SUBSECTION 33 05 13
MANHOLE REHABILITATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment, and incidentals required for the purpose of restoring structural integrity, eliminating water infiltration, repair of voids, and providing corrosion protection of the sanitary sewer manholes as shown on the Drawings and specified herein.

A. Sanitary sewer manhole rehabilitation shall include the following:

1. Leak-proofing of deteriorated, leaking, or structurally unsound manholes by lining with lightweight structurally reinforced concrete systems.
2. Repair and sealing of the manhole base, benches, channel, walls, corbel/cone, and chimney of brick, block, or precast manholes, including the removal of any unsound material.
3. Injection of chemical grout.
4. Cleaning and preparatory patching of manholes receiving cementitious liners.
5. Replacement of manhole covers.
6. Resetting of loose, unstable, offset, or shifted existing manhole frames and covers.
7. Adjustment of existing manhole frames and covers to grade.
8. Installation of stainless steel inflow inserts within manhole frames.
9. Installation of manhole isolation pads as shown on the drawings.

1.02 SUBMITTALS

A. Product Data for each product used in manhole rehabilitation
B. The Contractor shall provide certification from each product manufacturer utilized that the applicator is certified to apply the product and the manufacturer has witnessed and approved the application in the first manhole to be rehabilitated with the product.
C. The contractor shall submit a written Vacuum Test Report for each test location indicating pressures, duration, actual leakage amounts, and other data to the Engineer for approval as a condition of acceptance.

PART 2 - PRODUCTS

2.01 MANHOLE REHABILITATION MATERIALS

A. General

1. All materials shall be designed, manufactured and intended for sewer manhole rehabilitation and the specific application in which they are used.
2. Each material shall be designed for application over damp surfaces (not wet surfaces or surfaces with actively running water) without degradation of the final product or the bond between the product and the manhole surface.

B. Infiltration Control - Stopping active leaks in concrete and masonry manholes shall be achieved by using the following:

1. A premixed fast-setting, volume-stable, waterproofing, cementitious plugging material. The material shall consist of hydraulic cement, graded silica aggregates, and special plasticizing/accelerating agents. It shall not contain chlorides, gypsum, plasters, iron particles, aluminum powder or gas-forming agents, nor shall it promote the corrosion of steel.

The material shall meet the following physical property requirements:

Set time (max)	ASTM C403	60 to 90 sec
Compressive strength (1hr)	ASTM C109	1000 psi
Bond strength (1hr)	ASTM C321	50 psi.

The product must be factory blended requiring only the addition of water at the job site and shall not include any basic ingredient that exceeds the maximum allowable EPA limit for any heavy metal. Water used to mix product shall be clean and potable.

2. A chemical grout as specified herein.

C. Patching Material - Patching, repointing, filling, and repairing nonleaking holes, cracks, and spalls in concrete and masonry manholes, including trough repair shall be achieved by using the following material:

1. A premixed non-shrink, cement-based, patching material. The material shall consist of hydraulic cement, graded silica aggregates, special plasticizing/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, nor shall it promote the corrosion of steel.

The material shall meet the following physical property requirements:

Set time (max)	ASTM C403	30 min
Compressive strength (1 hr)	ASTM C109	800 psi
Compressive strength (28 day)	ASTM C109	3000 psi.

The product must be factory blended requiring only the addition of water at the job site and shall not include any basic ingredient that exceeds the maximum allowable EPA limit for any heavy metal. Water used to mix product shall be clean and potable.

2.02 SPRAY APPLIED AND CENTRIFUGALLY CAST LINING MATERIALS

A. The material applied to the surface of the manhole shall be a lightweight structurally reinforced cementitious blend of siliceous aggregates, non-metallic fibers and other additives. The material shall produce a monolithic liner that is impervious to the flow of water, resistant to sulfide attack, and restores structural integrity to the existing manhole walls. The material shall be Permacast MS-10,000, Quadex QM-1s, SCM Reliner MSP, Strong Seal MS-2A, or approved equal.

B. The material shall have the following minimum requirements:

Compressive Strength (28 days), psi	ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars	3,000
Tensile Strength, psi	ASTM C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens	300
Flexural Strength, psi	ASTM C293 - Standard Test Method for Flexural Strength of Concrete	600
Bond Strength, psi	ASTM C321 - Standard Test Method for Bond Strength of Chemical-Resistant Mortars	130
Shrinkage, %	ASTM C596 - Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement	0
Density, lb/cf	(when applied)	105

C. The product must be factory blended requiring only the addition of water at the job site and shall not include any basic ingredient that exceeds the maximum allowable EPA limit for any heavy metal. Water used to mix product shall be clean and potable.

D. The cementitious lining system shall result in a monolithic

structure conforming to the interior shape and contour of the existing manhole and covering all interior surfaces. The lining system shall be completely watertight 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.

E. The cementitious lining system shall allow rehabilitation of a concentric, eccentric, or flat top manhole without removing the manhole frame casting and top section or corbel.

F. 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 a minimum depth of 12 feet. The manufacturer's recommended lining thickness dimensions to withstand groundwater pressure shall be submitted as required in Subsection 01300 - Submittals.

G. The material shall be designed for the selected method of application.

2.03 WALL CLEANING MATERIAL

A. High Pressure Water utilizing a 210-degree Fahrenheit Steam Unit: 3,500 psi minimum force and 4,500 psi maximum force.

B. Cleaners: Detergent or muriatic acid capable of removing dirt, grease, oil, and other matter which would prevent bonding of the sealing material to the manhole wall. The Contractor shall refer to the lining material manufacturer's recommendations for preparatory surface cleaning.

2.04 MANHOLE FRAMES AND COVERS

New manhole frames and covers shall be East Jordan Iron Works (Vulcan) V-1501, or approved equal, as detailed on the Drawings.

2.05 MANHOLE DISH INSERTS

A. Manhole dish inserts shall be concave and include the new dish, gasket, and relief valves. The Contractor shall use appropriate watertight inserts to fit wall and frame of manhole casting and cover.

B. The insert body shall be manufactured of 304 stainless steel with a thickness of not less than 18 gage. The insert shall have a design that allows a loose fit into the ring for easy removal.

C. The gasket shall be made of closed cell neoprene, and shall have a pressure sensitive adhesive on one side. The manufacturer shall install the gasket and the adhesive shall be compatible with the insert material to form a long lasting bond in wet or dry conditions.

D. The gas relief valve shall be designed to release at a pressure of 0.5 psi to 1.5 psi. The valve shall be installed in the insert by means of a hole tapped in the insert by the manufacturer. The valve shall be made of nitrile to prevent corrosion from contact with hydrogen sulfide, dilute sulfuric acid and other gases associated with wastewater collection systems.

E. Inserts shall have a plastic coated, stainless steel handle installed on the body of the insert dish. The handle shall be attached with a number 6 stainless steel rivet. The cable shall be braided in such a manner that resists cutting with common bolt cutters. The cable terminal and eye end shall be made of stainless steel.

2.06 CHEMICAL GROUT

A. The chemical grout shall be a hydrophilic liquid that is water reactive and will change from a free flowing liquid to a water impermeable elastomeric gel upon injection to stop excessive infiltration to a manhole. The reaction (curing) shall produce a chemically stable and non-biodegradable, tough, flexible gel. The chemical grout shall be a urethane liquid in uncured form with a moderate viscosity suitable for pumping and variable curing times. The polyurethane chemical grout shall be Scotch-Seal 5610 by 3M, Avanti AV-254, or approved equal.

B. The material shall meet or exceed the following requirements:

1. The liquid shall have a solids content of 80 % and a specific gravity of 1.04 to 1.11.
2. The liquid shall have a viscosity of 300 to 1000 centipoise at 70-degree Fahrenheit.
3. Gel times shall be in accordance with the manufacturer’s recommendations.
4. The grout shall have the ability to increase viscosity, density, gel strength and resistance to shrinkage by the use of additives in the reaction water.

C. A reinforcing agent shall be added to the reaction water at the

manufacturer's suggested rate. This agent is intended to increase the polyurethane gel's resistance to wet/dry cycles, freeze/thaw cycles, and solid movement stresses. The reinforcing agent shall be appropriate for the specific grout product that is to be used.

D. Additional chemical grout additives, such as catalysts or accelerators, needed to make the grout function properly shall be as manufactured by 3M, Avanti, or approved equal and shall be used in a manner approved by the manufacturer.

2.07 MANHOLE CASTING EMBEDMENT SEALANT

A. The sealant shall be a premium, extruded, bituminous, tacky rubber sealant in rope form for use on manholes as an embedment material for the frame to adjusting brick/mortar corbel.

B. Sealant shall conform to the latest version of ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants and Federal Specification SS-S-210A – Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints, Type I.

C. The sealant shall have the following properties:

Physical Properties	REQUIRED
Initial Elongation, %, min.	300
Elongation, %, min., at two weeks in total water immersion	300
Storage Life	Indefinite
Service Temperature Range, ^{0}F	-20 to 200

PART 3-EXECUTION

3.01 PERFORMANCE REQUIREMENTS

The Contractor shall perform all work needed to structurally repair manholes, improve sewer flow, prevent entrance of inflow or groundwater, and prevent entrance of soil or debris.

3.02 DELIVERY, STORAGE, AND HANDLING

A. The materials shall be delivered to the job site in original unopened packaging and clearly labeled with the manufacturer's identification and printed instructions. The Contractor shall handle and store all material in accordance with manufacturer instructions and shall dispose of all wastes in accordance with applicable regulations.

B. The Contractor shall keep products safe from damage. The Contractor shall promptly remove damaged products from the job site and replace damaged products with undamaged goods.

3.03 PROJECT CONDITIONS

A. Field Location of Manholes:

1. The Contractor shall be responsible for locating and uncovering all manholes. If the Contractor is unable to locate a manhole after due diligence with measuring tapes, metal detectors, and probing, the Contractor shall notify the Engineer in writing for assistance.
2. The Contractor is cautioned that manholes that are not part of the subsystem being rehabilitated may be located within the project limits. No payment will be made to the Contractor for work in manholes not indicated on the Drawings or as directed in writing by the Engineer.

3.04 SALVAGE

Manhole covers, frames, and adjusting rings from abandoned, broken, or adjusted castings shall remain the property of the VA. The Contractor shall deliver salvaged items at a time and to a property location designated by the Project Engineer.

3.05 PROTECTION

A. The Contractor shall provide traffic control.
B. The Contractor shall not allow sand, debris, or runoff to enter the sewer or drainage systems.

3.06 EXCAVATION

A. Excavation shall be in accordance with Specification 31 20 11 EXCAVATION.
B. The Contractor shall perform work in accordance with OSHA standards.

3.07 DIVERSION PUMPING

A. The Contractor shall install and operate diversion pumping equipment to maintain sewage flow and prevent backup or overflow.
B. In the event of a spill or overflow, the Contractor shall immediately stop and contain the overflow and take action to clean up and disinfect the spillage. Immediately notify the Engineer.

3.08 REHABILITATION OF MANHOLE STRUCTURE

A. Cleaning. All concrete and masonry surfaces to be rehabilitated shall be cleaned prior to the application of rehabilitation products. All grease, oil, laitance, coatings, loose bricks, mortar, unsound brick or concrete and other foreign materials shall be completely removed. Water blasting utilizing 210-degree Fahrenheit 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 and/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 not be washed downstream, but shall be removed from the manhole.

B. Disposal Sites. The Contractor shall dispose of sludge, sand, debris, grit, and liquid wastes resulting from performance of operations in an approved, licensed disposal sites at no additional cost to the Government.

C. Infiltration Control. After surface preparation and prior to the application of mortars and coatings, infiltration shall be stopped by use of an approved water stop compound or chemical grout.

D. 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 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 grouted with approved nonshrink-patching mortar.

E. The Contractor shall remove all loose grout and rubble from existing channel. The Contractor shall rebuild channel if required by reshaping, repairing slope of shelves or benches. 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, CCTV, etc.

F. All existing manhole steps shall be cut smooth with the wall or be removed completely prior to lining.

G. The lining system shall be installed in accordance with the manufacturer’s recommendation to withstand groundwater pressures. Cementitious lining shall be applied to manhole wall, bench and

channel surfaces. All cementitious linings shall have a minimum thickness of 5/8 inch.

H. Application of all products shall be by manufacturer certified applicators.

3.09 SPRAY APPLIED AND CENTRIFUGALLY CAST LINING

A. Manholes requiring lining shall be cleaned no more than 2 hours before lining. The surface prior to lining shall be damp without noticeable free water droplets or running water. Materials shall be applied to a minimum uniform thickness insuring that all cracks, crevices, and voids are filled and a smooth surface remains after light troweling.

B. For spray applied lining, the first application shall take an initial set (disappearance of surface sheen which could be 15 minutes to 1 hour depending on ambient conditions) before the second application, if necessary, to assure a minimum total finished thickness of 5/8 inch. For centrifugally cast lining, the rotating casting applicator shall be positioned to evenly apply the material and shall be withdrawn at a rate to ensure a final minimum thickness of 5/8 inch. A depth gauge shall be used during application, at various locations, to verify the required thickness.

C. The Contractor shall apply light troweling to compact the material into voids and set the bond. The surface shall be troweled to a smooth finish with care taken not to over trowel and bring additional water to the surface.

D. The bench covers used to catch debris shall be removed and the bench and channel lined to produce a gradual slope from the walls to the channel with the thickness at the edge of the channel being no less than 5/8 inch. The wall and channel intersection shall be rounded to a uniform radius along the circumference of the intersection.

E. No application shall be made to a frozen surface or if freezing is expected to occur within the manhole for 24 hours after application. If ambient temperatures are in excess of 90-degree Fahrenheit, precautions shall be taken to keep the mix temperature at the time of application below 90-degree Fahrenheit.

F. The application shall have a minimum cure time as recommended by the manufacturer before being subjected to active sewer flow.

G. Liner samples shall be taken by the testing laboratory on a weekly basis or as directed by the Project Engineer.

3.10 MANHOLE BENCHES AND CHANNELS

A. The Contractor shall remove obstructions and loose materials from benches prior to shaping the channel. The Contractor shall form a smooth, U-shaped channel having a minimum depth of one-half exiting pipe diameter and connecting the inlet and exiting pipes of the manhole using an approved manhole rehabilitation material. The Contractor shall control flow to allow sufficient setting time for material used.

B. The Contractor shall form a smooth transition between the reshaped channel and a raised manhole bench to eliminate sharp edges of pipe, concrete bench, and channel. The Contractor shall make finished benches and channels smooth and without defects which would allow for accumulation of debris.

3.11 MANHOLE COVERS AND FRAMES

A. The Contractor shall adjust manhole frames, install new covers to grade, and reset loose manhole frames. This adjustment shall include the removal and delivery of existing metal or plastic adjusting rings to the VA. Pre-cast concrete adjustment rings or bricks shall be combined so that the elevation of the installed casting extends flush with the natural ground in unpaved areas. In paved areas, the casting shall be set flush and smooth with pavement grades.

B. The Contractor shall apply an approved sealant between the top adjustment ring and the manhole frame. An approved non-shrink cement-based patching material shall be applied between the adjustment rings and patching the chimney up to 6” below the bottom of the casting to fill voids and cracks.

3.12 MANHOLE INSERTS

A. The Contractor shall install stainless steel manhole inserts at locations shown on the drawings.

B. The Contractor shall exercise care in selecting the proper insert dish to fit properly with the manhole frame and cover. The outer flange of the insert shall have an outside diameter 3/16" less than the inside diameter of the frame and cover seat. Once a proper fit is established, the Contractor shall remove all dirt, grit, and debris from the manhole frame with a wire brush. The insert shall be fully seated on the manhole frame, providing a water tight seal.

C. Damaged, tight fitting, or missing inserts shall be replaced by the Contractor at no additional cost to the Government.

3.13 MANHOLE REHABILITATION ACCEPTANCE

A. All rehabilitated manholes utilizing a full depth comprehensive lining system shall be tested by using a vacuum method. This testing shall follow the manufacturer's recommendations for proper and safe procedures. Vacuum testing of manholes and structures shall be performed following proper curing of the lining. Any visible leakage in the manhole or structure, before, during, or after the test shall be repaired regardless of the test result at no additional cost to the Government.

B. All pipes for vacuum testing shall be installed at the top access point of the manhole. A vacuum of 10 inches of mercury (5.0 psi) shall be drawn on the manhole and the time for the pressure vacuum to drop 9 inches of mercury (4.5 psi) shall be measured. Manholes will be considered to have failed the air test if the time to drop 1 inch of mercury is less than the value shown in the following table.

Vacuum Test Timetable

Manhole Diameter

Depth ft-	**48 inches**	**60 inches**	**72 inches**	**96 inches**
4	10 sec.	13 sec.	16 sec.	19 sec.
8	20 sec.	26 sec.	32 sec.	38 sec.
12	30 sec.	39 sec.	48 sec.	57 sec.
16	40 sec.	52 sec.	64 sec.	76 sec.
20	50 sec.	65 sec.	80 sec.	95 sec.
24	60 sec.	78 sec.	96 sec.	

C. Manhole depths shall be rounded to the nearest foot. Testing times for intermediate values of manhole depth shall be interpolated.

D. If the manhole or structure fails the vacuum test the Contractor shall perform additional repairs and repeat the test procedures until satisfactory results are obtained at no additional cost to the Government.

E. After the manhole rehabilitation work has been completed, the Contractor shall allow the manhole to be visually inspected by the Engineer. The finished surface shall be free of blisters, "runs", "sags", or other indications of uneven lining thickness. There shall be no evidence of visible leaks.

- - - E N D - - -