

San Antonio Water System Standard Specifications for Construction

ITEM NO. 901

Rehabilitation of Sanitary Sewer By Cured-In-Place Pipe (Hot Water)

901.1 DESCRIPTION: This specification includes requirements to rehabilitate existing sanitary sewers by the installation of a resin-impregnated flexible tube, which is formed to the original conduit. The lining is inserted via an existing manhole or other access and, depending on the system selected, is installed using one of the following insertion methods:

1. Water inversion – where the lining is inverted under the pressure of water, and cured by circulating hot water.
2. Winched insertion – where the lining is winched into place and inflated against the sewer wall by either a removable bladder inverted into the lining under the pressure of water or a pre-positioned bladder, which is simply inflated. Curing is accomplished using circulated hot water.

901.2 REFERENCED STANDARDS: Reference standards cited in this Specification Item No.901 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
 - a. Specifications for Water and Sanitary Sewer Construction (2014)
 - b. SAWS Material Specifications
2. City of San Antonio (COSA) Standard Specifications for Construction
3. Texas Commission of Environmental Quality (TCEQ)
 - a. Chapter 217 Design Criteria for Domestic Wastewater System
 - b. Chapter 213 Edwards Aquifer
4. American Society for Testing and Materials (ASTM) International:
 - a. D543, Standard Practice for Evaluating the Resistance of Plastics to Chemical Reagents
 - b. D638, Standard Test Method for Tensile Properties of Plastics
 - c. D695, Standard Test Method for Compressive Properties of Rigid Plastics
 - d. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 - e. F1216, Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of Resin Impregnated Tube
 - f. F1743, Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe
 - g. 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)
 - h. F2561, Standard Practice for Rehabilitation of a Sewer Service lateral and Its Connection to the Main Using a One Piece Lateral Cured-in-Place Liner
 - i. D2990, Standard Test Methods for Tensile, Compressive and Flexural Creep and Creep-Rupture of Plastics

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- j. D3567, Standard Practice for Determining Dimensions of Fiberglass (Glass-Fiber Reinforced Thermosetting Resin) Pipe and Fittings
- k. D3681, Standard Test Method for Chemical Resistance of “Fiberglass” (Glass Reinforced Thermosetting Resin) Pipe in a Deflected Condition
- l. D5813, Standard Specification for Cured-In-Place Thermosetting Resin Sewer Pipe

901.3 SUBMITTALS: The Contractor shall submit to SAWS the following specifications, drawings, test results, and other data showing details of the fabrication and installation of the CIPP liner; these submittals shall be considered incidental to this project, unless a specific bid item for such is included in the project bid proposal:

1. Product specifications and technical data for the resin catalyst system, sealing materials, and liner tube.
2. Manufacturer provided information that describes the CIPP materials, curing speeds, curing installation processes, installation pressures, and temperature limitations.
3. Certified test results of physical properties testing and chemical resistance testing of the proposed resin material.
4. Complete design calculations for the liner thickness per ASTM F1216, for each manhole to manhole segment of main to be rehabilitated. The design calculations shall be signed and sealed by a professional Engineer registered in the State of Texas and certified by the manufacturer as to the compliance of the manufacturer’s material to the values used in the calculations. Review of the calculations by the Owner or its Engineer shall not relieve the Contractor of any contractual obligations.
5. If a field wet-out procedure will be used for liner impregnation, submit a complete description of the proposed wet-out procedure with detailed information on equipment and material storage locations, resin volumes and/or weights, liner length, start times, finish times, resin injection locations, and any other pertinent data documenting the wet-out procedure. Provide plan indicating procedure for reconnection of laterals and pipe end seals.
6. Map that legibly shows proposed liner insertion location(s), construction staging area(s), and bypass pump and piping locations.
7. Traffic control plan (if required) in accordance with City of San Antonio Street Cut Policy or TxDOT (Traffic Coordination).”
8. Bypass pumping plan in accordance with Specification Item No. 865, “Bypass Pumping-Small Diameter Sanitary Sewer” or No. 864, “Bypass Pumping-Large Diameter Sanitary Sewer”.
9. Hydraulic flow capacity calculations with a copy of certification verifying Manning’s roughness “n” value for the proposed liner.
10. Schedule of operations for each project or work order.
11. Liner curing parameter records.
12. Pre and post television inspection videos and logs on DVD in accordance with Specification Item No. 866, “Sewer Main Television Inspection”.
13. Physical samples. Samples removed for testing shall be individually labeled and logged with the following information:
 - a. Owner’s Project number and title.
 - b. Sample number.
 - c. Segment number of line as noted on plans.

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- d. Date and time of sample.
 - e. Name of Contractor.
 - f. Name and location of firm performing testing on sample.
14. Certified test results of structural properties of CIPP samples for each segment installed under this contract.
 15. Log of pulling forces measured during insertion.
 16. Any other testing results or submittals specified in this document or required by applicable ASTM standards.

901.4 MATERIALS

1. Tube
 - a. The tube shall consist of one or more layers of absorbent needled felt fabric or an equivalent non-woven or woven material, or a combination thereof which meets the requirements of ASTM F1216 or ASTM F1743, Section 5. The tube shall be constructed to withstand installation pressures and curing temperatures, have sufficient strength to bridge missing pipe, and stretch to fit irregular pipe sections.
 - b. The impregnated tube shall have a uniform and homogenous thickness that when compressed at installation pressures will meet or exceed the design thickness.
 - c. The tube shall be sized that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion.
 - d. The outside layer of the tube (before wet out) shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate monitoring of resin saturation during the resin impregnation (wet out) procedure.
 - e. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.
 - f. The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.
 - g. Seams in the tube shall be stronger than the un-seamed felt and meet the requirements of ASTM D5813.
 - h. The outside of the tube shall be marked for distance at regular intervals along its entire length, not to exceed 5 ft. Such markings shall include the manufacturer's name or identifying symbol. The tubes must be manufactured in the USA.
2. Resin
 - a. The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy and catalyst system.
 - b. When properly cured, the tube composite meets the requirements of ASTM F1216, ASTM F1743 and ASTM F2019, the physical properties herein, and those that are to be utilized in the design of the CIPP for this project.
 - c. The resin shall produce CIPP that will comply with the structural and

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chemical resistance requirements of this specification.

3. Structural Requirements:
 - a. The CIPP shall be designed as per ASTM F1216, Appendix X1. The CIPP design shall assume no bonding to the original pipe wall.
 - b. The Contractor must have performed long-term testing for flexural creep of the CIPP pipe material installed by his Company. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be utilized in the product design. This is a performance test of the materials (Tube and Resin) and general workmanship of the installation and curing. A percentage of the instantaneous flexural modulus value (as measured by ASTM D790 testing) will be used in design calculations for external buckling. The percentage, or the long-term creep retention value utilized, will be verified by this testing. Values in excess of 50% will not be applied unless substantiated by qualified third party test data. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in design.
 - c. The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers. If separation of the layers occurs during testing of field samples, new samples will be cut from the work. Any reoccurrence may cause rejection of the work.
 - d. The CIPP shall be classified as conforming to the following structural properties:

MINIMUM PHYSICAL PROPERTIES		
Property	Test Method	Cured Composite
Modulus of Elasticity	ASTM D790 (short term)	250,000 psi
Flexural Strength	ASTM D790	4,500 psi
Compressive Strength	ASTM D695	6,500 psi
Tensile Strength (for pressure pipe only)	ASTM D638	3,500 psi

- e. The required structural wall thickness shall be based as a minimum on the physical properties listed above, the design equations in ASTM F1216, Appendix X1 (as referenced by ASTM F2019), and the following design parameters:
 - 1) Pipe condition: Fully deteriorated.
 - 2) Minimum design safety factor: 2.0.
 - 3) Percentage ovality of original pipe: 2.0%.
 - 4) Soil density: 120 lbs/ft³.
 - 5) Traffic Loads: HS-20-44 per AASHTO highway loading.
 - 6) Soil Modulus: 500 psi.
 - 7) Groundwater depth shall be ground surface at a minimum or the elevation of the 100 year floodplain water surface, whichever is greater”, in order to account for all reasonable anticipated future loadings;

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- 8) Long Term Flexural Modulus Retention: 50%
- 9) Soil depth: maximum distance in feet measured between the crown of the pipe and the highest point of soil cover over the length of continuous CIPP section.
- 10) The liner shall be designed for a minimum fifty-year service life under continuous loading conditions.
- f. Contractor shall submit design calculations in accordance with ASTM F1216 that substantiate the CIPP wall thickness for each continuous length of CIPP installed. The required CIPP wall thickness shall be uniform from CIPP start point to CIPP finish point with no deviation in thickness.
4. Acceptable Manufacturer
 - a. Vendors must have approval through SAWS Standards Committee prior to product use and must meet all requirements set forth in this Specification Item No. 901.

901.5 CONSTRUCTION

1. Installer Qualification Requirements
 - a. Installation of the CIPP products shall be performed by a work force that is experienced and certified in installation of the products. The installer shall be certified by the CIPP product manufacturer to have been trained and approved in the installation of their CIPP products and have a minimum of 3 years total experience with the product. The Contractor shall submit such certification of hot water CIPP Installer to Owner. Contractor shall also submit to Owner at least five (5) recent references of the CIPP installer, indicating successful installation of proposed hot water CIPP on projects of similar size and scope. Installer's project manager must have a minimum of 3 years of CIPP installation experience and must be on-site during the installation of the CIPP products
2. Installer Equipment Requirements
 - a. Installer shall only use hot water equipment that has been certified and approved for use by the CIPP product manufacturer.
3. Public Notification
 - a. The Contractor shall maintain service usage throughout the duration of the project. In the event that a service will be out of service, the maximum amount of time of no service shall be 8 hours for any property served by the sewer. A public notification program shall be implemented, and shall as a minimum, require the Contractor to be responsible for contacting each home or business connected to the sanitary sewer informing them of the work to be conducted, when the sewer will be offline, and any alternative method of service that may be provided. The Contractor shall also provide the following:
 - b. Written notice to be delivered to each home or business two business days prior to the beginning of work being conducted on the section, and a local telephone number of the Contractor they can call to discuss the project or any problems which could arise.
 - c. Personal contact with any home or business which cannot be reconnected within the time stated in the written notice.
 - d. Inform SAWS Inspection Department 48 hours prior to starting the work.
4. Protection

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- a. The Contractor shall provide for the general safety of workers, pedestrians and traveling public throughout the project. Existing surface improvements and underground facilities and utilities shall also be protected. Damage caused by the Contractor shall be repaired at his own expense. Protection to be provided shall include but not be limited to:
 - b. Provide barricades, warning lights and signs for excavations created by point repairs and/or excavation pits. Conform to requirements of TxDOT, City of San Antonio, Bexar County, or any other governing entity, and of contract documents.
 - c. Protection of Manholes/Structures: Install all pulleys, rollers, bumpers, alignment control devices and other equipment required to protect existing manholes/structures, and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Under no circumstances will the liners be stressed beyond their elastic limit.
 - d. Do not allow sand, debris, or runoff to enter sewer system.
 - e. Verify location of all underground utilities and facilities potentially impacted by rehabilitation or other related project activities and take necessary precautions to provide protection from damage. Damage caused by the Contractor shall be his responsibility and repaired at no additional cost to SAWS.
 - f. Protect the liner and components during all phases of work including, but not limited to hauling, installation, entry into the entry pit, and prevention of scarring or gouging of the liner, pipe or components.
 - g. Contractor will be responsible for monitoring weather prior to planning a CIPP tube insertion to account for a sufficient duration of tube wet out and insertion and curing in order to ensure that wet weather that will prevent access to the project site is accounted for. Contractor's failure to account for oncoming weather will be Contractor's sole responsibility which may extend to removal of damaged or improperly cured CIPP resulting from interrupted CIPP construction process.
 - h. Contractor shall notify owner 72 hours prior to liner wet out process for approval. Weather conditions and on-site conditions need to be considered.
 - i. One (1) hour prior to liner being installed, Contractor must televise host pipe with Inspector present to ensure no pipe condition changes have occurred.
5. Access Pit Location
- a. Location and number of insertion or launching pits will be chosen by the Contractor and approved by SAWS, and will typically be located at or near existing or proposed manholes or junction boxes, Points of Intersection (P.I.) in the line, at logical breaks in the construction phasing, or at locations to comply with access or maintenance requirements. The ends of the insertion excavation pit shall be sloped 2:1 or flatter, or proper shoring devices shall be used. Pits shall be placed and located to minimize the total number of pulls and maximize the length of CIPP, within the constraints of maintaining service and access and other requirements. When excess ground water is encountered, it shall be removed by the Contractor, and will be considered incidental to the project.

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6. Sewage Bypass
 - a. A detailed bypass plan shall be submitted by contractor and approved by Engineer and Owner prior to starting work. The bypass plan shall be developed in accordance with Specification Item No. 865, Bypass Pumping-Small Diameter Sanitary Sewers or No. 864, Bypass Pumping-Large Diameter Sanitary Sewers.
7. Cleaning and Television Inspection
 - a. Before installing the new pipe, the existing sewer shall be cleaned and inspected per Specification Item No. 866, "Sewer Main Television Inspection" and Specification Item No. 868, "Sanitary Sewer System Cleaning". Notify SAWS Inspection Department of any conditions which may prevent proper installation of the liner. All CCTV work will confirm active laterals and location.
8. Point Repairs and Obstruction Removal
 - a. SAWS shall be notified and shall approve any point repair or obstruction removal before it is constructed. Point Repairs and Obstruction Removals shall conform to Specification Item No. 1103, "Point Repairs and Obstruction Removals."
9. Pipe Leakage Control
 - a. Contractor shall stop infiltration or leakage into the existing pipeline to prevent contamination of resin in liner.
10. Operation
 - a. CIPP installation shall be in accordance with ASTM F1216, Section 7, or ASTM F1743, Section 6, and manufacturer's recommendations with the following modifications:
 - b. Resin Impregnation – The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used. To ensure thorough resin saturation throughout the length of the felt tube, the point of vacuum shall be no further than 25 feet from the point of initial resin introduction.
 - c. After vacuum in the tube is established, a vacuum point shall be no further than 75 feet from the leading edge of the resin. The leading edge of the resin slug shall be as near to perpendicular as possible. A roller system shall be used to uniformly distribute the resin throughout the tube. If the installer uses an alternate method of resin impregnation, the method must produce the same results. Any alternate resin impregnation method must be proven.
 - d. Tube Insertion – The wetout tube shall be positioned in the pipeline using either inversion or a pull-in method. Under the inversion method, care shall be taken during the inversion process so as not to over-stress the tube. If pulled into place, a power winch should be utilized and care should be exercised not to damage the tube as a result of pull-in friction. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extended to the next designated manhole or termination point. The contractor shall install a gauge to monitor the pulling force of the pulled in tube. A written log shall be kept noting the pulling force and any fluctuations in the pulling force. The force shall not

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exceed the manufacturer's recommendations. Any occurrences exceeding the manufacturer's recommendations will be cause for rejection of work.

- e. The manufacturer shall provide the minimum pressure required to hold the tube tight against the existing conduit, and the maximum allowable pressure so the tube is not damaged. These pressure ranges shall be maintained until the inversion has been completed. A temporary water meter shall be installed on the fire hydrant, if used for inversion process.
The cost to coordinate and install the meter for construction purposes shall be at the Contractor's expense.
- f. Temperature gauges shall be placed between the impregnated tube and the existing pipe at the invert level of each end to monitor the temperatures during the cure cycle. A written log shall be kept and submitted to the owner. Any invalid temperature readings not recommended from the manufacturer will be cause for rejection.
- g. The curing shall be accomplished by utilizing hot water under hydrostatic pressure in accordance with the manufacturer's recommended cure schedule. After the tube is cured, the new pipe shall be cooled to a temperature below 100° F (38° C) before relieving the internal pressure within the section. In addition, care shall be taken during cool down so that a vacuum will not develop that may damage the newly installed pipe.
- h. Branch connections or service reconnections shall be reopened without excavation, utilizing a remote controlled cutting device, monitored by a video TV camera. The Contractor shall certify he has a minimum of 2 complete working cutters plus spare key components on the site before each inversion. Unless otherwise directed by the owner or his authorized representative, all laterals will be reinstated. Open cut excavation for service reconnections will only be allowed if it has been approved in writing from a SAWS Inspector. Service reconnections shall be in accordance with Item No. 1109, "Sanitary Sewer Lateral Stub Outs or Reconnections." Contractor shall provide all coupons removed as part of the reinstatement of service process to confirm that a) the appropriate number of service connections has been made and b) no coupons were left in the pipe to create an obstruction.

11. Finished Product

- a. The finished CIPP shall be continuous over the entire length of an inversion run. If any of the conditions described in this section are present in the finished product then the Contractor shall remove and replace the CIPP in these areas at no cost to SAWS.
- b. Defects such as foreign inclusions, dry spots, pinholes, delamination, lifts, seam separation, lateral overcuts, and wrinkling beyond the specification allowances, determined by the Engineer as affecting the integrity or strength of the CIPP, or as adversely affecting the hydraulic capacity of the pipe, shall be repaired or replaced at the Contractor's expense. Method of repair shall be proposed by the Contractor and submitted to the Engineer for review and approval.
- c. Wrinkles in the finished CIPP which cause a backwater of one (1) inch or more or a reduction in cross sectional area of 5% of the diameter are unacceptable and shall be removed or repaired by the Contractor at no

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additional cost to the Owner.

- 1. If a void between the wrinkle and the pipe exists, the Contractor shall repair or replace that section of the pipe at no additional cost to the Owner.
- 2. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for review and approval.
- d. Separations of liner seams in the finished liner pipe are unacceptable and shall be removed and replaced by the Contractor at no additional cost to the Owner.
 - 1. If a separation of a liner seam exists, the Contractor shall repair or replace that section of the pipe at no additional cost to the Owner.
 - 2. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for approval.
- e. Wrinkles in the finished CIPP that reduce the structural integrity of the CIPP are unacceptable and shall be removed or repaired by the Contractor at no additional cost to the Owner.
 - 1. If a void between the wrinkle and the pipe exists, the Contractor shall repair or replace that section of the pipe at no additional cost to the Owner.
 - 2. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for review and approval.

12. Clean Up

- a. 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.

901.6 TESTING

- 1. Chemical Resistance - The CIPP shall meet the chemical resistance requirements of ASTM F1216, Appendix X2 except as modified herein. Table X2.1 of ASTM F1216 shall be modified as follows. It is required that CIPP samples with and without plastic coating meet these chemical testing requirements. Proof of chemical resistance test shall be provided to the Engineer at least 15 days prior to commencement of work.

<u>Chemical Solution</u>	<u>Concentration %</u>
Tap water	pH of 5 to 11
Acids	pH not less than 5.0
Gasoline	Total BETX limit of 100 mg/L
Oil & Grease	50 mg/L
Total Phosphorous	40 mg/L
Sodium Hydroxide and other	pH not higher than 11.0 Strong bases
Ferric Chloride	3 mg/L
Sodium Hypochlorite	3 mg/L

- 2. Hydraulic Capacity - The Contractor shall submit design calculations verifying that the CIPP shall have flow capacity equal to at least 100 percent of the existing pipe. Flow capacity calculation shall be based on Manning's formula using n (Manning's

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roughness coefficient) of 0.013 for existing sewer. The “n” value for CIPP used shall have been verified by an independent testing laboratory (third party testing) which the Contractor shall provide.

3. For each CIPP liner section installed, the Contractor shall obtain CIPP samples large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing. CIPP samples shall be prepared and physical properties tested in accordance with ASTM F1216 or ASTM F1743, Section 8, using either method proposed. The properties must meet or exceed the values listed in Section 901.2.3.d. If test results do not meet the properties, Contractor shall remove and replace CIPP at no cost to SAWS.
4. Visual inspection of the CIPP shall be in accordance with ASTM F1743, Section 8.6 and Specification Item No. 866, “Sewer Main Television Inspection.”

901.7 MEASUREMENT

All sewer pipes will be measured from center of manhole to center of manhole or end of main.

901.8 PAYMENT

Payment for items included in this specification shall be in accordance with the pay items listed below. Work included in these items shall include and the price provided by the Contractor will be considered as full compensation for furnishing and placement of all materials, labor, tools, equipment, testing, preparation, repairs, inspection, phasing, protection, work execution and any other work necessary to complete the project. Payment will be made under the following:

1. **INSTALL CIPP SANITARY SEWER PIPE (HOT WATER), ALL DEPTHS (PAY ITEM 901.1):** The inserted pipe will be paid for at the contracted bid price per linear foot of pipe installed using the CIPP method complete in place for the type and size constructed. Said price shall be full compensation for furnishing all materials, all submittals, sealing materials at manholes/structures and annulus (if required), launching pits, receiving pits, post testing, shoring, bedding, backfilling, curing, site restoration, and all necessary, corresponding, and related work to complete the project. Site restoration (including but not limited to replacement of pavement, sidewalks, driveways, curbing, landscaping, sodding, etc.) will not be paid for separately and shall be considered subsidiary to the CIPP rehabilitation bid items.
2. **SERVICE RECONNECTION:** Measurement and payment for Sanitary Sewer Service Connections shall be made in accordance with Specification Item No. 1109, “Sanitary Sewer Lateral Stub Outs or Reconnections.”
3. **POINT REPAIRS AND OBSTRUCTION REMOVAL:** Measurement and payment for point repairs and obstruction removals shall be in accordance with Specification Item No. 1103, “Point Repairs and Obstruction Removals.”
4. **EXTRA LENGTH POINT REPAIR, ALL DEPTHS:** Measurement and payment for extra length point repairs shall be in accordance with Specification Item No. 1103, “Point Repairs and Obstruction Removals.”
5. **BYPASS PUMPING:** Payment will be made in accordance with SAWS Specifications for Construction Specification Item No. 865 “Bypass Pumping-Small Diameter Sanitary Sewers” or No. 864, “Bypass Pumping-Large Diameter Sanitary Sewers”. There will be no additional or separate payment for documentation, required submittals, and associated or related work.

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6. TELEVISION INSPECTION: Payment will be made for television inspection of the sewer line prior to pipe rehabilitation in accordance with SAWS Specifications for Construction Specification Item No. 866 “Sewer Main Television Inspection”. There will be no additional or separate payment for “post-TV” video inspection, documentation, required submittals, and associated or related work.
7. CLEANING: Payment will be made for cleaning in accordance with SAWS Specifications for Construction Specification Item No. 868 “Sanitary Sewer System Cleaning”. There will be no additional or separate payment for documentation, required submittals, and associated or related work.

-End of Specification-