

SECTION 02900

SANITARY SEWER MANHOLE REHABILITATION

PART 1 — GENERAL

1.01 SECTION INCLUDES

- A. This section of these Specifications provides for rehabilitating manholes to include the repair/replacement/rebuilding/sealing of the base, trough, bench, walls, and cone, and removal of unsound construction material. Work includes surface preparation, sealing, and testing.

1.02 RELATED SECTIONS

- A. Section 01520: Sewer Flow Control
- B. Section 02276: Site Restoration and Erosion Control

1.03 REFERENCES

- A. The following published standards from the American Society for Testing and Materials International (ASTM)

ASTM C78	Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimen)
ASTM C157	Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM C-191-08	Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear
ASTM C876	Half-Cell Potentials of Uncoated Reinforcing Steel in Concrete
ASTM D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D638-10	Standard Test Method for Tensile Properties of Plastics
ASTM D695-10	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D-790	Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

ASTM D2240-05 (2010)	Standard Test Method for Rubber Property— Durometer Hardness BS 7816-3:1998- (ASTM D2240-75 not found; this standard published 07/15/1998 by British Standards Institution.)
ASTM D2566	Withdrawn Standard: ASTM D2566 Test Method for Linear Shrinkage of Cured Thermosetting Casting Resins During Cure (Withdrawn 1993)
ASTM D2584	Standard Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates

- A. International Concrete Repair Institute (ICRI) Technical Guideline No. 03730 - Surface Preparation Guidelines for the Repair of Deteriorated Concrete Resulting From Reinforcing Steel Corrosion.
- B. Potable Water Main, Gravity Sanitary Sewer, and Sanitary Sewer and Force Main Design Standards, DeKalb County Department of Watershed Management, Latest Edition and Version.

1.04 SUBMITTALS

- A. All Submittals shall be received and approved by the Owner's Representative prior to beginning work.
- B. The Contractor shall submit the following items at least thirty (30) calendar days prior to starting manhole/vault rehabilitation:
 1. Manufacturers' Certificate of Compliance certifying compliance with the applicable specifications and standards. The certifications shall list all materials furnished under this Section and confirm the materials furnished for rehabilitation system selected are compatible with one another.
 2. Certified copies of factory test reports required by the applicable standards, the manufacturer, and this Section.
 3. Manufacturer's handling, storage, and installation instructions and procedures.
 4. Manufacturer's Certification indicating the installer is approved to install specified rehabilitation system.
 5. Documentation of successful projects in the specified rehabilitation system and confirmation of required experience.

6. Shop drawings and samples for any material proposed as equal to a specified material. The Contractor shall submit sufficient manufacturer's information to include, but not be limited to, the rehabilitation system, equipment components, material/chemical properties, mixing and proportioning requirements, maximum pot life, film/coating thickness, curing, and environmental requirements for application
- C.** The Contractor shall complete, and provide to the Owner's Representative, a daily written record (diary) detailing the work carried out and any small items of Work incidental to the Work. The Contractor shall include in his daily record and reference to the following:
1. Delays: Dense traffic, lack of information, sickness, labor or equipment shortage, etc.
 2. Weather: Conditions (e.g., rain, sunny, windy, etc.).
 3. Equipment: On site (e.g., specialty cleaning, by-pass equipment, etc.).
 4. Submittals: To the Owner's Representative.
 5. Personnel: On site by name (e.g., all labor, specialty services, etc.).
 6. Accident: Report (e.g., all injuries, vehicles, etc.).
 7. Incident: Report (e.g., damage to property, property owner complaint, etc.).
 8. Major defects encountered: including collapsed pipe, if any, cave-ins, sink holes, etc.
 9. Visitors: On site.
 10. Disposals: Type and quantity of debris (including liquids).

1.05 EXPERIENCE/QUALIFICATIONS

- A.** The supervisor of the field crews shall have received proper training and have a minimum of three (3) years' experience in applying the specified product(s) covered under this section of the Specifications, practicing safe working practices and confined space entry procedures, and using the types of equipment and product/materials required. Submit confirming documentation.
- B.** Field crew leaders shall have received proper training in this function and have a minimum of two (2) years' experience in applying the specified product(s) covered under this section of the Specifications, practicing safe working practices and confined space entry procedures, and using the types of equipment and product/materials required. Submit confirming documentation.
- C.** Experience shall include, at a minimum, projects successfully completed, incorporating not less than 250 manholes and performed within the last 10 years using the specified rehabilitation system. Submit confirming documentation.
- D.** No crewmembers shall enter confined spaces without the necessary certified training as required under applicable Federal, State, and local laws, regulations,

standards, policies, procedures, and requirements, and permit.

1.06 LINING SYSTEMS

The lining system used shall result in a monolithic structure to the shape and contour of the interior of the existing manhole. The lining system shall be completely water tight and free of any joints or openings other than pipe inlets, pipe outlets and the rim opening. The junction of the lining material with the pipe material at the inlets and outlets shall be watertight.

1.07 RESPONSIBILITY FOR OVERFLOWS/SPILLS AND DAMAGE TO PROPERTY AND UTILITY

A. Reference Specification Section 01030 – Special Project Procedures.

1.08 SAFETY

A. All work shall be performed in accordance with OSHA standards and local, State and Federal safety regulations.

B. No person shall enter a confined space without the documented requisite training, certification, and entry permit.

PART 2 — PRODUCTS

2.01 GENERAL

A. Materials:

1. The materials used shall be designed, manufactured, and intended for sewer manhole/vault rehabilitation and the specific application for which they are used. The materials shall have a proven history of performance in sewer manhole/vault rehabilitation for a minimum of 10 years nationally, regarding similar age, groundwater levels, and environmental characteristics. The materials shall be delivered to the Work Site in original unopened packages and clearly labeled with the manufacturer's identification and printed instructions. All materials shall be stored and handled per the manufacturer's published recommendations. All materials shall be mixed and applied per the manufacturer's written instructions.
2. The Contractor shall warrant and save harmless the Owner against all claims for patent infringement and any loss thereof.
3. Dispose of all wastes in accordance with applicable regulations.
4. Each coating/lining system shall be designed for application over wet surfaces, but not active running water, without degradation of the final product and/or the bond between the product and the manhole/vault surfaces.

B. Pressure grout active leaks:

1. Pressure grout shall be an acrylamide gel pressure sealant system provided

by a single manufacturer. The acrylamide gel pressure sealant system shall consist of a dry powder chemical readily dissolvable in water to form a low viscosity solution stiffening to a gel when mixed with an aqueous persulphate catalyst and a triethanolamine activator.

2. During injection, chemical sealant shall be able to react in presence of infiltrating water.
3. The system shall have the following characteristics:
 - a. A minimum of ten (10) percent acrylamide base material by weight in the total sealant mix.
 - b. A higher concentration (percent) of acrylamide base material may be used to increase strength or offset dilution during injection.
 - c. Capable of withstanding submergence in water without degradation.
 - d. Prevent passage of water through manhole defect
 - e. Flexible as opposed to brittle or rigid.
 - f. In place, able to withstand freeze/thaw and wet/dry cycles without adversely affecting seal.
 - g. Mixing of component materials shall be compatible with field conditions
 - h. Residual sealing materials shall be easily removable from manhole bench.
 - i. Constant viscosity during reaction period.
 - j. Additives to increase viscosity, adjust cure time though the range of ten (10) seconds to one (1) hour, density, shrinkage, compressive strength, tensile strength, and pH.
 - 1) Diatomaceous earth (Celite 209 or equal) can be added to concentration of five percent.
 - 2) Use of other additives following manufacturer's recommendation and Engineer's approval.
 - k. Cured product shall be resistant to dehydration, homogeneous, chemically stable, non-biodegradable, firm, flexible gel. Any suggested manufacturer and material identification.
 - l. Root control additive 2, 6-Dichlorobenzonitrile, may be added following manufacturer's recommendation and the Owner's Representative's direction. Any suggested manufacturer and material identification.

C. Stopping active leaks (hydraulic cement):

1. A premixed fast-setting product, specifically formulated for leak control,

creating a volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsum's, plasters, iron particles, aluminum powder or gas-forming agents, or promote the corrosion of steel it may come in contact with. Set time shall be approximately one (1) minute. Ten (10) minute compressive strength shall be approximately 500 psi.

- a. The product shall be designed to rapidly stop flowing leaks in vertical and horizontal, concrete and masonry surfaces.

Cure Time	Compressive Strength ASTM C109	Tensile Strength ASTM C496
1 day	3500 psi	-----
7 day	4900 psi	290 psi
28 day	5500 psi	575 psi

- b. Hydraulic cement shall be manufactured by Quadex, Madewell Products Corporation, Fosroc, IPA Systems, or approved equal.

- 2. A silicate-based liquid accelerator field mixed with neat Portland cement. The set time shall be approximately one (1) minute.
- 3. The elastomeric polyurethane resin-soaked method, using dry twisted jute oakum, or resin-rod with polyurethane resin (water activated).

D. Patching, repointing, filling, and repairing non-leaking holes, cracks, and spalls in concrete and masonry manholes (Cement Mortar):

- 1. A premixed non-shrink cement-based patching material consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents, which has been formulated for vertical or overhead use. It shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents or promote the corrosion of steel it may come into contact with. Set time (ASTM C-191) shall be less than thirty (30) minutes. One- (1) hour compressive strength (ASTM C-109) shall be a minimum of 200 psi and the ultimate compressive strengths (ASTM C-882- Modified) shall be a minimum of 1700 psi.
- 2. The product shall display the following properties:

	Strength (psi)		
	Day	7 Day	28 Day
Compressive Strength (ASTM C 109)	3,875	4,550	6,190
Flexural Strength (ASTM C 78)	-----	825	985
Tensile Strength (ASTM C 496)	-----	290	575
Shrinkage (ASTM C 157, Modified)	0.04 Percent @ 28 Days		

3. Shall be a factory blended, low shrinkage, high strength, polymer modified, sprayable, microsilica mortar.
4. The cement mortar shall be QM-1s Restore by Quadex, Inc., Mainstay ML-72 by Madewell Products Corporation, or approved alternate.

E. Spray applied or centrifugally cast lightweight structural reinforced cement manhole lining (Cement Mortar):

1. A premixed non-shrink cement-based patching material consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents, formulated for vertical or overhead use. It shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents or promote the corrosion of steel it may come into contact with. Set time (ASTM C-191) shall be less than 30 minutes. One-hour compressive strength as required in ASTM C-109. The product shall display the following properties:

	Strength (psi)		
	Day	7 Day	28 Day
Compressive Strength (ASTM C 109)	3,875	4,550	6,190
Flexural Strength (ASTM C 78)	-----	825	985
Tensile Strength (ASTM C 496)	-----	290	575
Shrinkage (ASTM C 157, Modified)	0.04 Percent @ 28 Days		

2. Shall be a factory blended, low shrinkage, high strength, polymer dcfmodified, sprayable, microsilica mortar.
3. Shall be suitable for low-pressure spray or trowel application for the repair of vertical and horizontal concrete and masonry structures.
4. Cement mortar shall be QM-1s Restore by Quadex, Inc., MS-2A by Strong, Silatec MSM by CemTec (A.W. Cook Cements), SewperCoat or approved alternate.

F. Spray applied corrosion protection (epoxy coating):

1. Only structures exhibiting damage due to corrosion shall receive the epoxy coating.
2. The material sprayed onto the surface of the manhole shall be one-hundred percent (100%) solids high build epoxy coating formulated for application within a sanitary sewer environment.
3. The coating thickness shall be a minimum of 125 mils in one (1) or two (2) multi-pass coats.
4. The coating color shall typically be white or off white.
5. If an adhesion coating is required between the concrete structure and the epoxy coating, the cost of the adhesion coat is included in the cost of the 100% solids, high build epoxy coating.

6. Manufacturer’s published directions regarding surface preparation shall be followed and is included in the cost of the 100% solids, high build epoxy coating. Manufacturer shall approve preparation of surface prior to application.
7. The cured epoxy resin system shall conform to the following minimum structural standards:

	Strength (psi)
Compressive Strength (ASTM D-695)	13,000
Flexural Strength (ASTM D-790)	13,000
Tensile Strength (ASTM D-638)	7,000
Flexural Modulus (ASTM-790)	500,000

8. The epoxy coating shall be Mainstay DS-5 by Madewell Products Corporation, Raven 405 by Raven Lining Systems, Cor-Cote SC (Sewer Coat) by Sherwin- Williams or approved alternate.
9. Composite structure/corrosion protection system.
10. Only structures exhibiting damage due to corrosion shall receive the composite system.
11. The coating thickness shall be a minimum of ½-inch.
12. If an adhesion coating is required between the concrete structure and the composite system, the cost of the adhesion coat shall be included in the cost of the composite system.
13. The composite system shall be SewperCoat by Lafarge Aluminates or approved alternate.

PART 3 — EXECUTION

3.01 REHABILITATION OF MANHOLE STRUCTURE

- A. Contractor to provide the following items, but not limited to, as directed by the Owner’s Representative:
 1. Pressure grout leaks.
 2. Repair leaking crack, joint and/or lift hole with hydraulic cement mortar.
 3. Repair non-leaking crack, joint and/or lift hole with non-shrink cement based mortar.
 4. Restore the structural integrity by lining the manhole with cement mortar.
 5. Provide corrosion barrier by lining the manhole with an epoxy coating.
 6. Restore the structural integrity of the manhole while providing corrosion barrier by installing a fiberglass insert liner.

7. Rebuild bench and trough using TYPE S cement mortar.
8. Provide thickness gauges, wet film gauges and other testing equipment to test the thicknesses, surface profiles and coating continuity as required by this specification.
9. Provide survey grade (+/- 0.01-foot) data on a manhole using GPS.
10. Provide survey grade (+/- 0.01-foot) data on a manhole using conventional survey methods.
11. Provide bypass pumping to facilitate rehabilitation activities.
12. Provide manhole condition assessment services.
13. Locate and expose buried manholes, adjust frame and cover heights as required
14. Install internal frame seal and external seal wraps
15. Remove intruding pipe or obstruction
16. Remove manhole steps

B. General Procedures:

1. **Cleaning:** All concrete and masonry surfaces to be rehabilitated shall be clean. All grease, oil, laitance, coatings, loose bricks, mortar, unsound brick or concrete and other foreign materials shall be completely removed. Initial cleaning shall be done by utilizing a minimum 5000 psi pressure washer with the proper nozzles; however, additional required cleaning shall be accomplished by other methods including but not limited to wet or dry sandblasting, acid wash, concrete cleaners, degreasers or mechanical means, as may be required to properly provide additional cleaning of the surface. All surfaces using these methods shall be thoroughly rinsed, scrubbed, neutralized and tested with test strips, in order to confirm the removal of all cleaning agents and their reactant products. Debris resulting from cleaning shall be removed from the manhole and not discharged downstream. The debris is to be disposed of properly in accordance with all laws. The local municipality can furnish a letter to the landfill stating the Contractor is authorized to dispose of the non-hazardous materials. Debris and liquids quantities are to be tracked in the daily Contractor diary.
2. **Stopping Infiltration:** After surface preparation and prior to the application of mortars and coatings, infiltration shall be stopped either by plugging with a hydraulic cement or chemical grout sealing.
3. **Patching:** All large holes and/or voids, joints or pipes, all spalled areas, all lifting holes and all holes caused by missing or cracked brick shall be patched and all missing mortar repointed using a non-shrink cement mortar. All cracked or disintegrated material shall be removed from the area to be patched or repointed, exposing a sound sub-base. All cracks not subject to movement shall be cleaned to remove all unsound material so a solid fixed surface is established and patched with non-shrink patching mortar. If any reinforcing is

exposed, a corrosion inhibiting product shall be used to coat the steel prior to patching.

4. Manhole Walls: The thicknesses of the patches, coatings, etc. must form a uniform, vertical wall established from the manhole bench to the manhole cone section.
 5. Flow Control: The Contractor shall be responsible for Wastewater Flow Control in accordance with 01520 Sewer Flow Control.
 6. The Contractor shall remove all foreign material, loose grout, debris and rubble from the existing channel. The Contractor shall rebuild the existing channel, if required, by reshaping or repairing the slope of shelves or benches. Manhole rehabilitation work shall include aligning inflow and outflow ports to prevent the deposition of solids at the transition point. All troughs shall follow the grades of the pipe entering the manhole. Changes in direction of the sewer and entering branch or branches shall have a true curve as large a radius as the size of the manhole will permit, but will be shaped to allow easy entrance of maintenance equipment including buckets, T.V. camera, etc.
 7. Manhole steps: The Contractor shall remove all manhole steps prior to rehabilitation. No steps shall be installed after rehabilitation.
 8. Each lining system shall be installed in accordance with the manufacturer's recommendation to withstand groundwater pressures. For manholes greater than twelve (12) feet in depth, the lining shall be capable of withstanding the pressures associated with a groundwater depth equal to the manhole depth. Linings for all other manholes shall be capable of withstanding the pressures associated with groundwater depth of twelve (12) feet. The Contractor shall measure groundwater depth from manhole bench to top of ground surface.
- C. Application of products shall be by factory certified applicators. Submit confirming documentation of certification.

3.02 SPRAY APPLIED LIGHTWEIGHT STRUCTURAL REINFORCED CEMENT

- A. The surface prior to spraying shall be properly prepared and cleaned and be damp without noticeable free water droplets or running water. Materials shall be spray-applied to a minimum uniform thickness to insure all cracks, crevices, and voids are filled and a smooth surface remains after light troweling. The light troweling is performed to compact the material into voids and to set the bond.
- B. The first application shall have begun to take an initial set (disappearance of surface sheen, lasting from 15 minutes to 1 hour depending upon ambient conditions) before the second application to assure a minimum total finished thickness of 1/2 inch. The final finished thickness may need to be greater than the 1/2 inch recommended by the manufacturer to withstand groundwater pressures. A depth gauge shall be used during application, at various locations, to verify the required thickness. The readings are to be recorded in the Contractor's Daily Report. The surface then shall be troweled to a smooth finish with care taken to not over trowel in a manner bringing additional water to the surface and weaken it. The Contractor shall follow the manufacturer's recommendations.

- C. The bench covers used to catch debris and rebound shall be removed and the bench and trough sprayed so a gradual slope is produced from the walls to the trough with the thickness at the edge of the trough being no less than 1/2 inch. The wall-bench intersection shall be rounded to a uniform radius the full circumference of the intersection.
- D. No application shall be made to frozen surfaces or if freezing is expected to occur within the manhole for twenty-four (24) hours after application. If ambient temperatures are in excess of 95° F, precautions shall be taken to keep the mix temperature at time of application below 90° F, using ice if necessary. Contractor shall monitor and maintain the temperatures within the range required by the manufacturer. The contractor shall provide a hi/lo thermometer and record the readings in the daily report.
- E. The final application shall have a minimum of four (4) hours cure time before being subjected to active flow.

3.03 CENTRIFUGALLY CAST STRUCTURAL REINFORCED CEMENT

- A. The rotating casting applicator shall be positioned to evenly apply the material and be withdrawn at a rate to assure a final minimum thickness of 1/2-inch. The final finished thickness may need to be greater than 1/2-inch, as recommended by the manufacturer, to withstand groundwater pressures. A depth gauge shall be used during application, at various locations, to verify the required thickness. The readings are to be recorded in the Contractor's Daily Report. The surface shall be troweled to a smooth finish with care being taken to not over trowel in a manner bringing additional water to the surface and weaken it.
- B. The bench covers used to catch debris and rebound shall be removed and the bench and trough sprayed or hand applied so a gradual slope is produced from the walls to the trough with the thickness at the edge of the trough being no less than 1/2-inch. The wall-bench intersection shall be rounded to a uniform radius the full circumference of the intersection. The surface shall be troweled to a smooth finish with care taken to not over trowel in a manner bringing additional water to the surface and weaken it.
- C. No application shall be made to frozen surfaces or if freezing is expected to occur within the manhole for 24 hours after application. If ambient temperatures are in excess of 95° F, precautions shall be taken to keep the mix temperature at time of application below 90° F. Contractor shall monitor and maintain the temperatures within the range required by the manufacturer. The contractor shall provide a hi/lo thermometer and record the readings in the daily report.
- D. The final application shall have a minimum of one (1) hour cure time before being subjected to active flow.

3.04 EPOXY COATING

- A. The epoxy coating shall be applied onto the interior surfaces of the manhole to produce a smooth coating and yield the required minimum thickness. A depth gauge shall be used during application at various locations to verify the required thickness. The readings are to be recorded in the Contractor's Daily Report.

- B. The epoxy resin shall be applied at the required recommended thickness. The application shall have a minimum of three (3) hours cure time at required temperatures before being subjected to active flow.
- C. Conduct and record WFT tests during application and have Tooke gauge (DFT) tests done after application. Also suggest that high voltage holiday tests be required contingent upon required millage. All tests shall be conducted at the contractor's expense, by an independent NACE certified technician, and shall be witnessed by the Owner's Representative. Results of tests to be provided to Owner's Representative. Owner reserves the right to verify testing. Results of Owner's test takes precedence.
- D. An epoxy putty or other surfacer recommended by the epoxy manufacturer shall be used as necessary to repair any slight surface irregularities prior to applying epoxy.
- E. The sloped surface of the manhole bench shall be made non-skid by broadcasting aluminum oxide or sand into the surface prior to gelatin/set.

3.06 MANHOLE REHABILITATION ACCEPTANCE

- A. After the manhole rehabilitation work has been completed, the Owner's Representative shall visually inspect the manhole. The finished surface shall be free of blisters, "runs" or "sags" or other indications of uneven lining thickness. The finished surface shall not have any evidence of visible leaks.

3.07 MANUFACTURER CERTIFICATION

- A. The manufacturer should be on-site for 2 to 5 eight-hour days or more depending on project size to confirm the Contractor is doing the installation correctly.

3.08 CLEANUP

- A. After the work has been completed and all testing acceptable, the Contractor shall clean up the work area.
- B. All debris and excess materials not incorporated into the permanent installation shall be disposed of by the Contractor. The debris and liquids are to be disposed of properly in accordance with all applicable laws. The local municipality can furnish a letter to the landfill stating the Contractor is authorized to dispose of the non-hazardous materials. Debris and liquid type and quantities are to be tracked in the daily Contractor diary. Hauling and disposal costs will be borne by the Contractor.
- C. The work area shall be left in a condition equal to or better than prior condition. Disturbed grassed areas shall be seeded or sod placed as directed by the Owner's Representative at no additional cost to the Owner. The work site restoration work shall be completed in accordance with the requirements Section 2276 – Site Restoration and Erosion Control.

3.09 DOCUMENTATION

- A. The Contractor shall complete work on each asset as assigned via the Owner's Computerized Work Order Management system. Upon starting the work, the Contractor shall receive work orders as assigned by the Owner's Representative.

The Contractor shall maintain and synchronize the status of each rehabilitation work order issued.

3.10 WARRANTY

- A.** The Contractor shall guarantee the work for a warranty period of one (1) year from the date of final acceptance. If, at any time during the warranty period, any defect is identified, the Contractor shall make repairs acceptable and at no additional cost to the Owner. In this case, the Contractor shall warrant the work for one (1) year in addition to the warranty required by the Contract.
- B.** If the frequency of similar defects requiring repair increases, then the entire project will be re-evaluated.

END OF SECTION