

SECTION 02733

CURED-IN-PLACE PIPE LINING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section includes furnishing all labor, materials, equipment, and incidentals required to install and test the cured-in-place pipe (CIPP) lining and appurtenances complete..
- B. The Contractor shall remove all pipeline obstructions and protruding service connections as required to complete the CIPP rehabilitation. Removal of all pipeline obstructions and protruding service connections greater than ½-inch for host pipe diameters smaller than 18-inch and greater than ¾-inch for larger host pipe diameters required for sewer rehabilitation using cured-in-place pipe lining shall be completed prior to the pre-rehabilitation CCTV inspection.
- C. Neither the CIPP system, nor its installation shall cause adverse effects to any City of Brentwood processes or facilities. Product use shall not result in forming or producing any detrimental compounds or by-products in the wastewater system. The Contractor shall notify the WSD and identify any by-products produced due to the installation operations and shall test and monitor the levels and comply with any and all local waste discharge requirements.
- D. The Contractor shall cleanup, restore existing surface conditions and structures and repair any CIPP system determined to be defective. The Contractor shall conduct installation operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, businesses, and property owners or tenants.

1.02 SUBMITTALS

- A. Submit product data, design calculations, installation details, and shop drawings to the WSD in accordance with Section 013 00. The Contractor shall provide this information without delay or claim to any confidentiality. Submittals shall include the following:
 - 1. CIPP lining supplier's name and a materials list
 - 2. CIPP lining schedules including field-verified lengths and diameters for all CIPP linings and appurtenances required.
 - 3. Shop drawings and product data to demonstrate compliance with these specifications and identify construction materials including resins, catalysts, felt, etc., felt manufacturer and facility location, wet-out facility location, etc.

4. Manufacturers' shipping, storage, and handling recommendations for all CIPP system components
5. MSDS sheets for all materials to be furnished for the project
6. Detailed installation procedures including CIPP lining production schedule, acceptable inversion heads and pressures, inversion procedures, curing and cool-down procedures and temperatures, and times for each process stage
7. Prior to each CIPP lining shipment, certified test reports showing the CIPP lining for this Contract was manufactured and tested in accordance with all ASTM Standards specified and referenced herein.
8. A detailed public notification plan shall be prepared and submitted including detailed staged notification to residences affected by the CIPP installation.
9. A complete description for the proposed wet-out procedure for the proposed technology. Wet-outs "over-the-hole" for large CIPP diameters/lengths shall be identified for the segment(s) and include full details of the procedure including environmental conditions control, resin temperature control, quality assurance procedures and etc.
10. Wet-out forms with detailed information including, but not limited to resin volumes and/or weights, CIPP liner length, roller gap settings, start times, finish times, gel times, resin injection locations, and any other pertinent data documenting the wet-out for each CIPP liner section manufactured.
11. Design data and specification data sheets listing all parameters used in the CIPP liner design and thickness calculations based on ASTM F1216. All calculations shall be prepared under and stamped by a Tennessee registered professional engineer.
12. A list with all service laterals abandoned or reconnected as part of the work as further defined herein.
13. Manufacturer's recommended cure method for each CIPP liner diameter and thickness to be installed including detailed curing procedures describing the curing medium and the application method.
14. CIPP lining curing reports documenting the liner installation for all sewer segments. The CIPP lining reports shall document all lining installation details including manhole numbers, street names/sewer location, project number, date, time, temperature, curing temperature, curing time, CIPP liner thickness, etc. A sample report shall be submitted to the WSD for approval prior to installing any CIPP lining.
15. Pre- and post-rehabilitation CCTV inspection data.

16. Ten reports from projects within the past 2 years from independent testing laboratory for liner materials analysis showing the elasticity modulus as determined by appropriate ASTM standard and flexural stress as determined by appropriate ASTM standard. The lining must be the same resin system and felt tube materials as proposed for this project.
17. Installed liner(s) samples for testing to be performed by an ASTM-certified independent testing laboratory, as described further herein
18. Data on the maximum allowable stresses and elongation of the tube during installation and the means the Contractor will use to monitor stress and elongation
19. A detailed summary about the proposed quality controls to be performed by the Contractor including:
 - a. Proposed procedures for quality control
 - b. Product sampling and testing method and frequency for product sampling and testing in raw material form and cured product form
 - c. Inspection forms and guidelines for quality control inspections
- B. Submit the name and experience for lead personnel including verifiable references, as described in the Qualifications subsection below.

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 1. ASTM D543 – Standard and Practice for Evaluating the Resistance of Plastics to Chemical Reagents
 2. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
 3. ASTM D790 – Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 4. ASTM D792 – Standard Test Methods for Density and Specific Gravity of Plastics by Displacement
 5. ASTM D2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
 6. ASTM F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
 7. ASTM F1743 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)

8. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
 9. ASTM D5813 – Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping Systems
 10. ASTM D2990 – Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
- B. National Association of Sewer Service Companies (NASSCO)
1. Recommended Specifications for Sewer Collection System Rehabilitation
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 EXPERIENCE AND CERTIFICATIONS

- A. The Contractor performing the CIPP lining work shall be experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be certified and/or licensed as an installer by the CIPP lining manufacturer.
- B. The lead personnel including the supervisor, the foreman, and the lead crew personnel for the CCTV inspection, factory and “over-the-hole” resin wet-out, the CIPP lining installation, lining curing and the robotic service reconnections each must have a 3-year and/or 250,00 feet minimum total continuous 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. Personnel replaced by Contractor during the execution of the work shall have similar verifiable experience as personnel originally submitted for project.

1.05 GUARANTEE

- A. All placed CIPP linings shall be guaranteed by the Contractor and manufacturer for a 3-year period from the final acceptance date. During this period, the Contractor shall remove and replace any and all serious defects discovered in the CIPP lining, as determined by the WSD, which may materially affect the pipe’s integrity, strength, function, and/or operation in a satisfactory manner to WSD at no cost to City of Brentwood. Defects replaced during this 3-year period shall be fully warranted by Contractor and manufacturer for a period of two years from date the defect was repaired.
- B. CIPP tube manufacturer shall warrant the tube and resin materials to be free from any defects for a 10-year minimum from the manufacture date.

1.06 QUALITY ASSURANCE

- A. All CIPP linings shall be from a single manufacturer. The suppliers shall be responsible for providing all test requirements specified herein as applicable. In addition, all CIPP linings to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing

laboratory provided by the WSD. The Contractor shall require the manufacturer's cooperation with these inspections.

- B. The WSD may inspect CIPP lining after delivery. The CIPP lining shall be subject to rejection at any time if it fails to meet any requirements specified, even though sample CIPP lining may have been accepted as satisfactory at the manufacturer. CIPP lining rejected after delivery shall be marked for identification and removed from the job site.
- C. In the event that an installation is rejected based on review of the post-rehabilitation CCTV inspection, the Contractor shall repair the sewer segment to the satisfaction of Metro at no additional cost to City of Brentwood.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in shipping, handling, and laying to avoid damaging the CIPP liner. Any CIPP liner damaged in shipment shall be replaced as directed by the WSD.
- B. Any CIPP lining showing a split or tear or which has received a blow that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the work.
- C. While stored, CIPP shall be adequately supported and protected in a manner as recommended by manufacturer.
- D. The CIPP lining shall be maintained at a proper temperature in refrigerated facilities at all times prior to installation to prevent premature curing. The CIPP lining shall be protected from UV light. Any CIPP lining showing evidence of premature curing shall be rejected for use and immediately removed from the site.

1.08 WATER

- A. Water for all construction operations shall be available from identified City fire hydrants at normal commercial rates.
- B. Water usage shall be in accordance with City backflow and metering policies.

1.09 SEWER CHECK VALVES

- A. If an existing sewer service includes a check valve, then that check valve should remain in place or be replaced with a new check valve during construction.
- B. Removal of an existing check valve shall only occur for the hours of explicit construction for service lateral lining or replacement.
- C. Notify the WSD immediately of the presence of a service line check valve and maintain the sewage backup prevention aspect of the valve.

PART 2 - PRODUCTS

2.01 CIPP FELT LINER AND RESIN

- A. CIPP lining shall be Inliner Technologies by Layne Inliner, Inc.; Insituform by Insituform Technologies, Inc.; MooreLiner by Moore Construction Co.; SAK Liner by SAK Construction; CIPP Corporation liner by American Infrastructures Technologies; Inverta A Pipe liner by Inland Pipe Rehabilitation (IPR Southeast); or pre-bid approved equal.
- B. The CIPP liner shall have tubing material with one or more layers of a flexible non-woven polyester felt with or without additives such as woven fiberglass or other fibers and shall meet ASTM F1216, ASTM F1743, ASTM D5813, and ASTM D2990 requirements. The CIPP liner's felt content shall be determined by the Contractor, but shall not exceed 15 percent of the total impregnated liner volume. The fabric tube shall be able to absorb and carry resins, be constructed to withstand installation pressures and curing temperatures, and have sufficient strength to bridge missing pipe segments and stretch to fit irregular pipe sections.
- C. The CIPP liner tube may be single or multiple layer construction with any layer not less than 1.5 mm thick. The wet-out fabric tube shall have a uniform thickness and excess resin distribution which, when compressed at installation pressures, will meet or exceed the design thickness after cure.
- D. The tube's outside layer prior to being inverted shall be coated with an impermeable material compatible with the resin and fabric.
- E. The manufactured tube's exterior shall have distance markings along its length at regular intervals not to exceed 5 feet. Use these marks as a gauge to measure elongation during insertion. Should a reach's overall elongation exceed 5 percent, the liner tube shall be rejected and replaced.
- F. The tube shall be homogenous across the entire wall thickness, containing no intermediate or encapsulated 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 upon visual inspection as evident by color contrast between felt fabric and activated resin containing a colorant.
- G. Seams in the tube shall be stronger than the non-seamed felt material and shall meet the requirements of ASTM D5813.
- H. The CIPP's interior wall color after installation shall be a relatively light reflective color so a clear detailed examination with CCTV equipment may be made. Hue of the color shall be dark enough to distinguish a contrast between fully resin saturated felt fabric and dry or resin lean areas.
- I. Resin: Shall be a corrosion resistant polyester or vinyl ester resin and catalyst system or epoxy and hardener system that, when properly cured within the tube composite, meets the requirements of ASTM F 1216, ASTM F 1743 or ASTM F 2019, the physical properties herein, and those, which are to be utilized in the

design of CIPP for this project. Resin shall produce CIPP which will comply with or exceed structural and chemical resistance requirements of this specification. Liner material and resin shall be completely compatible. Generally, resin shall not contain fillers, except those required for viscosity control or fire retardance or increase strength, and with applications for which inert fillers would facilitate better heat transfer and retention during installation. Liner contractor may add up to 5 percent by mass, a thixotropic agent for viscosity control, which will not interfere with visual inspection.

- J. The felt tubing shall be vacuum impregnated with a thermosetting polyester resin and catalyst, vinyl ester resin and catalyst, or epoxy resin, inhibitors and hardener.
- K. The resins may contain pigments, dyes, or colorants which shall not interfere with visually inspecting cured lining. The resin quantity 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 resin loss through cracks and irregularities in the original pipe wall. Use a serial vacuum impregnation process (or equal) to provide maximum resin impregnation throughout the tube.
- L. The Contractor shall identify the wet-out facility where all CIPP linings under this Contract will be manufactured. All CIPP linings shall be manufactured from this designated wet-out facility throughout the entire Contract, unless specifically approved otherwise in writing by the WSD. Multiple wet-out facilities shall not be allowed except for identified and approved "over-the-hole" on-site wet-out facilities for large diameter CIPP.
- M. The City of Brentwood or its representatives may inspect the CIPP lining during manufacturing and wet-out. The City and its representatives must be given an opportunity to witness the manufacturing for all CIPP linings for this project. If the City decides to inspect the CIPP lining manufacturing, the Contractor shall provide full access to witness the wet-out process and any and all information related to the manufacturing as requested without delay and without claims about confidentiality or product privacy. The City is responsible for costs associated with witnessing the CIPP lining manufacturing.
- N. Applying resin to the felt tubing (wet-out) shall be conducted under factory or controlled on-site conditions using vacuum impregnation, and the materials shall be fully protected against UV light, excessive heat, and contamination at all times.
- O. Liners that are impregnated at the factory and transported to the project site in refrigerated trucks shall be installed as soon as possible and no more than ten (10) days after the date of impregnation at the factory.
- P. When cured, the CIPP lining shall form a continuous, hard, impermeable lining which is chemically resistant to any chemicals normally found in domestic sewage per Table x2.1 in ASTM F1216. The CIPP lining shall be chemically resistant to trace amounts of gasoline and other oil products commonly found in municipal sewerage and soils adjacent to the sewer pipe to be lined. The CIPP lining shall provide the maximum available abrasion resistance.

- Q. The Contractor shall measure the existing pipelines in the field prior to ordering lining. The CIPP lining's length shall be as deemed necessary by the Contractor to effectively carry out inserting and sealing the CIPP lining at the outlet and inlet manholes.
1. The CIPP lining tube shall be manufactured or fabricated to a size that will tightly fit the internal circumference of the sewer being rehabilitated after being installed and cured.
 2. The CIPP lining shall be able to fit into irregularly shaped pipe sections and through bends (up to 45 degrees) and dips within the pipeline.
 3. Allowance for longitudinal and circumferential expansion shall be taken into account when sizing and installing the CIPP lining.
 4. The tube shall be properly sized to the existing pipe's diameter and the length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends.
 5. Contractor shall verify lengths in field prior to ordering and prior to impregnation of tube with resin, to ensure that tube will have sufficient length to extend entire length of the run, which is defined as the length of the existing host pipe measured from the interior walls of the manholes, and/or from the ends of the pipe when/if the pipe extends into the manholes. Contractor shall also measure inside diameter and circumference of existing pipelines at face of each manhole in field prior to ordering liner so that liner can be installed in a tight-fitted condition with little or no wrinkling.
- R. The Contractor shall verify the proposed CIPP lining thicknesses and submit the associated calculations. The CIPP lining for 8-inch through 10-inch host pipe shall be designed in accordance with the applicable ASTM F1216 provisions for "fully deteriorated gravity pipe conditions." The CIPP lining for other pipe sizes may be designed in accordance with the applicable ASTM F1216 provisions for "partially deteriorated gravity pipe conditions," unless it is noted on the Drawings that "fully deteriorated gravity pipe conditions" shall apply based on reviewing the CCTV video. For sewers where previous CCTV inspection data was not available, the Contractor should submit the completed inspection to determine if "partially deteriorated" or "fully deteriorated" apply. The CIPP lining shall meet the following minimum design conditions, unless the City agrees to the change or as noted on the Drawings:
1. AASHTO H-20 Live Load with two trucks passing
 2. Constrained soil modulus of native soil in the pipe zone = 1,000 psi
 3. Soil weight with 120 pounds per cubic foot and a coefficient of friction of $Ku' = 0.130r$ shall be used for the installed depths.

4. The long-term flexural modulus used in the design calculations shall be estimated by multiplying the lowest short-term flexural modulus specified in the ASTM standards by a long-term retention of mechanical properties factor equal to 50 percent.
5. Design safety factor = 2.0
6. Typical groundwater levels shall be estimated at 1/2 the distance between the pipe's invert and the ground surface. If actual groundwater depth information is available from USGS or other sources, it may be used in the calculations. If the sewer is within 50 feet of a creek or other water body or if indicated on the Drawings, the groundwater depth used in the calculations should be the maximum depth from the ground surface to the pipe crown.
7. Service temperature range shall be 40 °F to 100 °F.
8. Maximum long-term deflection shall be 5 percent.
9. Minimum pipe ovality shall be 2 percent.
10. The CIPP lining thickness to be used shall be the largest thickness as determined by calculations for deflection, bending, buckling, and minimum stiffness.
11. The CIPP shall be designed to withstand all imposed loads, including live loads and, if applicable, hydrostatic pressure. The liner shall have sufficient wall thickness to withstand all anticipated external pressures and loads that may be imposed after installation
12. Submit to the WSD for approval the structural design for other size sewers and depths or "fully deteriorated" gravity sewers when conditions apply.
13. The minimum lining thickness after installation and curing shall be as follows:

Minimum Lining Thickness Following Installation and Curing* ** ***			
Pipe Diameter (in)	Depth of Sewer to Top of Pipe (ft)	Fully Deteriorated Pipes Minimum Liner Thickness (mm)	Partially Deteriorated Pipes Minimum Liner Thickness (mm)
8-inch	3 to 20	6	N/A
10-inch	3 to 15	6	N/A
10-inch	15 to 20	7.5	N/A
12-inch	3 to 9	6	6
12-inch	9 to 17	7.5	6
12-inch	17 to 20	9	6
15-inch	3 to 9	7.5	6
15-inch	9 to 15	9	6

Minimum Lining Thickness Following Installation and Curing* ** ***			
Pipe Diameter (in)	Depth of Sewer to Top of Pipe (ft)	Fully Deteriorated Pipes Minimum Liner Thickness (mm)	Partially Deteriorated Pipes Minimum Liner Thickness (mm)
15-inch	15 to 20	10.5	7.5
18-inch	3 to 8	9	6
18-inch	10 to 14	10.5	7.5
18-inch	14 to 18	12	7.5
18-inch	18 to 20	12	9
<p>*Chart assumes normal groundwater condition (1/2 distance between pipe invert and ground surface).</p> <p>**Contractor shall submit calculations for liner thickness in alternate pipe sizes, depths not listed, or if sewer is within 150 feet of a creek or body of water.</p> <p>***8-inch and 10-inch pipes are always assumed to be Fully Deteriorated.</p>			

- S. The CIPP lining shall be watertight.
- T. The CIPP lining shall provide a 50-year service life and shall have the following minimum initial and long-term properties:

Property	Test Method	Initial (psi)	Long-term (psi)
Flexural Strength	ASTM D790	4,500	2,250
Flexural Modulus of Elasticity	ASTM D790	300,000	150,000

2.02 END SEALS

- A. End seals shall be composed of hydrophilic rubber and molded or formed as a one-piece cylinder which when installed will form a 360 degree seal between the host pipe and the newly installed liner. Use of caulking in lieu of an end seal will not be allowed. Acceptable end seals are Insignia™ End Seals by LMK Enterprises, Hydrotite by Greenstreak, or approved equal.

PART 3 - EXECUTION

3.01 PRE-INSTALLATION

- A. The Contractor shall notify all property owners who discharge sewage directly to the sewer being lined that their service will be temporarily discontinued during the CIPP lining installation. The Contractor shall notify individual property owners at least 72 hours in advance, giving the date, start time, and estimated completion time for the work being conducted.
- B. The Contractor shall clean each pipe length to be lined and shall dispose of any resulting material offsite.

- C. The Contractor shall conduct a pre-rehabilitation CCTV inspection for all sewers to be rehabilitated by CIPP lining methods. The inspection shall be to identify pipe defects, to document all service lateral connection locations, and to confirm additional needed point repair locations other than those indicated on the Drawings. The contractor's project manager and/or superintendent shall review the pre-rehabilitation inspection videos to confirm the quality of the videos, locations of lateral connections, and locations of point repairs to be performed; only after the contractor has confirmed that the quality of the videos is adequate for a clear review of the pipeline, they shall be submitted to the WSD who will review pre-rehabilitation inspection videos to confirm point repair locations to be performed by the Contractor. The Contractor may not proceed with CIPP lining installation until the WSD has reviewed and approved the Contractor's pre-rehabilitation CCTV inspection data. A minimum of 5 working days shall be provided to review each pre-rehabilitation CCTV inspection data submittal.

- D. The Drawings will provide the Contractor the location for known laterals; however, this list shall not be interpreted as all-inclusive. The Contractor shall be responsible for verifying active customer service connections prior to rehabilitation. If the Contractor discovers an error or addition to the list provided, the Contractor shall immediately notify the WSD. Upon completing the rehabilitation work, a list with all service laterals abandoned or reconnected as part of the work shall be submitted to the WSD. The compiled list shall include the following information:
 - 1. Location for each service lateral based on the CCTV inspection logs, which shall include an accurate distance measured from the starting manhole centerline and a notation (by clock-reference) stating where on the pipe circumference the service lateral connects.
 - 2. Status (Active or Inactive)

- E. During the pre-rehabilitation CCTV inspection and prior to installing the CIPP lining, all protruding service lateral connections greater than or equal to ½-inch for less than 18-inch pipe and ¾-inch for larger pipe shall be internally cut or ground down flush with the pipe wall using a robotic cutter specifically designed for this purpose. The internal cutter shall be able to cut cast iron, PVC, vitrified clay pipe, concrete pipe, ductile iron pipe, and Orangeburg pipe. All materials/cuttings shall be removed from the sewer and properly disposed.

- F. The Contractor shall provide sewage flow bypass pumping in accordance with Section 02767. Service connection effluent may be plugged only after proper notification to the affected residence and may not remain plugged overnight or longer than 10 hours or approved alternate measures taken. Lining installation shall not begin until the Contractor has installed the required plugs or a sewage by-pass system and until all pumping facilities have been installed and tested under full operating conditions including bypassing mainline, side sewer flows, and services addressed. Once the lining process has begun, existing sewage flows shall be maintained until the resin/felt tube composite has been fully cured, cooled down, fully televised, and the CIPP ends finished..

- G. The Contractor shall furnish and install the CIPP lining in the sewer's full length as shown on the Drawings. The CIPP lining installation shall be in complete accordance with applicable ASTM F1216 provisions and the manufacturer's recommendations.
- H. If the CIPP lining manufacturer believes the infiltration rate in the sewer segment is high enough to risk washing out the resin, the Contractor shall perform required measures to minimize infiltration prior to installation. If any infiltration runners or gushers as defined by NASSCO PACP are observed during the pre-CCTV inspection, the Contractor shall submit in writing for approval by the WSD the methods and materials for mitigating any adverse impacts from the infiltration.
Infiltration runners or gushers that are observed may be stopped by injecting a chemical hydrophilic grouting using a remote packer as an acceptable and preferred method.
- I. The Contractor shall evaluate CIPP liner installations for the potential of adverse odor issues such as from styrene and implement measures including, but not limited to, supplemental ventilation, service plugging, and monitoring in accordance with pertinent state and federal rules and regulations. The evaluations shall include issues that may occur from long duration installations, extended curing times, close proximity to buildings, and/or resident's sensitivities, impairments, or known health conditions relative to respiratory issues.

3.02 INSTALLATION

- A. The CIPP lining for 6-inch through 18-inch sewers without sags greater than 30% may be installed via inversion using hydrostatic head or air pressure or pull-in methods in accordance with ASTM F1216 and manufacturer's recommendations.
- B. The Contractor shall install a hydrophilic seal at each manhole face prior to inverting or pulling in the uncured CIPP lining.
- C. If the CIPP lining does not fit tightly against the original pipe at its termination points, at no additional cost to the City of Brentwood, the full circumference of the CIPP lining exiting the host pipe shall be filled with a resin mixture compatible with the CIPP and approved by the CIPP manufacturer. There shall be no groundwater leakage between the existing pipe and the CIPP lining at the manhole connection or service lateral connections. Any leakage found shall be eliminated by the Contractor at no additional cost to the City of Brentwood.
- D. The installed CIPP lining shall be cured using circulating heated water or steam in accordance with ASTM F1216 and manufacturer's recommendations for sewers 18-inch diameter and smaller with temperature monitoring at manholes and service openings if available. For sewers greater than 18-inch diameter, the installed CIPP lining shall only be cured using circulating heated water in accordance with ASTM F1216 and manufacturer's recommendations.
- E. The resin-impregnated flexible felt tube lining shall be processed to affect the desired cure throughout the tube's length, extending full length from manhole to manhole(s). The resin shall be cured into a hard impermeable pipe of the

minimum specified thickness, providing a structurally sound, uniformly smooth interior and tight-fitting lining within the existing pipe.

- F. Cool-down procedures shall be in accordance with ASTM F1216 and manufacturer's recommendations.
- G. UV cured CIPP will not be permitted without written approval from WSD and after reviewing the documentation to ensure the lining is compatible with all specifications and other related work including any lateral lining systems.
- H. The Contractor may install CIPP lining in multiple sewer segments at one time where possible. When installing CIPP lining in multiple sewer segments at one time, remove the top 1/2 of the CIPP lining in the intermediate manhole and fill the void between the CIPP lining and existing channel with non-shrink grout. The manhole bench shall be reconstructed as required to provide a smooth transition to the new CIPP lining.
- I. Temperature monitoring systems shall be required for all 18-inch or larger sewers, any sized sewer that crosses a stream, creek, or other body of water, or as noted on the Drawings. This system shall be installed at the pipe invert per the manufacturer's recommended procedures. The temperature sensors shall be placed at intervals as recommended by the sensor manufacturer. Additional sensors shall be placed where significant heat sinks are likely or anticipated. The sensors, if installed, shall be monitored by a computer using a tamper proof database which can record temperatures at the lining interface and the host pipe. Provide the WSD with access to the longitudinal temperature monitoring system data during the installation via digital data, web-based or other approved methodology and printed reports. Temperature monitoring systems shall be Zia Systems or Vericure by Pipeline Renewal Technologies.
- J. If cool-down is to be accomplished by introducing cool water into an inversion standpipe to replace the water being drained from a small hole made in the downstream end, cool the hardened pipe to a temperature below 100 °F (38 °C) before relieving static head in the inversion standpipe. When releasing static head, ensure a vacuum will not be produced that could damage the newly installed CIPP lining.
- K. Vent and/or exhaust noxious fumes or odors generated during and remaining after the curing process has been completed. This process shall remain in place at all manholes, laterals, etc., until noxious odors have dissipated to an acceptable level in accordance with OSHA requirements for the materials used and there is no potential health hazard left to the general public or the construction workers.
- L. Identify and submit for approval to the WSD the points to where curing water will be discharged if other than the downstream sanitary sewer system at acceptable discharge rates. NO discharge to storm sewers or drainage systems shall be allowed.
- M. Provide piping, pumps, valves, and other equipment to discharge curing water.

- N. All cutting and sealing of CIPP liner at manhole connections and/or walls shall provide watertight pipe and manhole seals. All cut edges of cured liner shall be thoroughly sealed with same resin as was used in liner. Catalyst or hardener used shall be compatible with resin/catalyst used in liner previously but shall not require an external heat source to begin exothermic reaction (curing). There shall be no leakage of groundwater into manhole between CIPP liner and existing sewer pipe and between existing sewer pipe and manhole wall.
- O. The installed CIPP lining shall be continuous over the sewer line section's entire length and be free from visual defects such as foreign inclusions, dry spots, pinholes, fins, major wrinkles, and delamination. The lined invert and lower third of the pipe in normal wastewater flow depth shall be of particular concern to defect avoidance. The CIPP lining shall be impervious and free from any pipe leakage to the surrounding ground or from the ground to inside the lined pipe.

3.03 REINSTATING SERVICES

- A. After the new CIPP lining has been cured and completely cooled down, the Contractor shall reconnect the existing service laterals as designated by the pre-installation CCTV report generated by the Contractor. This shall be done without excavation from the pipeline's interior using a television camera and a remote cutting device that reestablishes the service connection to not less than 90 percent of the original diameter. All connections between the CIPP lining and the service connection shall be watertight. All openings shall be clean and neatly cut, and the cut shall be buffed with a wire brush to remove rough edges and provide a smooth finish. The bottom of the openings shall be flush with the bottom of the lateral pipe with no protruding material able to hinder flow or catch debris.
- B. For service renewals by excavation methods, InsertaTees may be used for solid wall pipes having a 0.36-inch or greater wall thickness. InsertaTees shall be "Fatboy" type with hub manufactured of SDR 26 PVC material incorporating a 360 degree integral stop on the hub surface and exceeding ASTM F1336 Section 10.3 Pipe Stop Load Support Test, or approved equal. Romac type saddles shall be used for pipes having a wall thickness thinner than 0.36-inches.
- C. Inactive service laterals will be abandoned by not reopening the service connection after installing the CIPP lining.
- D. Provide a fully operational backup device for reinstating service laterals. If for any reason the remote cutting device fails during a service lateral's reinstatement, immediately deploy the standby device to complete the reinstatement. The backup device shall be fully functional without needing to remove parts from the primary device. The backup equipment shall be on site throughout the reinstatement process.

3.04 FIELD TESTING AND ACCEPTANCE

- A. The Contractor shall perform a 4 psi air test on each CIPP lining segment in the WSD's presence after curing the CIPP and prior to internally re-instating laterals on all 18-inch and smaller diameter sewers. Larger diameter sewers will be

visually inspected only by CCTV for no visible leaks. The CIPP shall be able to hold a 4 psi pressure for a 5-minute minimum duration after a 2-minute stabilization period. Any lining not able to meet this testing requirement shall be repaired and retested at no additional cost to the City.

- B. Field acceptance for the CIPP lining shall be based on the WSD's evaluation of the installation including reviewing the CIPP lining curing data, the post-rehabilitation CCTV inspection data, the certified test data for the installed CIPP lining, and CIPP air testing results. All CIPP sample testing and repairs to the installed CIPP as applicable shall be completed and documented in written form before final acceptance.
- C. For every 1,000 linear feet for pipe less than 24-inches in diameter of CIPP lining installed, the Contractor shall perform sampling and testing to determine the installed CIPP lining's flexural properties and thickness. After 10,000 feet of acceptable test results have been received, the WSD may reduce the test sample frequency to one sample every 2,000 feet from the same wet-out batch, as long as samples continue to meet all minimum standards and sampling results are received in a timely manner. The testing frequency may be increased by WSD and performed by the Contractor at no additional cost to the City when the required tests show the installed CIPP lining does not meet the specifications.
- D. Tests shall be performed by an independent testing laboratory certified by the American Association for Laboratory Accreditation (A2LA). The Contractor shall submit to the WSD the name and location for the independent testing laboratory, a certified statement from the laboratory indicating they are independent from and not associated with the Contractor in any way, and the ASTM certification for the independent testing laboratory.
- E. All expenses for sampling and testing the installed lining shall be paid by the Contractor. The cost for all manufacturers' testing to qualify products furnished to the project site shall be the Contractor's responsibility.
- F. Sampling and testing for the installed CIPP lining shall conform to the following requirements.
 - 1. Remove one restrained sample of the installed CIPP lining at least 18-inches in length. The sample shall be captured by installing the CIPP lining through a section of PVC or similar cylindrical tube (same diameter as the existing sewer diameter) within the installation's most downstream manhole and at all intermediate manholes if multiple sewer segments are lined at the same time. The Contractor may elect to cut the sample longitudinally and take 1/2 the sample for direct shipping to the laboratory and keep the other sample 1/2 for additional testing if necessary.
 - 2. For sewers 18 inches in diameter and larger, a minimum of two plate samples formulated out of the same felt blend and resin mixture as the installed liner shall be prepared and cured in the downtube of the installation column.

3. The CIPP lining thickness shall be measured in accordance with *ASTM D5813*. Flexural properties shall be determined in accordance with *ASTM D790*. The Contractor shall label and date all samples for shipping to the independent testing laboratory. The WSD shall be copied on all transmittals to the independent testing laboratory. Testing results shall be submitted to the WSD within 30 days after installing the CIPP lining or payment will be withheld.
4. Any CIPP lining not meeting the specified installed strength and/or thickness requirements, regardless of the amount below the specified requirements, shall not be approved for payment until the deficiency has been corrected by the Contractor in a manner approved by the WSD at no additional cost to the City. Options considered for correcting deficient CIPP lining installations include the following.
 - a. Remove the existing CIPP lining and re-line the sewer.
 - b. Provide open-cut sewer replacement from manhole to manhole.
 - c. Re-line the sewer with the existing CIPP lining in place. Note that this will not be accepted if WSD determines that the sewer section has capacity concerns.
 - d. Accept the following penalties depending on the structural and thickness test results.
 - 1) If the tests are within 90 percent of the specification, the payment reduction shall be 10 percent of the bid price per item.
 - 2) If the tests are between 75 percent and 89 percent of the specification, then 75 percent of the bid price shall be paid.
 - 3) If the tests are below 75 percent, the Contractor must reline or replace the segment.
- G. The Contractor shall perform a post-rehabilitation CCTV inspection for all sewers rehabilitated using CIPP lining methods. The post-rehabilitation CCTV inspection shall be performed following the CIPP lining installation and reinstating all active service laterals. The Contractor's project manager and/or superintendent shall review the post-rehabilitation inspection videos to confirm the quality of the videos and of the installed CIPP; only after the Contractor has confirmed that the video is of good quality, the videos shall be submitted to the WSD. If it is determined that any repairs are needed at any segment, a new CCTV inspection shall be performed of the entire segment(s) after the repairs have been completed.
- H. The WSD shall review and approve payment based on the Contractor having satisfactorily completed a lining free from significant defects. The finished lining shall be continuous between manholes and shall be free from visual defects such

as foreign inclusions, reverse curvatures, splits, flats, cracks, lifts, kinks, wrinkles, flats, dry spots, pinholes, shrinkage, crazing, leaks, and delamination. The maximum allowable size for wrinkle or bulge as shown in the inspection shall not exceed 3 percent of equivalent pipe diameter or 1-inch by visual measurement, whichever is smaller. No wrinkles will be allowed in the invert of pipe between 4:00 and 8:00 o'clock positions.

- I. Contractor will be responsible to remove and repair, at Contractor's expense, all such defects in a manner that is satisfactory to the WSD.
- J. Shrinkage of the CIPP liner's length, of more than two (2) inches for pipe diameters less than 18-inch and three (3) inches for 18-inch or larger diameter from the face of the manhole shall be repaired with a fiberglass reinforced CIPP spot repair at no cost to the City.
- K. The cured CIPP lining and all pipe-to-manhole connections shall be watertight and free from infiltration.
- L. Following rehabilitation or replacement of the service laterals, the Contractor shall perform an air test in the WSD's presence for each 18-inch and smaller segment lined or may test each lateral and connection area individually in lieu of the full segment air test.

3.05 CLEANUP

- A. Upon the installation work and testing acceptance, restore the project area affected by the operations to a condition at least equal to what existed prior to the work.

END OF SECTION