

**STANDARD SPECIFICATIONS FOR
CONSTRUCTING SANITARY SEWER FACILITIES**

DIVISION III - CONSTRUCTION SPECIFICATIONS

**SECTION 5
REHABILITATION OF SANITARY SEWER MAINS
BY THE CURED-IN-PLACE PIPE (CIPP) METHOD**

5.01 SCOPE

It is the intent of this specification to define the approved methods and materials for the trenchless rehabilitation of existing sanitary sewer lines by the Cured-In-Place (CIPP) process.

These specifications form a part of the Contract Documents and shall govern for rehabilitating sanitary sewer mains and laterals by the cured-in-place pipe (CIPP) process. The work covered in this section includes the furnishing of all plant, labor, equipment, appliances and materials and performing all operations in connection with the complete rehabilitation of the existing deteriorated sanitary sewer system piping and testing of CIPP lining within the sewer main.

The CIPP process is defined as the reconstruction of sanitary sewer pipe by the installation of an epoxy vinyl ester or polyester resin, thermosetting resin, vacuum impregnated flexible polyester felt fiber tube, having an impermeable inner surface. The resin impregnated tube shall be formed to the host pipe by means of a water column. Curing shall be accomplished by circulating hot water throughout the length of the tube in accordance with the specified curing schedule supplied by the resin manufacturer. The CIPP shall extend the full length of the pipe reach being rehabilitated and shall provide a structurally sound, impermeable, jointless, close-fitting, pipe that when cured is mechanically bonded to the host pipe.

The Contractor shall complete all work in strict accordance with all applicable current OSHA standards. Particular attention is drawn to those safety requirements involving work on an elevated platform and entry into a confined space. It shall be the Contractor's responsibility to comply with OSHA Standards and Regulations pertaining to all aspects of the work.

When required for acceptable completion of the pipe rehabilitation or replacement, the Contractor shall provide by-pass pumping for continuous sewage flow around the section(s) of pipe designated for the installation of replacement pipe. The pump bypass lines shall be of adequate capacity and size to handle the flow in accordance with the specifications herein and DU standards.

Installation methods and materials shall conform to ASTM F 1216 in addition to these specifications.

5.02 REFERENCES

Standards referenced in this Section are listed below:

ASTM D790-07 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

- ASTM D2990-01 - Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.
- ASTM D5813-04 - Standard Specification for Cured-In-Place Thermosetting Resin Sewer Pipe.
- ASTM F1216-07B - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

5.03 QUALIFICATIONS

The Contractor shall have a minimum of three (3) years of continuous experience installing CIPP liners in pipe of similar size, length and configuration as contained in this contract. A minimum of 150,000 linear feet of shop wet-out liner installation is required and a minimum of 6 onsite wet-out installation are required as specifically applicable to this contract. The lead personnel including the superintendent, the foreman and the lead crew personnel for the CCTV inspection, resin wet-out, the CIPP liner installation, liner curing and the robotic service reconnections each must have a minimum of three (3) years of total experience with the CIPP technology proposed for this contract and must have demonstrated competency and experience to perform the scope of work contained in this contract.

5.04 DELIVERY, STORAGE, AND HANDLING

Care shall be taken in shipping, handling and storage to avoid damaging the liner. Extra care shall be taken during warm weather construction. Any liner damaged in shipment shall be replaced as directed by the Owner at no additional cost to Owner.

The CIPP shall be adequately supported and protected while stored. The CIPP shall be stored in a manner as recommended by the manufacturer and as approved by the Engineer/Owner.

5.05 QUALITY CONTROL

No change of material, design values, or procedures may be made during the course of the Work without the prior written approval of the Engineer/Owner.

All liners to be installed under this Work may be inspected at the manufacturer's plant(s) and wet-out facility for compliance with these Specifications by the Owner or Engineer. The Contractor shall require the wet-out facility's cooperation in these inspections. The cost of inspection will be the responsibility of the Owner.

The Contractor shall inspect each lot of liner for defects at the time of manufacture. The Contractor shall inspect each liner at delivery to assure the liner is homogeneous throughout, uniform in color, free of cracks, holes, foreign materials, blisters, or deleterious faults.

The Contractor shall have a Quality Control Plan or Procedure in place that will allow the Engineer/Owner to monitor the resin impregnation process.

5.06 SUBMITTALS

- A. The following submittals shall be submitted prior to beginning work:
1. Independent third party certified laboratory test reports showing that the resin/liner combination to be used for this project meets the requirements for initial structural properties and chemical resistance in accordance with ASTM F1216 and ASTM D790.
 2. Independent third party certified laboratory test reports showing the resin/liner combination long term flexural modulus and long term flexural strength test results for ASTM D2990.
 3. Structural Design calculations certified by a professional engineer in accordance with ASTM F1216 Appendix for each length of liner to be installed.
 4. MSDS sheets for all materials to be provided for this project.
 5. Fabric Tube manufacturer and product components description including the nominal void volume in the felt fabric that will be filled with resin.
 6. Flexible membrane coating material data sheet including repair recommendations.
 7. Raw Resin manufacturer and product components description.
 8. Manufacturer's shipping, storage and handling recommendations for all components of the CIPP system.
 9. Description of the proposed wet-out procedure.
 10. Manufacturer's recommended cure method for each diameter and thickness to be used in the project which shall include a detailed curing schedule for each segment.
 11. Contractor's proposed installation schedule.
 12. Contractor's public notification door hanger.
 13. Contractor's detailed proposed method and procedures for installation.
 14. Contractor's contingency plan for performing repairs of defects.
- B. The following documentation shall be submitted during construction:
1. Pre and Post Video Inspection
 2. Homeowner Notification Delivery Form
 3. Liner/Delivery Inspection Form

4. Wet-Out Report
5. Pre-Installation Pipe Inspection Form
6. Curing Log
7. CIPP Test Sample Form
8. Service Connection Documentation Form
9. Defect Documentation Form

5.07 MATERIALS

A. Design Requirements:

1. The CIPP liner shall form a continuous, tight fitting, hard, impermeable liner that is chemically resistant to chemicals found in both domestic sewage and seawater.
2. The CIPP liner shall have the minimum physical characteristics listed below:

Physical Characteristic	Minimum Values	Test Method
Flexural Strength	4500 psi	ASTM D 790
Modulus of Elasticity	250,000 psi	ASTM D 790

B. CIPP Thickness:

1. The required structural CIPP wall thickness shall be based, at a minimum on the criteria below:
 - a. In accordance with ASTM F1216, Appendix X1, Design Considerations for a fully deteriorated host pipe.
 - b. A safety factor of 2.
 - c. A minimum service life of 50 years under continuous service.
 - d. Creep Retention Factor of 50%
 - e. A soil density of 120 lbs/ft³.
 - f. Constrained Soil Modulus of 1,000 psi
 - g. The groundwater elevation shall be assumed at grade for each pipe segment.
 - h. Ovality for each segment shall be a minimum of 2%.
 - i. Live loads for each segment shall be HS-20 unless otherwise noted on the drawings.
 - j. Soil depth for each segment to be lined will be based on the max distance in feet measured between the crown of the pipe and the highest point of soil cover over the length of the pipe.

- C. The minimum CIPP finished thicknesses for the physical characteristics required above are listed in Table below:

MINIMUM FINISHED LINER THICKNESS			
Sewer Diameter	Pipe Invert Depth Up To 10'	Pipe Invert Depth 10-15'	Pipe Invert Depth 15' and Over
6"	4.5 mm	4.5 mm	4.5 mm
8"	6.0 mm	6.0 mm	6.0 mm
10"	6.0 mm	6.0 mm	7.5 mm
12"	7.5 mm	7.5 mm	9.0 mm
15"	7.5 mm	9.0 mm	10.5 mm
18"	9.0 mm	12.0 mm	13.5 mm
21"	10.5 mm	13.5 mm	15.0 mm
24"	12.0 mm	15.0 mm	16.5 mm
30"	15.0 mm	18.0 mm	21.0 mm
36"	16.5 mm	21.0 mm	24.0 mm
42"	19.5 mm	24.5 mm	28.5 mm
48"	22.5 mm	28.5 mm	33.0 mm
54"	24.5 mm	33 mm	39.0mm

- D. The Contractor shall verify the liner thicknesses included in referenced Table for accuracy and advise of any variations required to accommodate the selected process and structural requirements. No additional compensation will be allowed for these variations. Any proposed adjustments to the liner wall thickness or installation procedures shall be submitted by the Contractor to the Engineer/Owner for approval including design criteria, calculations and other information required to ensure the structural integrity and hydraulic capacity of the proposed liner materials.

The Contractor shall field verify all lengths and diameters prior to construction.

- E. Fabric Tube:

1. The fabric tube shall consist of one or more layers of absorbent non-woven felt fabric that meets the requirements of ASTM F1216.
2. The fabric tube shall be capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures and have sufficient strength to bridge missing pipe segments, and stretch to fit irregular pipe sections.
3. The wet-out fabric tube shall have a uniform thickness and excess resin distribution that when compressed at installation pressure will meet or exceed the design thickness after cure.

4. No material shall be included in the tube that may cause delamination in the CIPP. No dry or unsaturated layers shall be evident.
5. The inside layer of the fabric tube shall be coated with an impermeable, flexible membrane that will contain and protect the resin during installation and curing.
6. The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.
7. The fabric tube shall be manufactured to a size and length that when installed will tightly fit the internal circumference of the existing pipe. Allowance shall be made for circumferential stretching during installation. The tube shall be properly sized to the diameter of the existing pipe and the length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends. The Contractor shall determine the minimum tube length necessary to effectively span the designated run between manholes including obtaining the required samples for testing. The Contractor shall verify the lengths in the field prior to ordering and prior to impregnation of the tube with resin, to ensure that the tube will have sufficient length to extend the entire length of the run. The Contractor shall also measure the inside diameter of the existing pipe in the field prior to ordering the liner so that the liner can be installed in a tight-fitted condition.

F. Resin:

1. Mainline CIPP: The resin shall be corrosion resistant polyester or vinyl ester resin and catalyst system and when properly cured meets the requirements of ASTM F1216 and the requirements specified in this section.

The resin shall be a liquid thermosetting resin and shall be suitable for the design conditions as well as the curing process

2. Short Liner: The resin shall be a two-part, ambient cure 100% solid epoxy vinyl ester or polyester resin and a compatible catalyst system to accommodate the environment of the existing sanitary sewer with multiple temperature range hardeners suitable for ambient conditions at the time of installation and when properly cured meets the requirements of ASTM F1216 and the requirements specified in this section.

Resins shall be non-volatile and safe for use in the interior of sanitary sewer pipe. Resins shall have a maximum shelf life of six (6) months. The Contractor shall not use any resin that has exceeded its shelf life or expiration date.

3. The resin shall saturate the tube and produce a properly cured liner which is resistant to abrasion due to solids, grit, and sand.
4. The resin to tube ratio, by volume, shall be furnish as recommended by the manufacturer.

- G. Hydrophilic Seals:
 - 1. Hydrophilic seals shall be installed between the pipe and liner inside the pipe near each manhole prior to installation of the liner.
 - 2. The hydrophilic waterstop end seals shall be bands that are 20 mm wide and 5 mm thick and shall be installed at every entrance to a manhole.
 - 3. Manufacturer: GreenStreak Hydrotite Style RS-0520-3.51, or an Engineer/Owner approved equal.

- H. CIPP End Seal:
 - 1. Install cured-in-place pipe (CIPP) end seals to seal the end of the CIPP where it enters the manhole.
 - 2. The Contractor shall use the LeakMaster product manufacturer: GreanStreak or an Engineer/Owner approved equal.

- I. Pre-Liners:
 - 1. Pre-liners shall be a thin, fully circumferential, plastic liner sized to nominal host pipe inside diameter.
 - 2. Manufacturer: Griffolyn TX 1200 or an Engineer/Owner approved equal.

- J. Short Liners:
 - 1. Short liners, when required, shall be of the same material as described above for a full length CIPP liner except for the resin which shall be as described above for short liners.

5.08 CONSTRUCTION PROCEDURES

- A. General: The following construction procedures shall be performed as a minimum. Additional procedures shall be performed to accommodate actual conditions. The general procedure shall include the following:
 - 1. Hydraulically clean existing piping.
 - 2. Video inspect existing piping and locate existing laterals.
 - 3. Remove line obstructions, where applicable.
 - 4. Perform CIPP process.
 - 5. Reconnect existing active laterals.

6. Video inspect rehabilitated pipe.
- B. Preparation: The following preparation procedures shall be completed, as a minimum:
1. Review Owner's television inspection logs of the pipes when available to plan rehabilitation work. Inspect and confirm the inside diameter, alignment and condition of each pipe segment to be lined.
 2. Provide notification to all homeowners affected by the rehabilitation process including the Contractor's contact information.
 3. The Owner or Contractor shall determine the location of all active service connections prior to lining. Dye test to verify all active service connections, if necessary, or otherwise required by the Contract Documents. Do not reopen taps that are not active. The Contractor shall submit a Lateral Reinstatement Plan.
 4. Hydraulically clean the pipe to be rehabilitated in accordance with DU Standard for Cleaning of Sewer Mains prior to performing pre-rehabilitation video inspection.
 5. Remove intruding taps, debris, and obstructions prior to pre-rehabilitation video inspection. When an obstruction requires removal by open cut methods, the Contractor shall notify the Owner immediately.
 6. Flow bypassing required to perform the rehabilitation shall be performed in accordance with DU Standard for Pumping and By-Passing.
 7. Remove pockets of water from the pipe.
 8. In the presence of the Owner or Engineer, perform a pre-lining video inspection immediately prior to CIPP lining to demonstrate that the pipe is clean and free of roots, grease, sand, rocks, sludge, PACP Runners or Gushers, pockets of water, or structural impediments that would affect long-term viability of the pipe liner. Obtain Owner's/Engineer's verbal approval of the acceptability of the existing pipe condition prior to installation of the CIPP.
 9. When approved by the Owner or Engineer, a pre-liner may be installed to protect the CIPP liner from existing infiltration.
- C. CIPP Installation: The Contractor shall submit a detailed description of the proposed techniques and procedures for rehabilitating the existing piping. The Contractor shall submit details to the Owner for approval prior to beginning work. The format shall generally conform to the following:
1. Resin Impregnation (Wet Out): The Contractor shall designate a location where the flexible tube will be impregnated with resin using distribution rollers and vacuum to thoroughly saturate the flexible tube prior to installation. A catalyst system, or additive compatible with the resin and flexible tube, may be used as recommended

by the manufacturer and with approval of the Owner/Engineer provided they will not impair or reduce the resin's quality to withstand the minimum chemical resistance criteria. The Contractor shall take care in handling the resin-impregnated flexible tube to retard or prevent resin setting until it is ready for insertion.

2. Insertion: The resin impregnated tube shall be transported and kept in a refrigerated truck until it is inserted through an existing manhole by manufacturer's techniques/process. The insertion area, equipment platform, etc., shall be securely protected. When required by the Owner, Prior to insertion the Contractor shall install temperature sensors between the host pipe and the liner in the bottom of the host pipe throughout its length to monitor the temperature on the outside of the liner during the curing process. The temperature sensors can be placed at ten foot intervals. The sensor should be monitored by a computer using a tamper proof database that is capable of recording temperatures at the interface of the liner and the host pipe. The output report stating the maximum temperature and the minimum cool down temperature for each sensor shall be provided to the Owner. The liner material shall be inserted through a manhole by means and methods required by the manufacturer, and shall be fully extended to the downstream manhole.

Insert continuous or properly trimmed hydrophilic waterstops at each manhole opening, centered within the intersection of the host pipe and the manhole wall. Trimmed waterstop edges shall be butted up against each other at the crown of the pipe using a 45° miter cut. Waterstops with any gap between the ends will not be accepted. For manholes with outside drops, install two hydrophilic waterstops, one approximately one inch inside the manhole wall and another approximately nine inches upstream of the outside drop and reinstate the drop opening through the CIPP. If defects in the host pipe near the manhole are such that the end seal will not form a watertight seal between the liner and host pipe, apply hydraulic cement to the defects in the host pipe to provide a smooth surface to receive the end seal.

The pressure head used during the installation process shall be sufficient to hold the liner tight to the pipe wall, produce dimples at all service connections and the two access manholes, and prevent wrinkles in the cured liner. The same head shall be great enough to prevent infiltration from entering the pipeline during the curing process. Pressure head shall be maintained sufficiently long enough to allow pockets of water to exfiltrate through the host pipe and prevent lifts in the liner and resin washout.

3. Curing: Curing shall be accomplished by the use of water or steam in accordance with the manufacturer's recommended cure schedule. The curing source temperatures shall be monitored and logged during the cure cycles. The manufacturer's recommended cure method and schedule shall be used for the size, thickness, and conditions of the liner being installed. Maintain the curing temperature as recommended by the liner system manufacturer. Prevent excessive temperatures that could scald or bubble the liner. Scalded or blistered liner shall be rejected if, in the opinion of the Owner/Engineer, the performance of the liner is compromised. Fit suitable monitors to any heat source to gauge the temperature

of incoming and outgoing water or steam supply. Monitor temperatures through thermal couplings at each end of the liner or by temperature strips described above when required by the Owner. Continue uninterrupted curing until the desired product is achieved. Provide for vapor tight connections in the downstream manhole such that no vapors enter downstream pipes or provide styrene odor reducing agents, venting, and downstream plugs sufficient to prevent steam, styrene, or other odors from entering downstream buildings.

4. **Cool Down:** Initiate a controlled cool-down to cool the hardened liner to a temperature below 100°F, in accordance with the cure schedule. Care shall be taken in the release of the pressure column so that a vacuum will not develop that could damage the newly installed liner. Cooling/Curing water shall only be discharged into the sanitary sewer. Discharging of cooling/curing water to the ground or storm water system is not permitted. Temperatures shall be recorded by the Contractor and provided to the Owner.
5. **Finished Pipe:** The finished CIPP liner shall be continuous over the entire length and be free from visual defects such as foreign inclusions, dry spots, pinholes, delamination, and major wrinkles. The CIPP liner shall be impervious and free from any leaks. Any defect which will affect the integrity of the pipe or hinder the flow of the sanitary sewer shall be repaired at the Contractor's expense.
6. **Short Liners:** Short liners shall meet the specifications for design, preparation, installation, inspection, and testing as required for full length mainline CIPP except for the method of installation and the resin material.

The short liner shall be wrenched into place on a carrier train/plug assembly and positioned by a closed circuit TV camera. The Short Liner shall overlap the area to be repaired by a minimum of one foot on each side.

The Contractor shall furnish a two-part, ambient cure 100% solid epoxy vinyl ester or polyester resin and a compatible catalyst system to accommodate the environment of the existing sanitary sewer with multiple temperature range hardeners suitable for ambient conditions at the time of installation. Resins shall be non-volatile and safe for use in the interior of sanitary sewer pipe. Resins shall have a maximum shelf life of six (6) months. The Contractor shall not use any resin that has exceeded its shelf life or expiration date.

5.09 CONSTRUCTION METHODS

- A. **Trimming at Manholes:** Delay final trimming and sealing of the liner at manholes according to Manufacturer's guidelines.

Seal the manhole/wall to CIPP interface with GreenStreak LeakMaster or an Owner approved product in accordance with the manufacturer's recommendation. Neatly and smoothly trim the finished ends of the liner to within four inches of host pipe end. Do not leave any rough edges that may catch debris. Do not leave any portion of CIPP within the manhole channel unless directed by the Owner to remain. The channel shall allow for ease

of access by a remote camera. Provide a smooth transition between the existing manhole channel invert and the effluent liner using cementitious or other approved material to prevent settling of sediments or debris from catching on the liner.

- B. Reconnection of Existing Lateral Services: The Contractor shall maintain two working lateral reinstatement cutters at the job site at all times. Lining work shall not commence if the Contractor does not have the required number of working cutters on site. No additional time or compensation shall be awarded to the Contractor in the event that work is stopped due to the Contractor's failure to comply with this requirement.

The Contractor shall reopen all existing active lateral service connections, as submitted in the Lateral Reinstatement Plan, in each length of sewer immediately following installation of the liner.

The Contractor shall reopen active service connections from inside the sewer by means of a remote controlled, video assisted cutting device appropriate for the liner material and the rehabilitated sewer pipe. Each active service connection shall be cut completely open at a minimum of 95% of the service pipe diameter and shall have smooth edges with no protruding material capable of hindering flow or catching and holding solids contained in the flow stream. The Contractor shall not overcut the lateral connection. Excess resin shall be removed from the lateral. Any damage to the saddle or tee caused from cutting out the coupon shall require replacement of the connection by excavation or a CIPP "Service Connection Seal" at the Contractor's expense.

When the lateral connection reinstatement exceeds 100% of the lateral opening, the Contractor shall install a CIPP repair to cover the over-cut at no additional cost to the Owner.

The Contractor shall not reopen capped or inactive lateral connections without consulting with the Owner. The Contractor shall confirm the locations of all capped or inactive laterals during pre-construction video inspections.

All coupons from lateral reinstatement shall be removed at the downstream manhole and shall not be allowed to enter the sanitary sewer system. Lateral reinstatement by excavation shall be in accordance with DU standards and Projects Specifications.

The Contractor shall be responsible for restoring/correcting, without any delay, all omitted or faulty reconnections, as well as for any damage caused to the property for not reconnecting the services soon enough or for not giving notice to the property's owners.

5.10 POST TELEVISION OF COMPLETED SECTIONS

Provide post-construction video inspection documentation showing completed work in accordance with DU Standard for Internal Video Inspection.

5.11 FINAL CLEANUP

Upon completion of rehabilitation work and testing, clean and restore project area affected by the Work.

5.12 TESTING

Physical Properties and Thickness Test: The Contractor shall collect a restrained pipe sample by placing a section of PVC pipe in the adjacent manhole. Select PVC material and size to match the inside diameter of the sewer being lined as closely as practical. Run the impregnated tube through the pipe and cure the CIPP under restrained conditions. Cut a cylindrical sample from the center of the restrained pipe sample. The sample shall be sized to allow for all applicable ASTM test methods to confirm compliance with these specifications. Label samples with the contract number, date of installation, street location, segment number(s), and specified thickness. Deliver the sample to the Owner for testing of the physical properties and thickness. The Contractor shall coordinate with the Engineer/Owner to be present for obtaining the sample.

5.13 FORMS

The Contractor shall utilize and complete the required forms for quality assurance.

5.14 WARRANTY

All lining work shall be fully guaranteed by the Contractor for a period of five (5) years from the date of Final Acceptance unless otherwise stipulated in writing by the Owner prior to the date of Conditional Acceptance. During this period, all defects discovered by the Owner or Engineer shall be addressed by the Contractor in a satisfactory manner at no cost to the Owner. The Owner may conduct independent inspections, at its own expense, of the lining Work at any time prior to the completion of the guarantee period.

Any defect discovered during this five (5) year period shall be repaired within four (4) weeks for from the date of defect notification to the Contractor at no additional cost to the Owner. When the Owner determines that the defect must be addressed immediately to prevent an overflow or backup the Owner may require the Contractor to repair or replace the section immediately at no additional cost to the Owner. The Owner may begin bypass procedures immediately until the Contractor can arrive with the appropriate liner section for repair. The Contractor shall be responsible for all repair costs including pavement restoration if necessary and bypassing.

The five (5) year warranty shall be backed by a two (2) year warranty bond and a five (5) year Manufacturer's warranty letter. The five (5) year Manufacturer's warranty letter shall be supplied on the Manufacturer's letterhead and specifically state the project name and Owner's name and shall not contain any exclusion of activities in the manhole or sanitary sewer system.

END OF SECTION