

SECTION 336082

MONOLITHIC MANHOLE LINING SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

- A. Furnish all labor, materials, equipment, and incidentals required to install and test an Epoxy Manhole Monolithic Lining System as noted on engineering plans (if applicable) and as specified herein for the purpose of:
1. Eliminating infiltration and exfiltration.
 2. Providing corrosion protection.
 3. Repairing voids and restoration of the manhole structural integrity as a result of applying a monolithic liner to the wall and bench surfaces of brick, concrete, or any other masonry construction material.
 4. Extending lining from invert to top of cone, as specified.
- B. Accurately field measure and size each individual manhole. Contractor is reminded that each existing wastewater collection system manhole designated to receive monolithic lining may have a different configuration and varying field dimensions. Field measurements shall conform to requirements of monolithic lining manufacturer.
- C. Do not install manhole lining until other manhole rehabilitation and procedures for manhole preparation and cleaning as specified on the Plans and in Section 336080 Manhole Rehabilitation work is complete.
- D. Contractor is advised that presence or absence of leakage through manhole wall noted on manhole inspection reports and as seen in Contractor's independent inspection of manholes prior to bidding is dependent upon ground water levels and conditions at time of inspections. High ground water levels in project area typically occur in summer months (June through October) but will vary with rainfall in any given year. Contractor shall reflect its assumptions and judgments on leakage through manhole walls based on this information in unit prices bid for lining manholes. Stop leakage prior to lining manholes. No additional payment will be made to Contractor for repairing leaks not visible prior to bidding or wastewater collection system rehabilitation.

1.2 RELATED WORK

- A. Trenching, Backfilling and Compaction - Section 311020
- B. Sewer Line and Manhole Cleaning – Section 336070
- C. Manhole Rehabilitation – Section 336080
- D. Cured-in-place Pipe Liner – Section 336084

1.3 ACRONYMS

- A. EMMLM: Epoxy Manhole Monolithic Liner Material
- B. EMMLS: Epoxy Manhole Monolithic Liner System

1.4 SUBMITTALS

- A. Submit to the City and Engineer, in accordance with Division 01 of the Specifications, shop drawings, product data, and installation methods. Submittals shall include, but are not limited to the following:
 1. Manufacturers’ product data, including physical properties, surface preparation, repair, application, curing, and field quality control procedures.
 2. Manufacturer and applicator qualifications as specified herein.
 3. Type of monolithic lining system to be installed for each manhole.
 4. Diameter, depth (rim to invert), and material for each manhole.
 5. Design data and specification data sheets listing parameters used in EMMLS design and thickness calculations based on applicable provisions of ASTM Standards.
 6. A list of municipal installations performed by the manufacturer and Contractor over past five (5) years along with contact name, telephone number, and brief description of work performed.
- B. Submit to the City and Engineer, within 10 days of Effective Date of the Agreement, name of supplier (manufacturer), name of installer, and a list of materials to be furnished.
- C. Submit a step-by-step description of methods, practices, intervals, etc. to be used in application and curing of monolithic lining system to meet

requirements of this specification Section.

D. Test Reports

1. Prior to each shipment of materials, submit certified test reports that materials for this Contract were manufactured and tested in accordance with ASTM Standards specified herein.

1.5 REFERENCED STANDARDS

A. ASTM International Standards:

1. ASTM C 267 - Standard Test Method for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing.
2. ASTM C 722 - Standard Specification for Chemical Resistant Resin Monolithic Surfacing.
3. ASTM C 882 - Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
4. ASTM C 884 - Test Method for Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay.
5. ASTM C 1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
6. ASTM D 638-98 - Standard Test Method for Tensile Properties of Plastics.
7. ASTM D 695-96 - Standard Test Method for Compressive Properties of Rigid Plastics.
8. ASTM D 790 - Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics.
9. ASTM D 870 - Practice for Testing Water Resistance of Coatings Using Water Immersion.
10. ASTM D 1763 - Standard Specifications for Epoxy Resins.
11. ASTM D 2240-97e1 - Standard Test Method for Rubber Property Durometer Hardness.
12. ASTM D 2247 - Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.

13. ASTM D 4787-13 - Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
14. ASTM D 6132-08 - Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage.
15. ASTM D 7234-12 - Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
16. ASTM F 1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
17. ATSM F 2414-04 (2009) - Standard Practice for Rehabilitation of Sewers Using Chemical Grouting.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 QUALIFICATIONS

A. Contractor performing the work shall be fully qualified, experienced, and equipped to complete this work expeditiously and in a satisfactory manner. Contractor shall submit the following information to the City and Engineer for review and approval before any work is performed:

1. Be certified by manufacturer to install monolithic lining system.
2. Have a minimum of five (5) years' experience or 500 manholes in performing this type of specialized work. This may be waived by the City through their product approval process with documented demonstration projects.
3. Be capable of providing crews as needed to complete this work without undue delay.
4. City reserves right to disapprove use of Contractor, based on insufficient qualifications.

1.7 QUALITY ASSURANCE

A. Supplier shall be responsible for provisions of test requirements specified in above referenced ASTM Standards as applicable. In

addition, monolithic lining products to be installed under this Contract may be inspected at plant for compliance with these specifications by an independent testing laboratory provided by the City. Contractor shall require manufacturer's cooperation in these inspections. Cost of plant inspection of lining products and materials approved for this Contract shall be borne by City.

- B. Inspections of lining products and materials may also be made by Engineer or other representatives of City after delivery. Lining products and materials shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though samples may have been accepted as satisfactory at place of manufacture. Lining materials rejected after delivery shall be marked for identification and shall be immediately removed from job site.
- C. Contractor shall furnish services of manhole liner manufacturer's field service technician, who has complete knowledge of manhole rehabilitation, to advise and assist manhole lining installation and provide instruction to Contractor for rehabilitation of first five manholes. Field service technician shall be fully qualified and experienced in manhole rehabilitation work with epoxy manhole lining systems.
- D. Provide monolithic epoxy lining from a single manufacturer. Supplier shall be responsible for provisions for test requirements specified in ASTM Standards C 722, C 882, C 884, D 870, D 1763, and D 2247 as applicable for monolithic lining.
- E. Inspections of EMMLM may be made by Engineer or other representatives of City after delivery. EMMLM shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample EMMLM may have been accepted as satisfactory at place of manufacture. EMMLM rejected after delivery shall be marked for identification and shall be removed from the job at once.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in shipping, handling, and placing to avoid damaging lining products. Extra care may be necessary during cold weather construction. Lining product or material damaged in shipment shall be replaced as directed by Engineer or the City.
- B. Lining product showing deterioration, or which has been exposed to any other adverse storage condition that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the job site.

- C. While stored, lining products shall be adequately packaged and protected. Lining products shall be stored in a manner as recommended by manufacturer.
- D. Materials shall be stored, shipped, and handled according to their material safety data sheet and manufacturer's recommendations. EMMLM damaged in shipment shall be replaced as directed by Engineer at no additional cost to the City.

1.9 SAFETY AND SITE CONDITIONS

- A. Comply with and enforce Federal, State, and Local safety regulations. Contractor's personnel shall be certified for confined space entry.

1.10 WARRANTY

- A. Warranty monolithic lining placed by Contractor for a period of two (2) years from date of Substantial Completion. During this period, defects discovered in monolithic lining, as determined by the City or Engineer, shall be repaired, or replaced in a satisfactory manner at no cost to the City. Such repair or replacement shall include cost of removal and reinstallation. After 21 months following Substantial Completion of manhole lining, the City or Engineer will inspect the work to ensure proper performance. If deficiencies are found during these inspections, Contractor shall make necessary repairs at no additional cost to the City.
- B. Contractor shall be responsible for stopping leaks prior to installation of monolithic lining system.

PART 2 – PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. Design and install monolithic manhole lining system to protect concrete, brick and mortar, and other manhole surfaces from corrosion. Design products to stop infiltration, root intrusion, and further deterioration in manhole. Interior surfaces to be protected shall include walls, benches, inverts, pipe junctions and chimney (corbel).

2.2 EPOXY MONOLITHIC MANHOLE LINING SYSTEM (EMMLS) (HARSH SULIFDE CONDITIONS – SUBSTRATE SURFACE OF PH 1.0 OR HIGHER)

- A. Note: Epoxy Liner is suitable for harsh hydrogen sulfide conditions, pH of 1.0 or higher, structures with very turbulent flow such as pump station wet wells and force main discharge structures.
- B. EMMLS shall be a resin-filled system suitable for use as a trowel-, spray- or spin-applied monolithic lining in wastewater collection manholes. Resin shall be 100 percent epoxy resin. EMMLS shall conform to ASTM C 722. EMMLS materials shall be suitable for specified design conditions.
1. EMMLS shall provide a minimum service life of 25 years.
 2. Cured EMMLS shall be continuously bonded to brick, mortar, concrete, chemical sealant, grout, pipe, and other surfaces inside wastewater collection system manhole. Provide bond strength data on cured EMMLS based on ASTM C882 test method.
 3. Cured EMMLS shall provide a minimum total thickness of 0.10 inches (100 mils). Cured lining thickness shall be continuous with proper sealing connections to unsurfaced areas.
 4. Chemical sealants or grouts used to seal active manhole leaks, to patch cracks, to fill voids and to otherwise prepare manhole surfaces shall be compatible with EMMLS.
- C. When cured, EMMLS shall form a continuous, tight-fitting, hard, impermeable lining, which is suitable for wastewater collection system service and chemically resistant to any chemicals or vapors normally found in domestic wastewater.
- D. EMMLS shall bond to wastewater collection system manhole being rehabilitated after being placed and cured. EMMLS shall cover complete interior of existing wastewater collection system manhole including benches (shelves), inverts (channels or troughs) and pipe connections. EMMLS shall provide a continuous watertight seal or barrier.
1. EMMLS shall effectively seal interior surfaces of wastewater collection system manhole and prevent any penetration or leakage of groundwater infiltration.
 2. Provide water resistance data on EMMLS based on ASTM Standards D 870 and D 2247 test methods.
 3. EMMLS shall be compatible with thermal condition of wastewater collection system manhole surfaces. Surface temperatures will range from 30 degrees F to 80 degrees F. Provide test data on EMMLS thermal compatibility based on ASTM C 884.

4. EMMLS shall be separated from manhole frame by a suitable joint. Joint shall be sealed with joint sealing tape.
- E. EMMLS shall be as manufactured by Raven Lining Systems, Warren Environmental, Sauereisen, AP/M PermaForm, WBE Dorcas Inc., or an approved equal.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Notify property owners who discharge wastewater directly to manhole being surfaced that their service will be disrupted while lining is being placed, cured and active pipe and service connections reopened. Notify individual property owners at least 72 hours in advance, giving date, start time, and estimated completion time for the work being conducted. This notification shall be coordinated with distribution of door hangers.
- B. When existing surfaces adjacent to areas where work of this Section is scheduled may be damaged or harmed, provide temporary materials to protect those existing surfaces. Contractor shall determine type and quantity of protective materials.

3.2 INSTALLATION – EPOXY MONOLITHIC MANHOLE LINING SYSTEM (EMMLS)

- A. Notify property owners who discharge wastewater directly to manhole being surfaced that EMMLS is being placed and that bypass pumping of wastewater flows will be provided. Notify individual property owners at least 72 hours in advance, giving date, start time, and estimated completion time for the work being conducted.
- B. Provide bypass pumping of wastewater flows where and when rehabilitation work is being performed.
- C. Place EMMLS in manhole. Installation of EMMLS shall be in complete accordance with applicable provisions of ASTM C 722 and manufacturers' specifications. Manufacturer's representative shall be present during actual installation.
 1. Prior to placing EMMLS, manufacturer's representatives shall approve surface preparation work and installation conditions including temperatures.
 2. Surfaces shall be sufficiently dry and even.

3. Bottom and horizontal surfaces including benches and channels shall have EMMLS applied to required thickness by hand troweling or spray on methods.
 4. Side vertical surfaces shall have EMMLS applied to required thickness by manufacturer's recommended methodology.
 5. Temperature limitations shall be handled as appropriate and as approved by the installer.
- D. Cutting and sealing of EMMLS at manhole pipe and top connections shall provide watertight seals.

3.3 FIELD QUALITY CONTROL – GENERAL

- A. The Engineer or the City may enter manholes to inspect benching, invert channels, manhole wall/pipe connections, surface preparation, and other parts of the work. Contractor shall provide forced air ventilation, gas monitors and detectors, harnesses, lights, etc. for Engineer or City to enter manhole and perform inspection in complete accordance with OSHA requirements at no additional cost to the City.
- B. Finished manhole surface shall be continuous and as free as commercially practicable from significant defects. Defects which will affect, in foreseeable future or warranty period, the integrity or strength of manhole shall be repaired at Contractor's expense, in a manner mutually agreed upon by the City/Engineer and Contractor.
- C. There shall be no cracks, voids, pinholes, uncured spots, dry spots, lifts, delamination, or other type defects in liner. If any defects are discovered after liner has been installed, it shall be repaired or replaced in a satisfactory manner within 72 hours and at no additional cost to the City. This requirement shall apply for entire warranty period.
- D. Active infiltration through lining system shall be zero.
- E. Contractor is responsible for coordinating testing times with the City and Engineer.

3.4 FIELD QUALITY CONTROL – EPOXY MANHOLE MONOLITHIC LINING SYSTEM (EMMLS)

- A. Field acceptance of EMMLS shall be based on the City/Engineer's evaluation of proper monolithic lining of manhole. Field acceptance shall

also be based on City/Engineer's evaluation of appropriate installation and curing test data along with review of manhole inspections.

- B. EMMLS shall provide a continuous monolithic lining with uniform thickness throughout manhole interior. If thickness of EMMLS is not uniform or is less than specified, it shall be repaired or replaced at no additional cost to the City.
1. Engineer or the City will measure EMMLS cured thickness by physically cutting through lining (by drilling or coring) and making a direct measurement. Make a minimum of two thickness measurement locations in each EMMLS manhole. A suitable non-destructive type of thickness measurement may also be used.
 2. EMMLS thickness measurement locations shall be repaired by Contractor in accordance with manufacturer's recommendations. These repairs shall be included in two-year EMMLS warranty.
 3. Contractor shall also perform in-place testing in each manhole to verify adhesion of EMMLS to existing manhole substrate. Adhesion strength tests shall be in accordance with ASTM D 7234 and test area shall be isolated from remaining portion of manhole by coring through liner into substrate. Two tests shall be performed in each manhole at locations directed by the City or Engineer. Testing shall consist of a calibrated pull test. Equipment shall be provided by Contractor. Samples shall meet a minimum pressure resistance of 400 pounds per square inch (psi).
- C. There shall be no cracks, voids, pinholes, uncured spots, dry spots, lifts, delamination, or other type defects in EMMLS.
- D. Contractor shall submit proposed method for testing for these defects. One of the following tests shall be performed by Contractor as directed by City or City's Agent.
1. Vacuum Test: A vacuum test conforming to requirements of ASTM C 1244 shall be performed for every lined manhole or circular structure where practical.
 2. Holiday Detection Test: A high voltage holiday detection system may be used to determine if any holidays (pinholes, voids, etc.) exist in lining. Set sensitivity control of holiday tester to accommodate thickness of applied lining (100-125 volts for each one (1) mil thickness). Follow guidelines of holiday testing equipment manufacturer for correct control settings. One such service is Tinker & Razor Holiday Tester Model APW.

3. Should a holiday be detected, it shall be marked, and the lining installation Contractor shall repair void according to correct procedure determined by system manufacturer.
4. Ultrasonic Testing: Per ASTM D 6132.

3.5 CLEANING

- A. Remove temporary protective materials at existing surfaces surrounding work of this Section.
- B. Remove excess materials, installation equipment, and clean work areas around manholes. Properly remove trash and debris leaving work area in condition that existed prior to work performed under this Section.

END OF SECTION