**SECTION 0000**

**REHABILITATION OF CONCRETE AND MASONRY**

**MANHOLES OR UNDERGROUND VAULTS**

**WITH A CEMENTITIOUS LINER**

**PART 1 GENERAL**

1.01 SUMMARY

1. The intent of this work is to rehabilitate existing brick and mortar manholes. A monolithic, fiber-reinforced, structurally enhanced, cementitious-based liner material shall be spray applied to the wall and bench surfaces of the manhole.
	1. SCOPE OF PROJECT
2. This work shall stop inflow, infiltration, and exfiltration; repair voids; restore structural integrity; and provide protection against corrosion. **INSERT RELATED SECTIONS HERE OR DELETE.**
3. Schedule of Work Hours – The Contractor shall work during the hours of 7:00 AM to 7:00 PM Monday through Friday. If there is a need for after-hours work or weekend work, prior consent shall be obtained from the Engineer.
4. Traffic Control – The Contractor shall be solely responsible for all signage, flagging, cones, personnel and any other item or personnel required for traffic control. All costs for traffic control shall be incidental to the project, unless otherwise specified in the contract documents.

	1. RELATED SECTIONS

**INSERT RELATED SECTIONS HERE OR DELETE**

1.04 REFERENCES

1. ASTM C 78 - Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
2. ASTM C 94 - Ready-Mixed Concrete.
3. ASTM C 109 - Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
4. ASTM C 234 - Comparing Concretes based on the Bond Developed with Reinforcing Steel.
5. ASTM C 267 - Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing.
6. ASTM C 321 - Bond Strength of Chemical-Resistant Mortars.
7. ASTM C 496 - Splitting Tensile Strength of Cylindrical Concrete Specimens.
8. ASTM C 596 - Drying Shrinkage of Mortar Containing Portland Cement.
9. ASTM C 666 - Resistance of Concrete to Rapid Freezing and Thawing.
10. ASTM C 827 - Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
11. ASTM C 952 - Bond Strength of Mortar to Masonry Units.

1.05 SUBMITTALS

1. Safety Plan - The Contractor shall provide a safety plan and identify designated safety supervisory personnel to the Engineer. The plan shall include confined space entry provisions and training, listing of personal protective equipment, and a traffic control plan (if applicable).
2. Product Data - The Contractor shall submit the Manufacturer's product data, including physical properties, surface preparation, repair, application, curing, and field quality control.
3. Manufacturer Qualifications - The Contractor shall submit list of a minimum of ten (10) manhole rehabilitation projects completed during the past three (3) years.
4. Applicator Qualifications - The Contractor shall submit the qualifications of its Applicator(s) including:

 1. A certification stating the Applicator is factory trained and approved by the Manufacturer in application of the specified products; and

 2. A list of recently completed manhole rehabilitation projects, including project name and location, names of the Owner and Engineer, and a description of the products used, substrates encountered, and application procedures followed.

1.06 QUALITY ASSURANCE

1. Material Qualifications - The Material used on this project shall have a minimum of ten (10) years’ history of being used for rehabilitation of sanitary system manholes.
2. Applicator Qualifications - The Applicator shall have the following qualifications, including:

 1. The Applicator or Contractor shall be factory trained and approved by the Manufacturer in application of the specified products; and

 2. The Applicator or Contractor shall employ persons trained for the application of the specified products.

1.07 DELIVERY, STORAGE, AND HANDLING

1. Delivery - The Contractor shall have delivered the materials to the jobsite in the Manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and Manufacturer.
2. Storage - The Contractor shall also:

 1. Store materials in accordance with the Manufacturer's instructions;

 2. Keep containers sealed until ready for use; and

 3. Store materials in a cool, dry environment.

1. Handling - The Contractor shall protect materials during handling and application to prevent damage.

1.08 SITE CONDITIONS

1. Acceptable Temperatures - The Contractor shall not apply materials if ambient temperature is below forty degrees Fahrenheit (40°F).
2. Freezing Conditions - The Contractor shall not apply materials to frozen surfaces or if freezing is expected within substrate within twenty-four (24) hours after application.
3. Mix Temperatures - The Contractor shall keep mix temperature at time of application below ninety degrees Fahrenheit (90° F).
4. Water Temperature - The Contractor shall not use water for mixing where water temperature exceeds eighty degrees Fahrenheit (80° F).

**PART 2 PRODUCTS**

2.01 MANUFACTURER

1. Acceptable Manufacturers of the cementitious material used on this project shall include:

	1. Strong-Seal Systems Corporation, Pine Bluff, Arkansas; or
	2. Approved Equal(s)
	3. **Product Designation:** Engineer shall specify the product(s) to be used by structure using a criteria of biogenic corrosion resistance as follows:

		1. For environments of 3.0 pH and higher, Strong Seal MS2A or approved equal shall be used,
		2. For environments of 2.0 pH and higher, Strong Seal MS2C or approved equal shall be used,
		3. For environments of 1.0 pH and higher, Strong Seal High Performance Mix or approved equal shall be used,
	4. MATERIALS
2. General: The Contractor shall use materials that meet the following requirements, including:
3. Materials applied shall be from a single Manufacturer; and
4. Materials applied shall be compatible with the substrate and with each other.

1. Patching Material - The Contractor shall apply a rapid-setting, fiber-reinforced, high-early-strength, corrosion-resistant, hand-mixed and hand-applied, Portland cement or calcium aluminate based cementitious material. The material shall have the following characteristics, including:

|  |  |
| --- | --- |
| Cement | Portland or Calcium Aluminate Cement |
| Minimum Compressive Strength | ASTM C109 – 1,400 PSI at 6 hours |
| Minimum Bond | ASTM C321 – 145 PSI at 28 days |
| Applied Density | 105 ± 5 pounds per cubic foot |
| Shrinkage | ASTM C596 – 0% at 90% relative humidity |

1. Infiltration Control Material - The Contractor shall apply a rapid-setting, high-early-strength, hand-applied, cementitious material. The material shall have the following characteristics, including:

|  |  |
| --- | --- |
| Compressive Strength | ASTM C109 0 400 PSI at 1 hour; 1,800 PSI at 24 hours |
| Expansion | ASTM C827: .10% |
| Sulfate Resistance | ASTM C267: No weight loss after 15 cycles |
| Freeze/Thaw Resistance | ASTM: C666, Method A: 100 cycles |
| Pull Out Strength | ASTM C234: 14,000 pounds |

1. Liner Material - The Contractor shall install a fiber-reinforced, spray-applied, cementitious mortar. The material shall have the following characteristics:

|  |  |
| --- | --- |
| Minimum Compressive Strength | ASTM C109: 9,000 PSI at 28 days |
| Minimum Tensile Strength | ASTM C496: 800 PSI at 28 days |
| Minimum Flexural Strength | ASTM C78: 1,200 PSI at 28 days |
| Shrinkage | ASM C596: 0% at 28 days, 90% relative humidity |
| Minimum Bond | ASTM C952: 2,000 PSI at 28 days |
| Applied Density | 134 ± 5 pounds per cubic foot |
| Freeze/Thaw Resistance | ASTM C666, Method A: 300 cycles, no visible damage |
| Factory Blended | Requires only water at the site |
| Minimum Cement Content | 50% of total bag weight |
| Dry Bulk Density | 74 – 76 pounds per cubic foot |
| Fiber Reinforcement | 1/2” to 5/8” alkaline-resistant fiberglass rods |

1. Water - The Contractor shall use water that is clean and potable. The Contractor shall test non-potable water in accordance with ASTM C 94.

**PART 3 EXECUTION**

3.01 EXAMINATION

1. Preliminary Examination - The Contractor shall examine surfaces to receive manhole rehabilitation. The Contractor shall also notify the Engineer in writing if surfaces are not acceptable. The Contractor shall not begin surface preparation, repair, or application until unacceptable conditions have been corrected.

3.02 SURFACE PREPARATION

1. Instructions - The Contractor shall prepare surfaces in accordance with the Manufacturer(s)’ instructions.
2. Protection - The Contractor shall place covers over all pipe inverts to prevent extraneous material from entering the sewer lines.
3. Cleaning - The Contractor shall clean manhole walls and bench by using a minimum of fifteen hundred (1,500) PSI water spray to remove contaminants, dirt, debris, and other foreign materials.
4. Removal of Materials - The Contractor shall remove loose, unsound, and protruding brick, mortar, and concrete.

1. Voids - The Contractor shall repair and fill voids greater than 2 inches in depth with patching materials specified in 2.02(B) above. The patching material shall be applied in accordance with the Manufacturer's instructions.
2. Active Leaks - The Contractor shall take the following steps to stop active leaks in the manholes, including:

 1. Stop active leaks with patching material or infiltration control material. Apply material in accordance with the Manufacturer's instructions;

 2. Install weep holes as required to localize infiltration during application of patching material or infiltration control material;

 3. Plug weep holes after application with infiltration control material before application of liner material; and

 4. Severe Infiltration: Drill as required to pressure grout using a cementitious or chemical grout. Apply the grout in accordance with Manufacturer's instructions.

3.03 APPLICATION OF LINER MATERIAL

1. Manufacturer’s Recommendations - The Contractor shall apply liner material in accordance with manufacturer's instructions.

1. Equipment - The Contractor shall spray apply liner material using approved equipment designed and manufactured by the material Manufacturer for the specific application.
2. Mixing - In mixing water with the cementitious material to be applied, the Contractor shall:

 1. Mix liner material with water in accordance with Manufacturer's instructions;

 2. Discharge prepared mix into the hopper; and

 3. Continue mixing as liner material is continuously sprayed.

1. Cleaning - The Contractor shall ensure that the surface is clean and free of foreign material.
2. Saturated Surface - The Contractor shall ensure that the surface is damp and totally saturated with water without noticeable free water droplets or running water, just before application of the liner material.
3. Spraying and Minimum Thickness - The Contractor shall spray apply the liner material in one (1) or more passes from the bottom of the wall to the bottom of frame to form a structurally enhanced monolithic liner. **Minimum total thickness achieved shall be one half inch (1/2”).**
4. Finishing - The Contractor shall ensure a quality finish to the manhole or structure by following the following steps:

 1. Trowel the surface of sprayed liner material to a relatively smooth finish. Care should be taken to not over trowel; and

 2. A brush finish shall be applied to the trowel finished surface.

1. Time between Applications - The Contractor shall follow the Manufacturer's instructions whenever more than twenty-four (24) hours have elapsed between applications of the cementitious material.
2. Application to Bench - When applying cementitious material to the bench area of the manhole, the Contractor shall:

 1. Remove wood covers;

 2. Spray the bench with liner material mixed in accordance with the Manufacturer's instructions;

 3. Spray-apply the liner material to produce a gradual slope from the walls to the invert(s) to form a structurally enhanced monolithic liner. **A minimum thickness at the invert of one half inch (1/2”) shall be achieved**; and

1. Round the full circumference of the intersection of the wall and the bench to a uniform radius.

1. Application to New Cast-In-Place or Precast Concrete Manholes - When applying cementitious material to new cast-in-place or precast manholes, the Contractor shall:

 1. Prepare the surface with bonding agent in accordance with the Manufacturer's instructions;

 2. Spray apply a single application of the liner material to prevent corrosion; and

 3. **Achieve a minimum total thickness of one half inch (1/2”).**

3.04 CURING

1. Manufacturer’s Instructions - The Contactor shall cure the materials applied in accordance with the Manufacturer's instructions.
2. Exposure - The Contactor shall take the following precautions regarding exposure of the cementitious material to the elements, including:

 1. Minimize exposure of the applied materials to sunlight and air movement;

 2. Cover the structure if time between applications of additional coats is to be longer than fifteen (15) minutes;

 3. Do not expose finished materials to sunlight or air movement for longer than fifteen (15) minutes before covering or closing access; and

 4. Shade the manhole while rehabilitation is in process in hot and arid climates.

1. Concrete Curing Compound - The Contractor shall take the following precautions regarding curing compound, including:

 1. Apply a concrete curing compound if relative humidity is less than seventy percent (70%) within the manhole; and

 2. Apply the curing compound in accordance with the Manufacturer's instructions.

1. Cure Time - The Contactor shall allow a minimum of eight (8) hours cure time before subjecting manholes to flows.

3.05 FIELD QUALITY CONTROL

1. Compressive Strength Test - The Contactor shall perform a compressive strength test in accordance with the following:

 1. Cast four (4) two inch (2”) cubes each day or from each pallet of material;

 2. Label, package, and mail the cubes to the Manufacturer of the material; and

 3. Have the Manufacturer test all cubes for compressive strength in accordance with ASTM C 109 and submit the test results to the Contractor and the Engineer.

1. Leaks - The Contactor shall visually verify absence of leaks after application of the materials.

3.06 PROTECTION

 A. Traffic Control - The Contactor shall not allow traffic to resume over the newly rehabilitated manhole(s) for a minimum of 24 hours after final application of the liner material.

 **PART FOUR DELIVERABLES AND PAYMENTS**

* 1. MEASUREMENT
1. Units for Payment - All manholes receiving cementitious material shall be submitted for payment on a “per vertical foot” basis.
	1. ACCEPTANCE
2. Defective Work – Within sixty (60) days of the final delivery of written reports, the Engineer shall notify the Contractor of any defective work. Defective work (if any) shall be corrected by the Contractor within sixty (60) days of receipt of this written notification. These corrections shall be made to the satisfaction of the Owner and Engineer.
	1. DELIVERABLES
3. Written Reports – As part of the final submittal on this Project, the Contractor shall provide two copies of a bound written report in the approved format. This report shall include a cover page with the name of the Project, scope of the Project, date of submission, and an index page with listings of this Project’s data (if applicable). The written report shall detail by manhole a graphic overlay of the location of all holes drilled and grouted, the total numbers of holes drilled and grouted, and the total vertical footage of cementitious material applied per manhole.
4. Incidental Costs – All reports, DVDs, hard drives, printing, copying, software, and other costs associated with developing and rendering these deliverables to the Engineer or Owner shall be considered incidental to the Project.
	1. PAYMENTS
5. Pay Estimates - Pay estimates shall be submitted on a regularly scheduled basis to the Engineer by the Contractor.
6. Approval of Quantities - The Engineer shall review the quantities submitted by the Contractor, and shall immediately inform the Contractor of its certification or disallowing of any quantities submitted for payment. If the quantities of work in question by the Engineer can’t be immediately resolved to the satisfaction of both parties, the pay estimate shall move forward without those quantities included. Said denied quantities may be resolved and submitted on the next pay estimate.

**END OF SECTION**

**RECOMMENDED PAYMENT SCHEDULE**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Item Number** | **Description** | **Est. Qty.** | **Unit** | **Unit****Price $** | **Total Price $** |
|  |  |  |  |  |  |
|  | **GENERAL ITEMS** |  |  |  |  |
|  | Mobilization | 1 | Lump Sum |  |  |
|  | Traffic Control | 1 | Lump Sum |  |  |
|  | **CEMENTITIOUS MANHOLE REHABILITATION** |  |  |  |  |
|  | Application of Cementitious material  | 000 | Vertical Foot |  |  |
|  | **TOTAL BID** |  |  |  | **00,000.00** |