SECTION 33 01 25
SEWER LINING –
FIBERGLASS COMPOSITE CIPP CURED WITH UV LIGHT

PART 1 GENERAL

1.3 SUMMARY:

A. It is the intent of this section to provide the Contractor with the work performance requirements for the renewal of a pipe, culvert, or conduit by the installation of a resin impregnated flexible tube that is pulled into a pipe/culvert/conduit and expanded to fit tightly against said pipe/culvert/conduit by the use of air pressure. The thermosetting resin system in the tube shall then be cured by exposing the resin saturated tube to a UV-light source that produces the needed intensity and wavelength of light to cause the photo-initiators in the resin to drive the hardening process to essentially a complete cure.

B. This Work consists of furnishing all labor, tools, materials, equipment, and supervision for installing and testing of the CIPP. The Work also includes, but is not limited to the bypass pumping/flow control, pipe cleaning, pre- and post-CCTV inspection of the reaches of the pipe/culvert/conduit to be lined, permitting, traffic control, installation of a pre-liner, quality controls, quality assurance testing sampling, and the reinstatement of any existing live branch connections.

1.4 RELATED DOCUMENTS:

A. Drawings, Technical Specification Sections, General and Supplementary Conditions of the Contract and other Division 00 and Divisions 01 Specifications Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly pertinent to this Section, and this Section is directly pertinent to them.

1.5 RELATED SECTIONS: Specified elsewhere may include:

A. Section 00 40 31: Contractor’s Intent to Subcontract CIPP Work
B. Section 00 89 00: Project Permits and Approval
C. Section 01 06 50: Public Notification
D. Section 01 21 00: Allowances
E. Section 01 33 00: Submittals
F. Section 01 45 29: Testing Laboratory Services
G. Section 01 54 50: Construction Safety
H. Section 01 57 00: Traffic Maintenance and Protection
I. Section 33 01 29: Cleaning of Sewers
J. Section 33 01 31: CCTV Inspection of Sewers
K. Section 33 29 60: Sewer Bypass Pumping
L. Section 33 39 18: Sewer Manhole Rehabilitation-General
M. Section 33 90 51: Structural Lateral Reconstruction Injection Sealing

1.6 REFERENCE STANDARDS:

A. The Reference Standards shown below shall be the most recent version available at the stated time of the bid opening.
B. American Society for Testing and Materials (ASTM)
4. ASTM D5813 – Standard Specification for Cured-In-Place Thermosetting Resin Sewer Pipe
5. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
6. ASTM F2019 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)

C. International Standards Organization (ISO)
1. ISO 11296-4 – Plastics Piping Systems for renovation of underground non-pressure drainage and sewerage networks – Part 4; Lining with Cured-in-Place Pipes
2. ISO 178 – Plastics - Determination of Flexural Properties
3. ISO 899-2 – Plastics – Determination of Creep Behavior
4. ISO 7685 – Glass Reinforced Thermosetting Plastics (GRP) Pipes – Determination of Initial Specific Ring Stiffness

1.7 DEFINITIONS:
A. CIPP: Cured-in-Place Pipe.
B. CIPP Installer Contractor: The firm who directly installs the CIPP system. The CIPP Installer Contractor could be the Prime Contractor or a Sub-Contractor.
C. CIPP System Manufacturer: The entity responsible for the engineering and assembling of the resin system(s) and CIPP tube(s); along with the other components required (i.e. pre-liner). This entity has taken on the responsibility of conducting the required third-party qualifications based testing for the CIPP lining system. In the event that the system is an independently assembled CIPP system, the Contractor shall have performed the same level of engineering and testing to qualify the proposed independent system.
D. Lateral: Service Pipe from Property Line to Mainline, excluding the Lateral Connection.
E. Lateral Connection: The junction connecting the Lateral line to the Mainline.
F. Lateral Connection Seal: Watertight Seal between Lateral line and the Mainline.
G. Manufacturer: Provider of the CIPP System, which includes the Glass Fabric Tube, the Resin System, and other components as needed for the CIPP's Installation. This entity is accountable for the required qualification-based testing of the CIPP System and its methodology of installation to ensure the CIPP Installer Contractor delivers on this qualification-based testing on this project.
H. Mainline: Sewer Main or Culvert pipe.
I. Qualification Test: one or more tests used by the manufacturer to prove the design of the product; not a routinely performed test.

J. Quality Control Test: one or more tests used by the manufacturer of the CIPP system during its manufacture or assembly.

K. Quality Assurance Test: one or more tests used to verify the physical properties of the CIPP liner as installed.

L. Reach: A length of pipe between two points containing a specified feature; usually manholes, but may also be junction boxes or headwalls.

M. Reinstate Lateral Connection: Cutting open or trimming an opening in a CIPP to allow flow from the Lateral or branch pipe to enter the Mainline.

1.8 WARRANTY:

A. The Contractor shall warrant all Work for a period of one (1) year from the date of the Certificate of Final Completion of work by <the Owner>.

B. During this period, <the Owner> may inspect the installed CIPP at <the Owner's> expense. The specific locations will be selected by <the Owner>. If the CIPP is found to have any defects such as those defined in Table 1 in Sub-Section 3.6 herein, the defects shall be remedied by the Contractor at no additional cost to <the Owner>. The Contractor will be notified and invited to attend <the Owner's> inspection at the Contractor’s discretion. Notification to the Contractor shall be a minimum of fourteen (14) days prior to the inspection.

C. For CIPP where a remedy was made prior to the issuance of the Certificate of Final Completion, the basis upon which future corrective actions during the warranty period will be based shall be the condition at the time of the Final Completion. Only defects found beyond those in place at the time of the Certificate of Final Completion will be considered the Contractor’s responsibility during the warranty period.

1.9 SUBMITTALS:

A. The Contractor shall submit the following information a minimum of 30 days in advance of commencing the fabrication of the CIPP tubes for this project:

1. CIPP System Manufacturer’s certification that the materials to be used on the project meet the appropriate qualifications based requirements of ASTM D5813 for the type CIPP System proposed. Included in this certification package shall be the Manufacturer’s recommendations for the shipping, storage and handling of all the components of the CIPP System throughout the construction process; as well as the Manufacturer’s recommended UV-light intensity level(s) and exposure times for the initiator cocktail used and the internal pressure(s) to be used throughout the various phases of the installation process.

2. CIPP System Manufacturer’s product specific data for the resin and initiator cocktail system, including:
   a. Resin trade name with formulation specific numbering.
   b. Resin Infrared Spectrographic documentation.
   c. Resin physical properties testing documentation; Short-term (Initial) Flexural Strength and the Short-term (Initial) and Time Dependent Flexural Modulus obtained in accordance with the appropriate ASTM Standard for the CIPP product being installed.
   d. Material Safety Data Sheets (or MSDS).
3. CIPP System Manufacturer’s product specific data for the glass fiber tube for this project; including the maximum allowable pulling force that will not damage the tube or compromise the physical properties of the finished CIPP.
   a. Tube trade name with fabrication specific numbering
   b. Finished CIPP physical properties testing documentation (results of the qualification based testing) using the resin system above with the proposed tube construction: Short-term (Initial) Flexural Strength and the Short-term (Initial) and Time Dependent Flexural Modulus in accordance with the appropriate ASTM standard.

4. System Manufacturer’s CIPP product specific qualification-based testing to further verify the in ground performance requirements.
   a. Strain Corrosion Resistance testing documentation using the resin system above for any CIPP product proposed that incorporates a fiber-reinforced tube construction; having a demonstrated minimum retention factor for the design life requirements contained later herein.
   b. Chemical Corrosion Resistance testing documentation per paragraphs 6.4.1 and 6.4.2 of the ASTM standard D5813 for all types of CIPP construction.

5. Manufacturer’s product specific information on the pre-liner or outer polymeric membrane (film) designed to encapsulate the resin system in the tube and provide for a water-tight, styrene emission abatement barrier on this project. Also included shall be specific information on the inner polymeric membrane, whether permanent or temporary, that is designed for the CIPP System's installation process which also has been designed to provide for the abatement of any styrene gas emission during the transportation and installation process.

6. The Manufacturer’s product specific data and instructions for the end sealing materials to be used at the manholes (or other designated mainline access structures) to ensure a long-term, groundwater-tight connection between the host pipe and the new CIPP will be achieved. The sealing material must be shown in the product literature to be compatible with (or formulated for) the environmental service conditions of the pipe being lined and capable of serving for the design life of the CIPP liner installed.

7. A Detailed Bypass Plan demonstrating how the existing flows stated in the contract documents will be adequately maintained throughout construction, including provisions for wet weather flow, and as specified in Section 33 29 60. Bypass Plan shall also include a description of Contractor’s approach to managing any flow from any live Laterals.

8. Work Plan: Contractor’s CIPP installation site plan including site layout, field verified reach lengths, equipment, access points, termination points for each reach, method of CIPP insertion (e.g. pulled-in-place), hardening method (e.g. UV light), traffic control devices, bypass plan, etc.

9. Design calculations for the reach specific wall thickness designs in accordance with accepted engineering design methodologies for the pipe geometry of the pipe structure. Calculations shall be completed and sealed by an engineer with a demonstrated proficiency in the design of CIPP (i.e. close-fit un-bonded liners) and licensed in the jurisdiction where the CIPP is to be installed. Calculations shall follow the CIPP Design Criteria described later herein.

10. Quality Control Plan (QCP) that includes the following:
a. A checklist documenting each critical step in the tube’s resin saturation process, unhardened CIPP tube’s insertion into the subject reach of pipe, hardening (processing) of the CIPP, etc. This reach specific QCP checklist shall have provisions where each critical step is checked off and initialed by the Contractor’s designated QCP personnel.

b. A listing of the defined responsibilities of the key project personnel who are charged with ensuring that all the quality control requirements listed are met.

11. Emergency Plan that includes the following and shall be kept on site during the entire duration of active CIPP installation:
   a. The procedures that will be followed in event of a health and safety emergency, pump failure, sewer overflows, service backups, and sewage spillage.
   b. Addresses the dangers associated with sewer rehabilitation work.
   c. Identifies the on-site designated Health and Safety Officer.
   d. List of the rehabilitation equipment that shall be inspected on daily basis.
   e. Description of proposed methods and equipment to be used to repair unacceptable CIPP defects and for removing failed CIPP. These shall be as developed by the CIPP System manufacturer to ensure that the required service life of the CIPP will still be achieved after the repair(s) is/are made. The Plan shall also include availability and accessibility of backup equipment such as air compressors, light train components, and lateral cutters.

12. Documentation of the Contractor’s pre-construction inspection and post-construction inspection in accordance with Section 33 01 31.

B. The Contractor shall submit to the engineer’s on-site construction observer (inspector) the following information for each CIPP reach within fourteen (14) calendar days of installation of the CIPP:

2. Hardening Documentation
   1. This documentation shall be in the form of a contemporaneous logging of the light intensity(s) and length of exposure time as the light train moves along the length of the subject reach of pipe. This log shall also be imprinted with the air pressure maintained inside of the liner during the hardening process. The data shall be recorded in a digital format that is tamper proofed.
   3. Preliminary CCTV video inspection of the installed CIPP liner clearly showing the fit and finish of the CIPP immediately after its completion.

C. The Contractor shall submit the following information prior to Final Acceptance:

1. Documentation demonstrating that the Quality Control Plan for each reach of CIPP installed was properly executed.
2. Documentation of the test results from the Quality Assurance samples taken of the installed CIPP demonstrating compliance with the Manufacturer’s stated Short-term Flexural Strength and Flexural Modulus; and with the minimum finished wall thickness required by the Engineer of Record’s design calculations.
3. Documentation of any corrective actions that were taken to address any defects and/or cosmetic blemishes to the CIPP that was required of the Contractor following the CIPP System Manufacturer's recommendations and/or that of NASSCO (industry vetted requirements that are included in their CIPP Inspector Training Course).

1.10 QUALIFICATIONS AND EXPERIENCE:
   A. Documentation of Qualifications and Experience as specified herein shall be submitted with Contractor’s Qualification Statement Section 00 00 00.
   B. License or certificate from the Manufacturer stating the CIPP Installer /Contractor is approved and qualified to install the Manufacturer’s CIPP system.
   C. CIPP System Manufacturer: The Manufacturer shall have at least eight years of active experience in the commercial application of the proposed CIPP System. The CIPP System shall have amassed a minimum of 250,000 linear feet and/or 1000 CIPP reaches in this timeframe which can be verified as successfully installed and currently performing as designed.
   D. CIPP Installer Contractor: The CIPP Installer Contractor shall have at least five years active experience in the commercial installation of the CIPP product bid. The CIPP Installer Contractor shall have at least 125,000 linear feet and/or 500 reaches of successful experience; which shall include a sufficient quantity of installations in the sizes proposed for this project to demonstrate proficiency. The CIPP Installer Contractor shall provide a list of a minimum of five (5) projects of comparable length, diameter, and/or complexity completed in the last five (5) years. The list shall include reference or Owner contact names, current phone numbers, diameter(s) and length(s) of lined pipes, and construction start, and construction completion dates.
   E. Field Superintendent for the CIPP Installer Contractor shall have been the Superintendent on a minimum of 25,000 linear feet of installation with the product bid within the past three (3) years. Contractor shall provide a list of similar installation projects managed by this Superintendent. The list shall include project names, owner contacts, current phone numbers, and years installed. If the Field Superintendent changes at any time during the performance of the work, Contractor shall submit documentation of compliance for the proposed new Field Superintendent prior to the replacement Field Superintendent arriving on site. The Field Superintendent for the CIPP Installer Contractor shall have a minimum of one (1) year of supervisory field experience with sewage bypass. The Field Superintendent shall be capable of communicating by both written and oral means to ensure that the work proceeds in a proper and efficient manner. All supervisory personnel who will be assigned to this project shall be entirely familiar with the terms, conditions, and details of the contract and related documents.

PART 2 PRODUCTS

2.1 MATERIALS:
   A. General:
      1. All components of the CIPP System shall be new and free of defects. The CIPP shall be continuous and of sufficient length to extend from manhole to manhole (or access point to access point).
      2. The CIPP System shall contain no intermediate or encapsulated elastomeric layer(s). No material(s) shall be included in the tube's construction that may cause delamination (or in-plane shear) in the cured CIPP product. No dry or unsaturated layers shall be visually or otherwise evident.
3. The CIPP System shall be capable of conforming to the irregularities normally found in buried pipes requiring renewal such as offset joints, fractured pipe, and otherwise disfigured pipe sections. It shall be able to stretch to fit these localized and/or global irregular pipe sections; and, when noted in the plans for the subject pipe reaches, negotiate bends.

B. Fabric Tube:
   1. The tube’s construction shall consist of two or more layers of nonwoven or woven glass fibers capable of transporting the proposed resin system while withstanding the rigors of the installation and hardening processes in accordance with the ASTM standards D5813 or F2019 as applicable. The tube shall be compatible with the resin system to be used on this project. The material shall be able to stretch to fit any irregular pipe sections and negotiate bends as stated above.

   2. The tube should be fabricated to a size that, when installed following the CIPP System Manufacturer’s written instructions, will tightly fit the internal circumference and the length of the host pipe structure while simultaneously minimizing the creation of any wrinkles or fins on the interior wall surface. Allowances should be made for the normally anticipated longitudinal and circumferential stretching that occurs during placement of the proposed tube into the host pipe structure.

   3. The tube shall be constructed to be uniform in thickness around its finished circumference; and when subjected to the Manufacturer’s stated installation pressures will meet or exceed the minimum finished wall thickness calculated for the subject reach of pipe.

   4. Any plastic film attached to the tube on what will become the interior wall of the finished CIPP shall be compatible with the resin system used, translucent enough that the resin is clearly visible, and shall be firmly bonded to the felt or other material when it is to become a permanent part of the finished CIPP. It shall also be formulated to create an impermeable barrier or membrane against the leaching of any volatile components of the resin system such as styrene prior to resin hardening taking place.

   5. The external plastic film shall also provide a barrier to ambient light UV exposure and be robust enough to survive the rigors of the sliding of the tube into its final position in the pipe to be renewed. The tube shall have an allowance for the required circumferential and longitudinal stretching during installation.

   6. The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color.

C. Resin System:
   1. The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy and catalyst system that when properly cured meets the minimum requirements given herein or those that are to be utilized in the design of the CIPP System for this project.

   2. Thixotropic agents that do not interfere with visual inspection may be added for viscosity control. Resins may contain pigments, dyes, or colors that do not interfere with visual inspection of the resin-impregnated CIPP or its required properties.

D. Hydrophilic End Seals: The ends of the installed CIPP entering and exiting the manholes or other access structures on this project shall be sealed with the following:
1. The hydrophilic waterstop is a single component hydrophilic mastic and is supplied in cartridge or sausage. Material cures and swells in the presence of water.

2. DeNeef Construction Chemicals, Inc: Swellseal WA gun grade polyurethane waterstop or approved equal.

E. CIPP Design Criteria:

1. CIPP installations in circular pipe shapes may be designed as a "partially deteriorated" pipe in accordance with the non-mandatory design Appendix X1 in the ASTM CIPP installation standard F1216. The Engineer of Record's design submittal shall clearly identify the physical properties of the proposed CIPP System upon which his/her design is based. When the circular pipe is a fractured, rigid pipe exhibiting an ovality equal to or greater than 10% an alternative design approach must be used.

2. CIPP installations in non-circular pipe shapes will need to be designed using an acceptable design approach for addressing their site specific multiple radii geometries. One such acceptable design approach can be found in the paper presented by Olivier Thépot to the 2000 ASCE Pipelines Conference entitled, "A New Design Method for Non-Circular Sewer Linings " which employs a modified Glock solution. Circular pipe shapes and excessively deflected circular pipe shapes (≥ 10%) can also be designed using this design approach. (Note: this design approach is currently under development into a new ASCE Manual of Practice on the design of close-fit flexible liners).

3. Prior to performing the required wall thickness design calculations and the ordering of the CIPP tube, the internal dimensions, including currently existing variations in the various radii of the existing sewer mainlines shall be verified by the Contractor to ensure the CIPP will be designed and constructed using the current site specific dimensions and geometry.

4. The design parameters for CIPP thickness calculation shall be based on the following:
   a. A minimum service life of 50 years.
   b. All pipes shall be considered partially deteriorated (subject only to those external loads that are likely to be transferred to the CIPP liner after its installation). Typically these will be any external hydrostatic pressure from the groundwater and any live load from surface vehicular traffic when applicable. Where no external hydrostatic pressure exists, the engineer will use a virtual head equal to 1.0 foot above the crown of the pipe structure.
   c. A minimum overall safety factor of 2.0 shall be employed in the engineer's calculations to account for seasonal variations in the external hydrostatic pressure, small variations in the wall thickness as defined in the referenced ASTM standards, and minor variations in the size of the annular space.
   d. The elevation (location) of the phreatic surface in the groundwater (i.e. water table) will be determined using site specific information obtained from geotechnical surveys or maintenance repair information for the subject areas in order to arrive at an appropriate estimate of the external hydrostatic load likely to be acting on the proposed CIPP liner.
   e. Any live vehicular loads at the surface are to be accounted for using commonly accepted approaches for the determination of the magnitude
of their vertical influence on the horizontal soil plane at the top of the pipe per applicable governing standards for the type of vehicle(s) creating this loading condition. The plans show the live load rating of the paved roadway surfaces (i.e. H10, H15, H20, H25, etc.) The rigid and flexible pavement thicknesses shown on the plans have been taken from as-built drawings and other sources for the Engineer of Record's use is calculating the net impact of the live load at the top of the pipe.

f. The depth of cover shall be field verified by the Contractor, as determined by the manholes or other access locations on the reach to be lined with the CIPP. The project plans indicate the vertical variations in the cover between the manholes.

g. An ovality of 1.0% may be assumed for circular shaped pipes up to 12 inches in diameter in rigid host pipe materials exhibiting longitudinal fractures that are visually indicating some change in shape has occurred. No ovality beyond what is allowed during manufacturing is required for rigid pipes that are not found to be so distressed (i.e. un-cracked and cracked pipes). For larger diameter circular pipe shapes demonstrating fractures and changes in shape, the site specific ovality shall be determined by the Contractor using quantifiable measuring tools such as laser profiling. Man-entry size pipes should be profiled using 3-dimensional profiling tools or other approved methods that allow for the variations in radii around the circumference of the pipe to be captured for use in the wall thickness design.

h. The minimum Enhancement Factor (K) value of 7.0 for calculations made using the referenced ASTM F1216 design appendix may be used for circular shaped pipes up to 12 inches in diameter. For larger circular shaped pipes the Engineer of Record should employ an Enhancement Factor commensurate with the size and DR of the proposed CIPP liner as per that given in the engineering literature.

i. Poisson’s Ratio shall be the actual ratio that has been determined by the CIPP System Manufacturer for the hoop direction of the hardened CIPP.

j. The minimum short term flexural modulus of elasticity (ASTM D790) for the various types of CIPP (at 73°F) shall be 1,000,000 psi.

k. The Flexural Modulus of Elasticity of the proposed CIPP System shall have a minimum creep retention factor of 0.60 for an estimated 50-year hydrostatic design loading period. The creep retention factor shall be determined by the CIPP System Manufacturer through long-term, qualification testing lasting a minimum of 10,000 hours at an appropriate stress level. Documentation of the retention factor will be submitted to the Engineer prior to any design calculations being made.

l. The design calculations shall use this value or the Manufacturer's stated minimal flexural strength value for the CIPP System being supplied for this project. The latter being the flexural strength value for the lower 95% confidence level value determined over a statistically significant number of tests.

PART 3 EXECUTION

3.1 GENERAL:

F. Contractor shall field verify the length, size, and other geometry information of each pipe scheduled to be lined.
G. Contractor shall locate all designated manhole access points and field verify the cover depths of the pipes at these locations. The Contractor shall also field verify if the cover depths are significantly greater between these access points.

H. Contractor shall complete all work in strict accordance with all applicable current OSHA standards. It shall be the Contractor’s responsibility to comply with OSHA Standards and Regulations pertaining to all aspects of the work.

I. Contractor shall submit the proposed work schedule a minimum of seven (7) days prior to all planned work. Contractor shall provide 48 hours advance verbal notice prior to pre- and post-installation CCTV inspections. Notice shall include notification of work shifts longer than eight hours and work times planned before 7:00AM or after 4:00PM.

J. <Owner> will perform water shutoffs to individual properties during installation of the CIPP when required.

3.2 CUSTOMER OUTREACH

A. The Contractor shall make every effort to maintain service usage throughout the duration of the project. In the event that a service will be temporarily out of service, the maximum amount of time of no service shall be 16 hours for any property served by the sewer.

B. Contractor shall follow requirements as specified in Section 01 06 50 Public Notifications.

3.3 PERMITS:

A. Contractors shall obtain all permits, as specified in Section 01 57 00 Traffic Maintenance and Protection and Section 00 89 00 Project Permits and Approvals prior to construction.

B. Contractor shall obtain the necessary permits for use of fire hydrants, excavation for point repairs, to occupy public space with equipment (i.e., close lanes of traffic, etc.), night work, and after hours noise permits.

C. <Owner's> Permit Operations Group shall be contacted prior to any water hydrant use. The Permit Operations Group will provide a permit and meter for the Contractor’s use. The Contractor will be required to pay for all water used at the current water rates when the meter is returned. The Contractor shall bring the meter to <address> once every 30 days to have the meter read and pay for the water usage. If the meter is not brought in, an estimate will be determined and a bill shall be sent to the Contractor.

3.4 INSTALLATION:

A. The CIPP shall be installed in accordance with the practices given in ASTM F2019. The quantity of resin used for the tube’s impregnation shall be sufficient to fill the volume of air voids in the tube (97% < volume of resin actually used < 102%). Material Saturation: Designate a location where the flexible tube will be impregnated with resin. Use a resin bath to thoroughly saturate the flexible tube prior to installation. All required environmental permits mandated from local, state, and federal levels must be obtained and kept onsite by the liner manufacturer. The liner manufacturer must be registered in accordance with ISO 9001:2008 for its Quality Management System.

B. Curing of the resin system shall be as per the CIPP System Manufacturer’s recommendations. For UV-light cured CIPP systems the curing shall proceed at the CIPP System Manufacturer's recommendation for the size and thickness of the proposed tube and the intensity and duration of the exposure to the photo-initiator's required UV-light wave length.
C. Flow Control and Bypassing Sewage: Contractor shall bypass sewage around the sections of the line that are to be rehabilitated as specified in Section 33.29.60.

D. Cleaning of Sewer Lines: Contractor shall clean all debris and foreign matter from inside of sewers to be renewed in accordance with Section 33.01.29; with the end goal being that the sewer shall have no debris prior to the CIPP’s installation. Cleaning shall be divided into three categories as delineated by NASSCO based the level of effort required in a reach of pipe.

1. Light Sewer Cleaning – is defined as the removal of Deposits Settled (DS) up to a depth of 25% of the rise (vertical diametrical) for pipes up to 12-inches in diameter, up to 15% for 13 to 24-inches in diameter, and 10% for 25 to 30-inches in diameter. This is for an unlimited number of passes with the hydraulic flusher.

2. Heavy Sewer Cleaning – is defined as the removal of obstructions (OB) and DS that exceed the percentage established for light cleaning. This also includes Deposits Attached Grease (DAGS) if they can be removed with a rotating nozzle or other mechanical means.

3. Deposits Cut – is defined as the removal of Deposits Attached Encrustation (DAE) and DAGS that requires a cutter be employed for their removal. Work done under this item requires substantial effort towards cleaning, cutting, chipping, cutting, grinding, etc. to remove these hardened deposits.

E. Project Site: Upon acceptance of the installation work and testing, the Contractor shall restore the project area affected by the operations to a condition at least equal to that existing prior to the work taking place.

F. Pre-Installation Video Inspection: Immediately before the start of the lining operation, the Contractor shall thoroughly inspect by CCTV, the interior of each reach of sewer scheduled to be rehabilitated meeting all the requirements of Section 33.01.31.

G. Obstructions, major:

1. The Contractor shall clear the sewer of obstructions, solids, dropped joints, protruding service lines, collapsed pipe, or any other obstruction that might prevent proper insertion of the CIPP. If CCTV inspection reveals an obstruction that would prevent successful installation of the CIPP, the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the <Owner> prior to the commencement of the work. The Contractor shall submit an excavation repair plan in accordance to all federal, state, and local regulations, in writing to <Owner> for all excavation work seven (7) days prior. Payment for excavated point repairs shall be paid under the “Open Cut Point Repairs (Contingent)” item.

2. All protruding services in small diameter pipes shall be cut with a remote robotic cutter to allow proper installation of the CIPP. Protruding services that require an excavated point repair (protruding material is cast iron or ductile iron pipe, steel pipe, etc.), shall be approved by <Owner> prior to the commencement of work, shall be paid under the “Open Cut Point Repair (Contingent)” item.

3. Damage to the existing sewer due to the Contractor’s negligence shall be repaired by the Contractor at no additional cost to <Owner>. Any repair shall be approved by <Owner> prior to beginning repair work.

H. Roots Removal: Roots shall be removed prior to installation of CIPP. Procedures may include, at the Contractor’s discretion, use of mechanical equipment such as rodding machines, bucket machines and winches using root cutters and porcupines, and high-
velocity jet cleaners as well as chemical root treatment. The level of effort required shall be classified as per NASSCO as follows.

1. Root Cut Medium – is defined as the removal of Roots Medium (RM), and Root Balls (RB) in one or two joints.
2. Root Cut Ball – is defined as the removal of Root Balls from 3 or more joints in a reach of pipe.

I. Delivery, Storage and Handling:

1. Contractor shall protect, store, and handle materials during transportation and delivery, while stored on-site, and during installation following Manufacturer's recommendations.
2. The CIPP shall be maintained at a proper temperature in facilities to prevent premature curing at all times prior to installation. Any CIPP showing evidence of premature curing shall be rejected for use and will be removed from the site immediately.
3. If any part of the CIPP material becomes damaged before or during insertion, it shall be repaired or replaced at the Contractor's expense before the work may proceed.

J. Hydrophilic End Seals:

1. The Contractor shall insert continuous hydrophilic end seals to the interior circumference of the existing sewer pipes at the inlet and outlet of each manhole along the length of the CIPP liner being installed.

K. Finished Mainline CIPP:

1. The finished CIPP shall be continuous over the entire reach and shall be free of any of the defects described in this Section.
2. The layers of the finished 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 such that the knife blade moves freely between the layers.
3. All layers, after cure, shall form one homogeneous structural pipe wall with no obvious indication that a part of tube was left unsaturated by resin.
4. The CIPP shall fit tightly to the internal circumference of the existing pipe. In the case of small diameter pipes there should be no visible annular space at the lateral openings.
5. Wrinkles or fins are undesirable cosmetic defects that may affect the operation of the subject reach of pipe. Where they occur, the engineer will utilize the industry acceptance criteria provided by NASSCO regarding the size and orientation of these defects in order to discern if they can be deemed as commercially acceptable. If they are not deemed acceptable they must be brought into compliance with this standard.
6. Hardened "lifts" in the finished CIPP are unacceptable and must be repaired in accordance with the CIPP Manufacturer's recommendation for the type of CIPP System that was used.
7. All other defects found, cosmetic or otherwise, shall be dealt with following the industry accepted standard practice as given in the NASSCO CIPP Inspector Training Program.

L. Laterals
1. Contractor shall determine the exact location of all sewer service connections in the field by CCTV inspection prior to lining of the sewer.

2. The Contractor shall provide a minimum of two (2) complete, functional cutters plus spare key components on the jobsite before each installation.

3. After the CIPP system has been installed, fully cured, and cooled down, all service connections shall be reinstated. A remote cutting tool shall reopen all existing active service connections in each length of sewer by cutting a hole matching the shape of the service connection. A fully restored service connection shall exhibit a nearly full-geometry hole, free from burrs or projections and with a smooth and crack-free edge. The hole shall be 90 percent minimum and 100 percent maximum of the original service connection opening. The invert of the service connection shall match the bottom of the reinstated service opening and shall produce no interruption of the flow from the lateral.

4. Coupons of pipe material resulting from service tap cutting shall be collected at the next manhole downstream of the pipe rehabilitation operation prior to leaving the site. Coupons shall not be allowed to pass through the system.

5. Contractor may use “brushing” as a technique to smooth edges of reinstated Lateral openings.

6. The Contractor shall re-open any service Lateral that does not meet these requirements as evidenced by the post-rehabilitation inspections at no additional cost to <Owner>.

7. If sewer and/or service connection is damaged during the restatement and trimming operation, the Contractor shall repair the damage. Any repair shall be approved by <Owner> prior to beginning repair work.

M. Lateral Connection Reconstruction Seal: The reconstruction of the lateral connection shall be made as specified in Section 33 90 51 and limited to those techniques listed/shown in the bid documents or on the drawings.

N. Styrene and Temperature Control for the local environment:
   1. The Contractor shall take precautions to minimize the release of styrene and mitigate styrene odors generated during the setup and CIPP lining process, and prevent such odors from entering structures, businesses, or other types of establishments, through service connections or other plumbing fixtures.

   2. Styrene air emissions shall comply with Federal and District requirements.

O. Finishing at Ends:
   1. Final trimming of the CIPP at any manhole/access point shall be done in such a manner as to provide a long-term mechanical connection between the CIPP and the host pipe.

   2. If the CIPP terminates on either side of a manhole, the invert through shall be built up to remove any flow restrictions and to form a continuous invert through the manhole. If a CIPP is installed through an intermediate manhole, the CIPP within the manhole shall be cut and removed above the top of the existing channel. The bench of the manhole shall then be grouted and shaped as necessary to support the CIPP.

   3. The seal between the CIPP and the host pipe at manhole shall be watertight for the stated service life of the CIPP installation using the preformed rubber seals described in paragraph 2.1.D above. No water shall be able to migrate between the CIPP and the host pipe; otherwise, the CIPP installation shall be considered defective and shall be repaired or replaced at no additional cost to <Owner>.
P. Post Installation Video Inspection:

1. After lining work is completed, the Contractor shall furnish <Owner> with a USB 2.0 external hard drive, showing each rehabilitated sewer section; after service connections have been reconstructed, reconnected and reactivated. All video and cameras shall be in accordance with Section 33 01 31. The picture should provide the Engineer with a clear and un-obstructed view of the finished CIPP.

2. The Contractor shall submit the video inspection USB 2.0 external hard drive to <Owner> within seven (7) calendar days after completion of the sewer lining. No payment will be made for the USB 2.0 external hard drive; the costs of which are to be included in the price bid for sewer lining.

3. QUALITY ASSURANCE TESTING:

A. The Contractor shall prepare three quality assurance samples for every 3,000 LF of CIPP installed. The samples shall be restrained samples for diameters of CIPP less than 18”; and flat plate samples for diameters of CIPP 18” and larger. UV cured CIPP flat plate samples must be hardened in a fixture on-site using the same light train under a similar exposure of light intensity and time to that which occurred underground. The samples collected by the Contractor shall be labeled with the date of installation, manhole number, and street address where the sample was taken. All restrained samples, where practical, shall be taken from an intermediate manhole location.

B. The Contractor shall maintain responsibility for the chain of custody for the samples.

C. Testing of the quality assurance samples shall be performed by an independent, certified ISO 17025 testing facility. Each test shall be performed by a laboratory with an American Association for Laboratory Accreditation (A2LA) for the specific test to be performed. Testing shall be in accordance with applicable ASTM test methods as given below:

1. Wall Thickness. The reported finished thickness of the CIPP’s wall shall be found in accordance with the appropriate procedure given in the ASTM standard D3567. For restrained circular samples the technician will make a series of at least 8 readings at randomly selected locations that are approximately equally spaced around the circumference.
   a. For reinforced (full composite) CIPP wall thickness measurements the lab shall employ an optical scale comparator with a 7 to 10X magnification; having a reticle with graduations as stated in paragraph 7.2 of D3567. After making the surface preparation of the cut edge, the reinforced wall thickness and neat resin inner and outer surface layers thicknesses shall be measured.
   b. When the quality assurance samples are of the flat plate type the Contractor shall be required to obtain the wall thickness measurements of the installed CIPP using the ultrasonic pulse echo method described in paragraph 8.6.1 of the ASTM F1216 standard for both types of CIPP.
   c. The reported reinforced CIPP wall thickness shall be the calculated average reinforced wall (or composite) thickness.

2. Flexural Properties. The initial tangent modulus of elasticity and flexural strength shall be measured for gravity pipe applications in accordance with the ASTM D790 standard as amended in the appropriate CIPP installation standard and as further amended below. This testing shall be accomplished using test method 1 – procedure A on at least 3 specimens; but 5 specimens are preferred.
a. Reinforced (full composite) CIPP test specimens shall be cut in the hoop direction at a minimum width of 2.0 inches (axial direction of the in situ liner). Modifications to the D790 flexural testing shall follow the guidance found in Annex B of the ISO standard 11296-4. The nominal span to depth ratio used in their testing shall be 16 to 1 just as for the non-reinforced CIPP specimen. These modifications address how to derive the true unsupported span length and the radius of curvature of the test piece at its mid-thickness. The datum or zero point for strain measurement shall be established from the point of intersection of the slope of the initial linear portion of the stress-strain curve with the strain axis. Where the testing machine software does not automatically correct for zero errors, the testing lab must follow the procedure described in B.5.3 (of Annex B) for deriving the flexural modulus from uncorrected strain data to find the true strain datum. Reinforced CIPP flexural testing should be terminated when the maximum strain in the outer-most fiber surface has reached 3.5% or at break if the break occurs prior to reaching this maximum strain.

b. The flexural properties test report shall include a statement as to the orientation of each test piece (i.e. hoop or longitudinal); the mean composite thickness and the maximum percentage deviation from the mean within the middle third of the test piece; and in the case of curved hoop test pieces: the mean total thickness; the true span length; and the determination of the mean radius. The flexural properties test report shall also include a copy of the stress-strain curve to a scale sufficient to evaluate the nature of the specimens' performance in bending.

D. The finished CIPP should be watertight throughout its full length. When this is not found to be the case, the allowable water infiltration (or exfiltration) between its termination points shall not exceed 50 gallons per inch of internal pipe diameter per mile per day. Any obvious visual leaks through the CIPP wall shall be repaired by the Contractor using a methodology recommended by the CIPP System manufacturer.

3.6 ACCEPTANCE:

A. Acceptance of the CIPP installed on this project shall be based on compliance with this Section as demonstrated with submitted quality control reports, curing logs, post-installation inspection video, and laboratory QA test results.

B. Acceptance of the CIPP shall also be based on a post-installation visual inspection using either CCTV equipment or by actual man-entry methods. Inspection results showing defects that exceed the stated accepted tolerance levels as defined in the following table shall be remedied by the Contractor. Should any of the defects be found to occur before the end of the Warranty Period, the Contractor shall be required to repair those defects. The repair method chosen by the Contractor may be the Acceptable Remedy listed in the Table 1 below. The Contractor may also submit an alternative remedy for approval by <the Owner> and, if <the Owner> approves the alternative remedy, the Contractor shall install the approved remedy. Defects shall be remedied at no additional cost to <the Owner>.

Table 1 - Defects
<table>
<thead>
<tr>
<th>Defect</th>
<th>Accepted Tolerance levels</th>
<th>Acceptable Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible leaking through CIPP wall</td>
<td>None</td>
<td>• Install internal CIPP spot repair, or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Remove and reinstall CIPP throughout entire reach.</td>
</tr>
<tr>
<td>Thickness</td>
<td>All measured thickness values must be (&gt; 87.5% of the submitted design wall thickness value)</td>
<td>• Install internal CIPP spot repair flush to adjacent CIPP.</td>
</tr>
<tr>
<td>Blistering / Dimples / Lifts / Foreign Inclusions / Dry Spots</td>
<td>Per NASSCO CIPP Inspector Training Program</td>
<td>• Install internal CIPP spot repair flush to adjacent CIPP.</td>
</tr>
<tr>
<td>Wrinkles and Fins</td>
<td>Per NASSCO CIPP Inspector Training Program</td>
<td>• May be left alone if less than 3% of the pipe ID. or 0.5 inches; whichever amount is less</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mill down to the industry acceptable height</td>
</tr>
<tr>
<td>Lateral Over Cut</td>
<td>&lt; ½ inch</td>
<td>• T-Liner (or approved equal)</td>
</tr>
<tr>
<td>Cracks</td>
<td>None</td>
<td>• For longitudinal crack, install internal CIPP spot repair flush to adjacent CIPP.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For circumferential cracks at Lateral, install any of the remedies described above for an overcut Lateral so long as the method appropriately covers the crack.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For circumferential cracks not located at a Lateral, install an internal CIPP spot repair.</td>
</tr>
<tr>
<td>Delamination</td>
<td>None</td>
<td>• Install 2nd full thickness CIPP.</td>
</tr>
<tr>
<td>Flexural Properties and/or the wall Thickness are less than those used in the design calculations</td>
<td>Installed Factor of Safety must be greater than or equal to 2.0</td>
<td>• Use the quality assurance sample’s test values to recalculate the actual factor of safety for the CIPP as installed. If the actual factor of safety falls below 1.25; install a 2nd full thickness CIPP.</td>
</tr>
</tbody>
</table>

**PART 4  MEASUREMENT AND PAYMENT**

4.1 MEASUREMENT:

A. CIPP Rehabilitation:
   1. Measurement for installation of Cured-in-Place Pipe shall be made from the center of the entry manhole to the center of the exit manhole.
   2. Measurement shall be per linear foot per diameter of pipe.

B. Pipe Cleaning, Light:
   1. Measurement for Pipe Cleaning (Light) shall be made from the center of the entry manhole to the center of the exit manhole.
   2. Measurement shall be per linear foot per diameter of pipe for the entire reach.

C. Pipe Cleaning, Heavy:
   1. Measurement for Pipe Cleaning (Heavy) shall be made from the center of the entry manhole to the center of the exit manhole.
2. Measurement shall be per linear foot per diameter of pipe for the entire reach.

D. Deposits Cut:
1. Measurement for removal of Deposits Attached Encrustation (DAE) and Depos- its attached Grease (DAGS) that required a cutter for their removal shall be made from the center of the entry manhole to the center of the exit manhole.
2. Measurement shall be per linear foot per diameter of pipe for the entire reach.

E. Root Cut:
1. Measurement for Root Cut Medium shall be made from the center of the entry manhole to the center of the exit manhole for removal of roots medium and root balls in one of two joints
2. Measurement for Root Cut Ball shall be made from the center of the entry manhole to the center of the exit manhole for removal of root balls in three (3) or more joints.
3. Measurement shall be per linear foot per diameter of pipe for the entire reach for the above defined level of root removal.

F. Lateral Cut:
1. Measurement for removing protruding laterals shall be on a per each basis. This item excludes ductile iron pipe, cast iron pipe, and steel pipe.

C. Pre- and Post-Installation Inspection:
1. Measurement for Pre- and Post-Installation Inspection shall be made from the center of the entry manhole to the center of the exit manhole.
2. Measurement shall be per linear foot per diameter of pipe.

D. Sewer Lateral Reinstatement:
1. Measurement shall be per each.

E. Bypass:
1. This shall be a Lump Sum item unless otherwise stated herein.

F. Traffic Control:
1. This shall be a Lump Sum item.

4.2 PAYMENT:
A. CIPP Rehabilitation:
1. Payment for installation of Cured-in-Place Pipe shall be paid on a linear foot basis per pipe diameter in accordance with the Unit Prices contained in the Schedule of Prices. When the actual factor of safety is less than 2.0 but greater than 1.25; the unit price shall be reduced by that ratio (actual SF/ design SF) for the subject reach.
2. Payment shall include the installation of a pre-liner, the CIPP lining, infiltration control, spill prevention plan, fuel, potable water, hydrophilic end seals, styrene odor mitigation, labor, equipment, material, installation, safety, dust/erosion control, Field Quality Control and quality assurance sample testing, site restoration, and all other associated work specified and/or required to provide a completed installation.
3. Any item not specified elsewhere shall be considered incidental to this work item. Contractor shall include all incidental costs in the Unit Price.

B. Pipe Cleaning (Light):
1. Payment for Light Pipe Cleaning (per pipe segment) shall be paid on a linear foot basis per pipe diameter in accordance with the Unit Prices contained in the Schedule of Prices.

2. Payment shall include the removal of Deposits Settled (DS) up to a depth of 25% of the rise (vertical diametrical) for pipes up to 12-inches in diameter, up to 15% for 13 to 24-inches in diameter, and 10% for 25 to 30-inches in diameter.

C. Pipe Cleaning (Heavy):

1. Payment for Heavy Pipe Cleaning (per pipe segment) shall be paid on a linear foot basis per pipe diameter in accordance with the Unit Prices contained in the Schedule of Prices.

2. Payment shall include the removal of obstructions (OB) and DS that exceed the percentage established for light cleaning. This also includes Deposits Attached Grease (DAGS) if they can be removed with a rotating nozzle or other mechanical means.

D. Deposits Cut:

1. Payment for Deposits Cut (per pipe segment) shall be paid on a linear foot basis per pipe diameter in accordance with the Unit Prices contained in the Schedule of Prices.

2. Payment shall include the removal of Deposits Attached Encrustation (DAE) and Deposits attached Grease (DAGS) that required a cutter for their removal.

E. Roots Cut Medium:

1. Payment for Roots Cut (per pipe segment) shall be paid on a linear foot basis per pipe diameter in accordance with the Unit Prices contained in the Schedule of Prices.

2. Payment shall include the removal of Roots Medium and any Root Balls in one or two joints in the subject pipe segment.

F. Roots Cut Ball:

1. Payment for Roots Cut Ball (per pipe segment) shall be paid on a linear foot basis per pipe diameter in accordance with the Unit Prices contained in the Schedule of Prices.

2. Payment shall include the removal of Root Balls in three or more joints in the subject pipe segment.

G. Lateral Cut:

1. Payment for removal of protruding lateral pipes shall be paid for on a per each basis in accordance with the Unit Prices contained in the schedule of Prices.

H. Pre- and Post-Installation Inspection:

1. Payment for the Pre- and Post-Installation Inspection shall be paid on a linear foot basis per pipe diameter in accordance with the Unit Prices contained in the Schedule of Prices.

2. Payment shall include pre- and post-construction CCTV inspection, hard drive and digital media of inspections; traffic control, maintenance and protection; permits, labor, equipment, material, installation, safety, and all other associated work specified and/or required to provide a completed installation.

I. Sewer Lateral Reinstatement:

1. Payment for Sewer Lateral Reinstatement shall be paid per each Lateral reinstated.
2. Payment includes CCTV inspection, labor, material, restoration, equipment, and all associated work specified or not which is required to provide a completed re-instatement.

J. Bypass:
   1. Payment for Bypass shall be paid on a lump sum basis in accordance with the Schedule of Prices.
   2. Payment shall include all bypass pumping, spill prevention plan, fuel, hydrostatic testing of bypass lines; traffic control, maintenance and protection; permits, labor, equipment, material, installation, safety, site restoration, and all other associated work specified and/or required to provide a completed installation.

K. Traffic Control:
   1. Payment for Traffic Control shall be paid on a lump sum basis in accordance with the Schedule of Prices.
   2. Payment shall include all traffic control, maintenance and protection, permits, labor, equipment, material, installation, safety, site restoration, and all other associated work specified and/or required to provide a completed installation.

~ END OF SECTION 33 01 25 ~