INTENT: To provide a system for manhole reconstruction that stops inflow, infiltration, exfiltration, restores structural integrity and provides protection against corrosion.

1.0 GENERAL

1.1 This specification shall govern all work, materials, and equipment required for substrate rehabilitation for the purpose of eliminating infiltration, exfiltration, providing corrosion protection, repair of voids, and restoration of the structural integrity of the substrate as a result of applying a monolithic fiber-reinforced structural cementitious liner to the wall and bench surfaces of brick, concrete, or other masonry construction material.

1.2 Described are procedures for cleaning, preparation, application and testing. The applicator, approved and trained by the manufacturer, shall furnish all labor, equipment and materials for applying a cementitious mix to form a structural monolithic liner of a minimum ½ inch thickness, with machinery specially designed for the application. All aspects of the installations shall be in accordance with the manufacturer’s recommendation and per the following specifications which includes:

A. The removal of any loose and unsound material
B. Cleaning of the area to be sprayed
C. The elimination of active infiltration prior to liner the application
D. The repair and filling of voids
E. The repair and sealing of the invert and benches
F. The spray application of a cementitious mix to form a structural monolithic liner

2.0 MATERIALS

2.1 PATCHING MATERIAL (Strong-Seal® QSR)

Strong-Seal® QSR, a quick setting fiber reinforced calcium aluminate corrosion resistant cementitious material, shall be used as a patching material and is to be mixed and applied according to manufacturer’s recommendations and shall have the following minimum requirements:
2.2 INFILTRATION CONTROL MATERIAL (Strong-Seal® Strong-Plug®):

Strong-Plug®, a rapid setting cementitious product specifically formulated for leak control, shall be used to stop minor water infiltration and shall be mixed and applied according to manufacturer’s recommendations and shall have the following minimum requirements:

<table>
<thead>
<tr>
<th>Strong-Seal® Strong-Plug® Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compressive Strength</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Sulfate Resistance</strong></td>
</tr>
<tr>
<td><strong>Freeze/Thaw</strong></td>
</tr>
<tr>
<td><strong>Pull Out Strength</strong></td>
</tr>
<tr>
<td><strong>Set Time</strong></td>
</tr>
</tbody>
</table>

2.3 GROUTING MATERIAL

2.3.1 Strong-Seal® Grout 250, a cementitious grout, shall be used for stopping very active infiltration and filling voids and shall be mixed and applied according to manufacturer’s recommendations. The cementitious grout shall be volume stable, and have a minimum 28 day compressive strength of 250 psi.

2.3.2 Strong-Seal® Grout 1000, a cementitious grout, shall be used for same application as Grout 250, but is designed for special soil conditions, and shall be used per manufacturer’s recommendations. The cementitious grout shall be volume stable and have a minimum 28 day compressive strength of 1000 psi.

2.3.3 Chemical grouts may be used for stopping very active infiltration and shall be mixed and applied per manufacturer’s recommendation.

2.4 LINER MATERIAL

Strong-Seal® cementitious liner products shall be used to form a structural monolithic liner covering all interior substrate surfaces and shall have the following minimum requirements:
<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Time</th>
<th>MS2-A®</th>
<th>MS2-C®</th>
<th>High Performance Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength</td>
<td>ASTM C109</td>
<td>28 days</td>
<td>&gt;9000 psi</td>
<td>&gt;8000 psi</td>
<td>&gt;9000 psi</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM C496</td>
<td>28 days</td>
<td>&gt;600 psi</td>
<td>&gt;800 psi</td>
<td>&gt;800 psi</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>ASTM C293</td>
<td>28 days</td>
<td>&gt;1000 psi</td>
<td>&gt;1500 psi</td>
<td>&gt;1200 psi</td>
</tr>
<tr>
<td>Shrinkage @90% R.H.</td>
<td>ASTM C490</td>
<td>28 days</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Bond</td>
<td>ASTM C882</td>
<td>28 days</td>
<td>&gt;2000 psi</td>
<td>&gt;2000 psi</td>
<td>&gt;2000 psi</td>
</tr>
<tr>
<td>Density, When Applied</td>
<td>N/A</td>
<td></td>
<td>134 ± 5lbs/ft³</td>
<td>134 ± 5lbs/ft³</td>
<td>145±5 lbs/ft³</td>
</tr>
<tr>
<td>Freeze/Thaw</td>
<td>ASTM C666</td>
<td>N/A</td>
<td>100 cycles no visible damage</td>
<td>100 cycles no visible damage</td>
<td>100 cycles no visible damage</td>
</tr>
</tbody>
</table>

2.4.1 Strong-Seal® MS2-A® shall be made with Type I Portland Cement and shall be used according to manufacturer’s recommendations in applications where there are no sulfide conditions (pH 3.0 or higher). Strong-Seal® MS2-A® product or approved equivalent shall be factory blended requiring only the addition of water at the jobsite. The bag weight shall be 63-67 pounds. The contents shall have a dry bulk density of 82-85 pounds per cubic foot. When mixed with the manufacturer’s recommended amount of water, it shall have a wet nozzle density in the range of 129-139 pounds per cubic foot and shall have a typical yield of .57 cubic feet per bag.

2.4.2 Strong-Seal® MS2-C® shall be made with calcium aluminate cement and shall be used according to manufacturer’s recommendations in applications where there is evidence of mild sulfide conditions (pH 2.0 or higher). Strong-Seal® MS2-C® product or approved equivalent shall be factory blended requiring only the addition of water at the jobsite. The bag weight shall be 63-67 pounds. The contents shall have a dry bulk density of 82-85 pounds per cubic foot. When mixed with manufacturer’s recommended amount of water it shall have a wet nozzle density in the range of 129-139 pounds per cubic foot and shall have a typical yield of .57 cubic feet per bag.

2.4.3 Strong-Seal® High Performance Mix, a blend of 100% pure fused aluminate clinker with a minimum aluminate content of 46% and calcium aluminate cement shall be used per manufacturer’s recommendations in any harsh hydrogen sulfide conditions as long as environment is in a municipal sanitary sewer system (pH greater than 1.0). Refer to the product specifications for physical properties and application procedures. Strong-Seal® High Performance Mix or approved equivalents shall be factory blended requiring only the addition of water at the jobsite. The bag weight shall be 63-67 pounds. The dry bulk density shall be 100-102 pounds per cubic foot. When mixed with manufacturer’s recommended amount of water it shall have a wet nozzle density in the range of 140-150 pounds per cubic foot, and shall have a typical yield of .48 cubic feet per bag. All Strong-
Seal® products shall be reinforced with alkaline resistant fiberglass rods not less than ½ inch in length.

The material should meet or exceed industry standards and shall not have any basic ingredient that exceeds EPA maximum allowable limits for any heavy metal.

2.5 WATER

Water used to mix product shall be clean and potable. Questionable water shall be tested by a laboratory per ASTM C-94 procedure. Potable water need not be tested.

2.6 OTHER MATERIALS

No other material shall be used with the mixes described in Parts 2.1, 2.2, 2.3, and 2.4 without prior approval or recommendation from Strong-Seal® Systems.

3.0 EQUIPMENT

3.1 Applicator must use approved equipment designed and manufactured by the material supplier specifically for the application of cementitious liners in sanitary systems.

3.2 Specially designed machines consisting of a progressive cavity pump and an air system for low velocity spray application of product, shall be used for applying Strong-Seal® Systems products. Equipment is complete with water storage and metering system. SprayMate® models 35C and 35D are approved machines for applying Strong-Seal® Systems products. Other models may be approved after review by Strong-Seal® personnel.

4.0 APPLICATION

4.1 PREPARATION

4.1.1 Place covers over invert to prevent extraneous material from entering the sewer lines before cleaning.

4.1.2 All foreign material shall be removed from the manhole wall and bench using a high-pressure water spray (minimum 3000 psi). Unusual conditions such as heavy grease build-up or residues of industrial or processing wastes may require hydro-blasting or chemical cleaning. Loose and protruding brick, mortar, and concrete shall be removed using a masons hammer and chisel and/or scraper. Fill any large voids with quick setting patching mix Strong-Seal® QSR (2.1).
4.1.3 Active leaks shall be stopped using quick setting, specially formulated mixes, such as Strong-Plug® (2.2) according to manufacturer’s recommendations. Some leaks may require weep holes to localize the infiltration during the application. After application the weep holes shall be plugged with the quick setting material Strong-Seal® Strong Plug® (2.2) prior to the application of the final coat. When severe infiltration exists, drilling may be required in order to pressure grout using a cementitious grout, Strong-Seal® Grout 250, Strong-Seal® Grout 1000 or chemical grouts (2.3). Manufacturer’s recommendations shall be followed when pressure grouting is required.

4.2 INVERT REPAIR

4.2.1 After all preparations have been completed, remove all loose material and wash wall again.

4.2.2 Any bench, invert, or service line repairs shall be made at this time using the quick setting patching mix, Strong-Seal® QSR (2.1) and shall be used per manufacturer’s recommendations.

4.2.3 Invert repair shall be performed on all inverts with visible damage or where infiltration is present or when vacuum testing is specified. After blocking flow through manhole and thoroughly cleaning invert, the quick setting patch material Strong-Seal® QSR (2.1) shall be applied to the invert in an expeditious manner. The material shall be trowled uniformly onto the damaged invert at a minimum thickness of ½ inch at the invert extending out onto the bench of the manhole sufficiently to tie into the structural monolithic liner to be spray applied. The finished invert surfaces shall be smooth and free of ridges.

The flow may be re-established in the manhole within 30 minutes after placement of the material.

4.3 MIXING OF LINER MATERIALS

4.3.1 For each bag of product, use the amount of water required per manufacturer’s recommendations following mixing procedures noted on product bag using only enough water to produce a mix consistency to allow application of liner material one (1) inch thick in a single application without material "sagging" on vertical surface and using the approved equipment for mixing and application.

4.3.2 Prepared mix shall be discharged into a hopper and another batch prepared to occur in such a manner as to allow spraying continuously without interruption until each application is complete.
4.4 SPRAYING

4.4.1 The surface shall be clean and free of all foreign material and shall be damp without noticeable free water droplets or running water, but totally saturated just prior to application of material. Materials shall be spray applied up to one (1) inch thick in one or more passes from the bottom of the frame; however, minimum total thickness shall not be less than ½ inch. The surface is then troweled to a relatively smooth finish being careful not to over trowel.

4.4.2 A brush finish shall be applied to the trowel-finished surface. Manufacturer’s recommendations shall be followed whenever more than 24 hours have elapsed between applications.

4.5 BENCH APPLICATION

4.5.1 The wooden covers shall be removed at this time and the bench sprayed with materials mixed per specifications as per 4.3 and spray applied in such a manner that a gradual slope is produced from the walls to the invert with the thickness at the invert to be no less than ½ inch. The wall/bench intersection shall be rounded to a uniform radius the full circumference of the intersection.

5.0 CURING

5.1 Caution should be taken to minimize exposure of applied product to quick surface drying and air movement. If time between application of additional coats is to be longer than 15 minutes, place cover on the manhole. In extremely hot and arid climates, manhole should be shaded while reconstruction is in process and a concrete curing agent should be used. Contact manufacturer for curing compound recommendations.

5.1.1 Strong-Seal® liner products shall have the following minimum cure times before being subjected to flow:

<table>
<thead>
<tr>
<th>Hold Times Before Releasing Flow</th>
<th>MS2-A®</th>
<th>MS2-C®</th>
<th>High Performance Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storm Run-off &amp; Surcharge</td>
<td>8 hrs.</td>
<td>4 hrs.</td>
<td>4 hrs.</td>
</tr>
<tr>
<td>Force Main Impact</td>
<td>12 hrs.</td>
<td>6 hrs.</td>
<td>6 hrs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hold Times Before Allowing Traffic</th>
<th>MS2-A®</th>
<th>MS2-C®</th>
<th>High Performance Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>After final application of the</td>
<td>24 hrs.</td>
<td>6-8 hrs.</td>
<td>6-8 hrs.</td>
</tr>
<tr>
<td>Strong-Seal® liner product, street traffic shall be withheld as noted per the following:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.0 WEATHER

6.1 No application shall be made if ambient temperature is below 40 degrees Fahrenheit. No application shall be made to frozen surfaces or if freezing is expected to occur within the substrate within 24 hours after application.

6.2 Precautions shall be taken to keep the mix temperatures at time of application below 90 degrees Fahrenheit. Water temperature shall not exceed 80 degrees Fahrenheit. Chill with ice if necessary.

7.0 PRODUCT TESTING

7.1 Four - two inch cubes may be cast each day or from every pallet of product used, and shall be properly packaged, labeled and returned to manufacturer for testing in accordance with the owner’s or manufacturer’s directions for compression strength per ASTM C109 procedure.

8.0 FINAL ACCEPTANCE TESTING

8.1 At the direction of the owner or his assignee, the reconstructed structure shall be tested by any one of the following methods:

8.1.1 Visually verify the absence of leaks.

8.1.2 Perform an exfiltration test.

8.1.2.1 For manholes 0 to 6 foot deep, if water loss is 1 inch or less in 5 minutes, manhole reconstruction is acceptable.

8.1.2.2 For manholes over 6 feet deep, if water loss is 1 inch plus 1/8 inch for each additional foot of depth of less in 5 minutes, manhole is acceptable.

8.1.3 Vacuum testing per ASTM C1244-93 procedure. Vacuum testing shall not be conducted earlier than 7 days after application.

9.0 SPECIAL APPLICATIONS

9.1 On new, poured in place or precast concrete structures in the municipal sanitary sewer system Strong-Seal® products may be applied to prevent corrosion to the substrate and to seal joints.

9.2 On new structures subject to mild corrosion (pH down to 1.0) a single application of Strong-Seal® High Performance Mix shall be spray applied to a total minimum thickness of ½ inch.
10.0 LIMITED WARRANTY

The Strong Company, Inc. warrants that this product was produced in conformity with its standard specification or formulations within recognized tolerances, free of adulteration or contamination, and that the product will perform in accordance with representations in Strong-Seal® Systems literature and Technical Data Sheets when properly applied in strict conformance with the printed instructions on container and prescribed in technical data instructions and when applied to a properly prepared surface.

The sole remedy of the purchaser shall be replacement of the product or refund of the purchase price of the product if any defect in material or workmanship or variance in the product beyond recognized tolerances in the specifications are found to exist. No other remedy including, but not limited to, incidental or consequential damages for lost profits, lost sales, injury to person or property, or any other incidental or consequential loss shall be available to the purchaser.

DISCLAIMER

THE WARRANTY DESCRIBED IN THE ABOVE PARAGRAPHS SHALL BE IN LIEU OF ANY OTHER WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. THERE ARE NO WARRANTIES THAT EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.