SECTION 02310
SEWER LINERS

PART 1  GENERAL

1.01 - References
A. American Society for Testing and Materials (ASTM):
   1. ASTM D638 – Test method for tensile properties of plastics.
   3. ASTM F1216 – Rehabilitation of existing pipelines and conduits by inversion and curing of a resin-impregnated tube.
   4. ASTM D3034 – Type PSM Polyvinyl Chloride (PVC) sewer pipe and fittings.
   6. ASTM F1504 – Rehabilitation of existing pipelines and conduits by inversion and curing of a resin-impregnated tube.
   7. ASTM F1533 – Standard specification for deformed PE Liner.
   8. ASTM F1606 – Standard specification for installation of deformed PE liner.

B. Videos of all sewers to be lined are available where indicated in the Contract Documents. It is recommended prospective contractors review the videos prior to bidding, to familiarize themselves with the project and to assure themselves of their ability to complete project work as required by the Contract Documents.

1.02 - Submittals
A. Product Data:
   1. Manufacturer’s product certification, product literature, and application and installation requirement for materials used in liner.
   2. Liner Pipe Thickness Design shall be in accordance with Appendix XI of ASTM F1216. In the liner thickness calculations, the minimum ovality of the host pipe shall be 5 percent, the enhancement factor (K) shall not be greater than 7.0, the minimum safety factor shall be 2.0, and the flexural modulus of elasticity shall be reduced to account for long term effects and used in the design equation E1. The reduction shall be 75 percent for HDPE material, 65 percent for PVC material and 50 percent for Cured-in-Place Pipe systems.
   3. For liner pipe thickness design, assume a ground water depth of 5.0 feet below existing ground surface, a maximum soil depth of 19 feet above pipe crown and a soil density of 130 pcf, unless shown or specified otherwise in the Contract Documents. To determine depth of bury, the designer shall use flowline grade elevations and manhole depths along with City aerial topography maps.
   4. Assume an HS-20 live load.
   5. Submit liner thickness calculations for review before installation.
   6. No liner shall be installed until it has been approved by Engineer for installation.
   7. Submit results of independent testing verifying that proposed liner substantially conforms to requirements set out herein. Testing shall be performed by a certified laboratory and certified by an engineer licensed in the State of Iowa. Testing performed on similar projects within the previous three years is acceptable for this submittal. If previous test results are submitted, provide name, address and telephone number of previous owner’s representative and/or engineer.
8. Proposed liner thickness will be the thicker of the following:
   a. Design liner thickness based on Paragraphs 1.02.A.2 through 1.02.A.4 inclusive.
   b. CIPP Liner Thickness Table

<table>
<thead>
<tr>
<th>Original Sanitary Pipe Diameter (in)</th>
<th>Nominal CIPP Thickness (mm)</th>
<th>CIPP Thickness, t, (in)</th>
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<tr>
<td>6</td>
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<tr>
<td>24</td>
<td>15</td>
<td>0.591</td>
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B. Miscellaneous Submittals:
1. Proposed plan for performance of Work, including but not limited to:
   a. Schedule for television investigation, liner installation, and anticipated cutoff periods for services.
   b. Specific procedures for verification of active service connections.
   c. Specific procedures for notifications to adjoining residences and businesses.
   d. Locations for equipment setup.
   e. Specific procedures for complying with traffic control and staging requirements as stated in Contract Documents.
2. Videotape of pipe condition (pre-lining and post-lining.)
3. All information, including measurements and results of smoke testing, associated with verifying whether or not services are active.
4. Test results.
5. Proposed plan for bypassing sewage during liner installation.

C. Submit in accordance with General Conditions.

1.03 - Quality Assurance
A. Corrosion: Fabricate finished liner from materials which, when cured, will be chemically resistant to withstand internal exposure to domestic sewage.
B. Manhole Connections: All manhole connections shall be watertight.
C. Testing:
1. Test finished pipe liner in accordance with applicable ASTM Standard Specifications. **Minimum test frequencies are as follows:**
   a. **One (1) test for each one thousand feet (1,000 feet) or fraction thereof for each pipe size installed on a project.**
   b. **One (1) additional test for a given pipe size if a failed test result is received.**
2. Testing shall be performed by a certified laboratory. Test results shall be certified by a licensed professional engineer.
3. Testing will be performed on a sample prepared in conjunction with Work on this project. Sample shall be prepared using methods, materials and conditions identical to actual liner installation.
1.04 - City Water Usage

A. CONTRACTOR may request access to potable water via the use of a water meter assembly from the City of Cedar Rapids Water Department. The City Water Department has developed a policy entitled; “City of Cedar Rapids Water Department Fire Hydrant Use Policy” which details the requirements/limitations regarding the access of potable water from fire hydrants. A copy of this policy may be obtained from Cedar Rapids Utilities Department, Water Division, or is included with the Contract Documents.

B. The Contractor shall pay for all City water used.

1.05 - Access to and Protection of Private Property

A. The Contractor is responsible to obtain permission from property owners to access manholes in existing easements.
   1. Remove and replace fence as required at Contractor’s expense.
   2. Repair damage to site, including but not limited to yard damage, ruts, cracked walls and foundations, fences and drainageways.

B. Access to private residential and commercial drives shall be maintained when work is not directly in front of the drive, unless alternatives are approved by the Engineer and the property and/or business owner.

PART 2 PRODUCTS

2.01 Prequalified Lining Processes: The following processes shall be prequalified for the rehabilitation of existing sanitary sewer mains:

A. Insituform lining process (Cured-in-Place Pipe).
B. National Liner Lining Process (Cured-in-Place Pipe).
C. C.I.P.P. Corporation Lining Process (Cured-in-Place Pipe).
D. Inliner Technologies (Cured-in-Place Pipe).
E. Premier Pipe USA Lining Process (Cured-in-Place Pipe).
F. Poly-Triplex Technologies Lining Process (Cured-in-Place Pipe for diameters 12-inch and greater)
G. Master Liner Inc. Lining Process (Cured-in-Place Pipe).

2.02 Color: Liner shall be of a light color to enhance television clarity for inspection purposes.

2.03 Cured In Place Liner (CIPP Liner)

A. Resin:
   1. Liner Bag: Polyester resin for general chemical applications.
      a. Resin shall not contain fillers, except those required for viscosity control. Up to 5 percent by mass thixotropic agent that will not interfere with visual inspection may be added for viscosity control.
      b. Resins may contain pigments, dyes or colorants which will not interfere with visual inspection of cured liner.
   2. Epoxy resin may be recommended by Contractor, if conditions are deemed to warrant their use. Use of epoxy resins shall be subject to Engineer’s approval.

B. Reinforcing Material:
   1. Non-Woven, needle interlocked polyester felt formed into sheets of required thickness.
   2. Felt tubes may be made of single or multiple layer construction, with any layer not less than 1.5 mm thick.
   3. Mechanical strengthener membrane or strips may be sandwiched in between layers where required to control longitudinal stretching.
4. **The prequalified manufacturer’s approved** membrane used during inversion of tube shall be left on internal surface of liner after curing.

5. Minimum thickness of bonded polyurethane membrane and inner liner, if used shall be 0.25 mm, +/-5 percent, and shall not affect structural dimension requirements of cured liner.

C. Felt Content: Content shall ensure cured thickness of liner as shown on Contract Drawings; thickness of cured liner to be as specified (tolerances of +10 percent to –4 percent) and shall not include thickness of polyurethane inner liner.

D. Resin Content: 10 to 15 percent by volume greater than volume of felt in liner bag.

E. Cured liner shall conform to the following standards (minimal): Tensile strength per ASTM D638 of 3,000 psi; flexural modulus of elasticity per ASTM D790 of 250,000 psi; flexural strength per ASTM D790 of 4,500 psi.

F. Fabricate liner to size when installed so that it will fit internal circumference of pipe. An allowance shall be made for circumferential stretching during insertion.

G. Meet requirements of ASTM F1216.

### 2.04 Deformed Polyethylene (PE) Pipe Liner

A. Pipe and Fittings: PE Type III, Grade P34, ASTM D1248, Cell Classification PE 345434C, ASTM D3350; Minimum Wall Thickness: SDR32.5, ASTM D2122

B. Meet requirements of ASTM F1533.

C. Pipe shall be UV-stabilized; limit UV exposure to period of installation.

D. Requirements:

<table>
<thead>
<tr>
<th>Density</th>
<th>Melt Index</th>
<th>Flexural Modulus</th>
<th>Tensile Strength</th>
<th>Flexural Modulus</th>
<th>Hydrostatic Design Basis</th>
<th>Color/UV Stabilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.941-0.955</td>
<td>&lt;0.15</td>
<td>110-160 ksi</td>
<td>3000-3500 psi</td>
<td>1600 psi</td>
<td>hrs. min.</td>
<td>Natural/ Subclass E</td>
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</tbody>
</table>

### 2.05 Deformed Polyvinyl Chloride (PVC) Pipe Liner

A. Pipe and Fittings: PVC cell classification 13223-B, ASTM D1784; minimum wall thickness: SDR41

B. Meet requirements of ASTM F-1504.

C. Pipe shall be UV-stabilized; limit UV exposure to period of installation.

D. Requirements:

<table>
<thead>
<tr>
<th>Tensile Strength (ASTM D638)</th>
<th>Tensile Modulus (ASTM D638)</th>
<th>Flexural Strength (ASTM D790)</th>
<th>Flexural Modulus (ASTM D790)</th>
<th>IZOD Impact Strength (ASTM D256)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4800 psi min.</td>
<td>155 ksi min.</td>
<td>6000 psi min.</td>
<td>145 ksi min.</td>
<td>0.65-1.5 ft-lb/in of notch</td>
</tr>
</tbody>
</table>

### PART 3  EXECUTION

#### 3.01 Examination

A. Pre-lining Television Investigation:

1. Examine tapes of condition of pipe interior before starting Work. The Contractor shall examine the tape provided by the City during the Bidding Period. The Contractor is also responsible to perform own television investigation prior to cleaning operations. All tape records shall be in color. The tape shall include verbal comments regarding pipe condition and other relevant information made at the time of the television investigation. A written log of observations and comments, including information regarding service locations shall be prepared in conjunction with television investigation.

2. All tapes and written records prepared during television investigation shall be provided to the Engineer.

3. If the first examination reveals heavy root intrusion, a second preliminary televising and examination shall be required after measures have been taken to remove roots.
4. If depth of flows in pipe exceed ¼ of the pipe inside bypass pumping shall be required in conjunction with television investigation.

5. The Engineer reserves the right to require repeating television investigation if resulting video record, plus supporting records, cannot be reasonably used to evaluate locations of services and condition of pipe and joints.

B. Determination of Active Service Connections:

1. The Contractor shall provide tracking of sanitary services not confirmed as active or inactive by other means. Approved methods include, but are not limited to televising (either from the sewer main or the building) or electronic means. The Contractor is responsible to make necessary arrangements for access to residences and businesses for tracking services.

2. The Contractor is liable for any sewer backups occurring during lining procedures. The Contractor shall provide affected residents and business owners with a 24-hour telephone number to call the Contractor to report backups.

3. To extent possible, make determination from review of tapes.

4. In addition to television investigation, smoke testing and/or dye testing of services may be required. The Contractor shall make necessary and appropriate arrangements with residences and businesses within the Project area for Site access required for these purposes. Written and/or televised results of said tests shall be provided to the Engineer.

3.02 Preparation

A. Prior to liner installation sufficiently clean roots and other debris from sewer line to provide for proper installation of product. Use of a root saw, or other approved means, to remove roots shall be considered incidental.

B. Remove or repair joints, protruding services, or collapsed pipe preventing insertion of liner:

1. Remove protruding services shown in contract documents or which protrude ½-inch or more into main line pipe.

2. Use of flail-type device to trim protruding services or remove roots is prohibited.

3. Excavation required to repair joints or replace collapsed pipes shall be paid as extra work or be performed by others.

C. Contractor or Engineer determines that existing pipe is 15 percent or more out of round, Contractor shall redesign liner. Notify Engineer of condition of pipe.

D. Sewage Bypassing:

1. Bypass pumping is required on any sewer line segment with insufficient capacity to be blocked for time required to complete the lining process or as otherwise set out in the contract documents.

2. The Contractor shall provide for flow of sewage around sections of pipe to be lined.
   a. Pump or bypass lines shall be of adequate size and capacity to accommodate flow.
   b. Coordinate bypassing operations with Owner.

3. Provide minimum 48-hour written notice to residences and businesses of any temporary cutoff of sanitary service lines.

E. Coordination for Water/Service Interruption:

1. The Contractor may coordinate with the local jurisdiction Water Department to determine if the shutdown of public water mains within the Project area is feasible during television investigation and liner installation operations.

2. The Contractor shall provide written notice to the City Water Department a minimum of five working days in advance of proposed shutdown.

3. The Contractor shall provide written notice a minimum of five working days in advance to all residences and businesses within and adjacent to the Project area that will be affected by a proposed water main shutdown. Said notice shall include estimated duration of shutdown periods.
4. Only personnel of the local jurisdiction’s Water Department may operate water main valves and perform water main shutdowns.

5. Contract Documents shall identify project areas where a short term shutdown of public water mains will not be allowed.

3.03 Installation

A. Cured in Place Pipe Liner:

1. Unless otherwise approved by the Engineer, liner installation shall be in lengths less than 850 feet.

2. No lining activities shall occur when ambient temperatures are less than 10 degrees Fahrenheit.

3. Preparation of Liner:

   a. Designate location where uncured resin in original containers and unimpregnated liner will be vacuum impregnated prior to installation. Contractor shall allow Engineer to inspect materials and "wet out" procedure.

   b. Resin and catalyst system compatible with requirement of this method shall be used. Quantities of liquid thermosetting materials shall be to manufacturer’s standards to provide lining thickness required.

   c. Liner tube shall be impregnated with resin prior to installation no sooner than recommended by prequalified manufacturer. The impregnated liner shall be stored at temperatures below 40ºF (4ºCelsius) and out of direct sunlight. Impregnated liners shall be stored per manufacturer's recommendations.

   d. Transport resin impregnated liner to Site immediately prior to inversion in suitable lightproof container with temperature maintained below 40 degrees Fahrenheit (4 degrees Celsius).

4. Insertion of Liner:

   a. Insert liner through an existing manhole or other access by means of an inversion process and application of hydrostatic head sufficient to fully extend liner (per ASTM F1216, Section 7) to next designated manhole or termination point or by pulling method (ASTM F1743, Section 6) to the next designated manhole or termination point. Lubricant may be used. Tube shall not be damaged.

5. Curing Liner:

   a. After inversion is complete, provide heat source and water recirculation equipment. Equipment shall be capable of delivering hot water throughout section to uniformly raise water temperature above temperature required to effect cure of resin.

   b. Provide heat source with suitable monitors to gauge temperature of incoming and outgoing water supply. Place second gauge between impregnated liner and pipe invert at remote manhole to determine temperatures during cure. Water temperature in line during cure period shall be as recommended by resin manufacturer.

   c. Steam curing is allowed as an inversion process. Steam curing shall be in accordance with ASTM F1216, Part 7.6.2 or ASTM F1743, Part 6.6.2. The Contractor shall guarantee their process will maintain required inversion pressures throughout cure process.

   d. Initial cure shall be complete when inspection of exposed portions of liner indicate it to be hard and sound and when remote temperature sensor indicates that temperature is of magnitude to realize an exotherm. Cure period shall be of duration recommended by resin manufacturer.

   e. Cool hardened liner to temperature below 100 degrees F before relieving static head in inversion standpipe. Cool down by introduction of cool water into inversion standpipe to replace water being drained from downstream end. Care shall be taken in release of static head so that vacuum will not be developed that could damage newly installed liner.
B. Deformed PE Pipe Liner:
   1. Insertion:
      a. Insert PE pipe into existing sewer through manhole.
      b. Take precautions to prevent ragged edges of broken sewer pipe from scoring liner pipe as it is being pulled into sewer.
      c. Once insertion is initiated, complete pull to terminus without interruption.
   2. Expansion: Conform with manufacturer’s recommendations.
   3. Any annular space between the outside wall of the liner and the inside wall of the host pipe or lateral junctions observed from within the manholes or by televising shall be sealed with an appropriate sealant compatible with the material used.

C. Deformed PVC Pipe Liner:
   1. Insertion: Insert PVC pipe into existing sewer through manhole. Take precautions to prevent ragged edges of broken sewer pipe from scoring liner pipe as its being pulled into the sewer. Once insertion is initiated, complete pull to terminus without interruption.
   2. Expansion: Conform with Manufacturer’s recommendations.
   3. Any annular space between the outside wall of the liner and the inside wall of the host pipe or lateral junctions observed from within the manholes or by televising shall be sealed with an appropriate sealant compatible with the material used.

D. Pipe Patch:
   1. Applies for repairing isolated small areas within pipe run.
   2. Use approved lining process on other Engineer approved product designed for repairing isolated small areas.
   3. Folding pipe patch material onto delivery system to as to prevent exposed, sharp or jagged edges in repair.

3.04 Service Connections
A. Reinstate and reconnect service connections unless inactive, as determined by Engineer.
B. Determine service connection locations from Contractor’s TV inspection videotapes.
C. Reconnect services without excavation by television camera and cutting device that reestablishes services for minimum of 95 percent of existing clear opening. Take precautions to ensure there is no obstruction of flowline of service pipe.
   1. Liner shall be sufficiently tight that there is no annular space between connection and liner.
   2. Proof test via visual inspection methods. This testing is to assure a positive seal between liner and pipe and to assure structurally-sound services. No air test will be required.
   3. Active leaks at reinstated service lateral connections that do not pass a proof test shall be sealed by chemical grout or other method approved by Engineer.
   4. Sealing at reinstated service lateral connections if deemed necessary by Engineer shall be considered and paid for as extra work.
D. Sanitary services shall not be out of service for more than 12 hours during lining process.
E. Manholes:
   1. Reconstruct benches and channels in manholes with grout to match new invert elevations.
   2. Remove top portions of liner in all manholes within 4 inches of interior wall to allow for use of sewer cleaning equipment for routine maintenance.
   3. Reconstruct or replace manholes where noted on plans.
3.05 Field Quality Control
   A. Cured in Place Pipe Liners:
      1. Finished liner:
         a. Liner shall be continuous over entire length of insertion run and be as free as practicable from
            visual defects such as foreign inclusions, dry spots, pinholes and delamination.
         b. During curing process, gauge watertightness under positive head. Rate of exfiltration shall be
            not greater than 200 gal per day per inch diameter per mile.
         c. Liner shall conform to shape of pipe existing before installation and not be out of round by
            more than 15 percent.
      2. Liner Thickness: Cured liner thickness shall be accurately measured and shall not be more than
         the specified thickness plus 5 percent. **Liner thickness shall be 6 mm nominal thickness for all liners determined by design to be 6 mm or less.**
   3. Felt and Resin Content of Liner:
      a. Visually inspect liner to ensure number of layers of felt conforms to specified number of
         layers and thickness.
      b. Calculate resin to felt ratio by weight. Ratio shall fall in range 1.0:1 to 1.15:1.
   4. Examination:
      a. Televise interior of pipe after completion of Work and provide tape and detailed written report
         to Engineer. Use pan and tilt color 3-LUX (or approved equal) camera to view the sewer
         service lateral connection reinstatement.
      b. During televising, bypass-pump flow if depth exceeds ¼ of pipe inside diameter.
   B. Deformed PE and PVC Pipe Liners:
      1. Testing of pipe liners shall be in accordance with and meet requirements of applicable ASTM
         Standard Specifications.
      2. Televise interior of pipe after completion of Work and provide tape to Engineer. Use pan-and-tilt
         color 3-LUX (or approved equal) camera to view the sewer service lateral connection
         reinstatement.

3.06 Cleaning And Restoration
   A. At completion of Work, remove rubbish, debris, dirt, equipment and excess material from Site. Clean
      adjacent surfaces soiled by and during course of Work.
   B. Restore areas disturbed in accordance with Contract Documents.
   C. **Provide report, including DVD of completed work to Owner’s Engineer.**

END OF SECTION 02310