate during field sample testing, new samples will be required to be obtained from the installed pipe. Any reoccurrence may cause rejection of the work.

The cured pipe material (CIPP) shall meet or exceed the minimum structural properties listed below (in accordance with ASTM D 790).

Property	Minimum	Enhanced Resin
Modulus of Elasticity	1724 Mpa (250,000 psi)	2758 Mpa (400,000 psi)
Flexural Stress	31 Mpa (4,500 psi)	31 Mpa (4,500 psi)

Structural CIPP section requirements shall be in accordance with the design equations in Appendix X1 of ASTM F 1216 and the following design parameters:

- (1) Design Safety Factor (typically used value) = 2.0
- (2) Retention Factor for Long-Term Flexural Modulus to be used in Design = 1% - 60% (As determined by long-term tests described above and approved by the Engineer).
- (3) Groundwater Depth (above invert of existing pipe) to be determined by the Contractor.
- (4) Soil Depth (above crown of existing pipe) to be determined by the Contractor.
- (5) Poisson's Ratio = 0.3
- (6) Enhancement Factor (K) = 7
- (7) DR = Dimension Ratio = Diameter / thickness  $\Rightarrow t = D/DR$
- (8) Effective reduction of  $E_i$  modulus to approximate effects of creep = 50%
- (9) Ovality % =  $100 \times (\text{Mean Dia.} - \text{Minimum Dia.}) / \text{Mean Dia.}$   
\* 2% ovality is typically assumed when the host pipe measurements have not been field verified.
- (10) Any layers of the tube that are not saturated with resin prior to insertion into the existing pipe shall not be included in the structural CIPP wall thickness computation.

A Type D Certification shall be submitted in accordance with Subsection 700.02 by the Contractor from the CIPP manufacturer for the CIPP materials.

The CIPP shall meet the chemical resistance requirements of ASTM F 1216, Appendix X2. CIPP samples for testing shall be of tube

and resin system similar to that proposed for actual construction. It is required that CIPP samples with and without plastic coating meet these chemical testing requirements.

CIPP samples shall be prepared and physical properties tested in accordance with ASTM F 1216 or ASTM F 1743, Section 8, using either method proposed. The flexural properties shall meet or exceed the values listed in Table 1 of the applicable ASTM.

Wall thickness of samples shall be determined as described in paragraph 8.1.6 of ASTM F 1743. The minimum wall thickness at any point shall not be less than 87½% of the minimum design wall thickness as calculated in paragraph 5.6 ASTM F 1743.

Visual inspection of the CIPP shall be in accordance with ASTM F1743, Section 8.6.

- xx. HYDRAULIC CAPACITY. The CIPP shall have a minimum diameter as shown on the Plans. The hydraulic cross-section shall be maintained as large as possible.
- xx. INSTALLATION. Temporary relocation of stream, when required, shall be performed in accordance with the requirements of TEMPORARY RELOCATION OF STREAM of Section 900.

The Contractor, when required, shall remove all internal debris and obstructions from the existing pipe, and perform any necessary repairs to existing pipe conditions that would interfere with the installation of the CIPP, in accordance with the manufacturer's recommendations and as directed by the Engineer.

CIPP installation shall be performed in accordance with ASTM F 1216, Section 7, or ASTM F 1743, Section 6, and the following requirements:

- (a) Resin Impregnation. The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin during installation through cracks and irregularities in the original pipe wall.

If a vacuum impregnation process is used, the point of vacuum shall be no further than 8 meters (25 feet) from the point of initial resin introduction. After vacuum in the tube is established, a vacuum point shall be no further than 23 m (75 feet) from the leading edge of the resin. The leading edge of the resin slug shall be as near to perpendicular to the longitudinal axis of the tube as possible. A roller system shall be used to uniformly distribute the resin throughout the tube. If the Installer uses an alternate method of resin impregnation, the method must produce the equivalent results. Any alternate resin impregnation method must be documented to the Owner's satisfaction that the saturation of the CIPP is sufficient.

- (b) Tube Insertion. The wet out tube shall be positioned in the pipeline using either inversion or a pull-in method. If pulled into place, a power winch should be utilized and care should be exercised not to damage the tube as a result of pull-in friction. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extend to the next designated manhole or termination point.
- (c) Curing. Temperature gauges shall be placed between the tube and the host pipe's invert position to monitor the temperatures during the cure cycle.

Curing shall be accomplished by utilizing hot water under hydrostatic pressure or steam pressure in accordance with the manufacturer's recommended cure schedule.

If hot water under hydrostatic pressure is to be used to cure the tube, this water shall be disposed of properly via sewer disposal or treatment plant disposal, due to the concentration of styrene.

- (d) Sealing. A watertight seal at the insertion and termination points in the drainage structures shall be provided in accordance with the manufacturer's recommendations.
- (e) Inspection. An internal video inspection of the completed liner shall be performed. The video inspection shall be conducted by someone experienced in the use of closed circuit television (CCTV) inspection techniques. Results of the inspection shall be provided to the Engineer both as video logs on compact disc and written logs.
- (f) Work Plan. Prior to installing the CIPP, the Contractor shall provide a work plan that will include necessary forming details, method of placement, methods of maintaining the location of the liner during installation operations, and where required methods of drilling CIPP in the location of the vertical riser as well as maintaining and sealing the connection between the riser and CIPP. The work plan shall be approved by the Engineer prior to commencing with the work.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Cured-In-Place Pipe Liner) of the size specified to be measured for payment will be the number of meter (linear feet) installed in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Cured-In-Place Pipe Liner) of the size specified will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified; for cleaning and repairing the existing pipe prior to CIPP installation; for drilling the CIPP in the location of the vertical riser as well as maintaining and sealing the connection between the riser and the CIPP; for

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performing required materials sampling and testing; for performing video inspection of the completed lining; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

When designated in the Contract Documents for a specific location, payment for work associated with access and staging or temporary relocation of stream will be made under Contract items 900.645 Special Provision (Temporary Access Road and Staging Areas, Culvert) and 900.645 Special Provision (Temporary Relocation of Stream), respectively.

When not designated in the Contract Documents for a specific location, payment for work associated with access and staging or temporary relocation of stream will be included in the unit price bid for Contract item 900.640 Special Provision (Cured-In-Place Pipe Liner).

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
900.640 Special Provision (Cured-In-Place Pipe Liner)(Existing X MM (X") Pipe)	Meter (Linear Foot)