

ITEM SWL-SPRAYWALL-16X; SPRAYWALL LINING SPECIFICATION

ITEM SWL-16X.01 DESCRIPTION.

This specification includes all work, materials and equipment required for the structural rehabilitation of structures.

The purpose is to eliminate infiltration, repair voids, restore structural integrity and provide corrosion protection by the application of a spray-applied monolithic resin liner to the wall and bench surfaces of brick/concrete structures or structures produced with any other masonry construction material. These structures include, but are not limited to manholes, wet wells, lift stations, vaults and pump stations.

A. Quality Assurance.

1. Furnish materials of quality required by the American Society for Testing and Materials (ASTM) standards or other approved standards and specifications.
2. Provide guarantee against defective materials and workmanship in accordance with the requirements of these specifications.
3. The contractor installing the finished protective liner will be a certified trained applicator of the specified process.
4. Provide verifiable independent third-party creep test results documenting no less than 70% retention of flexural modulus of elasticity after 50 years of service. The third-party testing firm may not be affiliated with the manufacturer in any way.

B. References. American Society for Testing and Materials (ASTM) Annual Book of Standards:

1. ASTM D638: Test Method for Tensile Properties of Plastics.
2. ASTM D695: Test Method for Compressive Properties of Rigid Plastics.
3. ASTM D790: Test Methods for Flexural Properties of Unreinforced and reinforced Plastics and Electrical Insulating Materials.

ITEM SWL-16X.02 SUBMITTALS.

All shop drawings shall be as specified above Item 16X.02B.

ITEM SWL-16X.03 MATERIALS.

A. Infiltration Control mix:

1. Minor Infiltration

- a. Cementitious Grout (De Neef Industrial Products). A rapid-setting cementitious grout or chemical grout specifically formulated for leak control should be used to stop minor water infiltration. It should be mixed and applied according to the manufacturer's recommendations and should meet the following minimum requirements.

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Compressive strength	ASTM C 109	1,800 psi @ ½ hr. 4,000 psi @ 24 hrs. 5,000 psi @ 7 days
Tensile strength	ASTM C 190	300 psi @ 7 days 350 psi @ 28 days

2. **Very Active Infiltration**

a. Chemical Grout (De Neef Industrial Chemicals)

- i. A chemical grout must be used for stopping very active infiltration, filling voids and should be mixed and applied according to manufacturer's recommendations. The cementitious grout should be volume stable having a minimum 1-day compressive strength of 50 psi and a 28-day compressive strength of 250 psi.
- ii. Chemical grouts can be used for stopping very active infiltration and should be mixed and applied per manufacturer's recommendations.

B. **Patching and Profiling Mix:**

1. **Cementitious Compound** (Strong Seal or equivalent product). A quick setting cementitious material can be used to bring the substrate to profile by filling voids, cracks, missing mortar and other substrate defects. It should be mixed and applied according to the manufacturer's recommendations and should meet the following minimum requirements.

Compressive strength	ASTM C 109	1000 psi @ 1 hr 3500 psi @ 48 hrs 5000 psi @ 28 days
Tensile strength	ASTM C 307	200 psi @ 24 hrs 300 psi @ 7 days

- C. **Resin Based Liner.** The resin-based material shall be used to form the sprayed on/structural enhanced monolithic liner covering all interior surfaces of the structure including benches and inverts of manholes. The finished liner shall be SprayWall® as manufactured by SprayRoq, Inc. or approved equal and conform to the minimum physical requirements listed below.

Compressive strength	ASTM D 695	10,500 psi
Tensile strength	ASTM D 638	7,000 psi
Flexural strength	ASTM D 790	12,000 psi
Bond	Shall exceed substrate tensile strength	
Flexural modulus (initial)	ASTM D 790	735,000 psi

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Density		87 pcf
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1. The finished structure shall be corrosion resistant to: Hydrogen Sulfide; 20% sulfuric Acid; 17% Nitric Acid; 5% Sodium Hydroxide; road salts for winter conditions as well as other common ingredients of the sanitary sewage environment.
2. The wall of the resin-based liner will be structurally designed to withstand the hydraulic load generated by the groundwater table & restore structural integrity. The long term (50 yr.) value of the flexural modulus of elasticity will be a minimum of 500,000 psi and is an integral part of the engineering equation used to design the wall thickness of the structural liner.

For this reason, the value of the long-term flexural modulus of the proposed product will be certified by an independent, third party testing lab and submitted with the design calculations for each individual structure.

Definition- Long-term value will be identified as initial flexural modulus less the reduction in value caused by Creep over a fifty (50) year minimum period and verified by DMA testing.

- D. **Other Materials:** Because of the advantages associated with rapid cure and infinite thickness capabilities, no resin-based materials other than polyurethane shall be used to achieve the structural enhancement without prior approval of the county.

ITEM SWL-16X.04 INSTALLATION.

- A. **Project/Site/Conditions.** Coordinate with the Project Manager (PM) for traffic control during rehabilitation work at each designated location.
- B. **Sequencing.** All required interruptions of flow through manholes, wet wells, pump stations or any other portion of the sanitary sewer collection system shall be coordinated with and approval received from the County prior to the interruption.
- C. **Inspection.**
1. **Evaluation of Atmosphere:** Prior to entering structures, an evaluation of the atmosphere will be conducted to determine the presence of toxic, flammable vapors or possible lack of oxygen. The evaluation shall be in accordance with local, state or federal safety regulations.
- D. **Preparation.**
1. Place covers over all pipe openings to prevent extraneous material from entering the sewer system. All foreign material shall be removed from the structures' wall and bench/floor using a pressure water spray (minimum

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2500 psi). The use of acid for cleaning purposes, no matter how dilute, will not be allowed.

Loose or protruding brick, mortar and concrete shall be removed by using a mason's hammer and chisel. Fill any large voids with quick setting patch mix as described in Paragraph (2.01 IIA). The surface to be repaired must be clean and free of any loose materials.

2. Minor leaks shall be stopped using the quick-setting specially formulated infiltration control mix (paragraph 2.01 IA) and shall be mixed and applied per manufacturer's recommendations.

When severe infiltration is present, drilling may be required in order to pressure grout outside the structure using either a cementitious or chemical grout (paragraph 2.01 IB). Manufacturer's recommendations shall be followed when pressure grouting is required.

E. Installation/Application

1. All products are to be applied by trained and approved SprayRoq Certified Partners only and in strict accordance with the directions for usage and installation of the SprayRoq product.
2. **Application Temperatures:** Application of liner shall not be made unless the ambient temperature inside the structure is 50° degrees or higher.
3. **Bench/Invert Repair:**
 - a. The manhole bench must be sprayed but depending on availability and future plans, some judgment consideration will have to be made regarding the invert. Important issue here is the necessity to insure a monolithic system is achieved.
 - b. After blocking flow through the structure and thorough cleaning/preparatory work has been achieved. The sprayed on resin-based liner shall be applied to the invert, bench and wall areas in the same manner as specified for the liner application below. The spray shall be applied such that the entire structure receives a structurally enhanced monolithic liner.
 - c. The finished invert surfaces shall be smooth, free of ridges and will be sloped in the direction of flow. Special care shall be used to insure a smooth transition between the new manhole invert and intersecting pipeline inverts such that flow will not be impaired.
4. **Liner Application:** The resin-based liner shall be manually sprayed on to all surfaces by a trained technician who is experienced in the application of a spray applied resin and has been certified by the manufacturer.

Appropriate personal protection equipment shall be utilized but, in every case, when applying the liner, the sprayer and personnel in direct contact with the spray atmosphere, will always be protected by supplied air.

The minimum thickness of the material applied is to be no less than 150 mils in order to support structural integrity. No other products such as cement or

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grouts may be used as part of the structural reinstatement, however, said products may be used as part of the repair process prior to sprayed application of the structure as specified above.

Application of the spray applied material must be completed in one (1) mobilization in order to minimize the disruption and cost of excessive bypassing, pipeline plugging, traffic control and all other support services.

The finished manhole must be returned to full service immediately after the spray application is complete.

5. **Curing:** The structure should be allowed to cure for 24 hours and return to ambient temperature prior to any physical testing, including vacuum testing.

F. Field Quality Control

1. The following test/inspection will be performed by the county.
2. Visually verify the absence of leaks from infiltration.

ITEM SWL-16X.05 WARRANTY.

- A. **Manufacturers Guarantee.** SprayRoq guarantees products to conform to the quality assurance procedures established by SprayRoq and its resin blending partners. Liability, if any, is limited to replacement of the product for a period of three (3) years from the date of application.
- B. **Additional Warranty.** SprayRoq shall provide the additional warranty period as specified in above SCMSD Sanitary Structurer Lining Specification Item 16X.06.

ITEM SS-OBIC-16X; SPECTRASHIELD/OBIC LINING SPECIFICATION By
CCI Spectrum/OBIC

ITEM SS-OBIC-16X.01 DESCRIPTION.

The work described within details a complete program for manholes.

This section details the methods, procedures, materials and equipment as required to produce A Total System for Manholes. The completed system will provide a corrosion resistant liner that restores walls to original surface levels and eliminates water infiltration and exfiltration.

A. Quality Assurance

1. The manufacturer and/or applicator of the total liner system of manholes shall be a company that specializes in the design, manufacture or installation of corrosion protection systems for manholes. Applicator shall be completely trained in leak repair, surface preparation and corrosion materials application on manholes. Corrosion materials/products shall be suitable for installation in a severe hydrogen sulfide environment without any deterioration to the liner.
2. The applicator shall be trained and certified by the manufacturer for the handling, mixing, application and inspection of the liner system as described herein.
3. To ensure total unit responsibility, all materials and installation thereof shall be furnished and coordinated with/by one supplier/applicator who turnkeys the work and assumes full responsibility for the entire operation.

B. References

American Society for Testing and Materials (ASTM) Annual Book of Standards:

1. ASTM 4541 - Adhesion
2. ASTM D412 - Tensile Strength (psi)
3. ASTM D412 - Elongation (%)
4. ASTM D624 - Tear Strength (PLI)
5. ASTM D2240 – Hardness
6. ASTM D1737 - Flexibility (1/8 mandrel)
7. ASTM 4060 - Taber Abrasion (mg loss)
8. CIGMAT Evaluation (UH 96-7) of Spectrashield Liner System for Wastewater Concrete and Clay Brick Facilities. University of Houston Department of Civil Engineering: December 1996

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ITEM SS-OBIC-16X.02 SUBMITTALS .

Shop drawings shall be as specified above Item 16X.02B.

All materials and procedures required to establish compliance with the specifications shall be submitted to the owner/engineer for review/approval. Submittals shall include at least the following:

1. Technical Data Sheet on each product used.
2. Material Safety Data Sheet (MSDS) for each product used.
3. ASTM References.
4. CIGMAT Evaluation.
5. Descriptive literature, bulletins and or catalogs of materials.
6. Work procedures including flow diversion plan, method of repair, etc.
7. Material and method for repair of leaks or cracks in manholes.
8. Final installation report on completed manholes.

ITEM SS-OBIC-16X.03 MATERIALS AND EQUIPMENT.

- A. The materials to be utilized in the lining of manholes shall be designed and manufactured to withstand the severe effects of hydrogen sulfide in a wastewater environment. Manufacturer of corrosion protection products shall have long proven experience in the production of the lining products utilized and shall have satisfactory installation record.
- B. Equipment for installation of lining materials shall be high quality grade and be as recommended by the manufacturer.
- C. The lining system to be utilized for manhole structures shall be a multi-component stress skin panel liner system as described below:

1. Liner.

<u>Installation</u>	<u>Liner</u>
Moisture barrier	Modified Polymer
Surfacer	Polyurethane/Polymeric blend foam
	Final corrosion barrier Modified polymer

2. **Modified polymer** shall be sprayable, solvent free, two-component polymeric, moisture/chemical barrier specifically developed for the corrosive wastewater environment.

Typical Chemical Analysis

A Component.

Viscosity, 77° F, cps.	450
Physical State	Liquid

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Color	Clear to amber
Hygroscopicity	Reacts with water

B Component

Viscosity, 77° F, cps.	500
Physical State	Liquid
Color	Flamingo Pink
Non-Volatile	100%

Reaction Profile (100 grams, 175°F sample).

Gel Time, seconds	10
Tack Free Time, seconds	20
Cure Time, seconds	90

Processing

A System / B System, volume ratio 1.00 / 1.00

Typical Physical Properties.

Tensile Strength, psi	>2,250
Elongation, %	>269
Tear Strength, PLI	>417
100% Modulus, psi	>1,668
Shore Hardness, Shore D	48

3. **Polyurethane Rigid Structure Foam**, low viscosity two-component, containing flame retardants.

TYPICAL CHEMICAL ANALYSIS

A Component

Viscosity, 77° F, cps.	200
Physical State	Liquid
Color	Dark Brown
Hygroscopicity	Reacts with water & evolves CO ₂ gas

B Component

Viscosity,	77° F, cps.660
Physical State	Liquid
Color	Transparent Dark
Hygroscopicity	Absorbs rapidly changing ratio

Reaction Profile (100 grams, 77° F sample).

Cream Time, seconds	1-4
Tack Free time, seconds	5-8
Rise Time, seconds	6-10

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Processing.

A System / B System, volume ratio 1.00 / 1.00

Typical Physical Properties.

Density, nominal, core, lbs/ft ³ ASTM D-1622 @ 74° F	4-10
Compression Strength, ASTM D-1621 @74° F parallel rise; PSI	90-150
Closed Cell Content, % @ 74° F	Over 95
Shear Strength, PSI - ASTM C-273@ 74° F	225- 250

4. Total thickness of multi-component stress panel liner shall be a minimum of 500 mils.
5. Product shall be
 - a. SPECTRASHIELD, by CCI Spectrum, Inc.,
 - b. OBIC, by OBIC, LLC.,
 - c. or approved equal.

ITEM SS-OBIC-16X.04 INSTALLATION.

A. INSPECTION.

1. Applicator shall take appropriate action to comply with all local, state and federal regulations including those set forth by OSHA, EPA, the Owner and any other applicable authorities.
2. Prior to conducting any work, perform inspection of structure to determine need for protection against hazardous gases or oxygen depleted atmosphere and the need for flow control or flow Diversion.
3. Submit plan for flow control or bypass to owner/engineer for approval prior to conducting the work.
4. New Portland cement structures shall have endured a minimum of 28 days since manufacture prior to commencing installation of the liner system.

B. SURFACE PREPARATION.

1. Conduct surface preparation program to include monitoring of atmosphere for hydrogen sulfide, methane, low oxygen or other gases, approved flow control equipment, and surface preparation equipment.
2. Surface preparation methods may include high pressure water cleaning, hydro blasting, abrasive blasting, grinding, detergent water cleaning and shall be suited to provide a surface compatible for installation of the liner system.
3. Surface preparation method shall produce a cleaned, abraded and sound surface with no evidence of laitance, loose concrete, brick or mortar,

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contaminants or debris, and shall display a surface profile suitable for application of liner system.

- a. After completion of surface preparation, perform the seven point check list, which is the inspection for:
 - i. Leaks.
 - ii. Cracks.
 - iii. Holes.
 - iv. Exposed Rebar.
 - v. Ring and cover condition.
 - vi. Invert condition.
 - vii. Inlet/Outlet pipe condition.
4. After the defects in the structure are identified, repair all leaks with a chemical or hydraulic sealant designed for use in field sealing of ground water. Severe cracks shall be repaired with a urethane based chemical sealant.

Product to be utilized shall be as approved by owner/engineer prior to installation. Repairs to exposed rebar, defective pipe penetrations or inverts, etc. shall be repaired utilizing non-shrink grout or approved alternative method.

C. MATERIAL INSTALLATION.

1. Application procedures shall conform to recommendations of the manufacturer, including materials handling, mixing, environmental controls during application, safety and spray equipment.
2. Spray equipment shall be specifically designed to accurately ratio and apply the liner system.
3. Application of multi-component liner system shall be in strict accordance with manufacturer's recommendation. Final installation shall be a minimum of 500 mils. A permanent identification and date of work performed shall be affixed to the structure in a readily visible location.
4. Provide final written report to owner/engineer detailing the location, date of report, and description of repair.

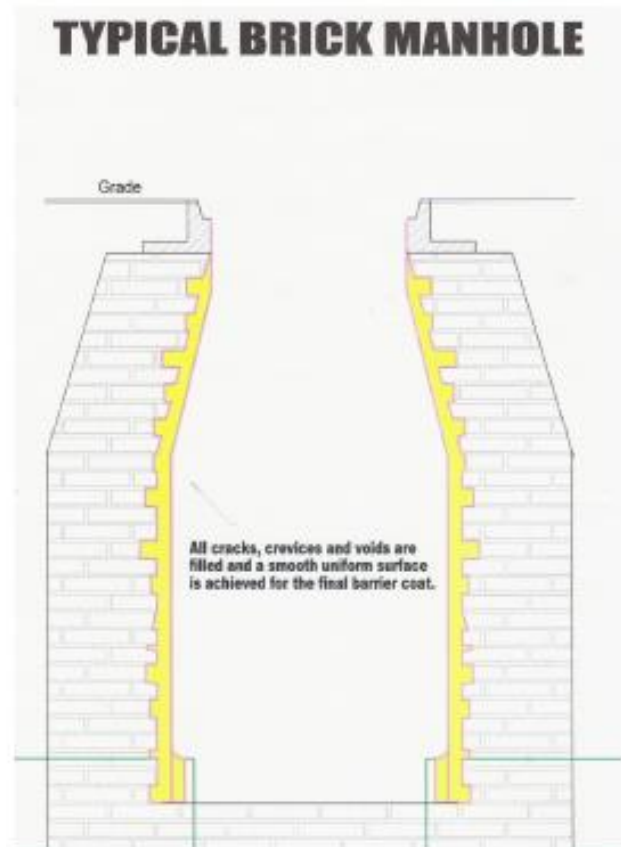
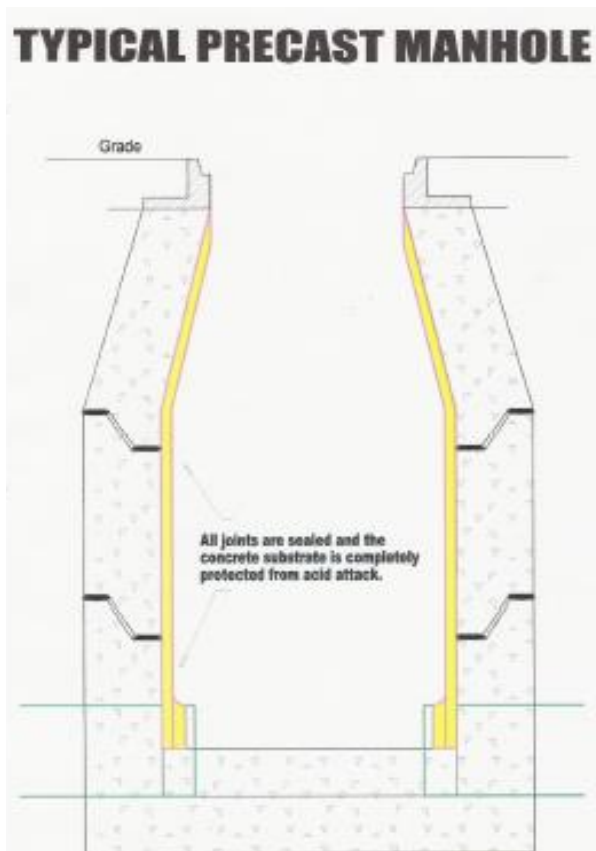
D. FINAL INSPECTION. The final liner system shall be completely free of pinholes or voids. Liner thickness shall be the minimum value as described herein.

1. The Owner/Engineer shall make visual inspection. Any deficiencies in the finished liner system shall be marked and repaired according to the procedures set forth by Manufacturer.
2. The sewer system may be returned to full operational service as soon as the final inspection has taken place.

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ITEM SS-OBIC-16X.04 10-YEAR LIMITED WARRANTY

- A. **Manufacturer Guarantee.** CCI Spectrum, Inc. (manufacturer) and/or OBIC shall guarantee the product conforms to the procedures established with in this specification. The warranty shall guarantee the product against failure and is limited to replacement of the product for the period as specified by the specific manufacturer's standard warranty.
- B. **Additional Warranty.** CCI Spectrum and/or OBIC shall provide the additional warranty period as specified in above SCMSD Sanitary Structurer Lining Specification Item 16X.06.



100% Solids Ultra High Build Epoxy Coating Structural Rehabilitation & Corrosion Protection for Structures in Wastewater Collection Systems

ITEM RAV-16X.01 DESCRIPTION.

This specification includes all work, materials and equipment required for the structural and corrosive rehabilitation of wastewater structures.

The purpose is to eliminate infiltration, repair voids, restore structural integrity and provide corrosion protection by the application of a spray-applied monolithic resin liner to the wall and bench surfaces of brick/concrete structures or structures produced with any other masonry construction material.

These structures include, but are not limited to manholes, wet wells, vaults, and other sanitary structures.

A. Quality Assurance

1. Furnish materials of quality required by the American Society for Testing and Materials (ASTM) standards or other approved standards and specifications.
2. Provide guarantee against defective materials and workmanship in accordance with the requirements of these specifications.
3. The contractor installing the finished protective liner will be a certified trained applicator of the specified process.
4. Provide verifiable independent third-party creep test results documenting no less than 70% retention of flexural modulus of elasticity after 50 years of service. The third-party testing firm may not be affiliated with the manufacturer in any way.

B. References. American Society for Testing and Materials (ASTM) Annual Book of Standards:

1. ASTM D638: Test Method for Tensile Strength & Elongation Properties of Plastics.
2. ASTM D695: Test Method for Compressive Properties of Rigid Plastics.
3. ASTM D790: Test Methods for Flexural Properties of Unreinforced and reinforced Plastics and Electrical Insulating Materials.
4. ASTM D2240: Hardness, Shore D.
5. ASTM D4060: Taber Abrasion, CS-17.
6. ASTM D4541: Adhesion Steel.
7. ASTM D7234: Adhesion Concrete.

ITEM RAV-16X.02 SUBMITTALS

All shop drawings shall be as specified above Item 16X.02B.

ITEM RAV-16X.03 MATERIALS.

A. **Repair Materials.** All areas of the existing manhole, wet well, vault of wastewater structure shall be repaired utilizing the following:

1. **Plugging Material.** Chemical sealant or grouts shall be used to plug and seal active wet well leaks. These materials shall be a cementitious non-shrinking grout, expanding polyurethane grout or a lightweight epoxy build-up material.

These materials shall be compatible with the Raven 405 system or approved epoxy system and approved the Engineer, prior to usage.

No latex patching materials will be accepted.

- a. **Plugging Materials** shall:
 - i. Adhere to wet or dry surfaces.
 - ii. Be 100% solids.
 - iii. Quick setting.
 - iv. Have 0% shrinkage in accordance with ASTM D2126.
 - v. Be ASTM, ANSI and NSF Approved.
 - b. Recommended Material manufacturers:
 - i. Thoro Seal.
 - ii. Green Mountain Inc.
 - iii. Sika.
 - iv. Avanti International.
 - v. Engineering Approved Equal.
2. **Cementitious Application (RAVEN 405 Only).** An intermediate one (1") thick, uniform cementitious substrate/leveling course will be permitted for use on brick or masonry manholes and structures, only.
 - a. The cementitious product used shall be Reliner MSP Cement by Standard Cement Materials, Inc or SCSE approved equal.
 - b. Installation shall be in accordance with all Raven 405 manufacturer's installation instructions.
 - c. NO intermediate cement layer will be permitted on concrete or metal surfaces.

3. **Light Weight Build-up Material.** All structural repairs or surface build-up material shall be a high-build lightweight epoxy coating system.

This material shall be airless spray applied or trowel applied to patch cracks, fill voids, make structural repairs and build-up deteriorated wet

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well surfaces back to existing thickness.

The material shall be a lightweight spray epoxy system with the following criteria:

- a. Adhere to wet or dry surfaces.
- b. Be 100% solids.
- c. Quick setting.
- d. 0% VOC's.
- e. Have 0% shrinkage in accordance with ASTM D2126.
- f. Non-toxic.
- g. Color to be Gray or engineering approved color.
- h. Be ASTM, ANSI and NSF Approved.

The material properties shall meet or exceed the following requirements:

- a. Typical Properties:
 - i. Tensile Strength; 8,000 psi.
 - ii. Flexural Strength; 14,000 psi.
 - iii. Flexural Modulus @ 0.100" 175,000 psi.
 - iv. Compressive Strength; 12,800 psi.
 - v. Heat Distortion Temp.; 176 deg. F.
 - vi. Adhesion to Damp Conc.; >450 Tensile Pull-off.
 - vii. Adhesion to Steel; >550 Tensile Pull-off.
 - viii. Shore D Hardness; 80 – 82.

All build-up and/or patching materials shall be submitted to the Engineer for approval prior to material usage.

4. Primer. The primer shall be:

- a. Raven Primer Recommended for:
 - i. Concrete or brick surface.
 - ii. Carbon steel surface
 - iii. Non-ferrous metal surface.

B. Resin Based Liner: The resin-based material shall be used to form the sprayed on/structural enhanced monolithic liner covering all interior surfaces of the structure including but not limited to; benches and inverts of manholes. The finished liner shall be Raven 405® as manufactured by Raven Lining Systems Inc. or approved equal and conform to the minimum physical requirements listed below.

Tensile strength	ASTM D 638	> 9,000 psi
Tensile elongation	ASTM D 638	6%
Compressive strength	ASTM D 695	>18,000 psi
Flexural strength	ASTM D 790	>15,000 psi
VOC Content	ASTM D2584	0%

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Bond	Shall exceed tensile strength of substrate	
Flexural modulus (initial)	ASTM D 790	700,000 psi
Density		88 pcf

1. The finished structure shall be a fast curing corrosion, chemical abrasion and moisture resistant liner in accordance with ASTM D 543/G20 to: Hydrogen Sulfide; 30% sulfuric Acid; 17% Nitric Acid; 10% Sodium Hydroxide; 12.5% Sodium Hypochlorite, road salts for winter conditions as well as other common ingredients of the sanitary sewage environment.
2. The wall of the resin-based liner will be structurally designed to withstand the hydraulic load generated by the groundwater table & restore structural integrity. The long term (50 yr.) value of the flexural modulus of elasticity will be a minimum of 500,000 psi and is an integral part of the engineering equation used to design the wall thickness of the structural liner.

For this reason, the value of the long-term flexural modulus of the proposed product will be certified by an independent, third party testing lab and submitted with the design calculations for each individual structure.

Definition- Long-term value will be identified as initial flexural modulus less the reduction in value caused by Creep over a fifty (50) year minimum period and verified by DMA testing.

3. When cured the system shall form a continuous, tight-fitting, hard, impermeable surface, which is suitable for water or sewer system service and chemically resistant to any chemicals, or vapors normally found in sanitary sewer systems.

The material shall be non-toxic and non-flammable in cured and uncured states.

No Solvents shall be used.

Finish coat color shall be light blue or as approved by the engineer.

- C. **Other Materials:** Because of the advantages associated with rapid cure and infinite thickness capabilities, no resin-based materials other than epoxy shall be used to achieve the structural enhancement without prior approval of the county.

ITEM RAV-16X.04 INSTALLATION.

All installation shall comply with the following requirements in addition to all Raven Specifications.

- A. **Project/Site/Conditions.** Contractor shall coordinate with the Project Manager (PM) for traffic control during rehabilitation work at each designated location.
- B. **Sequencing.** All required interruptions of flow through manholes, wet wells, pump stations or any other portion of the sanitary sewer collection system shall be coordinated with and approval received from the County prior to the interruption.
- C. **Inspection.**
 - 1. **Evaluation of Atmosphere:** Prior to entering structures, an evaluation of the atmosphere will be conducted to determine the presence of toxic, flammable vapors or possible lack of oxygen. The evaluation shall be in accordance with local, state or federal safety regulations.
- D. **Preparation.** Surface preparation for all structures shall be in the strict accordance with all Raven requirements for installation of Raven 405 Lining.
 - 1. Conduct surface preparation program to include monitoring of atmosphere for hydrogen sulfide, methane, low oxygen or other gases, approved flow control equipment, and surface preparation equipment.
 - 2. Surface preparation methods as indicated below for each type of structure material may include high pressure water cleaning, hydro blasting, abrasive blasting, grinding, detergent water cleaning and shall be suited to provide a surface compatible for installation of the liner system.
 - 3. Surface preparation method shall produce a cleaned, abraded and sound surface with no evidence of laitance, loose concrete, brick or mortar, contaminants or debris, and shall display a surface profile suitable for application of liner system.
 - 4. After completion of surface preparation, perform the seven-point check list, which is the inspection for:
 - a. Leaks
 - b. Cracks
 - c. Holes
 - d. Exposed Rebar
 - e. Ring and Cover Condition
 - f. Invert Condition
 - g. Inlet/Outlet Pipe Condition

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5. After the defects in the structure are identified, all repairs, leaks etc. shall be repaired as indicated above.
6. All repairs shall be completed in accordance with all liner manufacturer recommendations and these specifications.
7. Place covers over all pipe openings to prevent extraneous material from entering the sewer system, pump station etc.

Types of surface preparation materials shall be as follows:

8. **Masonry and Concrete Structures.** All foreign material shall be removed from the structures' wall and bench/floor using a pressure water spray (minimum 2500 psi). The use of acid for cleaning purposes, no matter how dilute, will not be allowed
 - a. Fill any voids using the buildup material as described herein and in accordance with all Raven and material requirements. Surface preparation for all masonry and concrete structures shall meet or exceed SSPC SP-13/NACE No. 6 Surface Preparation of Concrete.
 - i. Surfaces must be sound and contaminant free with a surface profile equivalent to minimum CSP3 to CSP5 in accordance with ICRI No. 310.R2-2013.
 - ii. Surface profile can be achieved by; abrasive blasting, shot blasting, high-pressure washing, water jetting or a combination of the cleaning method listed above.
 - iii. An intermediate 1" thick cementitious layer may be utilized on brick or masonry surfaces only, prior to application of the epoxy liner in accordance with RAV-16X.03 Section A Part 2 above.
 - iv. No cementitious layer is permitted on concrete or metal substrates.
 - b. Leaks shall be stopped using the plugging material as indicated above in accordance with all Raven and material requirements
 - i. When severe infiltration is present and cannot be stopped using the plugging material, drilling may be required in order to pressure grout outside the structure using either a cementitious or chemical grout. All manufacturer's recommendations shall be followed when pressure grouting is required.
 - ii. All procedures utilized to plug active infiltration through use of the above-mentioned materials shall be in accordance with all manufacture's specifications for:
 - a) Placement, drilling and setting packers.
 - b) Toweling, pumping and/or injection of any cementitious non- shrinking grout or polyurethane grout.

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- c) As part of final cleaning, all excess materials shall be removed for the internal wall surface including packers.

9. Steel Surfaces (Immersion). Steel surfaces which will be immersed shall be cleaned as follows:

- a. Initial Cleaning; Solvent cleaned in accordance with SSPC SP – 1
- b. Final cleaning in accordance with SSPC SP – 10/NACE No. 2 Near-white Metal Blast Cleaning.

10. Ductile Iron Surfaces (Atmospheric or Immersion) shall be cleaned in accordance with;

- a. Initial – Solvent Cleaned in accordance with NAPF 500-03-01.
- b. Final – Abrasive blast in accordance with NAPF 500-03-04.

11. Steel (Atmospheric/Non-Immersion) shall be cleaned in accordance with;

- a. Initial – Solvent cleaned in accordance with SSPC SP – 1
- b. Final cleaned in accordance with SSPC SP-6/NACE No. 3 commercial blast cleaning.
 - i. Angular anchor profile required shall be 2.5 to 4.0 mils.

E. Installation/Application.

- 1. All products are to be applied by trained, approved and Certified as installer of Raven 405 as approved Raven Lining Systems in strict accordance with the directions for usage and installation of the Raven product.

Application procedures shall conform to recommendations of Raven Lining Systems and Sanitary Structure Lining Specification 16X above, pertaining to materials, handling, mixing, environmental controls, lining application, safety and spray equipment.

Spray equipment shall be specifically designed to accurately ratio and apply the liner system.

Application of multi-component liner system shall be in strict accordance with Ravens recommendations.

A permanent identification and date of work performed shall be affixed to the structure in a readily visible location.

- 2. **Application Temperatures:** Application of liner shall be made based upon a substrate temperature of between 40° F and 120° F.

3. Bench/Invert Repair:

- a. The manhole bench and invert shall be sprayed to insure a monolithic system is achieved.
- b. After blocking flow through the structure and thorough cleaning/preparatory work has been achieved. The sprayed-on resin- based liner shall be applied to the invert, bench and wall areas in the same manner as specified for the liner application below. The spray shall be applied such that the entire structure receives a structurally enhanced monolithic liner.
- c. The finished invert surfaces shall be smooth, free of ridges and will be sloped in the direction of flow. Special care shall be used to insure a smooth transition between the new manhole invert and intersecting pipeline inverts such that flow will not be impaired.

4. Liner Application: In addition to the specifications herein the liner application shall be in the strict accordance with Raven installation requirements.

The resin-based liner shall be manually sprayed on to all surfaces by a trained technician who is experienced in the application of a spray applied resin and has been certified by the manufacturer.

Appropriate personal protection equipment shall be utilized but, in every case, when applying the liner, the sprayer and personnel in direct contact with the spray atmosphere, will always be protected by supplied air.

Unless otherwise specified by Raven the liner shall be applied in 4 graduated coats as indicated under SCMSD Specification Item 16X above. Each coat shall be sprayed via a pleural spray system to assure a uniform coating application.

Each coat shall be applied one after the other with an average cure time of two (2) to (3) hours between each coat or in accordance with material manufacturers requirements.

The entire interior surface shall include all area from the top of the structure or manhole casting to structure base or below the existing liquid flow line. This includes any internal piping located within said structure.

In order to provide structural integrity, the minimum thickness of the material applied is to be no less than 250 mils as indicated in above SCMSD Sanitary Structurer Lining Specification 16X, Section 04, Part E.

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No other products such as cement or grouts may be used as part of the structural liner, however, said products may be used as part of the repair process prior to sprayed application of the structure as specified in Section RAV-16X.03 above.

Application of the spray applied material must be completed in one (1) mobilization in order to minimize the disruption and cost of excessive bypassing, pipeline plugging, traffic control and all other support services.

The finished structure shall be returned to full service immediately after the spray application, required curing time and all testing requirements are successfully completed.

5. Curing: The Contractor shall comply with all Raven curing requirements pertaining to:

- a. Application of the four (4) graduated coats necessary to meet the total required Mil thickness.
- b. Complete cure time required to allow for return to ambient temperature as necessary to perform all physical testing, including vacuum testing.

F. Field Quality Control. The contractor shall comply with the following quality control requirements.

1. Visual Inspection of Structure prior to Lining Application. The Contract shall provide the SCMSD inspector within four (4) hours that the structure to be lined is ready for surface preparation inspection prior to the lining application.

- a. SCMSD inspector shall visually verify within four (4) hours of notification, that the internal surface preparation of the structure to be lined meets or exceeds all surface preparation requirement of this specification or Raven's requirements.
- b. If the surface passes inspection the liner may be scheduled for application
- c. If the surface does not pass the surface preparation inspection then the contractor is responsible for all additional work required to meet the surface preparation requirements.

G. Final Testing, Inspection and Acceptance Requirements. In addition to the following stipulations, all final inspection, testing and acceptance requirements shall comply with SCMSD Specification Item 16X.05 and 16X.06 requirements above.

1. The final liner system shall be completely free of pinholes or voids.
Liner thickness shall be the minimum value as described herein.

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2. The Owner/Engineer shall make visual inspection. Any deficiencies in the finished liner system shall be marked and repaired according to the procedures set forth by Manufacturer.
3. Provide final written report to owner/engineer detailing the location, date of report, and description of repair.
4. The sewer system may be returned to full operational service as soon as the final inspection has taken place.

ITEM RAV-16X.05 WARRANTY

All warranty requirements shall comply with the following:

- A. **Manufacturers Guarantee.** Raven guarantees products to conform to the quality assurance procedures established by Raven and its resin blending partners. Liability, if any, is limited to replacement of the product for a period of one (1) year from the date of successful application.
- B. **Additional Warranty.** In addition to complying with warranty requirements as specified in Specification Item 16X, 6.0, C., for brick or masonry surfaces with additional, intermediate 1" thick cementitious layers utilized, Raven shall also provide a warranty inspection on or near the ninth year anniversary date. Said inspection shall fully comply with conditions set forth in Item 16X, 6.0, C.

END OF SECTION