SECTION 02765

SANITARY SEWER MANHOLE REHABILITATION
(Level Yellow, Level Blue and Level Green Manhole Rehabilitation)

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sanitary sewer manhole rehabilitation including:
   1. Level "Yellow" Rehabilitation - Rehabilitation and leak-proofing of manholes by lining with spray applied or centrifugally cast lightweight structural reinforced concrete.
   2. Level "Blue" Rehabilitation - Rehabilitation and leak-proofing of manholes by lining with spray applied epoxy resin systems.
   3. Level "Green" Rehabilitation - Rehabilitation and leak-proofing of manholes as specified by Level "Yellow", and followed by lining with spray applied epoxy resin systems as specified by Level "Blue".
   4. The repair and sealing of the manhole base, invert, walls, corbel/cone, and chimney of brick, block, or precast manholes, including the removal of any unsound material.
   5. The inspection and testing of the various types of work to insure compliance.

1.2 LINING SYSTEMS

A. 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.

B. Lining system shall be of the type that allows rehabilitation of a concentric, eccentric or flat top manhole without removing the manhole ring and top section or corbel.

1.3 SUBMITTALS

A. Submit the following as required in Section 01340 at least 14 days prior to starting manhole rehabilitation:
   1. Manufacturers' Certificate of Compliance certifying compliance with the applicable specifications and standards. The certifications shall list all materials furnished under this Section.

2. Certified copies of test reports of factory tests required by the applicable standards, the manufacturer, and this Section.
3. Manufacturer's handling, storage, and installation instructions and procedures.
4. Recommended lining thickness design to withstand groundwater pressure as specified in Part 3 of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. The materials used shall be designed, manufactured and intended for sewer manhole rehabilitation and the specific application in which they are used. The materials shall have a proven history of performance in sewer manhole rehabilitation. The materials shall be delivered to the job site in original unopened packages and clearly labeled with the manufacturer's identification and printed instructions. All materials shall be stored and handled in accordance with recommendations of the manufacturer. All materials shall be mixed and applied in accordance with the manufacturer's written instructions.
2. The Contractor shall warrant and save harmless the Owner and his Engineer against all claims for patent infringement and any loss thereof.
3. Handle and store all materials and dispose of all wastes in accordance with applicable regulations.
4. Each 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 surfaces.

B. Stopping active leaks in concrete and masonry manholes:
1. A quick setting hydraulic cement compound used to stop seepage leaks in masonry or concrete (Permacast-Plug or equal). A premixed fast-setting, volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsums, 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 60 to 180 seconds. Ten-minute compressive strength shall be approximately 500 psi.
2. The elastomeric polyurethane resin-soaked method, using dry twisted jute oakum or resin-rod with polyurethane resin (water activated).

3. Chemical grouts (Avanti AV-202 Multigrout Urethane Resin or equal) injected to the exterior for stopping *very* active infiltration in accordance with manufacturer's recommendations.

C. Patching, repointing, filling, and repairing nonleaking holes, cracks, and spalls in concrete and masonry manholes:

1. A premixed nonshrink 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 30 minutes. One-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.

D. Exterior Chemical Curtain Grouting and/or for Major Active Leaks (>0.5 gpm)

1. Exterior chemical curtain grouting shall be used to stop significant infiltration sources. Chemical curtain grouting shall be solvent-free, hydrophilic resin designed to seal leaks in concrete and masonry structures. When it contacts water, chemical grout shall expand exponentially and form a tough, flexible foam seal that cannot be penetrated by water. Chemical curtain grouting shall be manufactured by Avanti International, DeNeef Construction Chemicals, or approved equal.

2. Exterior chemical curtain grouting shall be applied according to manufacturer's recommendations and shall have the following minimum requirements:

Minimum Requirements		
Bond Strength	ASTM C882	60 psi
Tensile Strength	ASTM D3574 ASTM D1623, free rinse	310 psi 54 psi
Elongation	ASTM D3574 ASTM D1623, free rinse	280% 64%
Shrinkage	ASTM D1042/D756	< 2%
Internal Linear Shrinkage		5%
Tear Resistance	ASTM D3574	20 lbs/in
Density	ASTM D3574	30.8 lbs/ft^3

3. Cured properties will vary depending on job conditions. Cured properties above (ASTM D3574) are derived from 10-15 pcf foam. Free rise properties are derived from 3-5 pcf foam.

4. Exterior chemical curtain grouting shall be suitable for the intended purpose and shall be compatible with the monolithic lining as certified by the manufacturer.

2.2 LEVEL YELLOW

A. Spray applied or centrifugally cast lightweight structural reinforced cement manhole lining:
   1. The material applied to the surface of the manhole (similar to Strong Seal MS-2, Permacast CR-9000, or Quadex QM-1S) shall be a cementitious blend of acid resistant binders, silicious aggregates, non-metallic fibers and other additives for constructing a liner that is impervious to the flow of water, is resistant to sulfide attack, and restores structural integrity to existing manhole walls.
   2. A monolithic liner shall be formed which covers all interior manhole surfaces and shall have the following minimum requirements at 28 days:
      a. Compressive Strength (ASTM C-109) 9,000 psi
      b. Tensile Strength (ASTM C-496) 600 psi
      c. Flexural Strength (ASTM C-293) (Modified) 750 psi
      d. Shrinkage (ASTM C-596) 0%@90%R.H.
      e. Bond (ASTM C-882) 2,000 psi

f. Density, when applied 135± pcf

2.3 LEVEL BLUE

A. Spray applied epoxy resin system manhole lining:

1. The material sprayed onto the surface of the manhole shall be an epoxy resin (similar to Raven 405, or Warren Environmental Systems M-201 and S-301) system formulated for application within a sanitary sewer environment. The resin will exhibit suitable corrosion resistance and enhance the structural integrity of the existing manhole.
2. The cured epoxy resin system shall conform to the following minimum structural standards:

DESCRIPTION	TEST METHOD	RESULTS
Tensile Strength	ASTM D-638	7,000 psi
Flexural Strength	ASTM D-790	11,000 psi
Flexural Modulus	ASTM D-790	500,000 psi
Compressive Strength	ASTM D-695	12,000 psi

PART 3 - EXECUTION

3.1 REHABILITATION OF MANHOLE STRUCTURE

A. General Procedures:

1. Safety: The Contractor shall perform all work in strict accordance with all applicable OSHA, TOSHA, and manufacturer's safety standards. Each method of manhole rehabilitation in this Section requires some degree of manhole entry by workers. Particular attention is drawn to those safety requirements regarding confined space entry and respiratory protection from airborne particulate materials during cleaning and product mixing and application.
2. 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. Water blasting utilizing a 210° F steam unit and proper nozzles shall be the primary method of cleaning; however, other methods such as wet or dry sandblasting, acid wash, concrete cleaners, degreasers or mechanical means may be required to properly clean the surface. All surfaces on which these methods are used shall be thoroughly rinsed, scrubbed, and neutralized to remove cleaning agents and their reactant products. Debris resulting from cleaning shall be removed from the manhole and not allowed to be carried downstream.
3. Stop Infiltration: After surface preparation and prior to the application of mortars and linings, infiltration shall be stopped.

This applies to defects within the manhole as well as any annular spaces between a host pipe and pipe liner. Water seepage shall be stopped with waterproof cement plug material or water activated polyurethane resins. Severe leaks which cannot be stopped with either of these two specified materials shall be reported to the Owner. If so directed by the Owner, then these severe leaks shall be stopped using chemical (urethane) grout injected through the manhole wall, the invert or the bench (as appropriate). Excess cured grout shall be completely removed from the inside surface before further patching or lining.

4. Patching: All large holes or voids around steps, joints or pipes, all spalled areas and all holes caused by missing or cracked brick shall be patched and all missing mortar repointed using a nonshrink patching mortar. All cracked or disintegrated material shall be removed from the area to be patched or repointed, exposing a sound subbase. All cracks not subject to movement and greater than 1/16 inch in width shall be routed out to a minimum width and depth of 1/2 inch and patched with nonshrink patching mortar.
5. Flow Control: The Contractor shall be responsible for plugging or diverting the flow of sewage as needed for repair and lining of manhole inverts and benches.
6. Remove all loose grout and rubble from existing channel. Work shall include aligning inflow and outflow ports in such a manner as to prevent the deposition of solids at the transition point. All inverts 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 of 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: Inspect all manhole steps prior to rehabilitation. Report to the Engineer any steps which appear loose, deteriorated, broken, or otherwise unsafe.
8. Each system shall be installed in accordance with the manufacturer's recommendation to withstand groundwater pressures. For manholes greater than 12 feet in depth, the lining shall withstand the pressures associated with a groundwater depth equal to the manhole depth. Linings for all other manholes shall withstand the pressures associated with groundwater depth of 12 feet. Measure groundwater depth from manhole bench to top of ground surface.
9. Application of products shall be by factory certified applicators.

3.2 SPRAY APPLIED LIGHTWEIGHT STRUCTURAL REINFORCED CEMENT (Level “Yellow” and Level “Green”)

A. The surface prior to spraying shall be damp without noticeable free water droplets or running water. Materials shall be spray-applied to a minimum uniform thickness to insure that all cracks, crevices, and voids are filled and a somewhat 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 which could be 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 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 surface then shall be troweled to smooth finish with care taken not to over trowel so as to bring additional water to the surface and weaken it. Manufacturer's recommendations shall be followed whenever more than 24 hours have elapsed between applications.

C. The bench covers used to catch debris shall be removed and the bench and invert sprayed such that a gradual slope is produced from the walls to the invert with the thickness at the edge of the invert 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 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.

E. The final application shall have a minimum of four (4) hours cure time before being subjected to active flow.

3.3 CENTRIFUGALLY CAST STRUCTURAL REINFORCED CEMENT (Level "Yellow" and Level "Green")

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.

B. The bench covers used to catch debris shall be removed and the bench and invert sprayed or hand applied so that a gradual slope is produced from the walls to the invert with the thickness at the edge of the invert being no less

than 1/2-inch. The wall-bench intersection shall be rounded to a uniform radius the full circumference of the intersection.

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.

D. The final application shall have a minimum of one (1) hour cure time before being subjected to active flow.

3.4 SPRAYED APPLIED EPOXY RESIN SYSTEM (Level "Blue" and Level "Green")

A. The epoxy resin shall be sprayed onto the surfaces of the manhole walls, and the benches to produce a smooth coating and yield the required structural integrity and corrosion resistance. A depth gauge shall be used during application at various locations to verify the required thickness.

B. The epoxy resin shall be applied to a minimum thickness of 0.125 inches at the top of the manhole and gradually thickened, in accordance with manufacturer's recommendations, to withstand groundwater pressures. The application shall have a minimum of three hours cure time before being subjected to active flow.

C. 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.

3.5 MANHOLE REHABILITATION ACCEPTANCE

A. Any visible leakage in the manhole or structure, before, during, or after the test shall be repaired regardless of any test results.

B. Testing for Level "Yellow" and Level "Green" Rehabilitation (lightweight structural reinforced concrete).
   1. Two test cubes (2" cube specimens according to ASTM C 109/C) of the spray applied or centrifugally cast lightweight structural reinforced concrete material shall be taken randomly as directed by the inspector at contractors's expense to verify strengths.
   2. Thickness shall be verified with a wet gage at any random point of the new interior surface. Any areas found to be thinner than the minimum specified thickness shall immediately receive additional material.

C. Testing for Level "Blue" and Level "Green" Rehabilitation (epoxy coating).

1. During application a wet film thickness gauge, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used. Measurements shall be taken, documented and attested to by Contractor for submission to Owner.
2. After the coating product(s) have set in accordance with manufacturer instructions, all surfaces shall be inspected for holidays with high-voltage holiday detection equipment. Reference NACE RPO 188-99 for performing holiday detection. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer's recommendations. Documentation on areas tested, results and repairs made shall be provided to Owner by Contractor.

END OF SECTION 02765 – SANITARY SEWER MANHOLE REHABILITATION