

## **SP-1 TECHNICAL REQUIREMENTS AND SPECIFICATIONS**

### **SEGMENTAL SLIPLINING**

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#### **PART 1 GENERAL**

1. The work specified in this section includes the requirements for pushing or pulling flush bell and spigot segmented liner pipe of fiberglass or polyvinyl chloride (PVC) into existing sewers by use of mechanical or hydraulic equipment. Once in place, liner pipe is allowed time to normalize and is then cut to fit between manholes. Annular spaces between liners and existing sewers are sealed at each manhole and filled with slip line grout. Manhole inverts and benches are reworked and reshaped. Existing sewers remain in operation during slip lining process, with sewage flowing.
2. Contractor shall submit a document detailing the selected pipe type to be installed, manufacturer's maximum allowable grout pressure, details identifying proposed installation method, bulkhead design, annular space grouting plan, equipment, and location of access shafts.
3. Prime contractor shall have completed a minimum of two (2) successful sewer trunk sliplining projects for local public agencies in the State of Oklahoma within the past ten (10) years. Each project must have had a minimum flush bell and spigot segmented slip lining length of 1,000 LF with slip liner pipe of 24-inch or larger diameter in this project's specified pipe material (PVC, fiberglass, or HDPE). In addition, prime contractor shall have completed at least one (1) successful project involving excavation of a pit, or trench at least ten (10) feet deep that included dewatering within the last five (5) years.

#### **PART 2 MATERIALS**

1. PVC pipe shall conform to Chapter SP-2 of these Special Provisions.
2. Fiberglass pipe shall conform to Chapter SP-3 of these Special Provisions.

#### **PART 3 EXECUTION**

1. Remove all obstructions, such as roots, rocks and other debris that will prevent the insertion of the liner pipe. Contractor shall clean only one segment, from manhole to manhole, at a time. Contractor shall remove debris at the downstream manhole and prevent debris from migrating downstream to the next pipe segment during cleaning operation.
2. A steel mandrel of at least the same outside diameter and length of individual pipe section of the slip liner pipe shall be pulled through the line prior to any insertion tests. A guide cable shall be attached to each end of the mandrel so that it may be removed from either end of the pipe section being tested.

3. Contractor shall complete pre-installation CCTV to verify that the existing pipe is clean and clear of debris prior to liner installation. Bypass pumping shall be utilized to be view the entirety of the existing pipe, including the flowline.
4. Locate access shafts so that the total number is minimized and the footage of linear pipe installed in a single section is maximized. Install and operate all necessary dewatering and surface water control measures.
5. Installation shall be completed per the following procedure:
  - a. Contractor shall saw cut at springline and carefully remove the upper half of the existing sewer necessary for the installation of the liner. Care shall be exercised so as not to disturb the lower half of the existing sewer.
  - b. At launch pits located at existing manholes to be replaced, Contractor shall completely remove the manhole. Contractor shall install new manhole per the City of Tulsa Standard Construction Specifications.
  - c. At existing manholes to be rehabilitated, launch pits are to be located at either side while preserving the manhole in place. Contractor shall brace or secure manholes as necessary during construction.
  - d. Section of liner pipe shall be field connected at the insertion point per manufacturer's recommendations. Contractor shall take precautions to prevent ragged edges of broken existing sewer pipe from scoring slip liner as it is being installed into sewer.
  - e. Allow liner pipe to normalize to ambient temperatures and recover from imposed stretch for a minimum of twenty-four hours before cutting to fit between manholes, sealing at manholes and shaping manhole invert.
  - f. Contractor shall cut the upper half of liner out at manholes as required to accommodate lateral and service connections.
  - g. The annulus between the liner pipe and the host pipe shall be sealed at termination points and at intermediate structures. Watertight bulkheads shall be constructed in sequence from upstream to downstream allowing sewage trapped in the annulus to escape.
  - h. Contractor shall grout annular space between the outside of liner and inside of host pipe.
  - i. Contractor shall install a concrete cap a minimum 4-inches thick where the top of the existing host pipe was removed to insert the liner pipe prior to backfill.
6. Pipe shall be tested in accordance with the City of Tulsa Standard Construction Specifications.
7. Contractor shall provide bypass pumping during post-construction CCTV operation to view the entirety of the liner, including the flowline.

#### PART 4 MEASUREMENT AND PAYMENT

1. Sliplining shall be paid for at the Contract Unit Prices as follows: The unit price shall cover the entire cost of sewer lining, measured to the nearest 0.1 foot, center of manhole to center of manhole, less one-half (1/2) the diameter of both the upstream and downstream manholes.

2. The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, pipe lining materials, pipe sealing materials, labor, backfilling, surface restoration, sodding, pavement replacement, sidewalk and driveway replacement, curb and gutter replacement, all testing, and all incidental costs.
3. The cost of cleaning and pre-construction television inspection shall be paid for at the unit price per linear foot. This shall include all costs associated with the internal television inspection, such as viewing, record logs, and standard transfer media. The linear feet paid shall be as measured from the center of the upstream manhole to the center of the downstream manhole. Payment shall only be made once for any manhole-manhole segment; no additional payment shall be made for multiple cleaning efforts and inspections of the same pipe segment. Payment will not be made until the post construction television inspection video has been reviewed by Engineer. No payment will be made for post-construction CCTV.

END OF SECTION

## **SP-2 TECHNICAL REQUIREMENTS AND SPECIFICATIONS**

### **LARGE DIAMETER PVC NON-PRESSURE PIPE**

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#### **PART 1 GENERAL**

1. The Contractor shall furnish and install PVC slipline pipe for rehabilitation of the existing 48-inch interceptor and all appurtenant work.
2. Contractor shall submit shop drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenances.
3. Quality assurance shall be as follows
  - a. All pipe shall be factory air tested with gasket in place and marked accordingly.
  - b. All materials testing will be based upon applicable ASTM Test Methods and AWWA Standards referenced herein for the materials specified.
  - c. All costs of such inspection and tests shall be borne by the Contractor.
  - d. The Contractor shall furnish manufacturer's notarized certificates of compliance.
  - e. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

#### **PART 2 MATERIALS**

1. Pipe manufacturer shall be Vylon or Engineer approved equivalent.
2. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, cell classification, ASTM F 1803 Designation, pipe stiffness, and pressure rating in psi. Minimum pipe stiffness shall be 46 psi, measured in accordance with ASTM D-2412.
3. The Contractor shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.
4. Apart from structural voids and hollows associated with profile wall designs, the pipe and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions and other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.
5. PVC profile wall pipe and fittings shall be manufactured in accordance with the requirements of ASTM F 1803 latest edition.
6. The joints for PVC profile wall pipe used for segmental slip lining shall be bell and spigot and be designed so that the pipe has a smooth interior and exterior with no increase or decrease of diameter. The joint shall be flush and meet the requirements of ASTM D3212.
7. Gaskets shall meet the requirements of ASTM F 477 and be molded into a circular form or extruded to the proper section, then spliced into circular form, and shall be made of

a properly cured high grade elastomeric compound.

8. Gaskets shall be factory installed and chemically bonded to the bell end of the pipe. Field installed gaskets and field cut beveled lengths of pipe shall be done in accordance with the manufacturer's instructions and recommended equipment and materials.
9. PVC profile wall pipe shall be made from a compound meeting the requirements of cell classification 12364 as defined by ASTM D 1784.
10. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

#### PART 3 EXECUTION

1. Pipe shall be installed in accordance with the Manufacturer's recommendations and the additional requirements herein.
2. Joint deflection shall be controlled to within 2 degrees.
3. Care shall be taken to avoid dragging the spigot on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.
4. The inside surface of the bell, the gasket groove and the gasket shall be cleaned and lubricated immediately prior to jointing with a compound recommended by the Manufacturer which will facilitate the telescoping of the joint.

#### PART 4 MEASUREMENT AND PAYMENT

1. This item is considered incidental to Segmental Sliplining. No additional payment will be made.

END OF SECTION

## **SP-3 TECHNICAL REQUIREMENTS AND SPECIFICATIONS**

### **FIBERGLASS REINFORCED PIPE**

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#### **PART 1 GENERAL**

1. The Contractor shall furnish and install fiberglass reinforced slipline pipe for rehabilitation of the existing 48-inch interceptor and all appurtenant work.
2. Contractor shall submit shop drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenances.
3. Quality assurance shall be as follows
  - a. All materials testing will be based upon applicable ASTM Test Methods and AWWA Standards referenced herein for the materials specified.
  - b. All costs of such inspection and tests shall be borne by the Contractor.
  - c. The Contractor shall furnish manufacturer's notarized certificates of compliance.
  - d. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

#### **PART 2 MATERIALS**

1. Manufacturer shall be HOBAS or Engineer approved equivalent.
2. Fiberglass reinforced pipe, joints, and fittings shall be manufactured in accordance with ASTM D 3262, with a minimum cell classification Type 1, Liner 2, Grade 3, or Type 1, Liner 1, Grade 1.
3. The pipe shall be manufactured by centrifugal casting process or continuous advancing mandrel process resulting in a dense, nonporous, corrosion-resistant, consistent, composite structure. Minimum stiffness shall be 46 psi, measured in accordance with ASTM D 3262.
4. Resin system shall be a thermosetting polyester epoxy resin, with or without filler, meeting ASTM D 3262.
5. Reinforcing glass fibers shall be commercial grade E-type glass filaments, with binder and sizing compatible with impregnating resin.
6. Filler shall be sand with at least 98 percent silica content and maximum moisture content of 0.2 percent.
7. The joints used for segmental sliplining shall be bell and spigot and be designed so that the pipe has a smooth interior and exterior with no increase or decrease of diameter. The joint shall be flush and meet the requirements of ASTM D 4161.

#### **PART 3 EXECUTION**

1. Pipe shall be installed in accordance with the Manufacturer's recommendations and the additional requirements herein.

5. Joint deflection shall be controlled to within 2 degrees.
2. Care shall be taken to avoid dragging the spigot on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.
3. The inside surface of the bell, the gasket groove and the gasket shall be cleaned and lubricated immediately prior to jointing with a compound recommended by the Manufacturer which will facilitate the telescoping of the joint.

PART 4 MEASUREMENT AND PAYMENT

1. This item is considered incidental to Segmental Sliplining. No additional payment will be made.

END OF SECTION

## **SP-4 TECHNICAL REQUIREMENTS AND SPECIFICATIONS**

### **FIBERGLASS MANHOLE**

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#### **PART 1 GENERAL**

1. The Contractor shall furnish and install fiberglass manholes per the Drawings.
2. Contractor shall submit shop drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenances.
3. Each completed manhole shall be examined for dimensional requirements, hardness, and workmanship. All required A.S.T.M. 3753 testing shall be completed and records of all testing shall be kept and copies of test records shall be presented to customer upon formal written request within a reasonable time period.
4. As a basis of acceptance the manufacturer shall provide an independent certification which consists of a copy of the manufacturer's test report and accompanied by a copy of the test results stating the manhole has been sampled, tested, and inspected in accordance with the provisions of this specification and meets all requirements.
5. Do not drop or impact the fiberglass manhole. Fiberglass manhole may be lifted by inserting a 4"x 4" x 30" timber into the top of manhole with cable attached or by a sling or "choker" connection around center of manhole, lift as required. Use of chains or cables in contact with the manhole surface is prohibited.
6. Each manhole shall be marked on the inside and outside with the following information:
  - a. Manufacturer's name or trademark
  - b. Manufacturer's factory location
  - c. Manufacturer's serial number
  - d. Total length

#### **PART 2 MATERIALS**

1. Manufacturer shall be L.F. Manufacturing or approved equivalent.
2. Fiberglass reinforced polyester manhole shall be manufactured from commercial grade polyester resin or other suitable polyester or vinyl ester resins with fiberglass reinforcements. Manhole shall be a one piece unit manufactured to meet or exceed all specifications of ASTM D3753.
3. The resins used shall be a commercial grade unsaturated polyester resin or other suitable polyester or vinyl ester resin.
4. The reinforcing materials shall be commercial Grade "E" type glass in the form of continuous roving and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.
5. The inner surface exposed to the chemical environment shall be a resin-rich layer of 0.010 to 0.020 inch thick. The inner surface layer exposed to the corrosive environment



shall be followed with a minimum of two passes of chopped roving of minimum length 0.5 inch (13 mm) to maximum length of 2.0 inch (50.8 mm) and shall be applied uniformly to an equivalent weight of 3 oz/ft. Each pass of chopped roving shall be well-rolled prior to the application of additional reinforcement. The combined thickness of the inner surface and interior layer shall not be less than 0.10 inch (2.5 mm). The interior surface shall be resin rich with no exposed fibers. The surface shall be free of crazing, delamination, blisters larger than 0.5 inch in diameter and wrinkles of 0.125 inch or greater in depth. Surface pits shall be permitted if they are less than 0.75 inch in diameter and less than 0.0625 inch deep. Voids that cannot be broken with finger pressure and that are entirely below the resin surface shall be permitted if they are less than 0.5 inch in diameter and less than 0.0625 inch thick.

6. After inner layer has been applied the manhole wall shall be constructed with chop and continuous strand filament wound manufacturing process which insures continuous reinforcement and uniform strength and composition. The cone section, if produced separately, shall be affixed to the barrel section at the factory with resin-glass reinforced joint resulting in a one piece unit. Seams shall be fiberglassed on the inside and the outside using the same glass-resin jointing procedure. The cone and barrel sections shall not be joined in the field except by the manufacturer.
7. For a UV inhibitor the resin on the exterior surface of the manhole shall have gray pigment added for a minimum thickness of 0.125 inches. The exterior surface shall be relatively smooth with no sharp projections. Hand-work finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 0.5 inch in diameter, delamination or fiber show.
8. Upon request stub outs may be installed. Installation of SDR PVC sewer pipe must be performed by sanding, priming, and using resin fiber-reinforced hand layup. The resin and fiberglass shall be same type and grade as used in the fabrication of the fiberglass manhole. Inserta-Tee fittings may be requested and installed per manufacturer's instructions. Kor-N-Seal boots may be installed by the manhole manufacturer using fiberglass reinforced pipe stub out for Kor-N-Seal boot sealing surface.
9. Fiberglass manholes will be required to have resin fiber-reinforced bottom. Deeper manholes may require a minimum of two fiberglass channel stiffening supports. All fiberglass manholes manufactured with a fiberglass bottom will have a minimum 3-inch wide anti-floatation ring. The manhole bottom shall be a minimum of ½ inch thick.
10. A fiberglass enclosed invert and bench area shall be installed in the manhole by the manufacturer. The invert will be formed using a non-corrosive material and completely enclosed in a minimum ¼-inch layer of fiberglass chop.
11. Fiberglass manholes must have the ability to be height adjustable with the use of a height adjustment ring. Height adjustment can be made as a field operation without the use of uncured resins or fiberglass layups. Fiberglass manholes must maintain all load and soundness characteristics required by A.S.T.M. D3753 after height adjustment has occurred.
12. Fillers, when used, shall be inert to the environment and manhole construction. Sand shall not be accepted as an approved filler. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing

process to be used to meet the requirements of this standard. The resulting reinforced-plastic material must meet the requirements of this specification.

13. All manholes shall be designed so that a ladder or step system can be supported by the installed manhole.
14. Manway reducers will be concentric with respect to the larger portion of the manhole diameters through 60 inches. Larger manholes may have concentric or eccentric manway reducer openings.
15. The manhole shall provide an area from which a grade ring or brick can be installed to accept a typical metal ring and cover and have the strength to support a traffic load without damage to the manhole. The grade ring should be extended past the perimeter of the manhole at least 1" in order to transfer as much load as practical to the exterior wall of the manhole.
16. Tolerance of inside diameter shall be +/- 1% of required manhole diameter.
17. The complete manhole shall have a minimum dynamic-load rating of 16,000 lbs. when tested in accordance with A.S.T.M. 3753 8.4 (note 1). To establish this rating the complete manhole shall not leak, crack, or suffer other damage when load tested to 40,000 lbs. and shall not deflect vertically downward more than 0.25 inch at the point of load application when loaded to 24,000 lbs.
18. In order to determine soundness, apply an air or water pressure test to the manhole test sample. Test pressure shall not be less than 3 psig or greater than 5 psig. While holding at the established pressure, inspect the entire manhole for leaks. Any leakage through the laminate is cause for failure of the test.
19. The fiberglass manhole and all related components shall be fabricated from corrosion proof material suitable for atmospheres containing hydrogen sulfide and dilute sulfuric acid as well as other gases associated with the wastewater collection system.

### PART 3 MEASUREMENT AND PAYMENT

1. Payment for this item shall be made at the unit price bid per fiberglass manhole and placed as shown in the drawings. If the manhole depth, measured from the top of bench to the top of the cover, exceeds six feet, the additional depth shall be paid for at the unit price bid per vertical foot of liner depth over six feet. This includes all materials, equipment and labor for a complete installation of a fiberglass manhole, including excavation, backfill and restoration. Separate payment will be made for each drop manhole. No additional Payment will be made for multiple drops at a manhole. Separate payment will be made at the unit price bid per vertical foot of drop manhole depth over six feet.

END OF SECTION

## SP-5 TECHNICAL REQUIREMENTS AND SPECIFICATIONS

### SLIPLINE GROUTING

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#### PART 1 GENERAL

1. The work specified includes requirements for completely filling the annular space between the sliplining pipe and the host pipe without deflecting the sliplining pipe.
2. Contractor shall submit detailed descriptions of
  - a. Equipment and operational procedures to accomplish the annular grouting operation, including mixing and pumping schedule, grouting pressures, rates of pumping, and methods for monitoring the effectiveness of the grouting.
  - b. Proposed locations of surface mixing equipment, subsurface injection points, flowlines, waste grout recovery, grout pressure limiting equipment, bulkheads, and venting system. Show details of bulkhead design.
  - c. Qualifications and experience of grout mix applicator.
  - d. Grout mix design and certified independent laboratory mix tests, with set time, compressive strength, viscosity, and density test results.
  - e. Initial set time of grout.
  - f. The 24-hour and 28-day minimum grout compressive strengths.
  - g. The grout working time before a 15% change in density or viscosity curves.
  - h. The proposed grouting method and resume of successful uses on previous projects.
  - i. The maximum injection pressures.
  - j. Proposed grout stage volumes. Note: Due to corrosion of the existing pipe, the annular space to be grouted may exceed the stated inside diameter by as much as 2-inches. Provide annular space volume calculations and estimated grout volume required.
  - k. Buoyant force calculations during grouting.
  - l. Flow control.
  - m. Pressure gauge and pressure recorder certifications.
  - n. Vent location plans.
  - o. Written concurrence that the Contractor has coordinated this work with the grout installer and the liner pipe manufacturer.
  - p. For each different type of grout or variations on procedure of installation, a complete package shall be submitted. The submittal shall include each of the above items and the sewer locations and conditions to which it applies. The Contractor shall notify the Engineer of any changes to be made in grout, mix, grouting procedures or installation.
  - q. A detailed plan showing how the liner pipe will be held on the invert for a period of time long enough to allow the grout to set when buoyant uplift is a factor.
3. Quality assurance shall pertain to density/viscosity. During placement of grout, measure density in accordance to ASTM C 138 and C 939 at least twice per hour. Adjust the mix as required to obtain the specified density.

#### PART 2 MATERIALS

1. The Contractor shall demonstrate to the Engineer that it is capable of grouting the annulus and meeting specifications regarding that work. Only a company specializing in the design and placement of annular fill with a minimum of 5 years of successful experience with grouting shall be employed. The company must have experience in design, placement, and testing on at least five relevant projects where annular fill was placed to strict quality control requirements in an annulus similar to or equal to around similar pipe with distances up to 500 feet between access points at injection pressures proposed. The applicator of the grout mix shall be certified by the grout mix manufacturer and approved by the Engineer. The certified applicator shall be regularly engaged in the placement of grout, including completion of pipeline grouting installations having at least 500 cubic yards in the past 3 years.
2. Materials shall be as stated below
  - a. Cement: Comply with ASTM C 150. Pozzolans and other cementitious materials are permitted.
  - b. Fly Ash: Comply with ASTM C 618; either Type C or Type F shall be used.
  - c. Sand: No sand shall be allowed in the grout mix.
  - d. Water: Use potable water free from deleterious amounts of alkali, acid, and organic materials which would adversely affect the setting time or strength of the slip lining grout.
  - e. Admixtures: Admixtures shall be selected by the slip lining grout manufacturer to meet performance requirements, improve pumpability, control set time and reduce segregation.
  - f. Compressive Strength. The grout shall have a minimum penetration resistance of 100 psi in 24 hours when tested in accordance ASTM C 403 and a minimum compressive strength of 300 psi in 28 days when tested in accordance of ASTM C 495 or C 109.
  - g. Performance Requirements. The Contractor shall submit the proposed grout mixes, methods, plans and criteria of the grouting operations.
  - h. Mix Designs. One or more mixes shall be developed to completely fill the annular space based, but not restricted to, the following requirements:
    - (i) Size of annular void. Note: Due to corrosion of the existing pipe, the annular space to be grouted may exceed the stated inside diameter by as much as 2-inches.
    - (ii) Absence or presence of groundwater.
    - (iii) Sufficient strength and durability to prevent movement of the liner pipe.
    - (iv) Provide less than 1 percent shrinkage by volume.
  - i. Density/Viscosity. The Contractor shall design a grout mix to be pumped for a distance of 500 feet +/-, without exceeding 90% of the pipe manufacturer's maximum allowable grout pressure. The density shall be designed to prevent floating of the liner pipe. The apparent viscosity shall be in accordance with ASTM C 939 unless otherwise approved by the Engineer. The apparent viscosity shall not exceed 20 seconds in accordance with ASTM C 939, unless otherwise approved by the Engineer.
3. No deleterious amounts of toxic or other poisonous substances shall be included in the grout mix nor otherwise injected underground.
4. Mixers and Pumps: The materials shall be mixed in equipment of sufficient size and capacity to provide the desired amount of grout material for each stage in a single operation. The system shall mix the grout to a homogenous consistency. Provide ways

to increase or decrease the water-cement ratio and accurately measure grout component quantities, pumping pressures, and volumes pumped.

5. Pressure Gauges:

- a. Pressure gauges shall be equipped with diaphragm seals, have a working range between 1.5 to 2.0 times the design grout pressure, and have an accuracy within 0.5 percent of full range.
- b. Provide at least one pressure gauge at the point of injection.
- c. Grouting shall not proceed without appropriate gauges in place and in working order.
- d. Grout pressure gauge and recorder shall be installed immediately adjacent to each injection port. During grouting operations, the recorder shall continuously record the actual grouting pressure versus time either with an electronic graph or on paper with ink. Pressure gauges shall be instrument oil filled and attached to a saddle-type diaphragm seal (gauge saver) to prevent clogging with grout. All gauges shall be certified and calibrated in accordance with ANSI B40, Grade 2A. The grout pressure recordings shall be identified as a minimum, with date, batch, and time of day grouting was performed and shall be submitted to the Engineer at the end of the work day that grouting was performed.
- e. The grouting system shall have sufficient gauges, monitoring devices, and tests to determine the effectiveness of the grouting operation and to ensure compliance with the liner pipe specifications and design parameters.

PART 3 EXECUTION

1. Place grout for a given pipeline segment between bulkheads. Place bulkheads at the ends of each pipeline segment to seal the annular space from sewer flow. Do not remove bulkheads until after grout has set.
2. Remove or control standing or running water in annular spaces to maintain the correct water ratio of the grout mixture. Grout the annular space by injecting grout from one end of the pipeline segment, allowing it to flow toward the other end. Vent the annular space to assure uniform filling of the void space.
3. Limit pressure on the annular space to prevent damage to the liner; do not exceed 90% of the manufacturer's maximum allowable grout pressure. Regardless of the pressure, Contractor shall be solely responsible for any damage or distortion to slip liner pipe due to grouting. At the bulkhead opposite to the point of grouting, provide and monitor an open-ended high point tap or equivalent vent.
4. Pump grout until grout within 0.3 pounds per gallon of specified grout injection density discharges from the end opposite the injection point. This procedure is intended to ensure that the grout is not diluted by extraneous water in the annulus.
5. The drilling of additional injection holes from the surface to facilitate grouting may be allowed if approved by the Engineer.
6. No hardened grout is permitted in the slipliner pipe invert after completion of grouting operations.
7. Contractor shall verify successful grout installation by comparing volume of grout placed and estimated annular space volume. Contractor will visually see grout in vent and

injection ports prior to finishing grout placement. Owner's representative shall also observe for confirmation.

8. This item is considered incidental to the cost of the sliplining.

END OF SECTION

## SP-6 TECHNICAL REQUIREMENTS AND SPECIFICATIONS

### SWAGELINING

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#### PART 1 GENERAL

1. The work described here is for compression fit sliplining (swagelining), which allows a new tight-fitting polyethylene (HDPE) pipe to be placed inside a new or existing pressurized pipeline. The system uses HDPE pipe which has an outside diameter slightly larger than the inside diameter of the pipe to be renewed. After sections of PE are butt fused together to form a continuous pipe, the PE pipe is pulled through a patented reduction die or similar device which temporarily reduces its diameter within the elastic limits of HDPE. This allows the HDPE pipe to be pulled through the existing pipeline. After the HDPE pipe has been pulled completely through the host pipe, the pulling force is removed and the HDPE pipe returns toward its original diameter until it presses tightly against the inside wall of the host pipe. Relaxation of the HDPE pipe will be a natural process. No forced reversion will be allowed using either water, steam, heat or other means. The tight fitting HDPE pipe results in a flow capacity close to or greater than the original pipeline design.
2. Contractor shall submit the following
  - a. Contractor must be approved by the process manufacturer such as Swagelining Limited or approved equal.
  - b. Certificate of training endorsed by the manufacturer of the constant tension equipment.
  - c. Certificate of training endorsed by the manufacturer of thermal fusion equipment in butt fusing of HDPE pipe and evidence training of electro-fusion couplings.
  - d. Certificate of training endorsed by the supplier or manufacturer of HDPE electro-fusion fusion couplers to be used in the method. In lieu of certificate, evidence of training may be substituted.
3. In order to assure quality execution of the compression fit slip lining method, the contractor must be a U.S. Swagelining license holder granted by Swagelining Limited, or other approved process method license holder for compression fit slip lining of pressure pipes.
4. For a process to be considered as acceptable and an "or equal", a minimum of 500,000 linear feet of successful municipal clients (i.e. cities, towns, water authorities, etc.) pressurized piping system installation in the US must be documented to assure commercial viability. Such documentation must be submitted and approved prior to the bid.
5. The contractor and/or his subcontractor shall not have less than five years of active experience in the installation of compression fit slip lining and shall have experience of a minimum of 30,000 linear feet in the range of 16-inch diameter and larger pressure pipes as required for this project. Project experience must be with municipal clients (i.e. cities, towns, water authorities, etc.). Such documentation must be provided with the bid.

## PART 2 MATERIALS

1. High Density Polyethylene Pipe must conform to ASTM F714 and NSF 61.
2. HDPE resin shall be PE4710 characterized by ASTM 03035.
3. All pipe shall be made of virgin material, no rework except that obtained from manufacturer's own production.
4. The Outside Diameter of the HDPE pipe to be installed must be selected to be slightly larger than the Inside Diameter of the host pipe being lined.
5. Cuts or gouges, per ASTM F585 are acceptable up to 10% of wall thickness. Beyond 10% of wall, damage must be removed by cutting the damaged section from the pipe string and butt fusing the ends.
6. Fittings for pressure systems shall be ductile iron and comply with AWWA C110. The minimum pressure rating shall be 200 psi and meet all city standard specifications.
7. Stiffener inserts per ASTM 240 shall be used for all fittings and connections to HDPE pipe. Stiffeners shall be 304 stainless steel.
8. Pipe connection fittings shall meet AWWA C906 and meet or exceed the pressure capacities of the HDPE pipe.
9. Certificate of compliance shall be supplied to the City that the product pipe is per specification.
10. All materials used with the coupling or connecting HDPE pipe must be submitted and approved by the City.
11. Pipe transport and handling shall be per manufacturer's recommendations.
12. Product other than pipe shall be stored and handled per manufacturer's recommendations.
13. The new installed HDPE pipe design parameters will, on request, be supplied to the Owner by the Technology Licensor.
14. Overall, the hydraulic cross section shall be maintained as large as possible.

## PART 3 EXECUTION

1. The Contractor shall submit a plan to the City on a marked up copy of the project drawings showing the Contractor's construction phasing and plans at the Pre-Construction Meeting. Plan details should include:
  - a. Pit locations for pipe launch and receive locations.
  - b. Schedule of when various sections are to be rehabilitated.
  - c. Distances of each pull.



- d. Pull calculations for each pull to include die sizing, insertion Outside Diameter of HDPE, reversion Outside Diameter of HDPE, final bore size, tightness of reversion, load in tonnages required to install HDPE pipe, and maximum tensile stress on HDPE during insertion.
2. The Project Construction drawings provided by the Owner shall be marked by the Contractor to show actual locations of services, fittings, and other reconnects. These markups shall be done the day of the actual placement. A set of marked up plans shall be returned to the Owner.
3. Butt fusion methods shall be in strict conformance to the pipe and/or fusing equipment manufacturer's recommendations to join sections of High Density Polyethylene Pipe. Fusing of sticks of pipe shall be performed in the general vicinity of the pipe insertion pit or lay down yard (staging area). De-beading is required to remove the outside fusion roll back bead prior to compression fit sliplining operations.
4. Swagelining operation described within provides guidance on the basic process. The following outlines the requirements necessary to implement successful operations.
  - a. Maximum use should be made of all available records. Details of material types together with the position of existing valves, plugs, bends, tees, collars, service connections or any other internal obstructions in the pipeline should be obtained.
  - b. Details of all other buried utilities must be obtained and both electricity cables and telecom ducts should be physically marked out on site, at the entry and exit excavation positions.
  - c. Wherever possible, excavations that are required for the removal of bends, tees or other internal obstructions should be utilized as launch/reception pits or access points for the CCTV survey and pipeline cleaning operations.
  - d. Internal inspection with the use of CCTV or man entry is required so that unknown internal obstructions can readily be identified and removed prior to the proving pig.
  - e. All internal obstructions will require removal prior to the compression fit slip lining process operation.
  - f. The pipeline should be thoroughly cleaned using scrapers, wire brushes etc. to ensure all scale and sediment has been removed before pipe insertion.
  - g. A proving pig slightly larger in diameter than the Outside Diameter of HDPE pipe (i.e. pipe diameter after exiting the die) should be winched through the pipeline to ensure an unobstructed bore is available for pipe insertion.
  - h. A second PE pig will be used to determine the extent of any scoring which could be caused by protrusions within a host pipeline. If the depth of scoring exceeds 10% of the wall thickness, the pipe insertion operation must not be started and an investigation must be carried out to determine the cause of scoring which must then be removed.
5. Receive pit and launch pit locations shall be placed such that excavations are minimized. This may be accomplished by placing either or both of these pits at a point of a service connection or fitting. All pits shall be shored to ensure worker safety per

OSHA or other regulations. All pits shall be fenced off and/or covered when not active per OSHA or local regulations to ensure public safety. Traffic control shall be provided by Contractor as per the Contract specifications. Safe traffic passage around pit excavations that are located in or adjacent to streets or highways shall meet the permit requirements of the relevant local government body responsible for right-of-way control. Parking of related employee vehicles, trucks and auxiliary and equipment shall be such that congestion and traffic delays are minimized. Traffic control plan shall be in accordance to the traffic control plan details of the contract document.

6. Rod payout is the process of assembling a string of rods and pushing them in a step wise manner from Receive Pit, through the interior of the host pipe to the Insertion Pit. Lifting of rod boxes into or out of the Receive Pit shall be performed per OSHA or other applicable requirements with respect to equipment and method. Threads or joining areas shall be cleaned of foreign matter before assembly. Counting of Rods during payout or quantity of rods per box shall be monitored such that the operator is aware of the distance between the constant tension machine and the lead end of the rod string. Host pipe in the Insertion Pit shall be cut or broken prior to arrival of the rod string. Sufficient length shall be removed so as to allow the pull head to enter the host pipe and bend the product within the allowable radius specified by the pipe manufacturer. The second end of the host pipe in the Insertion Pit shall be positioned or worked so as not to damage the product pipe as it travels through the Insertion Pit. Workmen shall not enter the Insertion Pit when the rod string is nearing the Pit. A workman shall be in visual or radio contact with the machine operator so as to have the payout halted in a position that allows attachment of the pull head.
7. The product pipe shall be moved into position for attachment to the rod string. Appropriate traffic or pedestrian control will be exercised along the path of the product pipe. The lead and second rod shall be painted orange or yellow so as to give notice to the machine operator position of the pull head.
8. During the start of the pull, the pull speed must be reduced to allow the pull head to travel through the reduction die or roller reduction box and into the host pipe. After the first 10 feet of HDPE enters the host pipe, the speed may be increased.
9. The pipe diameter of the HDPE will be temporarily reduced between 5% and 12% as the new pipe is pulled through the reduction die or other reduction device immediately before entering the host pipe. The reduction system must be approved in coordination with the process manufacturer licensee. The reduction system will be uniform around the entire circumference to ensure no distortion occurs on the HDPE during pull in. The actual pull-in load shall be continuously monitored during pull-in. It shall not be allowed to exceed the maximum allowable pull-in load or tensile force per the HDPE manufacturer.
10. Constant tension must be applied on the HDPE pipe string until the pull head reaches the receive pit. The equipment used during the tight fit operations must be of the constant tension type.
11. After the pull head reaches the receive pit, the pulling force is removed. The contractor must use caution to pull the new HDPE a sufficient distance into the receive pit so the pipe does not retract back into the host pipe. The HDPE pipe must then be allowed to relax to allow full reversion for a period of 24 to 48 hours

before commissioning activities begin. The reversion period may lengthen or shorten depending on the characteristics of each pull, temperatures and other site specific conditions. The reversion process will be natural and no forced reversion will be allowed using either water, steam, heat or other methods.

12. Hydrostatic pressure test shall be performed in accordance with ASTM F2164, AWWA M55 and PPI Handbook Chapter 2 and in accordance to testing limits provided by the Owner.

#### PART 4 MEASUREMENT AND PAYMENT

1. Swagelining shall be paid for at the Contract Unit Prices as follows: The unit price shall cover the entire cost of sewer lining, measured to the nearest 0.1 foot, center of manhole to center of manhole, less one-half (1/2) the diameter of both the upstream and downstream manholes.
2. The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, pipe lining materials, pipe sealing materials, labor, backfilling, surface restoration, sodding, pavement replacement, sidewalk and driveway replacement, curb and gutter replacement, all testing, and all incidental costs.
3. The cost of post construction television inspection shall be paid for at the unit price per linear foot. This shall include all costs associated with the internal television inspection, such as viewing, record logs, and standard transfer media. The linear feet paid shall be as measured from the center of the upstream manhole to the center of the downstream manhole. Payment shall only be made once for any manhole-manhole segment; no additional payment shall be made for multiple inspections of the same pipe segment. Payment will not be made until the post construction television inspection video has been approved. No payment will be made for pre-construction CCTV, or cleaning.

END OF SECTION

## SP-7 TECHNICAL REQUIREMENTS AND SPECIFICATIONS

### CORROSION PROTECTION OF CONCRETE WASTEWATER STRUCTURES

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#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. This specification covers all labor, materials, equipment and services necessary to complete the installation of interior corrosion protection for new concrete wastewater structures and rehabilitation of existing concrete structures as herein specified. The entire interior surface exposed to hydrogen sulfide gas and wastewater flow shall be coated.

##### 1.2 REFERENCES

- A. ASTM D4258 – Surface Cleaning Concrete for Coating
- B. ASTM D4259 – Abrading Concrete
- C. ASTM D638 - Tensile Properties of Plastics.
- D. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
- E. ASTM D695 - Compressive Properties of Rigid Plastics.
- F. ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester.
- G. ASTM D2584 - Volatile Matter Content.
- H. ASTM D543 - Resistance of Plastics to Chemical Reagents.
- I. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.
- J. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.
- K. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
- L. SSPC SP-13/NACE No. 6 – Surface Preparation of Concrete.
- M. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.
- N. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
- O. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.
- P. Los Angeles County Sanitation District – Evaluation of Protective Coatings for Concrete.
- Q. SSPWC 210-2.3.3 - Chemical resistance testing published in the Standard Specifications for Public Works Construction (otherwise known as “The Greenbook”).

##### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Technical data sheet on each product used.
  - 2. Material Safety Data Sheet (MSDS) for each product used.
  - 3. Technical data sheet and project specific data for construction and repair materials to be topcoated with the coating product(s) including compatibility

with the specified coating product(s), application, cure time and surface preparation procedures.

B. Contractor Data:

1. Current documentation from coating product manufacturer certifying Contractor's training and equipment complies with the Quality Assurance requirements specified herein.
2. Five (5) recent references of Contractor indicating successful application of coating product(s) of the same material type as specified herein, applied by spray application within the municipal wastewater environment.
3. Letter from the coating product manufacturer providing the name and qualification(s) of the Technical Representative to be on-site in accordance with this specification.
4. All testing conditions and results.

C. Technical Representative Data:

1. The coating manufacturer's Technical Representative shall approve surfaces for application of coating at each stage.
  - a. Letter providing the surface preparation method shall be submitted to the Engineer ten (10) days before work is to begin.
  - b. Letter approving the completion of surface prep shall be submitted to the Engineer prior to concrete repair.
  - c. Letter providing the concrete repair method recommended shall be submitted to the Engineer prior to the start of the repair.

1.4 QUALITY ASSURANCE

- A. Coating product(s) shall be capable of being installed and curing properly within the specified environment(s). Coating product(s) shall be resistant to all forms of chemical or bacteriological attack found in municipal sanitary sewer systems; and, capable of adhering to the substrates and repair product(s).
- B. Repair product(s) shall be fully compatible with coating product(s) including ability to bond effectively to the host substrate and coating product(s) forming a composite system.
- C. Contractor shall utilize equipment for the spray application of the coating product(s) which has been approved by the coating product manufacturer; and, Contractor shall have received training on the operation and maintenance of said equipment from the coating product manufacturer.
- D. Contractor shall be trained by, or have their training approved and certified by, the coating product manufacturer for the handling, mixing, application and inspection of the coating product(s) to be used as specified herein.
- E. Contractor shall utilize the services of the coating product(s) manufacturer's technical representative to provide on-site inspection at the following checkpoints during the project:
  1. Completion of Section 3.2 - Surface Preparation
  2. During installation of Repair Product(s) – Section 3.3
  3. During installation of Coating Product(s) – Section 3.4
  4. During Holiday Detection inspection – Section 3.5 B
- F. Inspectors, including Contractor and coating product(s) manufacturer personnel performing inspection, shall be trained in the use of testing or inspection instrumentation and knowledgeable of the proper use, preparation and installation of the coating product(s) to be used as specified herein.

- G. Contractor shall initiate and enforce quality control procedures consistent with the coating product(s) manufacturer recommendations and applicable NACE or SSPC standards as referenced herein.
- H. Pre-construction meeting shall take place no less than two (2) weeks prior to Contractor mobilization. All parties to have physical presence on the project during construction shall be present. At this meeting responsibilities and authorities during construction shall be discerned; comments and questions regarding materials and execution of these specifications shall be presented and addressed.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Coating product(s) are to be kept dry, protected from weather and stored under cover.
- B. Coating product(s) are to be stored between 50 deg F and 90 deg F. Do not store near flame, heat or strong oxidants.
- C. Coating products(s) are to be handled according to their material safety data sheets.

#### 1.6 SITE CONDITIONS

- A. Contractor shall conform to all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
- B. Confined space entry, flow diversion and/or bypass plans shall be presented by Contractor to Owner's Representative as necessary to perform the specified work.

#### 1.7 SPECIAL WARRANTY

- A. Contractor shall warrant all work against defects in materials and workmanship for a period of one (1) year, unless otherwise noted, from the date of final acceptance of the project. Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said one (1) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner.

### PART 2 PRODUCTS

#### 2.1 EXISTING PRODUCTS

Materials, regardless of type or quantity, used to fill voids, anchor attachments or otherwise alter the surface material of concrete structures scheduled to receive coating product(s) shall be compatible with the specified coating product(s). Prior to use, technical data, material safety data sheets and proof of compatibility with the specified coating product(s) of all such materials shall be submitted to the Engineer for approval. Any materials used without prior written approval shall be removed and replaced with approved materials by Contractor without cost to Owner.

- A. Standard Portland cement or new concrete (not quick setting high strength cement) shall be cured a minimum of 28 days prior to application of the coating product(s).
- B. Remove existing coatings prior to application of the coating product(s) which may affect the performance and adhesion of the coating product(s).

- C. Thoroughly clean and prepare existing products to affect a seal with the coating product(s).

## 2.2 REPAIR PRODUCTS

- A. Repair products shall be used to fill voids, bugholes, concrete surface anomalies, and/or smooth transitions between components prior to the installation of the coating product(s). Repair materials must be compatible with the specified coating product(s) and shall be used and applied in accordance with the manufacturer's recommendations.

## 2.3 COATING PRODUCTS

- A. Manufacturers:

**Raven Lining Systems**, Broken Arrow, Oklahoma 800-324-2810, 918-615-0020 or FAX 918-615-0140;

**A.W. Chesterton**, Pasadena, Texas,

**H&H Restoration**, 817-572-2266 or FAX 817-563-5448;

**Tnemec**, Oklahoma City, Oklahoma,

**Eagle Rock Coatings**, 405-842-8366 or FAX 405-751-8379;

**Citadel**, Tulsa, Oklahoma, 918-584-2220 or FAX 918-584-2221;

**Belzona**, Oklahoma City, Oklahoma 866-397-8885 or FAX 866-935-1335;

**Warren Epoxy Coating**, Tulsa, Oklahoma, 918-697-3245 or FAX 918-248-5354.

- B. Epoxy Coating System. Epoxy coating system shall be Raven 405, Chesterton S1HB, Tnemec Series 435 Perma-Shield, Citadel SLS-30, Belzona 5811 Immersion Grade, or Warren S-301-14.
- C. Primer Product(s): Primer must be compatible with the specified coating product(s) and shall be used and applied in accordance with manufacturer's recommendations.

## 2.4 COATING APPLICATION EQUIPMENT

- A. Manufacturer approved heated plural component spray equipment.
- B. Hard to reach areas, primer application and touch-up may be performed using hand tools.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Appropriate actions shall be taken by Contractor to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety during work.
- B. All structures to be coated shall be readily accessible to Contractor.
- C. New Portland cement concrete structures shall have cured a minimum of 28 days since manufacture prior to commencing coating installation.
- D. Any active flows shall be dammed, plugged or diverted as required to ensure all liquids are maintained below or away from the surfaces to be coated.
- E. Coating product(s) application shall not occur unless the temperature of the surface to be coated is between 40 and 120 deg F.
- F. Specified surfaces should be shielded to avoid exposure of direct sunlight or other intense heat source.

- G. Surface temperature logs shall be maintained by Contractor and used to identify when temperatures vary greater than 5°F. Coating product(s) application shall be scheduled when the temperature is falling versus rising.
- H. Prior to commencing surface preparation, Contractor shall inspect all surfaces specified to receive the coating and notify Owner, in writing, of any noticeable disparity in the site, structure or surfaces which may interfere with the work, use of materials or procedures as specified herein.

### 3.2 SURFACE PREPARATION

- A. Concrete surfaces to receive coating shall be inspected prior to surface preparation to determine the condition of the surfaces specified to receive the coating product(s) and the appropriate method or combination of methods to be used for surface preparation to meet the requirements of the coating system(s) to be applied.
- B. The Manufacturer's Representative shall approve surfaces for application of coating at each stage. Any material that is coated prior to the Owner's approval shall be stripped back and recoated.
- C. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed per ASTM D-4258.
- D. Concrete fins, protrusions, burrs, sharp edges and concrete spatter shall be corrected by grinding or scraping.
- E. Unless otherwise submitted and approved by the Engineer, surfaces to receive coating shall be abrasive blasted per ASTM D-4259 to remove laitance and weak concrete to expose subsurface voids, open honeycomb and air pockets. After blasting, surfaces shall be cleaned of all loose blast grit, dust and other debris by sweeping, vacuuming, air blasting and washing as necessary.
- F. Surface preparation method(s) used shall be performed in a manner that provides a uniform, sound, clean, neutralized surface suitable for the specified coating product(s).
- G. Infiltration shall be stopped by using a material which is compatible with the repair products and is suitable for topcoating with the coating product(s).

### 3.3 APPLICATION OF REPAIR PRODUCTS

- A. Repair products shall be used to fill all voids, honeycombs, bug holes, spalls, cracks, and other surface anomalies which may affect the performance or adhesion of the coating product(s) including their use to smooth or rebuild surfaces with rough profiles to provide a minimum profile of coarse (60) abrasive paper comparative to ICRI Replicas 4-6 (ICRI Guideline 03732) and suitable for the coating product(s) to be applied.
- B. Repair products shall be handled, mixed, installed, and cured in accordance with manufacturer guidelines.
- C. All repaired surfaces shall be inspected for cleanliness and suitability to receive the coating product(s). Additional surface preparation may be required prior to coating application.

### 3.4 APPLICATION OF COATING PRODUCT(S)

- A. Application procedures shall conform to the recommendations of the coating product(s) manufacturer, including environmental controls, product handling, mixing, application equipment, and methods.



- B. Spray equipment shall be specifically designed to accurately ratio and apply the coating product(s) and shall be in proper working order.
- C. Contractors qualified in accordance with Section 1.4 of these specifications shall perform all aspects of coating product(s) installation.
- D. Prepared surfaces shall be primed by application of the waterborne epoxy primer described herein at an application rate of 200 square feet per gallon (8 mils wet film thickness). The primer shall be allowed to dry to a tack free state. The solvent-free epoxy topcoat described herein shall then be spray applied to a minimum wet film thickness of 80-100 mils.
- E. No more than 12 hours shall be permitted to pass between each application of the waterborne epoxy, the solvent-free epoxy primer and the epoxy topcoat. Subsequent topcoating or additional coats of the coating product(s) shall occur within the product's recoat window as adjusted for temperature extremes. Additional surface preparation procedures will be required if this recoat window is exceeded.
- F. Coating product(s) shall interface with adjoining construction materials throughout the structure to effectively seal and protect concrete substrates from infiltration and attack by corrosive elements. Procedures and materials necessary to effect this interface shall be as recommended by the coating product(s) manufacturer.
- G. The coating shall be terminated at a saw cut key-in with minimum dimensions of ¼" x ¼". Surfaces not to receive the coating shall be masked or otherwise protected to prevent overspray or feathering of the coating termination. Termination points of the coating product(s) shall be made at joints and a minimum of 1" interfacing with each pipe penetration, and/or as shown within Project Drawings and Specifications.

### 3.5 TESTING AND INSPECTION

- A. During application a wet film thickness gauge, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used. Measurements shall be taken, documented and attested to by Contractor for submission to Owner.
- B. After the coating product(s) have set in accordance with manufacturer's instructions, all surfaces shall be inspected for holidays with high-voltage holiday detection equipment. Reference NACE RPO 188-99 for performing holiday detection. All detected holidays as indicated by the audible or visual signal of the test apparatus shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer's recommendations. Documentation on areas tested, results and repairs made shall be provided to Owner by Contractor.
- C. A minimum of three (3) 20-mm test dollies shall be placed and pulled to evaluate adhesion/bond of the coating to the substrate for every one (1) out of five (5) rehabilitated manholes. Testing shall be conducted in accordance with ASTM D4541 as modified herein. Owner's representative shall select the location of the dolly placement including at least one (1) test in each rehabilitated manhole. The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths in excess of the coating product and permitted to cure in accordance with manufacturer's recommendations. The coating and dollies shall be adequately prepared to receive the adhesive. Failure of the dolly

adhesive shall be deemed a non-test and require retesting. Prior to performing the pull test, the coating shall be scored through approximately 90% of the coating thickness by mechanical means without disturbing the dolly or bond within the test area. Two (2) of the three (3) adhesion pulls shall exceed 200 psi or concrete failure with more than 50% of the subsurface adhered to the coating. Should a structure fail to achieve two (2) successful pulls as described above, additional testing shall be performed at the discretion of the Owner or Engineer. Any areas detected to have inadequate bond strength shall be evaluated by the Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Contractor.

- D. Before final cleanup, a final inspection of the project shall be made of the project for deviations in specifications. Deficient work should be corrected in accordance with repair procedures as approved by the Owner's Representative. The following is a list of qualities or properties that are defined and agreed upon prior to installation and should be inspected in the course of application and after completion:
- Uniform color
  - Straightness and neatness of termination lines
  - Depressions or humps which could affect liquid flow
  - Smooth transitions at cover radii, internal and external corners, intersections and terminations
  - Spatter of cured and uncured resinous materials on surfaces not being coated
  - Complete coverage
- E. The municipal sewer system may be returned to full operational service as soon as final repairs have set dry to the touch and the final inspection has taken place.
- F. This item shall be paid for by the unit price per square foot, and include all work and materials.

END OF SECTION

# **SP- 8 TECHNICAL REQUIREMENTS AND SPECIFICATIONS**

## **FIBERGLASS-REINFORCED MANHOLE LINERS**

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### **PART 1      GENERAL**

#### **1.1 Section Includes**

- A. Specification for Fiberglass-Reinforced Manhole Liners

#### **1.2 References**

ASTM D695 – Test Method for Compressive Properties of Rigid Plastics  
ASTM D790 – Test Method for Flexural Properties of Non-Reinforced and Reinforced Plastics and Electrical Insulating Materials  
ASTM D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading  
ASTM D3753 – Standard Specification for Glass-Reinforced Polyester Manholes and Wetwells

### **PART 2      PRODUCTS**

#### **2.1 MATERIALS**

- A. Resin Systems: The resins used shall be a commercial grade unsaturated polyester resin or vinyl ester resin. Resins shall be suitable for the service environment intended (i.e. domestic sanitary wastewater).
- B. Additives: Additives, when used, shall produce a laminate that is inert to the service environment intended. All particulate additives used in filament wound components shall be pre-blended with resin using a high shear mixer to assure complete wetting of particulate surfaces. Pre-blending of particulate additives shall result in a homogeneous colloidal mixture (suspension) with additives evenly dispersed and suspended throughout the resin prior and during use. Manhole components manufactured using the filament winding process shall contain no sand. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added to meet the requirements of the ASTM D-3753 standard.
- C. Reinforcing Materials: The reinforcing materials shall be commercial Grade "E" type glass in the form of continuous roving and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.
- D. Interior Surfacing Material: The inner surface exposed to the chemical environment shall be a resin-rich layer of 0.010 to 0.020-inches thick. The inner surface layer exposed to the corrosive environment shall be followed with a minimum of two passes of chopped roving length of 0.5-inches (min) to 2.0-inches (max) and shall be applied uniformly to an equivalent weight of 3 oz/ft (min). Each pass of chopped roving shall be well rolled prior to the application of additional reinforcement. The combined thickness of the inner surface and interior layer shall be 0.10 inch (min). The interior surface shall be resin rich with no exposed fibers. The surface shall be free of crazing, de-lamination, blisters larger than 0.5-inch in diameter, and wrinkles of 0.125-inch or greater in depth. Surface pits shall be permitted if they are less than

0.75-inch in diameter and less than 0.0625-inch deep. Voids that cannot be broken with finger pressure and are entirely below the resin surface shall be permitted if they are less than 0.5-inch in diameter and less than 0.0625-inch thick. Indentations or other shape imperfections that will not affect performance are allowed.

- E. Exterior Surface: Exterior surface shall be coated with 0.125-inches of gel coat as an additional water barrier. Gel coat shall be pigmented gray as an additional UV inhibitor. The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to saturate all fibers and eliminate fiber show. The exterior surface shall be free of blisters larger than 0.5-inch in diameter, de-lamination or fiber show. Indentations or other shape imperfections that will not affect performance are allowed.
- F. Repairs: All fiberglass laminate repairs are subject to meet the requirements of ASTM D3753.

## 2.2 MANUFACTURE AND CONSTRUCTION

- A. Manhole cylinders, manway reducers, and connectors shall be produced from fiberglass- reinforced polyester or vinyl ester resin using a combination of chop and continuous filament winding process.
- B. Acceptable Manufacturer: Manufacturer shall have 10-years of experience in the manufacture of fiberglass manholes for use in domestic or industrial sanitary sewer applications. Acceptable manufacturer shall have a quality control program that is currently ISO 9001 certified. Manufacturer shall be L.F. Manufacturing, Inc., Giddings, Texas (1-800- 237-5791).
- C. Wall Construction Procedure: After the inner layer has been applied, the manhole wall shall be constructed using a chop and continuous strand filament wound manufacturing process, to ensure continuous reinforcement and uniform strength and composition. Each layer of glass laminate shall be mechanically roller compacted to remove entrapped air and thoroughly saturate the glass laminate with resin prior to adding another layer of glass reinforcement. The cone section, if produced separately, shall be affixed to the barrel section at the factory with a resin-glass reinforced laminate joint resulting in a one-piece unit. Seams shall be fiberglass laminated on the inside and the outside using the same glass-resin jointing procedure. Field joints shall be performed by the Manufacturer, its agent or qualified third-party.
- D. Ribs: When used, ribs may be manufactured as a solid construction or with fiberglass laminate applied over a structural or non-structural form. The resulting structure shall meet the requirements of ASTM D3753.
- E. Assembly segments: Individual fiberglass components of manhole shall be joined by fiberglass-reinforced laminate overlay. The resulting structure shall meet the all loading and soundness requirements of ASTM D3753.
- F. Height Adjustment: Fiberglass manholes shall be height adjustable using an internal adjustment ring. Riser sections cut for height adjustment shall be rejoined by fiberglass- reinforced laminate, MacWrap or approved equal. Fiberglass manholes shall maintain all loading and soundness characteristics required by ASTM D3753 after height adjustment has occurred. Interior Access: All manholes shall be designed so that a ladder or step system can be supported by the installed manhole wall. Steps shall be installed per project specifications and local standards. Vertical spacing between steps shall be in accordance with OSHA standards (or per local

requirements). Ladder or step bolts that penetrate manhole wall shall be sealed externally by a fiberglass-reinforced laminate.

- H. Manway Reducer: Manway reducers shall be concentric or eccentric with respect to the centerline of the manhole riser section, as designated by the Owner.
- I. Ring and Cover Support Platform: Top of cone/reducer shall have a fiberglass support platform upon which concrete grade rings may be installed to accept a typical cast iron ring. For H-20 traffic loading, a 4-inch (minimum) thick concrete grade ring is required. Outside diameter of grade rings, for H-20 loading, shall exceed outside diameter of fiberglass support plate by 1-inch (min) on all sides. Grade rings, ring and cover shall be placed over fiberglass neck (chimney) and onto fiberglass support plate in a manner that evenly distributes loading. No loading shall be placed onto fiberglass neck.
- J. Marking and Identification: Each manhole shall be marked on the inside and outside with the following information:
  - Manufacturer's name or trademark
  - Manufacturer's factory location
  - Manufacturer's serial number
  - Total manhole depth.

## 2.3 DIMENSIONS

- A. Diameters: Manhole inside diameter shall meet the requirements of the project specifications and shall be measured in accordance with ASTM D3753 Section 8.3. Tolerance of inside diameter shall be +/- 1% of required manhole diameter.
- B. Length: Manhole length shall be measured from lowest bench elevation to rim elevation and be sufficient to allow for 12-inches of concrete grade rings, plus ring height.
- C. Wall Thickness: Design thickness shall be sufficient to withstand all dead and live loads imposed on the manhole for the project conditions. Manholes subject to highway traffic loading (as indicated on Plans) shall meet the requirements of AASHTO H20 as described in ASTM D3753. Wall thickness shall be 1/4" (minimum).

## 2.4 TESTING

- A. Quality Control: Each completed manhole shall be examined by the manufacturer for dimensional requirements, hardness, and workmanship. All required ASTM D3753 testing shall be completed and records of all testing shall be kept, and copies of test records shall be presented to customer upon formal written request within a reasonable time period.
- B. Manholes: Manholes shall be manufactured and tested in accordance with ASTM D3753.
- C. Load Rating: The complete manhole shall have a minimum dynamic-load rating of 16,000- pounds when tested in accordance with ASTM D3753 8.4 (note 1). To establish this rating, the complete manhole shall not leak, crack, or suffer other damage when load tested to 40,000-pounds and shall not deflect vertically downward more than 0.25-inch at the point of load application when loaded to 24,000-pounds.
- D. Pipe Stiffness: For solid wall manholes, pipe stiffness (ASTM D2412) may be physically tested or calculated using the following formula:  $PS = (EI) / (0.149r^3)$ . For rib-reinforced manholes, Manufacturer shall provide structural design method. Per

ASTM D3753, manhole cylinder shall have the minimum pipe-stiffness values shown in the table below when tested in accordance with ASTM D3753.

| <u>Depth (feet)</u> | <u>F/ΔY (psi)</u> |
|---------------------|-------------------|
| 6 or less           | 0.72              |
| 6+ to 12            | 1.26              |
| 12+ to 20           | 2.01              |
| 20+ to 25           | 3.02              |
| 25+ to 35           | 5.24              |
| 35+                 | Note <sup>1</sup> |

Note<sup>1</sup> – For depths greater than 35-feet, pipe stiffness shall be extrapolated from shallower values or Manufacturer shall provide structural design method.

E. Chemical Resistance: Manhole and all related components shall meet the chemical resistance requirements of ASTM D3753 and be fabricated from corrosion resistant material suitable for domestic wastewater collection system environments.

G. Physical Properties:

Manhole riser sections shall have the following physical properties (minimum). All test shall be performed as specified in ASTM D3753 (latest edition), section 8.

|                         | <u>Hoop</u>           | <u>Axial</u>          |
|-------------------------|-----------------------|-----------------------|
|                         | <u>Direction</u>      | <u>Direction</u>      |
| Tensile Strength (psi)  | 18,000                | 5,000                 |
| Tensile Modulus (psi)   | 0.6 x 10 <sup>6</sup> | 0.7 x 10 <sup>6</sup> |
| Flexural Strength (psi) | 26,000                | 4,500                 |
| Flexural Modulus (psi)  | 1.4 x 10 <sup>6</sup> | 0.7 x 10 <sup>6</sup> |
| Compressive (psi)       | 18,000                | 10,000                |

## 2.5 UNLOADING, STORAGE AND HANDLING

- A. Unloading - Contractor shall inspect manholes upon arrival to jobsite, ensuring that manholes have arrived undamaged. Manufacturer shall be notified of any damage immediately upon discovering.
- B. Storage - Contractor shall avoid storing manhole on rocks, uneven ground or other surface that may cause point loading or damage to manhole. Manholes with a height-to-diameter ratio greater than 2:1 shall be stored in horizontal position, prior to use. Manholes shall not be stacked upon one another.

- C. Handling - Manholes shall not be dropped or impacted in a manner that may be detrimental to manhole. Manholes may be lifted using a forklift or nylon/textile sling wrapped around the main body of manhole. Use of chains or cables in contact with the manhole surface is prohibited. Manholes shall be unloaded from trucks one at a time. Manhole may be lifted by inserting a 4" x 4" timber of sufficient length to span the manhole opening and attaching cable to midpoint of timber or by attaching a nylon/textile sling around the center of manhole.

## PART 3 EXECUTION

### 3.1 INSTALLATION PROCEDURE

- A. Alterations: Contractor shall not alter the design or construction of manhole without notification of Manufacturer and Manufacturer's written consent. Only Manufacturer and its agents may alter design or construction of manhole.
- B. Host Manhole: Contractor shall confirm depth of manhole from rim to top of bench prior to excavation of host manhole cone. Manhole liner length shall be of sufficient length to provide the proper rim elevation after being placed on host manhole's bench.
- C. Removal of Host Manhole Cone: Contractor shall remove host manhole cone (to sufficient depth for brick manholes) to expose the full diameter of the manhole. Contractor shall assure proper circumference clearance of manhole liner by lowering into host manhole prior to trimming liner to proper length.
- D. Mapping of Host Manhole: After Contractor has confirmed sufficient fit and length of manhole liner, Contractor shall measure the centerline location and outside diameters of all pipe penetrations. Contractor shall trim the manhole liner to sufficient length to reach the proper rim elevation. Contractor shall take into consideration any concrete grade rings to be used. Contractor shall trim manhole liner for all pipe penetrations at the proper centerline locations. For steeply sloped bench surfaces, manhole liner may be trimmed to match bench slope. Contractor may wish to consider using masonry or carbide tipped cutters to cut and trim manhole liner. Contractor shall use OSHA approved eye protection and dust mask while cutting and trimming liner.
- E. Grout Bulkhead: Contractor shall place a ring of uncured grout along the circumference of host manhole bench (and over crown of pipe penetrations at invert) of sufficient strength, width and thickness to provide a bulkhead seal along the bottom of the manhole liner.
- F. Manhole Liner Installation: Where recessed pipe penetrations exist, a short "bridge" pipe may be used to extend adjoining pipes farther into the manhole. Manhole liner shall be lifted by placing a textile sling around liner or by placing a 4"x4" timber of sufficient length to internally span across manway, attaching a sling to the timber and lifting. Steel cables or chains shall not be wrapped around manhole liner for lifting and handling. Contractor shall carefully lift manhole liner and lower liner into host manhole in a controlled manner. Manhole liner shall be centered within the host manhole to create equal annular space around manhole liner. Bottom edge of manhole liner shall be carefully pressed down into uncured grout ring on bench. Excess grout on interior of manhole liner shall be troweled smooth around circumference of liner to assure no gaps exist between bottom of manhole liner and the bench surface. Small amounts of additional grout may be required to seal gaps around pipe penetrations at the invert. Wooden wedges may be placed at the top of the annular space (three, recommended minimum) and evenly spaced to maintain a center position and prevent teetering of manhole liner during grouting. Wooden wedges, if used, be placed by hand only and

shall not be hammered into place. Internal drops shall be reconnected prior to annular grouting.

- G. Pipe Connections: If possible, Contractor shall utilize a non-shear coupling to attach existing pipe to pipe utilized to extend the existing pipe connections to the inside of the liner. In addition, a waterstop gasket and non-shrink grout shall be utilized to fill in the annular space between the pipe and the newly installed liner. Fiberglass shall be field applied around the pipe connection to cover any exposed grout.
- H. Annular Grouting: Contractor shall allow grout bulkhead, at bottom of manhole liner, to cure to sufficient strength to prevent flowing or yield due to annular grout pressure. Annular grout shall be poured in lifts no greater than 12" around the manhole liner and be distributed evenly prior to adding more grout. Contractor shall ensure that equal pressure is maintained on all sides of manhole liner and that manhole liner is not subjected to unbalanced external grouting loads. Annular grout shall have a compressive strength of 300-psi (minimum). Maximum height of uncured grout shall not exceed 20 vertical feet. At 20 vertical feet, Contractor shall allow grout to cure prior to adding another stage of grout. Grout shall be poured to the top of the host manhole riser.
- I. Manhole Liner Backfill: Any manhole liner extending above and beyond the host manhole shall be backfilled with select native material or  $\frac{3}{4}$ " - 1" crushed aggregate. Backfill material shall be placed in 12-inch lifts (max) and compacted to 90% Standard Proctor Density. Backfill shall be distributed evenly around the manhole for each lift and compacted evenly prior to the following lift. Care should be taken to prevent the placement of large clods, cobbles, frozen soil, and organic matter against the manhole liner.
- J. Casting and Grade Rings: Top of cone/reducer, shall be clean and free of debris prior to placing concrete grade rings onto manhole. Concrete grade rings shall be carefully lowered over fiberglass neck (chimney) and onto top of cone, in a controlled manner, so as not to cause damage to manhole. For AASHTO H20 traffic rated manholes, a 4-inch thick (min) concrete grade rings shall overhang shoulder of fiberglass grade ring platform by 1-inch. Flexible grade rings (i.e. HDPE, rubber) shall not be used on H20 traffic rated manholes. Butyl mastic sealing material shall be placed between manhole, grade rings and cast iron ring to prevent the infiltration of ground water. Cast iron ring and cover may be placed directly on top of cone for non-traffic rated manholes.
- K. Repairs: Any damage to manholes shall be reported to the Manufacturer. All repairs shall be performed by Manufacturer, its agent or qualified third-party (with Manufacturer's written consent).
- L. Exposed Concrete: Any exposed concrete inside the manhole, including the bench and invert and grade adjustment, shall be either coated with epoxy or covered with field applied fiberglass to provide corrosion protection. Contractor shall follow manufacturer's recommended cure time for any freshly applied concrete or grout prior to applying corrosion protection.



### 3.2 FIELD TESTING

Inflow/Infiltration Test: Each manhole liner shall be visually inspected for inflow/infiltration. Any inflow/infiltration in excess of project specifications shall be corrected.

### PART 4 MEASUREMENT AND PAYMENT

Payment for this item shall be made at the unit price bid per liner and placed as shown in the drawings. If the liner depth, measured from the top of bench to the top of the cover, exceeds six feet, the additional depth shall be paid for at the unit price bid per vertical foot of liner depth over six feet. This includes all materials, equipment and labor for a complete installation of a fiberglass manhole, including grade adjustment, field fitting/cutting, manhole frame and cover, pipe connections, grouting, excavation, backfill and restoration.

END OF SECTION

**SP-9 TECHNICAL REQUIREMENTS AND SPECIFICATIONS**  
**COMPOSITE MANHOLE FRAME & COVER**

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PART 1 GENERAL

1.1 MATERIAL

- A. Composite manhole frame and cover shall be made of a fiber reinforced polymer using at least 45% fiber reinforcement and thermoset resin matrix.

1.2 USABILITY

- A. Composite unit must facilitate easy removal of the cover by one person, have a 750:1 strength to weight ratio and possess no possibility of corrosion welding between the frame and cover.
- B. Composite unit shall have an integrated gasket system to reduce traffic shock, noise, and odors.
- C. Composite unit shall have Stainless Steel quarter turn paddle lock.

1.3 PEDESTRIAN SAFETY

- A. Composite unit shall be heat insulating, non-conductive, and provide skid slip performance of 0.6 according to ASTM C1028.

1.4 LOAD CARRYING CAPACITY

- A. AASHTO M306-10 H-20 & H-25 traffic requirements of 50,000 lbs., with 100,000lb ultimate load bearing.

1.5 FATIGUE PERFORMANCE

- A. Must pass 2 million cycles at 16,000 lbs. and then proof load requirements U.S. AASHTO M306-10 H-20 & H-25 or EN 124 Class A-D.

1.6 MARKINGS

- A. AASHTO M306-10
- B. Country of origin

1.7 QUALITY & WARRANTY STATEMENT

- A. Manufacturer must provide a warranty for the composite unit for 5 years.
- B. Composite manhole frame and cover must be made in the USA.

1.8 ACCEPTABLE MANUFACTURERS

- A. EJ Group, Inc. - 2600 & 3200 Series / East Jordan, MI / 1-800-874-4100 or Pre-Approved Equivalent

END OF SECTION

**SP-10      TECHNICAL REQUIREMENTS AND SPECIFICATIONS**  
**PIPE TRANSITIONS**

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PART 1    GENERAL

- 1.1    Each reach of sewer shall be constructed using the same type of pipe between the structures at each end of the reach. Transitions between pipe types may only be made at the manholes.

END OF SECTION

## SP-11 TECHNICAL REQUIREMENTS AND SPECIFICATIONS

### OWNER ALLOWANCE

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PART 1      GENERAL

1. Work covered by allowance:
  - A. Allowances have been provided in the contract for various work not identified in other bid items. Descriptions and dollar amounts are identified in Form of Bid.
  - B. The allowance shall be used for cost of materials, labor installation and overhead and profit for additional work that is not identified in the Construction Documents/Plans, and not included in the base bid lump sum.
  - C. The allowance shall be used only at the discretion of the City of Tulsa. Any allowance balance remaining at the completion of the project will be credited back to the City of Tulsa on the final Application for Payment submitted by the contractor.
  - D. The Contractor shall provide, to the City of Tulsa Representative, a written request for the use of the allowance, with a schedule of values, and all associated backup information, including any time extension required to perform the work.
  - E. Contractor shall proceed with work included in the allowance only after receiving a written order, from the City of Tulsa Representative, authorizing such work. Proceeding with work in the allowance without a written order from the City of Tulsa Representative will be at the Contractor's cost.

END OF SECTION

**SP-12 TECHNICAL REQUIREMENTS AND SPECIFICATIONS**  
**SANITARY SEWER CONSTRUCTION FORM**

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PART 1      GENERAL

1. Contractor shall complete one (1) Sanitary Sewer Construction Form for each sanitary sewer line that has been rehabilitated or constructed on this project. Sample forms may be obtained from City of Tulsa Sewer Operations.
2. Contractor shall submit forms for all sanitary sewer lines completed with each monthly payment request.
3. Sanitary Sewer Construction Form shall contain at minimum the follow information.
  - a. Project number
  - b. Project name
  - c. Contractor name
  - d. Pay Application number
  - e. Upstream manhole number
  - f. Downstream manhole number
  - g. Footage of pipe measured from manhole to manhole
  - h. Type of rehabilitation or construction method
  - i. New pipe size and material
  - j. Date completed
  - k. Service connection information as follows for each connection
    - i. Property address served
    - ii. Measurement from downstream manhole
    - iii. Clock position of connection
    - iv. Active service or capped for future service
    - v. Type of service connection at main
    - vi. Footage of service pipe installed by contractor from sewer main
    - vii. Size and material of service pipe
    - viii. Type of coupling utilized to connect to customer's existing service pipe
    - ix. Size and material of customer's existing service pipe
    - x. Depth of contractor's connection to customer's existing service pipe.
4. No additional payment will be made for completion of Sanitary Sewer Construction Form.

END OF SECTION