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**Specification, Installation Practices, QC/QA and Warranty Information**

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Structurally Independent SIPP Linings for Pressure and Non-Pressure Pipes with Diameters of 6 in. and Greater

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**SPECIFICATION, INSTALLATION PRACTICES, QC/QA AND WARRANTY INFORMATION**

**1. General Information**

- 1.1. This performance specification guideline (PSG) identifies the materials and robotic applications of a polymeric lining system for the rehabilitation of pressure and non-pressure pipes and conduits, potable water ,sanitary and storm, intended to form Spray In Place Pipe (SIPP) system within the existing, deteriorated pipe to provide a structurally independent lining.
- 1.2. The rehabilitation of pipelines shall be done by the installation of a composite lining composed of resin or polymeric materials and high-strength carbon fiber filament, which, when cured, shall be continuous and tight-fitting throughout the entire length of the original pipe. The SIPP composite lining shall extend the full length of the original pipe and provide a jointless and water-tight new structurally independent pipe-within-a-pipe. The Contractor is responsible for proper, accurate and complete installation of the SIPP using the system selected by the Contractor meeting the Owner's requirements.
- 1.3. Neither the SIPP product, system, nor its installation, shall cause adverse effects to any of the Owner's processes or facilities. The installation process for the product shall not damage the system in any way, and the use of the product shall not result in the formation or production of any detrimental compounds or by-products at the wastewater treatment plant. The Contractor shall notify the Owner and identify any by-products produced as a result of the installation operations, test and monitor the levels, and comply with any and all local waste discharge requirements. The Contractor shall cleanup, restore existing surface conditions and structures, and repair any of the SIPP system determined to be defective. The Contractor shall conduct installation operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, businesses and property owners or tenants.
- 1.4. The prices submitted by the Contractor, shall include all costs of permits, labor, equipment and materials for the various bid items necessary for furnishing and installing, complete in place, SIPP in accordance with these specifications. All items of work not specifically mentioned herein which are required, by the contractor, to make the product perform as intended and deliver the final product as specified herein shall be included in the respective lump sum and unit prices bid.
- 1.5. SIPP Technology encompasses many different market sectors such as municipal, industrial, as well as, governmental. The work related to this PSG shall include host pipe physical and structural conditions, lining design, lining materials, requirements for lining cleaning and pre-lining preparation, spray lining procedure, post-lining inspection and verification for structurally independent SIPP lining

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systems. If there are conflicts between this PSG and the instruction from the lining material manufacturer, more stringent document will be used to enforce the work. Conflicts between this specification, instructions from the lining material manufacturer, and other specifications shall be immediately brought to the attention of the owner or the owner's representative. The owner or the owner's representative shall make the final decision or interpretation of the specification.

- 1.6. Since the pipeline rehabilitation/reconstruction products are intended to have a 50-year design life, and to minimize the owner's risk, only proven products with supporting scientific and empirical data shall be approved. For the SIPP product and installation contractors to be deemed commercially acceptable and approved for applying structurally lining, they must meet the criteria stated in this PSG.
- 1.7. This PSG covers all work necessary to furnish and install the SIPP system. The Contractor shall provide all materials, labor, equipment, and services necessary for traffic control, bypass pumping and/or diversion of flows, cleaning and television inspection of pipelines to be rehabilitated, lining installation, reconnection of service connections, all quality controls, provide samples for performance of required material tests, final television inspection, testing of the rehabilitated pipe system, warranty work and other work, all as specified herein.
- 1.8. The product furnished shall be a complete SIPP system including specific materials, applicable equipment and installation procedures. The SIPP system manufacturer may submit, a minimum of 14 calendar days in advance of the bid date, required information to the Owner to obtain pre-approval status. Those SIPP systems that have been pre-approved will not be required to furnish information as required in the submittal section of these specifications unless specifically requested to do so by the Owner or if any of the SIPP system components have changed from those pre-approved by the Owner. All other SIPP systems or multi-component products will be required to meet the submittal requirements as contained herein.
- 1.9. The SIPP system shall be continuous and jointless from manhole to manhole or access point to access point and shall be free of all defects that will affect the long-term life and operation of the pipe.
- 1.10. The SIPP system shall bond sufficiently to the existing pipe so as to not leak at the manholes, service connections or other discontinuities in the installed pipe. If leakage occurs at any discontinuity, the Contractor shall seal these areas to stop all leakage using a material compatible with the SIPP system as approved by the manufacturer and as directed by the Owner at the price bid in the Proposal. If leakage occurs through the wall of the pipe, the SIPP system shall be repaired or removed as recommended by the SIPP manufacturer. Final approval of the SIPP system will be based on a leak tight pipe.

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- 1.11. The SIPP system shall be designed for a life of 50 years or greater and an equal service life unless specified otherwise by the Owner.
- 1.12. The SIPP system should contain filament reinforcement to ensure a creep-resistance life of 50 years or an equal service life unless specified otherwise by the Owner.
- 1.13. The SIPP system may be designed to resist external groundwater pressures only or as a structurally independent pipe-within-a-pipe. If the design is for groundwater, only the design groundwater level is required for external loads. If specified in the contract documents, the installed SIPP system shall be a structurally designed pipe-within-a-pipe, meeting or exceeding all contract specified physical properties, fitting tightly within the existing pipe all within the tolerances specified. The installed SIPP system shall withstand all applicable internal loads (internal pressure, surge pressure, etc.), surcharge loads (soil overburden, live loads, etc.) and external hydrostatic (groundwater) pressure, if present, for each specific installation location.
- 1.14. All existing and confirmed active service connections and any other service laterals to be reinstated, as directed by the Owner, shall be re-opened robotically or by hand in the case of man-entry size piping, to their original shape and to 90% - 95% of their original area. All over-cut or under-cut service connections will be properly repaired to meet the requirements of these specifications.
- 1.15. All materials furnished, as part of this contract shall be marked with detailed product information, stored in a manner specified by the manufacturer and tested to the requirement of this contract.
- 1.16. Testing and warranty inspections shall be executed by the Owner. Any defects found shall be repaired or replaced by the Contractor.
- 1.17. The Contractor shall furnish, from the project installation, all samples for product testing at the request of the Owner. The Owner shall take possession of the samples for testing and shall maintain the chain of custody, deliver the samples to an approved laboratory and pay for all material and product testing performed under this contract.

## **2. References**

The following documents form a part of this specification to the extent stated herein and shall be the latest editions thereof. Where differences exist between codes and standards, the requirements of these specifications shall apply. All references to codes and standards shall be to the latest revised version.

ASTM-C1557 Standard Test Method for Tensile Strength and Young's Modulus of Fibers

ASTM-D149 Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

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- ASTM-D543 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
- ASTM-D570 Standard Test Method for Water Absorption of Plastics
- ASTM-D638 Standard Test Method for Tensile Properties of Plastics
- ASTM-D732 Standard Test Method for Shear Strength of Plastics by Punch Tool
- ASTM-D790 Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- ASTM-D1599 Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
- ASTM-D2240 Standard Test Method for Rubber Property—Durometer Hardness
- ASTM-D2990 Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
- ASTM-D2992 Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
- ASTM-D4060 Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- ASTM-D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- ASTM-D6289 Standard Test Method for Measuring Shrinkage from Mold Dimensions of Molded Thermosetting Plastics
- ASTM F1216 Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
- ASTM-F2207 Standard Specification for Cured-in-Place Pipe Lining System for Rehabilitation of Metallic Gas Pipe
- ASTM-G14 Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
- AWWA-C600 Installation of Ductile-Iron Mains and Their Appurtenances

### **3. Materials**

- 3.1. The SIPP System must meet the chemical resistance requirements of these contract documents. All materials shipped to the project site shall be accompanied by test reports certifying that the material conforms to the ASTM standards listed herein. Materials shall be shipped, stored, and handled in a manner consistent with written recommendations of the SIPP system manufacturer to avoid damage. Damage includes, but is not limited to, hydrating, freezing, spilling, mixing, contaminating of lining material, and cutting, fuzzing or ultra-violet (UV) degradation of carbon fiber filament. On site storage locations shall be approved by the Owner. All damaged materials shall be promptly removed from the project site at the Contractor’s expense and disposed of in accordance with all current applicable agency regulations.

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### 3.2. Lining material

- 3.2.1. The lining material shall consist of a thermosetting polymer, specifically designed for the use in pipeline applications.
- 3.2.2. The two-component, thermosetting, corrosion resistant lining materials shall be solvent free. In addition, for potable water pipe systems, the lining materials shall be NSF/ANSI 61 certified for use in the appropriate pipe diameter and at the applied thickness, when used in accordance with curing and restoration requirements of the certification.
- 3.2.3. The lining material shall have low viscosities that enable the pumping of the material components to a robotic application device.
- 3.2.4. The lining material shall be able to generate a high-build, slump-resistant lining.
- 3.2.5. The lining material must be able to be applied over a wide range of temperatures (32 °F to 120 °F).
- 3.2.6. The lining material must be moisture tolerant to produce a hard, smooth lining with excellent water & chemical resistance and long-term durability. The lining material shall meet the chemical resistance requirements of ASTM F1216.
- 3.2.7. The lining material shall be able to achieve required lining thickness while completely encapsulating all pipe welds, rivets, joints and edges.
- 3.2.8. The lining material shall have an initial rapid cure time (gel time) or thixotropic nature necessary to prevent sagging, dripping, or puddling of the lining material.
- 3.2.9. At 75 °F, the cure time of the lining material to be tack free shall not exceed 10 minutes, and normal immersion use shall not exceed 24 hours.
- 3.2.10. No primers are required for the lining material to achieve proper performance.
- 3.2.11. The lining material shall contain no volatile organic compounds (VOC) or solvents.
- 3.2.12. Laboratory testing report in accordance with ASTM or AWWA procedures as cited.
- 3.2.13. All lining materials within the lining system shall be produced and supplied by the same manufacturer.
- 3.2.14. When applied, the material shall produce a continuous, cured, smooth lining of consistent thickness, absent of serious lining faults.
- 3.2.15. The lining material shall have a minimum unopened shelf life of six months.
- 3.2.16. The lining shall have fluid resistance/permeability and long-term durability for a minimum 50-year design life.

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- 3.2.17. The two components shall be supplied in two distinct colors, when mixed together in the proper ratio, the mixed material shall produce a third distinct color.
- 3.3. Reinforcement filaments
  - 3.3.1. Reinforcement filaments are added in the lining structure to significantly increase the strength of the lining. The filament shall possess high tensile strength, modulus, long continuous length. The reinforcement filaments shall be chemically inert.
  - 3.3.2. The reinforcement filaments, normally carbon fiber, shall have uniform thickness, high strength and modulus that meet the requirements of these contract documents.
  - 3.3.3. The filaments shall be uniformly impregnated with UV initiated resin and wound on spools for storage before the lining application.
  - 3.3.4. The fiber shall be properly stored to avoid UV light activation of resin.
- 3.4. Structural requirements
  - 3.4.1. The physical properties and characteristics of the finished SIPP will vary considerably, depending on the types and mixing proportions of the materials used and the degree of cure executed. It shall be the responsibility of the Contractor to control these variables and to provide a SIPP system which meets or exceeds the minimum properties specified herein.
  - 3.4.2. The SIPP shall be designed as per the appendixes of ASTM F1216 The SIPP system design shall assume no bonding to the original pipe wall.
  - 3.4.3. The design engineer shall set the long-term (50 year extrapolated) Creep Retention Factor at a default of 50% of the initial design flexural modulus as determined by ASTM D790 test method. This value shall be used unless the Contractor submits long-term test data (ASTM D2990) to substantiate a different retention factor.
  - 3.4.4. The cured pipe material (SIPP) shall, at a minimum, meet or exceed the structural properties, as listed below.
- 3.5. Minimum physical properties
  - 3.5.1. The physical properties of SIPP lining material are variant depending on the polymeric type (epoxy, polyurea, polyurethane, hybrid) and their formulation (additives, etc.). The manufacturer shall provide all the testing data of the material properties of polymeric materials, fiber or fabric as required by TABLE 1 to TABLE 4, as part of material submittals.
  - 3.5.2. Closed cell porous elastomeric material shall comply with the properties and requirements in TABLE 1.

**TABLE 1 Initial Properties-Closed Cell Porous Elastomer Polymeric Materials**



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| Short Term Property <sup>A</sup>                                    | Test Method | Minimum Value |        |
|---|-------------|---------------|--------|
|   |             | psi           | (MPa)  |
| Tensile modulus   | D638        | 400           | (2.76) |
| Tensile strength  | D638        | 300           | (2.07) |
| Adhesion  | D4541       | 300           | (2.07) |
| Elongation  | D638        | 400%          |        |
| Dielectric Strength   | D149        | 250V/mil      |        |
| Long Term Property <sup>B</sup>                                     |             |               |        |
| 50 years design life retention of modulus and mechanical properties | D2990       | 50%           |        |

<sup>A</sup> The minimum values as certified by the manufacturer to the user for field sample testing in Table 1.

<sup>B</sup> The user should require the manufacturer to provide test results per Test Method D2990 to verify long-term structural properties.

3.5.3. Reinforcement filament material shall comply with the properties and requirements in TABLE 2.

**TABLE 2 Initial Properties-Filament Reinforcement Materials**

| Property         | Test Method | Minimum Value |           |
|------------------|-------------|---------------|-----------|
|                  |             | psi           | (MPa)     |
| Tensile modulus  | C1557       | 30 000 000    | (206 843) |
| Tensile strength | C1557       | 500 000       | (3 447)   |
| Elongation       | C1557       | 1.5%          |           |

3.5.4. Rigid polymeric materials shall comply with the properties and requirements in TABLE 3.

**TABLE 3 Initial Properties-Rigid Polymeric Materials**

| Short Term Property <sup>A</sup> | Test Method | Minimum Value |       |
|----------------------------------|-------------|---------------|-------|
|                                  |             | psi           | (MPa) |

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|  |              |               |         |
|--|--------------|---------------|---------|
| Flexural modulus   | D790         | 350 000       | (2 413) |
| Flexural strength  | D790         | 9 000         | (62)    |
| Tensile modulus  | D638         | 350 000       | (2 413) |
| Tensile strength   | D638         | 7 000         | (48)    |
| Shear Strength   | D732         | 5 000         | (34)    |
| Adhesion (steel) <sup>B</sup>  | D4541        | 800           | (5.5)   |
| Elongation   | D638         | 3%            |         |
| Hardness- Shore D  | D2240        | 75            |         |
| Dielectric strength  | D149         | 250V/mil      |         |
| Impact Resistance  | G14          | 75 in-lbs     |         |
| Long Term Property <sup>C</sup>                                      |              |               |         |
| 100 years design life retention of modulus and mechanical properties | D2990        | 50%           |         |
| Short Term Property <sup>A</sup>                                     |              | Maximum Value |         |
| Abrasion resistance <sup>D</sup>                                     | D4060        | 100 mg loss   |         |
| Water absorption   | D570         | 2%            |         |
| Thermosetting shrinkage  | D6289        | 2%            |         |
| Chemical resistance <sup>E</sup>                                     | D543 & F2207 | pass          |         |

<sup>A</sup> The minimum values as certified by the manufacturer to the user for field sample testing in Table 3.

<sup>B</sup> Concrete-300 psi or substrate failure.

<sup>C</sup> The user should require the manufacturer to provide test results per Test Method D2990 to verify long-term structural properties.

<sup>D</sup> C17 wheel - 1,000 g/1000 cycles.

<sup>E</sup> The user should require the manufacturer to provide test results per Test Method D543 and F2207 to verify chemical resistance properties.

3.5.5. Burst pressure test shall comply with the properties and requirements in TABLE 4.

**TABLE 4 Lining Bursting Tests**

| Property <sup>A</sup> | Test Method | Minimum Value |
|-----------------------|-------------|---------------|
|-----------------------|-------------|---------------|

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|   |       |          |
|---|-------|----------|
| Short-Time Hydraulic Pressure of Lining System  | D1599 | 2 × MAOP |
| Long-term Hydrostatic Pressure of Lining System | D2992 | 2 × MAOP |

<sup>A</sup> The hydraulic testing results for large diameter lining system can be obtained from modified D1599 and D2992 tests or extrapolated from the test results of small diameter lining systems.

- 3.5.6. The required structural SIPP wall thickness shall be based, as a minimum, on the physical properties of the cured composite and per the design of the Professional Engineer and in accordance with the Design Equations contained in the appendix of ASTM F1216 and the following design parameters:

**TABLE 5 Lining Design Parameters**

|                              |  |
|------------------------------|--|
| Design Safety Factor         | 2.0 (1.5 for pipes 36" or larger, if applicable) |
| Creep Retention Factor       | 50%  |
| Ovality                      | 2% or as measured by field inspection            |
| Constrained Soil Modulus     | Per AASHTO LRFD Section 12 and AWWA Manual M45   |
| Groundwater Depth            | As specified or indicated on the Plans           |
| Soil Depth (above the crown) | As specified or indicated on the Plans           |
| Live Load                    | Highway, railroad or airport as applicable       |
| Soil Load (assumed)          | 120 lb./cu. ft.                                  |
| Minimum Service Life         | 50 years   |

- 3.5.7. The Contractor shall submit, prior to installation of the lining materials, certification of compliance with these specifications and/or the requirements of the pre-approved SIPP system. Certified material test results shall be included that confirm that all materials conform to these specifications and/or the pre-approved system. Materials not complying with these requirements will be rejected.
- 3.5.8. The design soil modulus may be adjusted based on data, determined from detailed project soil testing results, as provided by the Owner in the contract documents.

**4. Lining Equipment**

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- 4.1. All the lining equipment planned to be used during the lining process shall be identified and explained in detail in the Performance Work Statement (PWS) submitted by the contractor. The lining equipment shall not be used in lining process until approved by the Owner.
- 4.2. Lining equipment used to apply the lining material shall be suitable for the intended work and meet the requirements of the lining material manufacturer.
- 4.3. Lining equipment used for application of lining shall be suitable to store, heat, move, and mix the lining material and function in accordance with the lining manufacturer's instructions for use.
- 4.4. Lining Equipment shall be capable of providing necessary heat, flow and pressure required for lining installation conditions.
- 4.5. Lining equipment heat sources shall be equipped with suitable monitors to gauge temperatures of lining material components.
- 4.6. Lining equipment used to pressurize and pump the lining material shall be equipped with flow meters and pressure gauges capable of monitoring the individual components of lining material to ensure material mixing within manufacturer's recommended tolerances for the specified mixing ratio. The mixing ratio shall meet the requirements from the lining material manufacturer.
- 4.7. Lining equipment flow meters and pressure monitors shall provide a continuous record of the information:
- 4.8. Volume and flow of material to the material casting assembly,
- 4.9. Pressure in all component hoses.
- 4.10. Lining equipment shall be capable of autonomous axial centering of the material casting assembly (application head, spinner, spinner cone, etc.) during all lining processes to assure uniform lining material dispersion and lining thickness.
- 4.11. Lining or ancillary equipment shall be capable of filling or applying thin adhesive membrane over all cracks, perforations and other discontinuities in the pipe prior to lining.
- 4.12. Lining equipment shall be capable of applying low Poisson's ratio closed cell elastomer as the initial bonding layer and a high tensile rigid layer to form the composite lining.
- 4.13. Lining equipment shall be capable of incorporating a reinforcing filament or fabric into the composite lining concurrently with the rigid lining installation process. Lining equipment shall incorporate helically and axially or both oriented reinforcing filaments into or onto the lining material concurrently with the lining installation process.
- 4.14. Lining equipment (umbilical and casting assembly) shall be capable of self-propulsion.
- 4.15. Lining equipment shall be equipped with an umbilical for the conveyance of fluids or communications or electrical power or combinations thereof between lining rig

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and lining device to be fully autonomous. Umbilical or tether equipment shall be capable of self-propulsion.

- 4.16. Lining equipment shall be capable of applying highly accurate and consistent material dispersion in any diameter of pipe.
- 4.17. Lining equipment shall be capable of real time lining thickness measurement at no less than four (4) points circumferentially on the lining surface with no less than 85 degrees separating any measurement point. Lining equipment shall consist of a real-time lining material thickness measurement and verification system.
- 4.18. Lining equipment shall be capable of traversing and lining through short radius ninety-degree (90°) pipe bends or mitered bends for the pipe diameter being lined.
- 4.19. Lining or ancillary equipment shall be capable of autonomously cleaning and sanitizing umbilical's/tethers prior to entry into the pipe for potable water applications.
- 4.20. Lining equipment shall be capable of real time, onboard video monitoring and recording of the lining process.
- 4.21. Lining equipment shall be capable of recording all lining video with time/date stamp. Lining equipment shall also be capable of reporting and documenting lining location, thickness and lining material processing data during lining operation.

### **5. Submittals**

- 5.1. The Contractor shall submit, to the Owner a Performance Work Statement (PWS) which clearly defines the SIPP product delivery in conformance with the requirements of these contract documents. Unless otherwise directed by the Owner, the PWS shall at a minimum contain the following:
  - 5.1.1. Clearly indicate that the SIPP system will conform to the project requirements as outlined in the Description of Work and as delineated in these specifications.
  - 5.1.2. Where the scope of work is specifically delineated in the contract documents, a detailed installation plan describing all preparation work, cleaning operations, pre-CCTV inspections, bypass pumping, traffic control, installation procedure, service reconnection, quality control, testing to be performed, final CCTV inspection, warranties furnished and all else necessary and appropriate for a complete lining installation. A detailed installation schedule shall be prepared, submitted and conform to the requirements of this contract.
  - 5.1.3. Contractor's description of the proposed SIPP system, including a detailed plan for identifying all active service connections maintaining service, during mainline installation, to each home connected to the section of pipe being lined, including temporary service for commercial, industrial and apartment complexes, if required by the contract.

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- 5.1.4. A description of the SIPP materials to be furnished for the project. Materials shall be fully detailed in the submittals and conform to these specifications and/or shall conform to the pre-approved product submission.
- 5.1.5. A statement of the Contractor’s training and certification. All contractors shall finish comprehensive (class-room and field) training by the SIPP material manufacturer or third-party organization, or both, prior to becoming approved for lining applications, and shall be re-approved annually thereafter. Contractors are subject to periodic training updates and field-level quality control checks by the manufacturer, which shall be documented in a written program. All contractors shall be in possession of proper training approvals for their field personnel and have copies of application procedures and field quality control records on site for review and oversight by the owner. The name and experience of each lead individual performing work on this contract shall be submitted with the PWS. Personnel replaced by the contractor, on this contract, shall have similar, verifiable experience as the personnel originally submitted for the project.
- 5.1.6. Engineering design calculations for each length of lining to be installed including the thickness of each proposed SIPP system shall be finished in accordance with ASTM F1216 The design for the lining shall be submitted to the Contract Administrator for approval 14 Days prior to installation. The design calculations shall show technical assumptions, identify the design formulas used and show the wall thickness and finished inside diameter. The design shall graphically illustrate the installation conditions, i.e., depth of pipeline, water table, pipe invert and crown, and full details of the parameters used. It will be acceptable for the Contractor to submit a design for the most severe line condition and apply that design to all the line sections. These calculations shall be performed and certified by a qualified, Professional Engineer. All calculations shall include data that conforms to the requirements of these specifications or has been pre-approved by the Owner.
- 5.1.7. Proposed manufacturers technology data shall be submitted for all SIPP products and all associated technologies to be furnished.
- 5.1.8. Submittals shall include information on the SIPP system intended for installation and all tools and equipment required for a complete installation. The PWS shall identify which tools and equipment will be redundant on the job site in the event of equipment breakdown. All equipment to be furnished for the project, including proposed back-up equipment, shall be clearly described. The Contractor shall outline the

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- mitigation procedure to be implemented in the event of key equipment failure during the installation process.
- 5.1.9. A detailed description of the Contractor’s proposed procedures for removal of any existing blockages in the pipeline that may be encountered during the cleaning process.
  - 5.1.10. A detailed public notification plan shall be prepared and submitted including detailed staged notification to residences affected by the SIPP system installation.
  - 5.1.11. An odor control plan shall be submitted, by the contractor, that will ensure that project specific odors will be minimized at the project site and surrounding area.
  - 5.1.12. Compensation for all work required for the submittal of the PWS shall be included in the various pipelining items contained in the Proposal.
- 5.2. Product submittals require the contractor to submit the materials to be incorporated in the installation. This also allows the contractor to submit alternative materials that may be equal or better than those specified. The engineer must be prepared to evaluate alternative materials through evaluation, certifications and third party testing to validate the alternative materials to meet the specified requirements of the contract.
- 5.2.1. Contractor shall submit test results of all lining materials and reinforcement filaments from USA accredited, independent laboratory for all required material tests.
  - 5.2.2. The Contractor must have performed long-term testing for flexural creep of the SIPP material installed by his Company and performed by USA accredited, independent laboratory. Such testing results are to be used to determine the long- term, time dependent flexural modulus to be utilized in the product design.
  - 5.2.3. Carbon fiber—including the manufacturer and description of product components, such as number of filaments, tensile strength, tensile modulus, elongation, density, filament diameter, UV initiated resin material, and Spectroscopic Wavelength diagram for the UV resin being furnished.
  - 5.2.4. Raw Lining Material Data - including the manufacturer and description of product components including the color, density, viscosity, mixing ratio, storage temperature, unopened shelf life, application, and precautions.
  - 5.2.5. Manufacturers’ shipping, storage and handling recommendations for all components of the SIPP system.
  - 5.2.6. All Safety Data Sheets (SDS) for all materials to be furnished for the project.

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- 5.2.7. A complete description of the proposed lining procedure for the proposed technology. The manufacturer’s recommendation and/or requirements for the pipe cleaning, preparation, and inspection, lining thickness of composite lining, reinforcement filament pitch distance, lining cure time, and post-lining inspection. The PWS shall contain a detailed lining procedure outlining the curing method for the reinforcement filament and the lining materials, the method of application and how the lining process and lining thickness will be monitored.
- 5.2.8. Compensation for all work required for the submittal of product data shall be included in the Lump Sum price contained in the Proposal for Mobilization.

### **6. Construction Requirements**

#### 6.1. Safety

- 6.1.1. The Contractor shall conform to all work safety requirements of pertinent regulatory agencies, and shall secure the site for the working conditions in compliance with the same. The Contractor shall erect such signs and other devices as are necessary for the safety of the work site.
- 6.1.2. The Contractor shall perform all of the Work in accordance with all applicable OSHA standards. Emphasis shall be placed upon the requirements for entering confined spaces and with the equipment being utilized for pipe renewal.
- 6.1.3. The Contractor shall submit a proposed Safety Plan to the Owner, prior to beginning any work, identifying all competent persons. The plan shall include a description of a daily safety program for the job site and all emergency procedures to be implemented in the event of a safety incident. All work shall be conducted in accordance with the Contractor’s submitted Safety Plan.
- 6.1.4. Compensation for all work required for the submittal of the Safety Plan shall be included in the various pipelining items contained in the Proposal.

#### 6.2. Quality control

- 6.2.1. A detailed quality control plan (QCP) shall be submitted to the Owner that fully represents and conforms to the requirements of these specifications. At a minimum the QCP shall include the following:
  - 6.2.1.1. A detailed discussion of the proposed quality controls to be performed by the Contractor.
  - 6.2.1.2. Defined responsibilities, of the Contractor’s personnel, for assuring that all quality requirements for this contract are met. These shall be assigned, by the Contractor, to specific personnel who is approved by the lining material manufacturer.



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- 6.2.1.3. Proposed procedures for quality control, product sampling and testing shall be defined and submitted as part of the plan.
- 6.2.1.4. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form.
- 6.2.1.5. Scheduled performance and product test result reviews between the Contractor and the Owner at a regularly scheduled job meeting.
- 6.2.1.6. Inspection forms and guidelines for quality control inspections shall be prepared in accordance with the standards specified in this contract and submitted with the QCP.
- 6.2.2. Two (2) days of inspector training, by the SIPP system manufacture, for the Owner’s inspectors shall be provided. This training shall be prior to lining installation, include both technical and field training and include all key aspects of visual inspection and sampling procedures for testing requirements. On smaller projects having an estimated duration of less than two (2) weeks of installation work, the system manufacturer shall furnish a check list containing key elements of the SIPP installation criteria that are important for the Owner’s inspector to ensure that quality control and testing requirements are performed in accordance with the contract documents.
- 6.2.3. Compensation for all work required for the submittal of the QCP shall be included in the various pipelining items contained in the Proposal. Compensation for inspector training shall be included in the price bid in the Proposal.
- 6.2.4. Contractor shall provide a NACE and/or SSPC and/or manufacturer approved lining inspector for QA/QC to be reviewed and approved by the owner. The QA/QC Lining Inspector will verify the overall lining was performed in the field per the requirements of this specification.
- 6.2.5. The QA/QC Lining Inspector shall review and certify that all tests results specified in the contract document are met. Contractor shall repair any damaged lining per manufacturer’s repair procedures that result from the QA/QC testing at no additional cost to the owner.
- 6.2.6. All pipe cleaning, surface preparation, and lining activities shall be inspected by the QA/QC Lining Inspector and approved by the owner. The contractor shall also notify the owner sufficiently in advance so as to be present during the following activities to witness the operations on site:
  - 6.2.6.1. The completion of pipe cleaning,
  - 6.2.6.2. The completion of surface preparation,
  - 6.2.6.3. Lining thickness measurements,

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- 6.2.6.4. During any lining repair.
- 6.2.7. The QA/QC Lining Inspector shall perform visual, CCTV inspections and dry lining thickness measurements after lining process. The QA/QC Lining Inspector shall submit daily reports to the owner for records. Reports shall include the following information as included but not limited to:
  - 6.2.7.1. CCTV color recording of the pipe line before and after cleaning prior to the lining process,
  - 6.2.7.2. Environmental conditions prior to lining application, including surface temperature, ambient air temperature, relative humidity and dew point,
  - 6.2.7.3. Observations of pipe cleaning and surface preparation,
  - 6.2.7.4. Temperature and Flow (GPM) of lining material during lining operations,
  - 6.2.7.5. Lining thickness measurements.
- 6.2.8. Contractor shall touch up any areas, where QA/QC lining inspection was performed, to the satisfaction of the QA/QC Lining Inspector, and reviewed and approved by the owner.
- 6.2.9. Contractor shall prepare samples of the lining material on pieces of steel, either salvaged from the removal of steel pipe from the existing pipeline or from material procured by the lining applicator, in a manner consistent with the application technique being used. The curing of samples shall be done in a like environment in which the pipe lining will be cured. The samples for bond strength, mechanical properties, porosity (holidays) and lining thickness shall be tested by USA accredited, independent laboratory. The test results will be reviewed and approved by the owner.
- 6.3. On-site activities
  - 6.3.1. Preparation, cleaning, inspection, flow bypassing and public notification. The Contractor shall clean the interior of the existing host pipe prior to installation of the lining. All debris and obstructions that will affect the installation and the final SIPP product delivery to the Owner shall be removed and disposed.
  - 6.3.2. The lining shall be constructed of materials and methods that, when installed, shall provide a jointless and continuous structurally sound SIPP to withstand all imposed static, and dynamic loads on a long-term basis.
  - 6.3.3. The Contractor may, under the direction of the Owner, utilize any of the existing manholes in the project area as installation access points. If a street must be closed to traffic because of the location of the pipeline, the Contractor shall furnish a detailed traffic control plan and all labor and

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equipment necessary. The plan shall be in conformance with the requirements of the local agency having jurisdiction over traffic control.

- 6.3.4. Cleaning of Pipe Lines – Before ordering lining materials for the project, the Contractor shall remove all internal debris from the pipe line that will interfere with the installation and the final product delivery of the SIPP, as required in these specifications, and accurately measure and document the exact size of the existing pipeline to be rehabilitated. Solid debris and deposits shall be removed from the system and disposed of properly by the Contractor. Moving material from manhole section to manhole section shall not be allowed. As applicable, the contractor shall either plug or install a flow bypass pumping system to properly clean the pipelines. Precaution shall be taken by the Contractor in the use of cleaning equipment to avoid damage to the existing pipe. The repair of any damage, caused by the cleaning equipment, shall be the responsibility of the Contractor. The Owner will designate a site for the disposal of all debris removed from the Owner’s sewer system as a direct result of the cleaning operation. Unless otherwise specified by the Owner, the Contractor shall dispose of all debris at no charge. Should any dumping fees apply, the Contractor shall be compensated at the respective unit price bid in the Proposal for cleaning.
- 6.3.5. Bypassing Existing Flows - The Contractor shall provide for the flow of existing mainline and service connection effluent around the section or sections of pipe designated for SIPP installation. With most small diameter pipelines, particularly on terminal sewers, plugging will be adequate but must be monitored on a regular basis to prevent backup of sewage into adjacent homes. Service connection effluent may be plugged only after proper notification to the affected residence and may not remain plugged overnight. Installation of the lining shall not begin until the Contractor has installed the required plugs or a sewage bypass system and all pumping facilities have been installed and tested under full operating conditions including the bypass of mainline and side sewer flows. Once the installation has begun, existing flows shall be maintained, until the lining composite is fully cured and televised. The Contractor shall coordinate sewer bypass and flow interruptions with the Owner at least 14 days in advance and with the property owners and businesses at least 1 business day in advance. The pump and bypass lines shall be of adequate capacity and size to handle peak flows. The Contractor shall submit a detail of the bypass plan and design to the Owner before proceeding with any SIPP installation. Compensation for bypass pumping

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- and all associated plans and approvals shall be at the price bid in the Proposal.
- 6.3.6. Contractor shall perform post-cleaning video inspections of the pipelines. Only PACP certified personnel trained in locating breaks, obstacles and service connections by closed circuit television shall perform the inspection. The Contractor shall provide the Owner a copy of the pre-cleaning and post-cleaning video and suitable log, and/or in digital format, for review prior to installation of the SIPP and for later reference by the Owner.
- 6.3.7. Line Obstructions - It shall be the responsibility of the Contractor to clear the line of obstructions that will interfere with the installation and long-term performance of the SIPP. If pre-installation inspection reveals an obstruction, misalignment, broken or collapsed section or sag that was not identified as part of the original scope of work and will prohibit proper installation of the SIPP, the Contractor may be directed by the Owner to correct the problem(s) prior to installation by utilizing open cut repair methods. The Contractor shall be compensated for this work under a contingency pay item designated for open cut point repairs. Removal of any previously unknown obstructions shall be considered as a changed condition. The cost of removal of obstructions that appeared on pre-bid video documentation and made available to the Contractor, prior to the bid opening, shall be compensated for on a unit price basis in accordance with the contract documents.
- 6.3.8. The Contractor shall be responsible for confirming the locations of all branch service connections prior to installing the SIPP. If required in the contract documents, each connection will be dye tested to determine whether or not the connection is live or abandoned. The cost for dye testing of existing service connections shall be compensated at the unit price bid in the Proposal for Dye Testing of Existing Service Connections. In the event the status of a service connection cannot be adequately defined, the Owner will make the final decision, prior to installation of the lining, as to the status. Typically, only service connections deemed “active” shall be reopened by the Contractor.
- 6.3.9. The Contractor shall be allowed use water from an owner-approved fire hydrant in the project vicinity. Use of an approved double check backflow assembly shall be required. Contractor shall provide his own approved assembly. Contractor shall pay current market price for all water usage.
- 6.4. Delivery, storage, and handling of lining material

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- 6.4.1. The lining material shall be delivered to the project site in unopened, sealed containers and labeled with the manufacturer's identification and printed instructions for use.
- 6.4.2. Care shall be taken during transportation, handling, and installation of lining material and safety procedures shall be maintained in accordance with SDS.
- 6.4.3. Lining material shall be stored in original sealed containers in a dry environment at a temperature specified by the material manufacturer.
- 6.5. Pipe cleaning
  - 6.5.1. The lining applicator shall perform a mechanical cleaning with a device specifically manufactured for the purpose of cleaning the pipe of the same diameter of the pipe to be lined to the requirements of the lining system to be applied. This includes the removal of corrosion by products; chemicals or other deposits; loose or deteriorated remains of old lining material; and oils, grease, and accumulations of water, dirt, and debris.
  - 6.5.2. Several lining techniques are available for removing corrosion, debris and encrustation and preparing the existing pipe:
    - 6.5.2.1. Power Boring,
    - 6.5.2.2. Drag Scraping,
    - 6.5.2.3. Air Scouring,
    - 6.5.2.4. High Pressure Water Jetting,
    - 6.5.2.5. Abrasive Pigging,
    - 6.5.2.6. Sponge Blasting,
    - 6.5.2.7. Venturi Media Blasting.
- 6.6. Pre-lining preparation
  - 6.6.1. After the cleaning process, the pipe shall be smooth, clean of loose material and free from standing water. If applicable, drying the pipe with foam swabs and or ventilating pipe with dry compressed air shall be executed after the cleaning.
  - 6.6.2. The presence of substantial amounts of water suggests leaking valves due to age and condition. The lining applicator shall prepare a plan to stop water from leaking valves, to be reviewed and approved by the owner.
  - 6.6.3. The contractor shall fill or apply thin adhesive membrane over all cracks, perforations, services, and other discontinuities in the pipe prior to lining.
- 6.7. Pre-lining inspection
  - 6.7.1. The lining applicator shall inspect the cleaned pipe throughout the length to be lined with CCTV system. In portable water applications, the lining applicator shall disinfect all parts of the equipment before insertion into the water mains. The CCTV system camera shall be specifically designed and constructed for pipe inspection. The camera should provide the

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flexibility in examining pipe details, especially joints and service connections extending into the pipe. The lighting system shall be capable of lighting the full periphery of the pipe. The camera shall provide a color picture.

- 6.7.2. The interior surfaces of the pipe shall be clean and with any water leaks stopped to a drip-tight condition before the lining material is applied. Service connections shall be carefully inspected to ensure that there is no debris blocking any service taps and there is no inflow of water into the pipe. If any services are leaking, appropriate steps shall be taken to stop the leak to a drip-tight condition. The method to be used shall be reviewed and approved by the owner or his representative. A video recording shall be made of the entire inspection and submitted to the owner for review and approved by the owner or his representative prior to lining. If the initial video inspection reveals significant issues and resolution is not clear, the CCTV inspection may be repeated.
- 6.8. Installation of lining
  - 6.8.1. The contractor shall follow the manufacturer recommendations on dehumidifying or heating the pipe, or both. The manufacturer's recommendations for both minimum and maximum temperatures of lining materials, and ambient air temperature and surface temperature for applying the lining material shall be followed.
  - 6.8.2. Before the lining material is applied, the contractor shall demonstrate that the equipment is functioning properly by circulation of the lining material components in the equipment. Temperature of the components and mixing ratio of the pumped lining material shall be verified (by weight or volume) to be within the manufacturer's tolerances. After pulling the umbilical through the length of pipe to be lined and attaching the lining head, the contractor shall "spin-up" the lining head to its operating rotation speed and sample the mixed lining material with the uniform color expected of thoroughly mixed components. Material dispersed from the lining apparatus during the demonstration shall not be applied to the pipe wall. Instead, a sacrificial surface shall be placed within the pipe which shall receive any material dispersed from the lining apparatus during the demonstration. After inspection, this sacrificial surface shall be removed from the pipe.
  - 6.8.3. Once pipe temperature has been checked, the lining rig is correctly heated, fully prepared and checked for operation, the lining material is at the correct temperature and any dehumidification equipment recommended by the manufacturer to facilitate the application has been put in place, lining can begin.

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- 6.8.4. The lining shall be applied in single or multiple passes using either an autonomous application device or an application device connected to a lining rig through an umbilical or tether. It shall be the lining manufacturer's responsibility to establish limitations, reviewed and approved by the owner on each lining application, including thickness of application per pass, lining material curing time, and instructions or limitations for multiple-layer lining and any re-linings.
- 6.8.5. The rigid lining material shall not bond directly to the host pipe. A low Poisson's ratio, closed cell porous materials shall be applied to the host pipe as the initial bonding layer of the composite lining system. Field samples shall be tested by USA accredited laboratory for tensile adhesion to the pipe wall in accordance with Test Method D4541. For the composite laminate lining, field samples of the inter-coat bonding between the elastomer layer and the rigid layer shall be also tested for tensile adhesion in accordance with Test Method D4541.
- 6.8.6. Reinforcement filaments shall be wound in a unidirectional or bi-directional helical orientation onto the initial bonding layer (elastomer layer) before applying the rigid layer of the composite. The filament shall be bonded to the elastomer layer and the rigid lining material shall be immediately applied over the elastomeric layer to encapsulate the filaments. The cured rigid lining material shall bond to the elastomer layer and filament layers to create the finished composite laminate lining system.
- 6.8.7. Once lining operations commences, the contractor shall operate the lining apparatus continuously in each run by using the computer-controlled accumulator reel on the synchronized lining rig and self-propulsion devices, such as tracks, wheels or belts on both the umbilical and lining device to propel the lining device through the pipe. Any maintenance stoppages shall not exceed the recoat time published by the lining manufacturer. This requirement may be modified if the contractor submits methods and details to prevent "cold joints" and ensure that the lining is continuous at all locations to the owner for review and approval.
- 6.8.8. The lining system manufacturer's instructions shall be followed to ensure the lining device and umbilical traverse in a synchronized fluid motion during the entire application process.
- 6.8.9. The lining applicator shall use the thickness measurement functionality of the lining equipment to measure and record the real-time lining thickness throughout the entire lining process.
- 6.8.10. The lining applicator shall monitor the lining device throughout the lining process via on-board cameras. On-board cameras shall be utilized to

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monitor all material casting assembly (application head, spinner, spinner cone) and filament winder functionalities. If a serious fault is suspected, the lining process shall immediately cease.

- 6.8.11. Once the lining is completed, a dip card or test spool shall be used to sample resin cure and shall be kept by the contractor as a permanent record. Immediately after lining, the contractor will review the lining printout in accordance with the manufacturer's procedures and provide a copy to the owner's representative. The cure period shall commence only when the lining device has been removed out of the pipe completely.
  - 6.8.12. If difficulties with the lining operation are encountered or there is a notable change in the rate of progress, the owner shall be contacted immediately. Within twenty-four hours of the difficulty, the contractor shall provide a written report to the owner describing the details of the difficulty and the actions that were taken or are proposed to be taken to deal with the difficulty. Where lining operations may cease due to the malfunction of the lining apparatus, the contractor shall be prepared to prevent discontinuities in the lining or the formation of "cold joints" by having sufficient spare parts or a second lining apparatus at the project site to continue lining operations without a delay lasting beyond recoat time published by the lining manufacturer.
  - 6.8.13. The contractor shall receive no additional compensation for any expenses resulting from the failure of the lining device or ancillary equipment to apply the lining material due to the malfunction of the lining apparatus. Contractor shall take every precaution to prevent a delay lasting beyond the recoat time published by the lining manufacturer.
  - 6.8.14. Should a "cold joint" form or the lining not be continuous at any point during lining operations, the contractor shall repair the defect following recommendations from the lining material manufacturer. Manufacturer guidelines must prescribe all additional lining preparation necessary if a repair is required and another material coat is to be applied after the lining materials recoat window has been exceeded. The Contractor shall receive no additional compensation for the preparation of "cold joints".
- 6.9. Post-lining inspection
- 6.9.1. Upon completion of lining operations and initial curing, a visual inspection at the entrance and exit points of the lined pipe shall be undertaken by the owner or owner's representative to verify that the lining is cured in accordance with the manufacturer's recommendations or requirements, or both and there is no evidence of uncured product.
  - 6.9.2. The contractor shall inspect the lined pipe throughout the entire length with CCTV equipment after the lining material has cured. The contractor



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shall limit bacteriological contamination from the CCTV equipment. The interior surfaces of the pipe must be completely covered by the lining material without evidence of poor mixing or excessive ringing. Attention must be paid to inspect the service connections to ensure that there is no evidence of blockage. A video recording shall be made of the entire inspection and turned over to the owner at the end of the project.

- 6.9.3. The travel speed of the camera shall allow the survey to be carried out effectively along the circumference and length of the lined pipe.
- 6.9.4. The unit price bid per linear foot of pipe line pre-lining inspection shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing and setting up of all equipment, labor, and materials necessary to clean and perform pre-video inspection of the pipeline, including an explosion-proof television camera, as necessary; recording all information on USB Plug and Play device (flash drive or hard drive) for review by owner; submittal of video in MP4 format and logs in pdf format, both of which must be submitted in accordance to the naming convention required within the applicable details, identifying and reporting structurally deficient pipe sections.
- 6.10. Final
  - 6.10.1. Manufacturer's recommendations or requirements, or both shall be followed to ensure fully-cured, bonded lining coverage at service connections, joints, and other discontinuities.
  - 6.10.2. The installed SIPP shall be continuous over the entire length of a sewer line section and be free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles and delamination. The SIPP shall be impervious and free of any leakage through the SIPP wall.
  - 6.10.3. All linings shall meet or exceed the requirements of the contract thickness as required by this specification.
  - 6.10.4. Any defect which will or could affect the structural integrity or strength of the SIPP shall be repaired at the Contractor's expense in accordance with the procedures submitted under Section 1.7 SIPP Repair/Replacement.
  - 6.10.5. If the wall of the SIPP leaks, it shall be repaired as recommended by the manufacture of the SIPP system.
  - 6.10.6. Compensation shall be at the actual length of SIPP installed. The length shall be measured from center of manhole to center of manhole. The unit price per linear foot installed shall include all materials, labor, equipment and supplies necessary for the complete SIPP installation. Compensation for service connection sealing and pipe sealing at the manhole/wall interface shall be at the unit price bid in the Proposal.
- 6.11. Manhole connection and reconnections of existing services

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- 6.11.1. Existing services shall be internally or externally reconnected unless indicated otherwise in the contract documents.
  - 6.11.2. Reconnections of existing services shall be made after the SIPP has been installed and fully cured. It is the Contractor's responsibility to make sure that all active service connections are reconnected.
  - 6.11.3. A CCTV camera and remote cutting tool shall be used for internal reconnections. The machined opening shall be at least 90 percent of the service connection opening area and the bottom of both openings must match. The opening shall not be more than 100 percent of the service connection opening. The edges of the opening shall not have pipe fragments or SIPP fragments which may obstruct flow or snag debris. In all cases the invert of the sewer connection shall be cut flush with the invert entering the mainline.
  - 6.11.4. In the event that service reinstatements result in openings that are greater than 100 percent of the service connection opening, the Contractor shall install a SIPP type repair, sufficiently in size to completely cover the over-cut service connection. No additional compensation will be paid for the repair of over-cut service connections.
  - 6.11.5. Compensation shall be at the actual number of services reconnected using either internal or external means as contained in the Proposal. The unit price bid per service line reconnected shall include all materials, labor, equipment and supplies necessary to complete the work as required in these specifications.
- 6.12. Hydrostatic testing
- 6.12.1. For pressure pipeline, the pressure testing procedure required to test the installed lining shall be accordance with AWWA C600, Section 5.2 - Hydrostatic Testing. Contractor shall perform the hydrostatic test of the lining at a pressure of 1.5 times the working pressure during the testing with a minimum of two hours duration. Test pressure shall not vary by more than  $\pm 5$  psi (34.5 kPa) for the duration of the test.
- 6.13. Final acceptance and return to service
- 6.13.1. All SIPP sample testing and repairs to the installed SIPP, as applicable, shall be completed before final acceptance, meeting the requirements of these specifications and documented in written form.
  - 6.13.2. The Contractor shall perform a detailed closed-circuit television inspection, in accordance with ASTM standards, in the presence of the Owner after installation of the SIPP and reconnection of the side sewers. Bypass pumping or plugging from the upstream manhole shall be utilized to minimize sewage from entering the line during the inspection. In the

case of bellies in the line, the pipe shall be cleared of any standing water to provide continuous visibility during the inspection.

6.13.3. After the inspection and the lining is approved by the owner, the bypass system shall be shut down and decommissioned, excavations can be backfilled, and surface conditions restored.

6.13.4. Demobilization from site shall follow a final user-approved site inspection.

## **7. Lining Faults and Repair/Over Lining**

- 7.1. Blisters—Blisters or bubbling, round, raised sections of hardened lining material, if it is in the owner’s opinion that the structural integrity of the lining is compromised, this section of the lining will be repaired according to an approach approved by the owner.
- 7.2. Uncured lining—Careful CCTV inspection should reveal any pipe sections of uncured lining, which are inevitably caused by a malfunction of the lining machine or manual equipment. The uncured material shall be removed from the pipe and the section must be relined.
- 7.3. Ringing—Ringing is the lining defect where ring or ridge protrusions appear on the interior lining wall. Ringing, which can be caused by jerky winches, is typically the result of the non-fluid movement of the umbilical and lining device inside the host pipe. This non-fluid movement is due to the friction between umbilical/application head and pipe wall. Any section of the lining with ringing shall be repaired according to approach approved by the owner.
- 7.4. Non-compliant thickness—The most prevalent causation of inconsistent thickness, exclusive of the above described ringing effect, is the material casting assembly’s (application head, spinner, spinner cone) inability to consistently maintain axial centerline in the pipe. Lining thickness variations (as with ringing) will create localized areas of stress resulting in lining fatigue and support a high probability for lining failure. Any section of the lining with non-compliant thickness shall be repaired according to approach approved by the owner.
- 7.5. Incomplete lining—Skips in the lining may be caused by machine malfunction. Incomplete lining shall be repaired to the satisfaction of the owner. If the incomplete lining cannot be repaired, the lining shall be replaced in accordance with lining system manufacturer’s recommendation or requirement.
- 7.6. Annulus—All thermosetting polymeric resin systems experience radial shrinkage which creates an annulus. The annular space created between the host pipe and the lining system can allow pressurized fluid infiltrate behind the lining at pipe discontinuities if not properly sealed. This infiltration can result in equalized pressure on both sides of the lining; rendering the lining system insignificant. Composite lining systems shall incorporate a flexible bonding layer followed by an adhered high tensile rigid material to forgo any creation of annular spaces. Any annulus at services, lining terminations and other discontinuities between rigid

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lining, closed cell porous materials and host pipe shall be repaired to the satisfaction of the owner.

- 7.7. Adhesion—The rigid lining material should not bond directly to the host pipe as the rigid lining material fails during host pipe failure events. If the rigid lining is directly adhered to the pipe wall, once fractures or remarkable deformations happen on the pipe, the deformations and strains on the pipe will be transferred onto the rigid lining via the adhesion bonding, causing the lining material to crack, fracture or tear. A closed cell porous elastomer material with low Poisson's ratio shall be applied as the initial bonding layer of a composite system. This type of system eliminates the potential for hydraulic failure from unsealed or unbonded lining material and resulting annulus at discontinuities in host pipe, as well as mitigating the strain applied on the rigid lining during the curing process or during a host pipe failure event.
- 7.8. Slump/Puddling—Slump is usually caused by applying excessive thickness of lining material to the pipe surface or overheating of the components. Puddling is caused by slumping of the lining material due to gravity forcing the lining material to flow down the sides of the pipe into the pipe invert prior to cure. Puddling can cause reduced hydraulic capacity, increased localized stress, lining fatigue and lining failure. Puddling shall be repaired according to an approach approved by the owner.
- 7.9. Water damage—Water damage is usually caused by lining through undetected standing water or water flow running along the invert during the lining material application and curing. Depending on the length of the fault and the length of the section being lined, the lining applicator shall submit process to remedy the situation, for review and approval of the owner. The owner may require lengths of pipe to be relined with new material.
- 7.10. Pinholes—Through wall pinholes, defective or damaged areas of the lining shall be relined, repaired, and/or over lined by contractor. Pinholes shall be repaired according to the approach approved by the owner representative. Any relining, repair, or over lining shall be re-inspected for dry film thickness and holidays before final acceptance by the QA/QC Lining Inspector and owner. Wall pinholes shall be tested for lining leakage in accordance with ASTM D4541.
- 7.11. Over lining—If it is determined by the Owner that it is necessary to apply an over lining to address minor blemishes or minor faults, the first coat of lining material must be completely tack free before the second coat is applied as recommended in the manufacturer's guidelines. Manufacturer guidelines must also prescribe a maximum curing time, relining window and additional preparation needed if an over lining coat is required.

### **8. Execution—Owner**

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- 8.1. Owner shall assist the contractor to secure a heated storage area for all contractor temperature sensitive materials when the ambient atmospheric air temperature is below 65 °F at any time during a 24-hour period.
- 8.2. Owner shall assist the contractor to secure a sufficient lay down area and parking nearby unit for ancillary equipment.
- 8.3. Owner shall provide contractor with unencumbered accesses to expose the pipeline to be lined or remove sections of the pipeline at the locations identified by contractor to provide access for lining operations.
- 8.4. Owner shall assist the contractor to secure an unencumbered location near all accesses to the pipe for equipment, material and personal staging.
- 8.5. Owner will provide contractor with a pipe that will not be subjected to any additional work by other contractors and/or Owner that would impede and or delay contractor's scope during the duration of the project.

### **9. Execution—Contractor**

- 9.1. Contractor shall apply lining material in accordance with the requirements of this section, the lining material application instructions provided by the lining material manufacturer, and the field technical support instructions from the QC/ QA Lining Inspector.
- 9.2. All safety procedures established by local, state, and federal agencies regarding job safety, which include confined space access requirements, shall be strictly adhered to by contractor. Contractor shall provide full time HSE personnel for the duration of the project.
- 9.3. No work shall be performed when the weather is not suitable or proper storage conditions are not in place for the lining operation, as determined by the QC/ QA Lining Inspector.
- 9.4. Contractor shall submit a schedule of lining operations to the owner at least thirty (30) days in advance of the start of work.
- 9.5. The pipe shall be cleaned before application of lining material. Contractor shall be responsible to ensure cleaning and surface preparation has been achieved for the lining process to the satisfaction of the QA/QC Lining Inspector and the owner.
- 9.6. Contractor shall perform a mechanical cleaning with devices specifically manufactured for the purpose of proper surface preparation of the pipe in accordance with the requirements of the lining system to be applied. This includes the removal of corrosion by-products; chemicals or other deposits; loose or deteriorated remains of old lining material; oils, grease, and accumulations of any water, dirt; and debris that is a direct result of the cleaning and or surface preparation process.
- 9.7. Upon completion of the lining process contractor will install stainless steel compression bands on all lining terminations except for service or other branch lateral connections. The contractor will submit the proposed stainless-steel

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compression bands, and the installation requirements to the owner representative for review and approval.

- 9.8. After the lining material has cured, the contractor's QA/QC inspector along with the owner's representative shall inspect the lined pipe throughout the entire length with CCTV equipment as described above. The interior surfaces of the pipe must be completely covered by the lining material at the specified thickness without evidence of poor mixing or ringing and service connections to ensure that there is no annulus at discontinuity and there is no evidence of blockage. A video recording shall be made of the entire inspection and turned over to the owner.
- 9.9. Upon completion of the work, debris, containers of lining materials, cleaners, and the other items used during lining shall be removed from the site and disposed by the lining applicator in accordance with local, state, and federal requirements.

### **10. Recording Documentation**

- 10.1. The Contractor is required to record the location and size of all pipe lines rehabilitated as well as the location and size of all service connections. Once completed with each post-installation inspection, the Contractor is required to mark up the drawings with accurate locations of all pipe lines and service connections. Prior to each pay estimate the Contractor must review the current record drawings with the owner representative. Providing inaccurate or incomplete record information is reason for withholding of progress payments. A final set of record documents shall be submitted by the Contractor, for As-Built purposes, prior to processing final payment.
- 10.2. As-Built drawings/records, pre-and-post inspection videotapes, CDs or other electronic media shall be submitted to the Owner, by the Contractor, within two (2) weeks of final acceptance of said work or as specified by the Owner. As-Built drawings/records will include the identification of the work completed by the Contractor and shall be prepared on one set of Contract Drawings/Records provided to the Contractor at the onset of the project.
- 10.3. As-Built drawings/records shall be kept on the project site at all times, shall include all necessary information as outlined in the PWS or as agreed to by the Owner and the Contractor at the start of the Contract, shall be updated as the work is being completed and shall be clearly legible.
- 10.4. Compensation for all work required for the submittal and approval of As-Built drawings/records shall be included in the various pipelining items contained in the Proposal.

### **11. Public Information and Notification**

- 11.1. All written notices shall be issued on current letterhead or door hanger. Notices will be prepared by the owner's Public Information Officer and provided to the contractor for distribution.

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- 11.2. The Public Information and Notification program shall be at a minimum, require the Contractor to be responsible for contacting each home or business affected by the pipeline rehabilitation/ re-construction and informing them of the work to be done in all the following ways:
  - 11.2.1. Attempt to contact each home and business owner on the day of pre-installation inspection of the pipeline.
  - 11.2.2. Written notice shall be delivered to each home or business describing the work, installation date/time, how the construction affects them, and a local telephone number of the Contractor they can call to discuss the project or any problems that may arise (Service Disruption Notice) a minimum of 48 hours in advance of the installation.
  - 11.2.3. Personal contacting each home or business owner and provide written notice the day prior to beginning work on the section of pipeline to which they are connected.
  - 11.2.4. Personal contacting any home or business owner before and after the service connection has diverted and been reactivated. Provide written notice with the time of reactivation posted on the front door of a residence or business.

### **12. Clean-Up and Site Restoration**

- 12.1. The Contractor shall reinstate all project areas affected by their operations to an equal or better than existing condition upon completion of the SIPP installation. All restoration must be completed prior to submitting that section of SIPP for consideration of payment. Re-grading of rutted areas and re-seeding of disturbed areas is required.

### **13. Patents**

- 13.1. The Contractor and the Contractor's suppliers shall warrant and save harmless the owner against all claims, potential litigation involving patent infringement, copyright violations and any loss thereof.

### **14. Typical Bid Items and Payments**

- 14.1. The unit price bid per linear foot of the SIPP-lining shall include all the Contractor's costs of whatsoever nature. The price bid shall include, but is not limited to:
  - 14.1.1. Mobilization – Lump Sum - Includes all PWS information, submittals, safety plan, as-built drawings, testing samples, mobilization/demobilization of labor, equipment and materials to the project site. Generally limited to 5% of the total amount bid for the project.
  - 14.1.2. Pre-Installation CCTV Inspection – Per linear foot - Includes pre-cleaning and post cleaning CCTV for Owner review. Does not include CCTV inspection just prior to SIPP installation. All inspections will be performed by PACP trained and certified personnel.

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- 14.1.3. Dye Testing of Service Connections – Per each - Includes dye testing and documentation of existing service connection on each pipe length to be lined.
- 14.1.4. Point Repairs – Per each or by Lump Sum Contingency - Includes excavation and restoration of a section or sections of pipe that are beyond rehabilitation using SIPP. Note: Point repair items shall be categorized by pipe size, a minimum length of excavation and depth category of excavation to be paid for in the Proposal. If point repairs are not identified in the contract documents, payment shall be on a contingency basis.
- 14.1.5. Standard Pipe cleaning – Per linear foot for each pipe size category – including all labor, equipment, materials and cost of material disposal.
- 14.1.6. Heavy Pipe Cleaning – Per linear foot for each pipe category – including all labor, equipment, materials and cost of material disposal.
- 14.1.7. Inspector training – Lump Sum – includes all labor, equipment and materials required to train the Owner's inspectors on the technology to be installed for a period of two days.
- 14.1.8. Pre-lining Installation – per linear foot installed by size category. Includes all labor, equipment and materials required.
- 14.1.9. Reinforced Pre-lining Installation - per linear foot installed by size category. Includes all labor, equipment and materials required.
- 14.1.10. Lining Installation – Per linear foot for each pipe size category - Includes all labor, equipment and materials required for the complete installation of a SIPP.
- 14.1.11. Traffic Control –Lump Sum – Includes all labor, equipment and materials required to implement a traffic control plan for the entire project and shall include all costs associated with sub-contracted traffic control specialists.
- 14.1.12. Sewage Bypass – Lump Sum – Includes all labor, equipment and materials required to implement a flow bypass plan for the entire project, including the cost of all sub-contracted flow bypass specialists.
- 14.1.13. Service Reconnections – Per each – Includes reconnecting existing live sewer service connections to the installed SIPP. Owner shall review and verify those connections that are not live and will be left unopened.
- 14.1.14. Manhole/Wall Interface Sealing – Per each – Includes sealing the interface between the installed SIPP and the manhole wall
- 14.1.15. Post Construction CCTV Inspection - Per linear foot - Includes post lining CCTV for submission to the Owner. All inspections will be performed by PACP trained and certified personnel.
- 14.1.16. Reserve for Testing – Lump Sum Reserve – For Owners use to include testing required as directed by the Owner, under this contract, by an



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independent laboratory. (The amount will be set by the Owner in the Bid Proposal)

- 14.2. Payment for this item will be a lump sum basis for the entire project divided into three equal payments, the first third of the cost will be included in the first pay estimate, the second third will be included in the second pay estimate, and the third payment will be included in the final pay estimate.

### **15. Engineering Design Calculations**

- 15.1. The design for the lining shall be submitted to the Contract Administrator for approval 14 Days prior to installation. The design calculations shall show technical assumptions, identify the design formulas used and show the wall thickness and finished inside diameter. The design shall graphically illustrate the installation conditions, i.e., depth of pipeline, water table, pipe invert and crown, and full details of the parameters used. The design work shall bear the seal and signature of installer's Registered Professional Engineer for review and approval.
- 15.2. All calculations shall include data that conforms to the requirements of these specifications. In the event the calculated thickness by the contractor is thinner than those shown in the bid tabulation, the contractor will install the specified thickness shown in the bid tabulation. Proposed manufacturer technology data, including third party test results for physical properties shall be submitted for all SIPP products and all associated technologies to be furnished.

### **16. Warranty**

- 16.1. The materials used for the project shall be certified by the manufacturer for the specified purpose. The Contractor shall warrant the SIPP material and installation for a period of two (2) year. During the Contractor warranty period, any defect which may materially affect the integrity, strength, function and/or operation of the pipe, shall be repaired at the Contractor's expense in accordance with procedures included in Section 7 and as recommended by the manufacturer.
- 16.2. On any work completed by the contractor that is defective and/or has been repaired, the contractor shall warrant this work for two (2) year in addition to the warrantee required by the contract.
- 16.3. After a pipe section has been rehabilitated and for a period of time up to two (2) year following completion of the project, the Owner may inspect all or portions of the rehabilitated system. The specific locations will be selected at random by the Owner's inspector and should include all sizes of SIPP from this project. If it is found that any of the SIPP has developed abnormalities since the time of "Post Construction Television Inspection," the abnormalities shall be repaired and/or replaced as defined in Section 7 SIPP Repair/Replacement and as recommended by the manufacturer. If, after inspection of a portion of the rehabilitated system under the contract, problems are found, the Owner may televise all the SIPP installed on the contract. All verified defects shall be repaired and/or replaced by

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the Contractor and shall be performed in accordance with Section 7 SIPP Repair/Replacement and per the original specifications, all at no additional cost to the Owner.

**\*\*END OF SECTION\*\***