

SECTION 03 40 02

MANHOLE REHABILITATION

PART 1: GENERAL

1.1. SCOPE OF WORK

- A. This section includes cleaning, plugging, sealing, lining, and general repairs of defective manholes.
- B. The Contractor shall be responsible for furnishing all labor, supervision, materials, and equipment required to complete all manhole rehabilitation work, testing, and surface restoration in accordance with this Specification.
- C. It is the intent of this Specification to ensure that the work, as completed, shall meet all applicable codes, ordinances, rules and regulations of every authority having jurisdiction in the area where the construction is located. Failure of the Contractor to point out items that do not meet such requirements does not relieve the Contractor or his Subcontractors of the responsibility of meeting them.

1.2. QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, or approved by OWNER.
- B. Contractor: Company specializing in performing work of this section with minimum three years documented experience and approved by Manufacturer, or approved by OWNER.

1.3. MATERIALS

- A. All supplies shall be stored and maintained by the Contractor in accordance with manufacturer's recommendations. Materials shall not be exposed to adverse conditions prior to the work. All materials shall be kept in a secured area and away from general public access. The Contractor shall review and maintain all Safety Data Sheets (SDS), product labeling, and technical literature at the project site.

PART 2: MANHOLE REHABILITATION METHODS AND PROCEDURES

2.1 GENERAL

- A. All work shall be in strict accordance with all Specifications and Requirements. Application of all products must also be in accordance with Manufacturer's Specifications and recommendations.
- B. When freezing temperatures are expected in the area, the Contractor shall take measures to keep applied materials within product specifications and provide the required heat in the manhole before repair work is started and the 24-hour period following application.
- C. The invert shall be covered during construction operations to prevent loose materials from collecting in the invert.
- D. Bypassing and/or blocking of the flow in the manholes shall be done only with prior approval of OWNER and with strict adherence to Specification 33 01 50.01 - Pumping and Bypassing.
- E. Use approved equipment designed and manufactured by the material supplier specifically for the application of all materials in sanitary sewer manholes.

2.2 MANHOLE CLEANING AND PREPARATION

- A. The floor and interior walls of the manhole shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, grease, sludge and all debris or material that may be attached to the wall or bottom of the manhole.
- B. When grease and oil are present within the manhole, and conditions allow, an approved detergent or muriatic acid may be used integrally with the high pressure cleaning water.
- C. All materials resulting from the cleaning of the manhole shall be removed prior to applying specified coatings.
- D. All loose or defective brick, grout, ledges, steps and protruding ledges shall be removed to provide an even surface prior to application of specified cementitious coating.

2.3 PATCHING

- A. Materials
 - 1. Patching material shall be quick setting, fiber reinforced, calcium aluminate, corrosion resistant, cementitious material, mixed and applied according to manufacturer's recommendations and having the following minimum requirements:

Compressive Strength ASTM C109	1,400 psi, 6 hours
Bond ASTM C321	145 psi, 28 days

Cement	Calcium Aluminate
Applied Density	105 lbs./ft ³
Shrinkage ASTM C596	0 percent at 90 percent relative humidity

B. Execution

1. Patching of manhole walls or sewer structures shall be required in areas where large voids exist, such as mortar missing between bricks, around step frames, pipes and spalled concrete. All loose, cracked and corroded material shall be removed from the area to be patched, exposing a sound substrate. A fast setting polymer mortar shall be applied to dampened surfaces. These products shall be allowed to cure before applying linings.
2. When leaks are not readily identifiable upon completion of cleaning operation, use a blower to dry the manhole interior for positive identification of leaks and weep areas.
3. Drill a hole at each identifiable leakage point from inside the manhole and extending through the sidewall of the manhole. Insert a metal rod through the hole to determine if exterior void space exists. Fill exterior void spaces with grout mix. Pump into void space until refusal is recorded by rise in pressure on pump pressure gauge. Ensure the hole through the manhole wall is kept open and free of patching material. Plug the hole and allow one hour for material to set.
4. Upon completion of grouting, pump manhole sealant until refusal at a minimum pressure of 3.0 psig through probe type injection equipment. Deposit sealant coating from interior surface of set grout through drilled hole to inside surface of manhole.
5. Upon setting of sealant coatings remove excess material protruding into inside of manhole.
6. Patching/plugging manhole defects as necessary shall be performed to provide a smooth surface for application of the lining material.

2.4 SEALING ACTIVE LEAKS

Stop active leaks with patching material or infiltration control materials applied according to manufacturer's instructions. Install weep holes as required to localize infiltration during application of patching material or infiltration control material. Plug weep holes after application with infiltration control material before applying liner material.

A. Infiltration Control

Infiltration control material shall be a rapid setting epoxy or cementitious product specifically formulated for leak control to stop minor water infiltration and to make repairs in concrete and brick structures. The material must be mixed and applied according to manufacturer's recommendations and typically having the following minimum requirements:

Compressive Strength ASTM C109	400-600 psi, 1 hour 1,800- 2,400 psi
C109	24 hours 0.10 percent
Expansion ASTM C827	No weight loss after 15 cycles
Sulfate Resistance ASTM C267	200 ppm 100 cycles
Freeze/Thaw ASTM C666	Method A
Pull Out Strength ASTM C234	14,000 lbs.
Placement time	Less than 1 minute

B. Severe Infiltration Control

Severe infiltration shall be identified in field by Owner. Grouting material shall be cementitious grout for stopping very active infiltration and filling voids when mixed and applied according to manufacturer's recommendations. The grout shall be volume stable with a minimum 28-day compressive strength of 250 psi.

2.5 REPAIRING INVERT, BENCH AND TROUGH

A. Materials

Materials used for bench and trough repairs shall be a rapid setting, high early strength, non-shrink material conforming to this Section for patching material.

B. Execution

1. Construct invert channels to provide a smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:
 - a. Slope of invert bench: 1-inch per foot minimum; 1-1/2-inches per foot maximum
 - b. Depth of bench to invert:
 - Pipes smaller than 15-inches: one-half of largest pipe diameter
 - Pipes 15 to 24-inches: three-fourths of largest pipe diameter
 - Pipes larger than 24-inches: equal to largest pipe diameter
 - c. Invert slope through manhole: 0.10 foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on Drawings.
2. Form invert channels with quick setting, fiber reinforced, calcium aluminate, corrosion resistant, cementitious material, mixed and applied according to manufacturer's recommendations and having the following minimum requirements if not integral with manhole base section.

Compressive Strength ASTM C109	1,400 psi, 6 hours
Bond ASTM C321	145 psi, 28 days
Cement	Calcium Aluminate
Applied Density	105 lbs./ft ³
Shrinkage ASTM C596	0 percent at 90 percent relative humidity

3. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.
4. Hand mix and use a rapid setting, high early strength, non-shrink patching material to fill all large voids and repair inverts prior to lining of the manhole. For invert repairs, flow must be temporarily restricted by inflatable or mechanical plugs prior to cleaning, or a bypass may be installed in accordance with Specification 33 01 50.01 – Pumping and Bypassing.
5. The area to be repaired must be cleaned and free of all debris per the guidelines set forth in paragraph 2.02 Manhole Cleaning and Preparation.
6. Mix water shall be clean potable water and require no additives or admixtures for use with cementitious patching materials.
7. Cementitious material shall be mixed in a mortar tub or 5-gallon pail with water per manufacturer's specifications. Material shall be mixed in small quantities, to avoid setting prior to placement in voids or inverts.
8. Once mixed to proper consistency, the materials shall be applied to the invert or void areas by hand or trowel. In invert applications, care should be taken to not apply excessive material in the channel, which could restrict flow. Once applied, materials shall be smoothed either by hand or trowel in order to facilitate flow.
9. Flows in inverts can be reestablished within 60 minutes of material placement.

2.6 REPLACING MANHOLE FRAMES AND COVERS

A. Materials

1. Castings

- a. Use castings for frames, grates, rings and covers conforming to ASTM A48, Class 35B.
- b. Use clean castings capable of withstanding application of AASHTO M306 - 40,000 pound proof loading without detrimental permanent deformation, or in accordance with local requirements.

2. Bearing Surfaces

Machine bearing surfaces between covers or grates and their respective frames so that even bearing is provided for position in

which casting may be seated in frame.

3. Frames and Covers

- a. Provide watertight manhole frames and covers with minimum of four bolts and gasket designed to seal cover to frame. Supply approved watertight manhole covers and frames.
- b. Provide manhole frames and covers with clear openings that match existing.

B. Execution

1. Remove and dispose of existing frame and cover, unless otherwise directed by OWNER.
2. Install castings according to OWNER's Standard Details, instructions in related specifications, and applicable directions from manufacturer's printed materials.
3. Set castings accurately at required locations to proper alignment and elevation. Keep castings plumb, level, true, and free of rack. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in form work until permanently set.
4. Fabricate grate rings in accordance with standards. Set in mortar in mouth of pipe bell.
5. Install adjustment rings in frames with clean bearing surfaces that are free from rocking.
6. Restore surface to pre-existing condition.

2.7 ADJUSTING MANHOLES TO GRADE

A Materials

Provide precast concrete manhole sections and adjustment rings conforming to requirements of Section 03 40 01 - Precast Concrete Manholes.

B. Execution

1. Examine existing structure, frame and cover for damage or defects affecting adjustment to grade. Report damage or defects to OWNER.

2. Establish grade with related items with existing grade and finished grade or paving, and relate to established bench mark or reference line.
3. Rebuild adjustment portion of manhole or inlet by adding or removing adjustments. Follow procedures in Section 03 40 01- Precast Concrete Manholes
4. Salvage and reuse cast-iron frame and cover.
5. Protect or block off manhole or inlet bottom using wood forms shaped to fit so that no debris or soil falls to bottom during adjustment.
6. Verify that manholes and inlets are free of visible leaks as result of reconstruction. Repair leaks in manner subject to OWNER's approval.
7. Backfill area of excavation surrounding each adjusted manhole, inlet, and valve box and compact according to requirements of Section 31 23 33 – Trenching and Backfilling.
8. Grade ground surface to drain away from each manhole and valve box. Place earth fill around manholes to level of upper rim of manhole frame. Place earth fill around valve box concrete slab.
9. In unpaved areas, restore ground surface in accordance with OWNER Specification 32 92 00 – Lawn Restoration.

2.8 MANHOLE FRAME SEAL

A. Materials

1. Manhole frame sealing includes the sealing of the frame adjustment area with a corrosion resistant aromatic flexible urethane resin coating. The sealing system shall be Flex-Seal Utility Sealant as manufactured by Sealing Systems Inc. or approved equal. It shall be designed to prevent leakage of water into the manhole through this area. The sealing system shall remain flexible and allow vertical movement of the frame up to 0.5-inches.
2. Primer- Flexible Aromatic Urethane Resin Liner Primer minimum requirements:

Hardness ASTM D2240	85
Elongation ASTM D412	400 percent
Tensile Strength ASTM D412	3200 psi
Adhesive Strength ASTM D903	400 lb/in
Tear Resistance ASTM D1004	210 lb/in

3. Final Coat: Flexible Aromatic Urethane Resin Liner Final Coat minimum requirements:

Hardness ASTM D2240	75
Elongation ASTM D412	800 percent
Tensile Strength ASTM D412	1150 psi Adhesive
Strength ASTM D903	175 lbs./in Tear
Resistance ASTM D1004	155 lbs./in

B. Execution

1. Contact surfaces shall be clean, smooth and circular, and free of excessive voids. Remove loose and protruding mortar and brick. Prepare surfaces of the ring adjustment area to include the lower 3-inches of the frame and the top 8-inches of the cone section according to manufacturer's instructions for a total of 12 vertical inches applied at 120 Mil thickness. Greater depths may be covered at the Owner's direction depending on conditions of the manhole.
2. If the masonry surface is rough, irregular, or contains excessive voids and will not provide an effective seal, apply a bed of patching mortar. Allow mortar to cure prior to installing the flexible manhole sealant system per manufacturer's recommendations. The minimum cure time will be 14 days before application of sealant.
3. Correct active internal leaks prior to installing the flexible manhole sealant system per manufacturer's recommendations.
4. Prepare internal surface by sand blasting casting section to white metal. After sandblasting, check the entire area to remove any loose sand, debris, laitance, dust, dirt, oil, grease or chemical combination. Sand is to be captured and not allowed to enter the manhole.
5. Use of a blower may be required to completely dry the surface as recommended by the manufacturer. Surface of manhole must be completely dry prior to primer application.
6. Mix and apply the adhesive primer to the clean and dry surface according to manufacturer's recommendations. Cover the ring adjustment area, the lower 3-inches of the casting frame and the top 8-inches of the cone section. Allow for proper drying of the adhesive primer, then apply sealant by brush, as evenly as possible over the entire area and allow to cure per manufacturer's recommendations. Minimum thickness of sealant is 120 Mils.

2.10 CHIMNEY SEALS

A. Materials

1. Chimney seals shall be designed to provide a watertight, interior, flexible seal between the manhole cover frame and manhole cone section. The seal shall consist of a rubber seal, stainless steel

expansion bands for compressing the seal against the manhole surfaces, and preformed extension(s) and band. The frame seal shall be certified capable of repeated vertical movement of not less than 2-inches and/or repeated horizontal movement of not less than 2-inch after installation and throughout its 25-year design life.

2. Rubber sleeves shall be extruded from a high-grade rubber compound meeting the applicable requirements of ASTM C923. Sleeves shall be double or triple pleated with a minimum unexpanded vertical height of 8-inches, a minimum thickness of 3/16-inch, and capable of expanding not less than 2-inches vertically when installed. They shall have integrally formed top and bottom expansion band recesses and multiple sealing fins. Any splices shall be factory vulcanized and shall be able to withstand a 180-degree bend with no visible separation at splices.
3. Expansion Bands shall be 16 gauge thickness, 1³/₄-inches wide and made of stainless steel meeting the requirements of ASTM A240, Type 304. Bands shall have an expansion mechanism capable of developing the pressure necessary to provide a watertight seal, a minimum adjustment range of not less than 2-inches and a positive locking mechanism. Bands must be removable with minimum effort and reusable.

B. Execution

1. Chimney seals and extensions shall be installed in strict accordance with the manufacturer's specifications and recommendations, including use of butyl caulk on the lower portion of the seal when installed in brick manholes. The installation of the chimney seal and extension shall include the preparation of the wall surfaces in the chimney area and the adjustment of the frame as required by the manufacturer's specifications and recommendations. Measurements shall be the responsibility of the Contractor.
2. Precast Manholes shall be sealed from the bottom 2-inches of the steel casting to the top 2-inches of the precast manhole cone and include all grade rings.
3. Brick manholes shall be sealed from the bottom 2-inches of the steel casting to the second level of brick courses of the manhole chimney.

2.11 MANHOLE STEP REPAIR

- A. Manhole step repair shall include replacing missing steps and others requiring replacement as directed by the Owner. The Contractor shall remove the existing steps where required, drill the necessary holes, and perform all other work to install and anchor the replacement steps. The metal portion of any replaced steps shall be removed completely.

- B. Manhole Ladders shall be fiberglass with 300-lbs. rating at appropriate length; and conform to requirements of OSHA, U.S. Department of Labor.
 - 1. Use components, including rungs, made of fiberglass and fabricated with nylon or aluminum rivets and/or epoxy. Apply non-skid coating to ladder rungs. Mount ladder using Manufacturer's recommended hardware. Rungs shall be located at 12-inch centers.
 - 2. Material shall be premium type polyester resin, reinforced with fiberglass; constructed to provide complete wetting of glass by resin; resistant to rot, fungi, bacterial growth and adverse effects of acids, alkalis and residential and industrial waste; yellow in color.
 - 3. Provide approved petroleum-based tape encapsulating bolts in access manhole.
 - 4. Comply with any applicable Federal, State and local regulations.

2.12 PRE-FORMED FIBERGLASS MANHOLE UNIT

A. Materials

Flowtite Fiberglass Rehabilitation Manhole, as provided by Containment Solutions, Inc., or pre-approved equal.

B. Execution

When indicated in the schedule, the manhole shall be lined with a pre-formed manhole unit. Installation procedures shall follow Manufacturer's recommendations.

2.13 EPOXY LINING SYSTEM

A. Materials

- 1. The epoxy manhole liner shall be a chemical resistant (below a pH of 2.0), VOC compliant, moisture tolerant, 100% solids, two (2) component epoxy system with the following properties:

Flexural Strength [ASTM D-790]:	9,000 psi
Compressive Strength [ASTM D-695]:	8,200 psi
Tensile Strength [ASTM D-638]:	6,300 psi
Adhesion:	Concrete Substrate Failure
Abrasion Resistance:	95 mg

B. Execution

- 1. When indicated in the schedule, the interior surface of the manhole shall be lined with a two component, 100% solids epoxy coating

system which provides a durable, high strength, monolithic lining. Provide mixing and application equipment designed for mixing and spraying epoxy coating as recommended by the Manufacturer. The two (2)-part epoxy liner shall be mixed in accordance with the Manufacturer recommendations.

2. The epoxy liner shall be applied in accordance with the manufacturer's recommendations. The surface prior to application may be damp but shall not have noticeable free running water. Materials shall be spray applied per Manufacturer's recommendations to an average thickness of 70 Mils with a minimum thickness of 65 Mils. The final application shall have a minimum of four (4) hours cure time before being subjected to active flow. The epoxy liner shall be applied from the invert (completely cover the Bench and Invert) to 3- inch onto the manhole frame.
3. During the application, a wet film gauge shall be used regularly to ensure that minimum thickness is being maintained. After the epoxy liner has set (hard to touch), all visible pinholes shall be repaired. Repairs shall be made by lightly abrading the surface and brushing the lining material over the area. All blisters and evidence of uneven coverage shall be repaired according to the manufacturer's recommendations. After the product has set to touch, the surface shall be inspected for pinholes and thin spots using a Holiday Detector capable of 16,000 volts. All pinholes and areas less than one square foot that test to be thinner than 65 Mils may be retouched by hand, but any areas larger than one square foot must be re-sprayed.

2.14 CEMENTITIOUS LINING SYSTEM

A. Materials

1. All cementitious lining materials shall be specifically designed for the rehabilitation of manholes. Liner materials shall be cement based, nylon fiber reinforced, shrinkage compensated, and enhanced with chemical admixtures and monocrySTALLine quartz (Granusil) aggregates. Liner materials shall be mixed with water per manufacturer's written specifications and applied using equipment specifically designed for either low-pressure spray or centrifugal spin casting application of cement mortars. All cement liner materials must be capable of a placement thickness of 2-inch to 4-inch in a one-pass monolithic application.
2. For low to mild hydrogen sulfide environments (pH > 3.0), cementitious lining materials shall be manufactured from Type II Portland Cement, and enhanced with silica fume. Approved material shall be Quadex QM-1s Restore as manufactured by Quadex, Inc., North Little Rock, Arkansas or "preapproved equal". Approved material shall exhibit the following 28-day minimum physical

properties.

Compressive Strength (ASTM C 109) >10,000 psi
Flexural Strength (ASTM C293) > 1,400 psi
Bond Strength (ASTM C321) Brick failed before bond
Permeability (AASHTO T-277) Not to exceed 350 coulombs
Freeze-Thaw (ASTM C666) No damage in minimum 300 cycles
Material Wet Density Minimum 142 +/-5 lbs./ft³

B. Execution

1. The work consists of spray applying and/or centrifugally spin casting a cementitious based liner to the inside of the existing manhole. The necessary equipment and application methods to apply the cementitious based liner materials shall be only as approved by the material manufacturer.
2. Material shall be mixed with water in accordance with manufacturer's specifications. Once mixed to proper consistency, the materials shall be pumped via a rotor-stator style progressive cavity pump through a material plaster hose for delivery to the appropriate and/or selected application device.
3. Spray application of the cementitious material:
 - a. Material hose shall be coupled to a low-velocity spray application nozzle. Pumping of the material shall commence and the mortar shall be atomized by the introduction of air at the nozzle, creating a low-velocity spray pattern for material application.
 - b. Spraying shall be performed by starting at the manhole invert and progressing up the wall to the corbel and chimney areas.
 - c. Material shall be applied to a specified uniform minimum thickness no less than 2-inches. Material shall be applied to the bench area in such a manner as to provide for proper drainage without ponding.
4. Centrifugal spin casting application of the cementitious material:
 - a. Material hose shall be coupled to a high speed rotating applicator device. The rotating casting applicator shall then be positioned within the center of the manhole at either the top of the manhole chimney or the lowest point elevation corresponding to the junction of the manhole bench and walls.
 - b. The high speed rotating applicator shall then be initialized, and pumping of the material shall commence. As the mortar begins to be centrifugally cast evenly around the interior of the manhole, the rotating applicator head shall be raised and/or lowered at a

controlled retrieval speed conducive to providing a uniform material thickness on the manhole walls.

- c. Controlled multiple passes are then made until the specified minimum finished thickness is attained. If the procedure is interrupted for any reason, simply arrest the retrieval of the applicator head until flows are recommenced.
 - d. Material thickness may be verified at any point with a depth gauge and shall be no less than a uniform 2-inches. If additional material is required at any level, the rotating applicator head shall be placed at that level and application shall recommence until that area is thickened.
- 5. Material shall be applied only when manhole is in a damp state, with no visible water dripping or running over the manhole walls.
 - 6. The low-velocity spray nozzle and the centrifugal spin casting head may be used in conjunction to facilitate uniform application of the mortar material to irregularities in the contour of the manhole walls and bench areas.
 - 7. Troweling of materials shall begin immediately following the spray application. Initial troweling shall be in an upward motion, to compress the material into voids and solidify manhole wall. Precautions should be taken not to over trowel. All troweled surfaces shall then be given a light brush finish. Brush shall be kept wet with potable water.
 - 8. It is important that the manhole cover is replaced immediately after troweling and brushing are complete to avoid moisture loss in the material due to sunlight and wind. Lining material may be subjected to active flows or surcharges after an initial set time of 9 to 12 hours. Ideal curing is achieved at a temperature of 72° F and 80% humidity. Curing may be affected when ambient conditions within the structure fall below the ideal temperature and/or humidity. Liners may be subjected to additional cleaning after a period of 24 hours at the above stated conditions.
 - 9. Material shall not be applied during freezing weather conditions. Material shall not be placed when the ambient temperature is 37° F and falling or when the temperature is anticipated to fall below 32° F during the next 24 hours.

--END OF SECTION 03 40 02--