



QUADEX SEWER STRUCTURE RESTORATION MATERIALS INSTALLATION SPECIFICATION

For Restoration Using Quadex Rehabilitation Materials

1.0 GENERAL

- 1.1 These specifications are intended to set a standard of quality and design for the application of cementitious and/or epoxy materials used in the rehabilitation of sanitary sewer structures.

2.0 DEFINITIONS

- 2.1 The term "approved" shall mean that the proposed material shall meet or exceed each of the performance criteria set forth in this specification. Manufacturers and vendors of various name brand materials must submit proof that any proposed material will meet the guidelines and requirements of this specification. Material approvals shall be made by the engineer no less than two weeks prior to bid date.

3.0 APPROVED MATERIALS

3.1 Infiltration Control

All fast setting materials furnished shall be designed to be applied in dry powder form, with no prior mixing of water, directly to active leaks under hydrostatic pressure in manholes or related structures. Materials shall consist of rapid setting cements, siliceous aggregates, and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles.

Approved infiltration control material shall be Quadex Quad-Plug as manufactured by Quadex, Inc.

Approved material shall exhibit the following minimum physical properties:

- a. Compressive Strength (ASTM C109)
 - 30 mins: 1850 psi
- b. Bond Strength (ASTM C321)
 - 28 day: >80 psi
- c. Set Time 30 seconds

3.2 Invert Repair and Patching

All material furnished shall be designed to fill large voids in structure walls and to repair or reconstruct inverts where no hydrostatic pressure exists. Material shall consist of rapid setting cements, high density, chemically stable aggregates, and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles.

Approved invert repair and patching material shall be Quadex Hyperform as manufactured by Quadex, Inc.

Approved material shall exhibit the following minimum physical properties:

- a. Compressive Strength (ASTM C109)
 - 30 minutes: > 1200 psi
 - 1 hour: > 2500 psi
 - 1 day: > 4000 psi
- b. Bond Strength (ASTM C882)
 - 28 day: >3000 psi
- c. Shrinkage (ASTM C596)
 - 0%

3.3 Cementitious Lining Materials

All cementitious lining materials shall be specifically designed for the rehabilitation of manholes and other related wastewater structures. Liner materials shall be cement based, poly-fiber reinforced, shrinkage compensated, and enhanced with chemical admixtures and siliceous 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 ½" to 4" in a one pass monolithic application.

A. Portland cement based lining materials

Portland cement materials shall be manufactured from Type II Portland cement and enhanced with silica fume and high-density chemically stable aggregates. Materials must resist corrosion when

placed in an environment capable of producing a maximum substrate pH level of 3.0. Approved material shall be Quadex QM-1s Restore as manufactured by Quadex, Inc., or “pre-approved” equal.

Approved material shall exhibit the following minimum physical properties:

- a. Compressive Strength (ASTM C109)
>9,000 psi
- b. Flexural Strength (ASTM C293)
>1,250 psi
- c. Bond Strength (ASTM C882)
>2,500 psi
- d. Shrinkage (ASTM C596)
0% @ 28 Days
- e. Permeability (AASHTO T-277)
Not to exceed 350 coulombs
- f. Freeze-Thaw (ASTM C666)
No damage in minimum 300 cycles
- g. Material Wet Density
Minimum 127 +/-5 PCF

B. Calcium Aluminate (CA) based lining materials

Calcium Aluminate materials shall be manufactured from 100% pure calcium-aluminate cement and enhanced with silica fume and high-density chemically stable aggregates. Materials must resist corrosion when placed in an environment capable of producing a maximum substrate pH level of 2.0. Approved material shall be Quadex Aluminaliner as manufactured by Quadex, Inc., or “pre-approved” equal.

Approved material shall exhibit the following 28-day minimum physical properties:

- a. Compressive Strength (ASTM C109)
>9,000 psi
- b. Flexural Strength (ASTM C293)
>1,600 psi
- c. Bond Strength (ASTM C882)
>2,500 psi
- d. Shrinkage (ASTM C596)
0% @ 28 Days
- e. Permeability (AASHTO T-277)
Not to exceed 350 coulombs
- f. Freeze-Thaw (ASTM C666)
No damage in minimum 300 cycles

- g. Material Wet Density
Minimum 127 +/-5 PCF

C. Specialty cementitious lining materials

Specialty cementitious lining materials shall be manufactured from Type II Portland cement with chemically activated fly ash, and enhanced with silica fume and high-density chemically stable aggregates. Materials must resist corrosion when placed in an environment capable of producing a substrate pH level of less than 2.0.

Approved cementitious material shall be Quadex Dynastone as manufactured by Quadex, Inc., or "pre-approved" equal.

Approved material shall exhibit the following minimum physical properties:

- a. Compressive Strength (ASTM C109)
>7,000 psi
- b. Flexural Strength (ASTM C293)
>750 psi
- c. Bond Strength (ASTM C882)
>2,000
- d. Permeability (AASHTO T-277)
>Not to exceed 300 coulombs
- e. Freeze-Thaw (ASTM C666)
No damage in minimum 300 cycles
- f. Material Wet Density
Minimum 127 +/-5 PCF

3.4 Epoxy Materials

All epoxy lining materials shall be specifically designed for protecting manholes and other related wastewater structures from severe hydrogen sulfide environments. Liner materials shall be 100% solids epoxy containing no VOC's and capable of building a minimum thickness of 150 mils in a single application. All epoxy lining materials shall be applied only by heated plural component equipment as approved by the manufacturer.

Epoxy materials shall meet the following minimum physical properties:

- a. Tensile Strength ASTM D638
5,600 psi
- b. Flexural Strength ASTM D790
11,000 psi
- c. Compressive Strength ASTM D695
15,000 psi
- d. Shore D Hardness ASTM D2240

- e. Elongation
4.8%
- f. Taber Abrasion ASTM4060
1000 gm load @ 1000 cycles
< 100mg loss

4.0 MATERIAL(S) SELECTION / DESIGN CRITERIA

- 4.1 Condition A: Low to mild hydrogen sulfide environments (pH > 3.0). Substrate shall receive a minimum of ½” cementitious lining material manufactured from Type II Portland cement, and enhanced with silica fume. Materials shall contain poly-fiber reinforcement, chemical admixtures, and siliceous aggregates.

Approved material shall be Quadex QM-1s Restore as manufactured by Quadex, Inc.

- 4.2 Condition B: High hydrogen sulfide environments (pH > 2.0). Substrate shall receive a minimum of ½” cementitious lining material manufactured from 100% pure calcium aluminate cement and enhanced with high-density chemically stable aggregates. Materials shall contain poly fiber reinforcement and chemical admixtures.

Approved material shall be Quadex Aluminaliner as manufactured by Quadex, Inc.

- 4.3 Condition C: New construction with anticipated harsh hydrogen sulfide environments (pH < 2.0) or substrate corrosion < 0.125 inch and harsh hydrogen sulfide environments (pH < 2.0). Substrate shall receive a minimum of 125 mils of 100% solids epoxy lining material containing no VOC's.

Approved epoxy material shall be Quadex Structure Guard.

- 4.4 Condition D: Severe hydrogen sulfide environments (pH < 2.0) and substrate corrosion > 0.125 inch. Substrate shall receive a composite system consisting of a minimum ½” cementitious lining material manufactured from 100% pure calcium aluminate cement and a 125 mil topcoat of 100% solids epoxy lining material containing no VOC's.

Approved cementitious material shall be either Quadex Aluminaliner or Quadex QM-1s Restore and approved epoxy material shall be Quadex Structure Guard.

Note: The selected use of Quadex QM-1s Restore in Condition D composite system applications requires a minimum 7-day cure window prior to the application of the Quadex Structure Guard Epoxy.

5.0 CEMENTITIOUS REHABILITATION

5.1 Structure Cleaning and Preparation

The floor and interior walls of the structure 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.

- a. High pressure water blasting with a minimum of 3500 psi shall be used to clean free all foreign material within the structure.
- b. When grease and oil are present within the structure, an approved detergent or muriatic acid shall be used integrally with the high pressure cleaning water.
- c. All materials resulting from the cleaning of the structure shall be removed prior to application of the cement based coating.
- d. All loose or defective brick, grout, ledges, steps and protruding ledges shall be removed to provide an even surface prior to application of cement based coating.

5.2 Sealing Active Leaks

The work consists of hand applying a dry quick-setting cementitious mix designed to instantly stop running water or seepage in all types of concrete and masonry structures. The applicator shall apply material in accordance with manufacturer's recommendations and following specifications.

- a. The area to be repaired must be clean and free of all debris per the guidelines set forth in 5.1.
- b. Once cleaned, prepare crack or hole by chipping out loose material to a minimum depth and width of $\frac{3}{4}$ inch.
- c. With gloved hand, place a generous amount of the dry quick-setting cementitious material to the active leak, with a smooth fast motion, maintaining external pressure for 30 seconds, repeat until leak is stopped.
- d. Proper application should not require any special mixing of product or special curing requirements after application.

5.3 Invert Repair and Patching

The work consists of hand mixing and applying a rapid setting, high early strength, non-shrink patching material to fill all large voids and repair inverts prior to spray lining of the structure. For manhole invert repairs, flow must be temporarily restricted by inflatable or mechanical plugs prior to cleaning.

- a. The area to be repaired must be cleaned and free of all debris per the guidelines set forth in Section 5.1.
- b. Mix water shall be clean potable water and require no additives or admixtures for use with cementitious patching materials.
- c. Cementitious material shall be mixed in a mortar tub or 5-gallon pail with water per manufacturer's specifications. Material should be mixed in small quantities, to avoid setting prior to placement in voids or inverts.
- d. 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 should be smoothed either by hand or trowel in order to facilitate flow.
- e. Flows in inverts can be reestablished within 30 minutes of material placement.

5.4 Application of Cementitious Liner

The work consists of spray applying and/or centrifugally spin-casting a cementitious based liner to the inside of the existing structure. The necessary equipment and application methods to apply the cementitious based liner materials shall be only as approved by the material manufacturer.

- a. 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.
- b. 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 bottom of the structure 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 1/2-inch. Material shall be applied to the bench area in such a manner as to provide for proper drainage without ponding.
- c. Centrifugal application of the cementitious material.

Spin-cast unit shall be approved by the material manufacturer and be driven only by a direct current (DC) motor with a minimum speed of 2,500 rpm. Motor torque shall be sufficient to apply lining materials evenly within a minimum 8 foot diameter structure.

- a. Material hose shall be coupled to the spin-cast unit. The spin-cast unit shall then be positioned within the center of the manhole at either the top of the manhole chimney or the lowest point corresponding to the junction of the manhole bench and walls.
- b. The spin-cast unit 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 structure, the rotating applicator head shall be raised and/or lowered at a controlled retrieval speed conducive to providing a uniform material thickness on the structure 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 ½-inch. If additional material is required at any level, the spin-cast unit shall be placed at that level and application shall recommence until that area is thickened.
- d. Material shall be applied only when the structure is in a damp state, with no visible water dripping or running over the walls.
- e. The low-velocity spray nozzle may be used in conjunction with the spin-cast unit to facilitate uniform application of the mortar material to irregularities in the contour of the structure walls and bench areas.
- f. When applying materials to open air structures, or within structures with low effluent flow special precautions shall be taken to ensure proper curing. When recommended by the manufacturer, the contractor shall perform the following:
 - a. Prior to applying materials contractor shall subject the structure to a water spray for a minimum of 24 hours to ensure substrate is fully saturated.
 - b. Contractor shall avoid spraying portions of the structure while subjected to direct sunlight.
- g. Troweling of materials shall begin immediately following the spray application. Initial troweling shall be in an upward motion, to compress the material into any voids within the structure walls. Precautions should be taken not to over-trowel.
- h. Once troweling has been completed the applied liner shall be brushed to remove trowel marks and to break up the latent surface brought about by trowelling. Brushing should be in the horizontal plane and as with troweling do not over work the lining material.
- i. As per Section 5.4 f above special conditions may exist within the structure that require additional curing techniques.

1. When directed by the manufacturer, contractor shall apply a manufacturer's approved curing agent to the surface of all applied and finished materials.
 2. Contractor shall cover applied materials with plastic sheeting as soon as feasible to prevent moisture loss.
- j. Curing will take place once the structure cover has been replaced. It is important that the structure lid/ cover is replaced no more than 5 minutes after brushing is complete to avoid moisture loss in the material due to sunlight and winds.
 - k. Material shall not be applied during freezing weather conditions. Material shall not be placed when the ambient temperature is 37 degrees Fahrenheit and falling or when the temperature is anticipated to fall below 32 degrees Fahrenheit within 24 hours.

6.0 EPOXY REHABILITATION

6.1 Certifications

To ensure contractor proficiency in applying specified epoxy products, the contractor and his equipment shall be certified by the manufacturer. Furthermore, certification of contractor and equipment must be by a NACE Certified Inspector, holding valid and current NACE certification at time of inspection. Written documentation shall be provided to contractor and Project Engineer/ owner before any work commences.

6.2 Coating Application Equipment

- a. Manufacturer approved heated plural component spray equipment.
- b. Hard to reach areas, primer application, and touch-up may be performed using hand tools.

6.3 Pre-Application Inspections

- a. Unless prior approval has been received from the manufacturer new Portland cement concrete structures shall have a minimum cure of 28 days. Should earlier coating be required, coating product manufacturer shall recommend specifications including appropriate cure assessment testing and use of speciality primers and sealers.
- b. All active flows shall be plugged or diverted away from all surfaces to be coated.
- c. Temperature of the surface to be coated should be maintained between 40 and 120 deg F.

- d. Specified surfaces should be shielded to avoid exposure of direct sunlight or other intense heat source. Where varying surface temperatures do exist, coating installation should be scheduled when the temperature is falling versus rising.
- e. Prior to commencing surface preparation, Contractor shall inspect all surfaces specified to receive the coating and notify Owner, in writing, of any noticeable disparity in the site, structure or surfaces which may interfere with the work, use of materials or procedures as specified herein.

6.4 Surface Preparation

- a. Concrete and/or mortar damaged by corrosion, chemical attack or other means of degradation shall be removed so that only sound substrate remains.
- b. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed.
- c. Choice of surface preparation method(s) should be based upon the condition of the structure and concrete or masonry surface, potential contaminants present, access to perform work, and required cleanliness and profile of the prepared surface to receive the coating product(s).
- d. Surface preparation method, or combination of methods, that may be used include high pressure water cleaning, water jetting, abrasive blasting, shotblasting, grinding, scarifying, detergent water cleaning, hot water blasting and others as referenced in NACE No. 6/SSPC SP-13 Surface Preparation of Concrete. Whichever method(s) are used, the work shall be performed in a manner that provides a uniform, sound clean neutralized surface suitable for the specified coating product(s).
- e. Resulting surface profile shall be at least a CSP 4 in accordance with ICRI Technical Guideline No. 03732.
- f. Prior to the application of the coating product, all infiltration shall be eliminated by use of appropriate repair material(s), such as hydraulic cements and/or repair mortars per Section 5.2. Consult with manufacturer when compatibility issues arise.

6.5 Application of Repair and Resurfacing Products

- a. Areas where rebar has been exposed shall be repaired by an abrasive blast according to SSPC-SP10 prior to applying specified primer, as recommended by the manufacturer or in accordance with the Project Engineer's recommendations.

- b. Repair products may be used to fill voids, bugholes, and other surface defects which may affect the performance or adhesion of the coating product(s).
- c. Resurfacing products shall be used to repair, smooth or rebuild surfaces with rough profiles to provide a concrete or masonry substrate suitable for the coating product(s) to be applied. These products shall be installed to minimum thickness as recommended within manufacturers published guidelines. Should structural rebuild be necessary, these products shall be installed to a thickness as specified by the Project Engineer.
- d. Repair and resurfacing products shall be handled, mixed, installed and cured in accordance with manufacturer guidelines set forth in Section 5.3.
- e. All repaired or resurfaced surfaces shall be inspected for cleanliness and suitability to receive the coating product(s).

6.6 Application of Epoxy Coating Product(s)

- A. Application procedures shall conform to the recommendations of the coating product(s) manufacturer, including environmental controls, product handling, mixing, application equipment and methods.
- B. Spray equipment shall be specifically designed to accurately ratio and apply the coating product(s) and shall be in proper working order.
- C. Contractors qualified in accordance per Section 5.1 of these specifications shall perform all aspects of coating product(s) installation.
- D. Prepared surfaces shall be coated via spray application of the coating product(s) described herein unless otherwise recommended by the coating product manufacturer.
- E. Coating thickness shall be in relation to the profile of the surface to be coated as recommended by the coating product manufacturer.
- F. In all cases the coating product(s) shall be applied to a minimum dry film thickness of 80 mils to surface profiles of CSP-4 to CSP-6 or 125 mils minimum DFT to surface profiles of CSP-7 or greater.
- G. Subsequent topcoating or additional coats of the coating product(s) shall occur within the product's recoat window or 24 hours which ever is less. Additional surface preparation procedures will be required if this recoat window is exceeded.
- H. Coating product(s) shall interface with adjoining construction materials/components throughout the structure to effectively seal and protect substrates from attack by corrosive elements and to ensure the effective elimination of infiltration into the sewer system.

- I. Procedures and materials necessary to effect the interface between dissimilar materials and the coating product shall be as recommended by the coating product(s) manufacturer.
- J. Sewage flow shall be stopped, bypassed or diverted as necessary for application of the coating product(s) to the invert/flowline.

7.0 QUALITY CONTROL – CEMENT

The quality and performance of the material and the workmanship of the applicator shall be maintained by one or more of the following measures to be determined and specified by the engineer or owner.

7.1 Visual Inspection

All structures will be visually inspected for cracks, bug holes, and unfinished surfaces.

7.2 Performance Testing

A. Vacuum Testing

All pipes entering the manhole should be plugged, taking care to securely place the plug from being drawn into the manhole. A vacuum pump apparatus shall be placed onto the manhole ring and sealed to the structure in accordance with the pump manufacturers' recommendations. A vacuum pump of ten (10) inches of mercury shall be drawn and the vacuum pump shut off. With the pressure relief valves closed, the time shall be measured for the vacuum to drop to (9) inches. The following are minimum allowable test times for manhole acceptance at the specified vacuum drop.

Manhole Depth (Feet)	Time (Seconds)		
	<u>48" Diameter</u>	<u>60" Diameter</u>	<u>72" Diameter</u>
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
For each additional 2 ft. depth add:	5	6.5	8

B. Exfiltration Testing

First, incoming and outgoing sewer and service lines shall be plugged. An optional soaking period of up to one (1) hour will be allowed if bypassing of the sewage is not required or has been provided for. At the end of this optional

soaking period, the manhole shall be completely filled with water to the manhole cover frame and the test initiated. For manholes that are 0-6 feet in depth, if water loss is less than one (1) inch or less in five (5) minutes, the manhole reconstruction shall be deemed acceptable. For manholes that are over six (6) feet in depth, if water loss is one (1) inch plus 1/8-inch for each additional foot of depth or less in five (5) minutes, the manhole reconstruction shall be deemed acceptable. Should the drop in the water level exceed the previously stated test standard, the manhole shall be deemed a failed installation.

C. Material Testing

One 2 x 2 inch sample cube shall be taken for every 56 bags of material used. Samples shall be sprayed from nozzle, identified, and sent to an independent test laboratory for compression strength testing as described in ASTM C-109 and shall have a minimum average of the strengths set forth in Section 3.3.

8.0 QUALITY CONTROL – EPOXY

- A. 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.
- B. High voltage holiday detection for coating systems installed in corrosive environments, when it can be safely and effectively employed, shall be performed to ensure monolithic protection of the substrate. After the coating product(s) have cured in accordance with manufacturer recommendations, all surfaces shall be inspected for holidays in accordance with NACE RPO 188-99 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates or ASTM D4787 Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates. All detected holidays shall be marked and repaired according to the coating product(s) manufacturer's recommendations.
 - a. Test voltage shall be a minimum of 100 volts per mil of coating system thickness.
 - b. Detection of a known or induced holiday in the coating product shall be confirmed to ensure proper operation of the test unit.
 - c. All areas repaired shall be retested following cure of the repair material(s).
 - d. In instances where high voltage holiday detection is not feasible a close visual inspection shall be conducted and all possible holidays shall be marked and repaired as described above.
 - e. Documentation of areas tested, equipment employed, results and repairs made shall be submitted to the Owner/Engineer by Contractor.
- C. Adhesion of the coating system to the substrate shall be confirmed in a minimum of 10% of the manholes coated, or for large structures once every 1000 square feet of coated area. Testing shall be conducted in accordance

with ASTM D7234 Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers. Owner's representative shall select the manholes or areas to be tested.

- a. For each test manhole a minimum of three 20 mm dollies shall be affixed to the coated surface; one at the cone area, one at the mid section and one near the bottom of the structure.
 - b. For larger structures a minimum of three 20 mm dollies shall be affixed to the coated surface at random locations within each 1000 square foot area or as otherwise agreed upon.
 - c. The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths in excess of at least twice the anticipated failure point (generally at least 1000 psi) and permitted to cure in accordance with manufacturer recommendations. The coating and dollies shall be adequately cleaned and prepared to receive the adhesive. Failure of the dolly adhesive shall be deemed a non-test and require retesting.
 - d. Prior to performing the pull test, the coating shall be scored to the substrate, or within 10 mils of the substrate surface, by mechanical means without disturbing the dolly or coating system bond within the test area.
 - e. Two of the three adhesion pulls in each test area shall exceed 200 psi and shall include substrate adhered to the back of the dolly or no visual signs of the coating product in the test hole. Pulls tests with results between 150 and 200 psi may be acceptable if more than 50 percent of the substrate in the test area is adhered to the dolly.
 - f. Should a structure, or area, fail to achieve two successful pulls as described above, additional testing shall be performed at the discretion of the Owner or Project Engineer. Any areas detected to have inadequate bond strength shall be evaluated by the Project Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Contractor
 - g. All adhesion testing shall be performed by qualified personnel using calibrated equipment as specified by the applicable ASTM standard(s).
 - h. All adhesion testing shall be documented and submitted in a consistent format detailing location, test values, description of the failure point/mode, scoring method employed, adhesive used, cure time of coating and adhesive and other data as deemed necessary by the owner/engineer.
 - i. All a adhesion test locations shall be repaired by the Contractor at no cost to the Owner.
- D. Visual inspection shall be made by the Project Engineer and/or Inspector. Any deficiencies in the finished coating effecting the performance of the coating system or the operational functionality of the structure shall be marked and repaired according to the recommendations of the coating product(s) manufacturer.
- E. The municipal sewer system may be returned to full operational service as soon as the final inspection has taken place and all coating materials have

been adequately cured according to the coating product(s) manufacturer's recommendations.

9.0 WARRANTY

- 9.1 Product manufacturers shall warrant all materials to be free of defects, product design, and workmanship for a period of one year from date of purchase. Manufacturer will provide replacement materials for any product proven to be defective when applied in accordance with manufacturer's recommendations. Manufacturer's obligation shall be limited solely to product replacement.