

SECTION 02565**SANITARY SEWER REHABILITATION****02565.01 GENERAL****A. Description**

Sanitary sewer rehabilitation shall include, but not necessarily be limited to, access for workers, material and equipment, sewer pipe cleaning, sewer flow control, television inspection, sewer pipe joint testing, sewer pipe joint sealing, sewer manhole sealing, sewer manhole rehabilitation, sewer manhole lining, slip lining, cured-in-place pipe lining, pipe and fitting replacement, and sewer manhole replacement in accordance with the Contract Documents. Sewer manhole replacement includes restoration of access ways preliminary to and during rehabilitation construction.

As authorized by the County, the Contractor may be required to line a sewer house connection either from the sewer main to the cleanout or from the cleanout to the sewer main by Cured in Place Pipe (CIPP) lining and installation of a resin-impregnated flexible tube.

B. Related Work Included Elsewhere

1. Protection of environment; Section 01500.
2. Structure excavation; Section 02220.
3. Trench excavation, backfill, and compaction; Section 02250.
4. Sanitary sewer and sanitary sewer house connection installation; Section 02561.
5. Sanitary sewer manhole installation; Section 02562.
6. Sanitary sewer force main; Section 02563.
7. Connections to existing sanitary sewer facilities; Section 02564.
8. This specification references standard specifications which are made a part hereof by such reference and shall be the latest edition and revisions thereof. All work accomplished must be in strict accordance with the referenced standards.

American Society for Testing and Materials (ASTM)

ASTM F-1216 Practice for Rehabilitation of Existing Pipelines and Conduits
by the Inversion and Curing of a Resin-Impregnated Tube

ASTM F-1743 Standard Practice for Rehabilitation of Existing Pipelines and
Conduits by Pulled-in-Place Installation of Cured-in-Place
Thermosetting Resin Pipe (CIPP)

ASTM D-543	Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D-638	Test Method for Tensile Properties of Plastics
ASTM D-695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D-732	Standard Test Method for Shear Strength of Plastics by Punch Tool
ASTM D-790	Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM C-78	Standard Test Method for Flexural Strength of Concrete
ASTM C-109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C-157	Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM C-307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing
ASTM C-580	Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
ASTM C-596	Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
ASTM C-882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete By Slant Shear
ASTM D-638	Standard Test Method for Tensile Properties of Plastics
ASTM D-792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D-4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D-4833	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
ASTM F-2414	Standard Practice for Sealing Sewer Manholes Using Chemical Grouting

C. Quality Assurance

1. Materials

- a. The Engineer will inspect all materials before and after installation to ensure compliance with the Contract Documents.
- b. Special grouts, sealers, and coating systems shall be delivered to the site in the manufacturer's sealed, labeled, and dated containers. Storing and handling materials shall be in strict accordance with the manufacturer's instructions. Failure to properly store and handle material will result in rejection of material for use. Materials beyond the expiration date indicating the manufacturer's recommended shelf life will not be permitted to be used. A freezing weather limitation of 32 degrees will be enforced.
- c. Personnel Involved in Installation of Manhole Rehabilitation Materials: Certified by manufacturer successfully completed training in handling, applying, and finishing materials used.
- d. Cured-in-place pipe lining materials shall be chemically stable and resistant to concentrations of acids, alkalis, and organics found in sewage. The materials may be delivered to the site in either separate or pre-wetted fabrications in transportation containers designed to protect the integrity of the resin, catalyst, and liner. The time of resin and catalyst mixing will be recorded at the location of liner "wetting". Special handling instructions such as minimum or maximum temperature to be maintained during transportation and installation will also be recorded. Liners "wetted" for a time interval which exceeds the resin manufacturer's specified "pot life" at the recommended temperature will not be permitted to be used. Any evidence of setting before installation will result in rejection of material.

2. Field Testing

a. General

- 1) After the asset in question has been rehabilitated or replaced, it will be inspected by the Engineer and, if required herein, shall be Contractor tested for compliance with these Specifications. The Contractor shall furnish all labor, tools, materials, and equipment (except water as provided for in Section 02563.02, and timers which will be furnished by the County) necessary to perform the specified tests. All testing will be conducted under weather conditions typical of contract period to check performance under adverse conditions.
- 2) The Contractor shall schedule all tests with the Engineer at least 48 hours in advance, and shall conduct all testing in the presence of the Engineer. The County will witness one test at no cost to the Contractor. If a portion of the Project is released for service following conditional acceptance tests, the County will

perform a final inspection, if required, at no cost to the Contractor. Should the pipeline fail the first County witnessed test, the Contractor shall reimburse the County for all costs resulting from such additional tests so required until the pipeline passes the test(s). The Contractor shall also reimburse the County for the cost of inspection if the Contractor is not prepared for any test, or for additional test(s) required following the final inspection of released portions of the Project.

- 3) If the item in question fails the test specified and/or inspection, the Contractor shall, at his own expense repair or replace any defective component in accordance with the manufacturer's recommendations and retest or have the Engineer reinspect the item until all requirements are met. Should any work be done by the County in the case of an emergency, the Contractor shall reimburse the County for the actual cost of replacing such materials and making such installations.
- 4) The physical properties of the installed CIPP shall be verified through field sampling and laboratory sampling. All materials for testing shall be furnished by the Contractor. All materials testing shall be performed at the Contractor's expense by an independent third-party laboratory approved by the County. The Contractor shall submit for approval the qualifications of a testing lab. All tests shall be in accordance with applicable ASTM test methods to confirm compliance with the requirements specified in these contract documents.

The Contractor shall provide samples for testing from the actual installed CIPP liner. One sample shall be provided for each lining run. The sample shall be cut from a section of cured CIPP that has been inverted or pulled through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags. All curing, cutting and identification of samples will be witnessed by the Engineer.

The laboratory results shall identify the test sample location as referenced to the nearest manhole. Final payment for the contract shall be withheld pending receipt and approval of the test results. If properties tested do not meet the minimum physical and thickness requirements, the CIPP shall be repaired or replaced by the Contractor.

All costs, to the Contractor, associated with testing shall be included in the linear foot price for CIPP lining.

- 5) Engineer:
 - a) May inspect and test liner or its materials at factory, before delivery to site or while in storage.
 - b) May inspect factory materials, wet-out procedure, and loading.
- 6) Contractor to internally inspect host pipe prior to lining and post-lining.

b. Sewer Cleaning

- 1) After completion of sewer pipeline cleaning, the Engineer will visually, or by closed circuit television camera, inspect in whole or part the pipe system for which the cleaning task has been completed. Evidence of significant remaining sediment, debris accumulation, or root intrusion will result in rejection of the pipe system. The Contractor shall repeat his cleaning operation and retest the line until the sewer is satisfactorily cleared of sediment, debris, grease, and roots.
- 2) In areas where television inspection is not performed, the Engineer may require the Contractor to pull a double squeegee (with each squeegee the same diameter as the sewer) or propel a "GO/NO GO" ball through each section of pipeline cleaned as evidence of adequate cleaning.
- 3) Force mains will be accepted when they can pass a sewer ball which has a diameter of at least 95% of the line being cleaned.

c. Manhole Sealing and Rehabilitation

After manhole rehabilitation procedures have been performed, the manholes will be visually inspected by the Engineer for leakage. Any leak or seepage which produces a visible trickle or stream will be cause for rejection of the work.

d. Gravity Sewer Pipe

- 1) Sliplined Pipe: After installation, but before any house connections are reinstated, the liner pipe shall be low-pressure air tested by the Contractor in accordance with the procedures specified in Section 02561.01.
- 2) Cured-in-Place Pipe Lining: After installation procedures have been performed and curing complete, but before any house connections are reinstated, the pipeline shall be hydrostatically tested by the Contractor.
 - a) The test shall be conducted by using the existing hydrostatic head provided by the inversion standpipe providing this head is at least 7 feet above the prevailing groundwater elevation. The test time shall be 1 hour during which time no makeup water shall be added to the standpipe. If, at the end of the test period, no water loss is observed in the standpipe, the cured- in-place pipe will be accepted.
 - b) If water loss is observed in the standpipe, the lining will fail the test.

e. Force Mains

- 1) After installation procedures have been performed for either sliplined or cured-in-place pipe lining, the lined force main shall be hydrostatically tested by the Contractor.

- 2) The completed liner shall be filled with water to eliminate all air and brought to the test gradient or pressure as indicated in the Contract Documents.
- 3) After the system has been pressurized to the test pressure and the pumps disconnected, the liner shall hold the test pressure with no visible drop in pressure for 1 hour.

D. Submittals

1. Shop Drawings - Sewer Rehabilitation
 - a. Shop drawings shall be submitted as specified in the "General Provisions" for all materials other than those furnished by the County. The Contractor shall submit product information and detailed manufacturer's recommendations and instructions on the storage, handling, mixing (where appropriate), and installation of all materials intended to be used for rehabilitation.
 - b. For those materials which rely on chemical reactions and/or heat (energy) sources to obtain a "cure" of the materials, details shall be submitted indicating "pot life" after mixing; curing time; temperature limitations during transportation, application, and installation; and special handling requirements.
 - c. Working drawings showing design calculations, soil impacts, live load, dead load, groundwater impacts, materials selected, and thickness of liner.
 - d. Catalog data showing manufacturer's clarifications and updates, ASTM references, material composition, specifications, physical properties, and chemical resistance of liner.
 - e. Manufacturer's recommended procedures for handling, storing, repairing, and installing materials selected.
 - f. Method of construction. Access manholes and site locations. Work dimensions. Existing utilities. Size of working area. Impacted portions of existing sewer. Site access points. Bypass pumping plan.
 - g. Emergency plan detailing procedures followed in event of health and safety emergency, pump failures, sewer overflows, service backups, and sewage spillage. Maintain a copy on site for the duration of the project. Address dangers associated with sewer rehabilitation work (i.e. working with large boiler trucks).

- h. Identify Health and Safety officer (i.e. crew chief)

Designated Health and Safety officer:

- 1) Responsible for providing health and safety oversight of personnel participating on the project team.
 - 2) Perform and document routine work area inspections, conduct safety meetings, and provide safety orientations for team members.
 - 3) Non-emergency number.
 - 4) Contractor's health and safety representative name and number.
- i. List of critical rehabilitation equipment, including boiler truck equipment, to be inspected on a daily basis.
 - j. Recently completed (previous month) monthly maintenance log.
 - k. Annual third-party certified inspection for boiler truck(s) to be used on project.
 - l. Certification of training for boiler truck operator.
 - m. Method of reinstatement and sealing of lateral-mainline interface including, but not limited to internal inspection equipment, and equipment used for reinstatement and sealing of lateral-mainline interface.
 - 1) Air testing not required for lateral-mainline interface seal installed utilizing the Janssen resin injection system or a full wrap profile, i.e., LMK T-Liner shorty or BLD SCS +L that extends from sewer main to sewer house connection cleanout.
 - n. Method of proposed point repair with details.
 - 1) Termination or transition details between cured in place point repair and existing sewer.
 - o. Infrared spectrograph chemical fingerprint and Certificates of Analysis for each lot of resins:
 - 1) Lot number
 - 2) Product name
 - 3) Manufacturer
 - 4) Brookfield Viscosity
 - 5) Thix Index
 - 6) Gel time at cure temperature

- 7) Peak temperature for failure
 - 8) Percent of non-volatile solids
 - 9) Specific Gravity
 - 10) Catalyzed Stability time at optimum temperature
 - 11) Catalyst to resin ratio
 - 12) Analysis signature
 - 13) Date tested
 - 14) Batch ticket for each resin-catalyst-colorant batch made up and impregnated into felt liner material.
- p. Stock sheets, order forms, delivery forms, invoices, and Hazardous Material forms for material used.
- q. Shipping manifest with:
- 1) Date shipped
 - 2) Origination and delivery locations
 - 3) Shipping method and carrier
 - 4) Shipping order number
 - 5) Purchase order number
 - 6) Shipped item
 - 7) Stock number
 - 8) Lot number
 - 9) Manufacturer
 - 10) Any shipping, storage, or safety requirements
 - 11) Received by, and date
 - 12) Signature of receiver
- r. Mark submittals with mainline pipe identification number, work order number, Contract number, Contractor's name, operator's name, and date of readings.
- s. Certified statement from manufacturer approved installer of their system. Include certificates of training for each crewmember involved in the installation process.
- t. ASTM certified lab test results for field installations in the United States of the same resin system and tube materials as proposed for actual installation. Test results must verify (CIPP) physical properties specified herein have been achieved in previous field applications. Third party is defined as ASTM or equivalent accredited materials testing firm with no financial or directorial link to manufacturer or Contractor.
- u. Curing logs: Include liner manufacturer recommended curing citations for each submittal. Store electronically on data logger. Submit printed copy with Post CCTV.
- 1) Heat cured liners

- a) Record temperature (degrees Fahrenheit) and pressure (psi) readings per unit of time collected during liner installation and curing.
- 2) UV cured liners
 - a) Record the curing speed (feet per minute), light source (number of lamps, intensity and wattage), inner air pressure (psi), and curing temperatures (degrees Fahrenheit) per unit time over length of liner.
- v. Materials delivery and storage: Record date, time and temperature readings at 15-minute intervals, minimum. Include sewer pipe material's stock identification number.
- x. Tabulation of time versus temperature by liner manufacturer with lengths of time exposed portions of liner will endure without self-initiated cure or other deterioration.
 - 1) Tabulate at 5 degrees F. increments, ranging from 70 degrees F. to 100 degrees F.
 - 2) Include analysis of progressive effects of such self-initiated cure on insertion and cured properties of liner.
- y. Provide to Engineer for review within 30 days prior to beginning work:
 - 1) Description of methods for avoiding liner stoppage due to conflict and friction with such points as manhole entrance and bend into pipe entrance.
 - 2) Plans for dealing with liner stopped by snagging within pipe.
- z. Personnel Involved in Installation of Pipe Liner: Certified by liner manufacturer successful completion of training in handling, insertion, trimming, reinstatement of laterals and finishing pipe liner.
- aa. Experience:
 - 1) Commercially Proven Mainline and Lateral Products:
Minimum 500,000 linear feet mainline and 3,500 linear feet laterals successfully installed and documented in the United States and Internationally.
 - 2) Commercially Proven Lateral-Mainline Interface Product:
Minimum 1,000 lateral-mainline interface services successfully installed and documented in the United States and Internationally.
- 2. Shop Drawings - Manhole Rehabilitation
 - a. Working drawings showing design calculations, materials selected, and manufacturer's installation requirements.

- b. Catalog data showing manufacturer's clarifications and updates, ASTM references, material composition, specifications, physical and chemical properties.
- c. Manufacturer's recommended procedures for handling, storing, repairing, and installing materials selected.
- d. Method of construction (as appropriate):
 - 1) Access manholes and site locations
 - 2) Work dimensions
 - 3) Existing utilities
 - 4) Size of working area
 - 5) Impacted portions of existing sewer
 - 6) Site access points
 - 7) Bypass pumping plan
- e. Emergency plan detailing procedures followed in event of health and safety emergency, pump failures, overspray, chemical spills, sewer overflows, service backups, and sewage spillage. Maintain copy on site for duration of project
 - 1) Address dangers associated with sewer rehabilitation work (i.e. working with large boiler trucks).
 - 2) Identify health and safety officer (i.e. crew chief)
 - a) Designated health and safety officer:
 - i. Responsible for providing health and safety oversight of personnel participating on the project team.
 - ii. Perform and document routine work area inspections, conduct safety meetings, and provide safety orientations for team members.
 - iii. Have the following contact information in easily accessible place;
 - (1) Non-emergency number
 - (2) Contractor's health and safety representative name and number
 - (3) Occupational health clinic number(s)
 - 3) Submit the following:
 - a) List of critical rehabilitation equipment, including boiler truck equipment, to be inspected on a daily basis.

- b) Recently completed (previous month) monthly maintenance log.
- c) Annual third-party certified inspection for boiler truck(s) to be used on project.
- d) Certification of training for boiler truck operator.
- e) Noise attenuation.
- f) Epoxy and cured-in-place (CIP) manhole liner products.
 - i. Infrared spectrograph chemical fingerprint and Certificate of Analysis for each lot of material:
 - (1) Lot number
 - (2) Product name
 - (3) Manufacturer
 - (4) Brookfield Viscosity
 - (5) Thix Index
 - (6) Gel time at cure temperature
 - (7) Peak temperature for failure
 - (8) Percent of non-volatile solids
 - (9) Specific Gravity
 - (10) Catalyzed Stability time at optimum temperature
 - (11) Catalyst to resin ratio
 - (12) Analysis signature
 - (13) Date tested
 - (14) Batch ticket for each resin-catalyst-colorant batch made up and impregnated into felt liner material.
 - ii. Shipping manifest:
 - (1) Date shipped
 - (2) Origination and delivery locations
 - (3) Shipping method and carrier
 - (4) Shipping order number
 - (5) Purchase order number
 - (6) Shipped item
 - (7) Stock number
 - (8) Lot number
 - (9) Manufacturer
 - (10) Any shipping, storage, or safety requirements
 - (11) Received by and date
 - (12) Signature of receiver
- f. Stock sheets, order forms, delivery forms, invoices, and Hazardous Material forms for

material used.

- g. Submitted following Section and specified herein.
 - 1) Certified statement from manufacturer approved installer of their system.
 - a) Include certificates of training from manufacturer for each crewmember involved in installation process.
 - 2) Documentation of Products and Installers: Engineer's approval required before installation of rehabilitation materials.
 - a) Descriptions of projects completed in past 2 years where proposed rehabilitation material was used.
 - i. Include vertical feet of manhole rehabilitated. Manhole identification number, work order number, Contract number, Contractor's name, operator's contact information, and date of readings.
 - 3) Safety plan for steam curing of cured-in-place bag liners.
 - 4) For manhole process involving materials that cure in field as component of their installation.
 - a) Provide ASTM certified lab test results for field installations completed in United States over the past two years.
 - i. In place properties for actual field installations for proposed materials.
 - ii. Test results must verify physical properties specified herein have been achieved in previous field applications.
 - 5) Detailed description of field testing processes and procedures.
 - a) Keep accurate record of work for each manhole rehabilitated under this contract.
 - i. Show manhole identification number and location, quantities of rehabilitation material used, estimate of infiltration eliminated, and results of post-rehabilitation inspection.
 - b) DVD-ROM with Color video inspection reports and all digital records (original inspection videos, photographic stills, etc) made following manhole rehabilitation.

- i. Provide to Engineer within 10 days, following Section.
- c) Curing logs: Show material curing readings per unit of time collected during material installation.
 - i. Store electronically on data logger. Submit printed copy with Post video inspection DVD-ROM.
- d) For CIP liners, provide tabulation of time versus temperature by liner manufacturer with lengths of time exposed portions of liner will endure without self-initiated cure or other deterioration.
 - i. Tabulate at 5 degrees F. increments, ranging from 70 degrees F. to 100 degrees F.
 - ii. Include analysis of progressive effects of such self-initiated cure on insertion and cured properties of liner.
- e) Third party material testing report complete with samples, tests done, results and Analyst signature.
 - i. Third party is defined as ASTM or equivalent accredited materials testing firm with no financial or directorial link to manufacturer or Contractor.

02565.02 MATERIALS

A. Materials Furnished by the County

Unless otherwise noted in the "Special Provisions" for the Bureau of Utilities Projects, the County will make available for one test only water from its potable water system to the Contractor at no charge.

B. Contractor's Options

1. The Contractor may furnish and install, unless otherwise noted, Polyethylene (PE), Reinforced Plastic Mortar (RPM), or cured-in-place liners, for lining existing gravity pipelines.
2. The Contractor may furnish and install Polyethylene (PE) or cured-in-place liners for lining existing force mains.

C. Detailed Material Requirements

1. Portland cement concrete for pipe encasement shall be Mix No. 1 as specified in Section 03310.
2. Quick-setting, non-shrink grout shall be as specified in Section 03600.

3. Chemical Sealing Materials

a. General

- 1) The intent of this Item is to define the properties a sealing material shall have to perform effectively in the intended application and under expected field conditions.
- 2) Generic chemical sealing materials currently used are listed with the basic properties, performance standards, and mix ratios which have previously given acceptable performance.
- 3) It is recognized that new and improved chemical sealing materials may become available. Sources, manufacturers, and product names of chemical sealing materials will change and therefore specific sources, manufacturers, and product names are not referred to in this Specification.
- 4) Sealing materials shall contain a root inhibitor such as dichlobenil.
 - a) All chemical sealing materials used in performance of the work specified shall have the following properties and characteristics:
 - i. While being injected, the chemical sealant shall be able to react/perform in the presence of water.
 - ii. The cured material shall be capable of withstanding submergence in water without degradation.
 - iii. The resultant sealant formation shall prevent passage of water.
 - iv. The sealant, after curing, shall be flexible as opposed to brittle or rigid.
 - v. In place, the resultant sealant formation shall be able to withstand freeze/thaw and wet/dry cycles without adversely affecting the seal.
 - vi. The sealant formation shall not be biodegradable. Additives may be used to meet this requirement.
 - vii. The cured sealant shall be chemically stable and resistant to concentrations of acids, alkalis, and organics found in sewage.
 - viii. Packaging of component materials shall be compatible with field storage and handling requirements. Packaging shall provide for worker safety and minimize spillage during handling.
 - ix. Mixing of component materials shall be compatible with field operations and not require precise measurements.

- (1) Cleanup shall be done without excessive use of flammable or hazardous chemicals.
 - (2) Residual sealing materials shall be removable from the sewer after injection to ensure no flow reduction, restriction, or blockage of sewage flows.
- b) Acrylamide base gel chemical sealing material requirements, properties, and characteristics:
- i. A minimum of 10% acrylamide base material by weight in the total sealant mix. A higher concentration (%) of acrylamide base material may be used, when desirable, to increase strength or offset dilution during the induction period.
 - ii. The ability to tolerate some dilution and react in moving water during the induction period.
 - iii. A viscosity of approximately 2 centipoise which can be increased with additives.
 - iv. A constant viscosity during the induction period.
 - v. A controllable reaction time (induction period) from 10 seconds to 1 hour.
 - vi. A reaction (curing) which produces homogeneous, chemically stable, non-biodegradable, firm, flexible gel.
 - vii. The ability to increase mix viscosity, density, and gel strength by use of additives, e.g.: diatomaceous earth.
- c) Acrylate base gel chemical sealing material requirements, properties, and characteristics:
- i. A minimum of 10% acrylate base material by weight in the total sealant mix. A higher concentration (%) of acrylate base material may be used, when desirable, to increase strength or offset dilution during the induction period.

Note: If the acrylate base material is in a 40% solution, it shall comprise 25% by weight of the total sealant mix to have 10% base material.
 - ii. A low toxicity of the acrylate base material, i.e acute oral toxicity in rats (LD₅₀) of 5000 mg/kg body weight of rats.

- iii. The ability to tolerate some dilution and react in moving water during the induction period.
 - iv. A viscosity of approximately 2 centipoise which can be increased with additives.
 - v. An essentially constant viscosity during the induction period.
 - vi. A controllable reaction time (induction period) from 10 seconds to 1 hour.
 - vii. A reaction (curing) which produces homogeneous, chemically stable, non-biodegradable, firm, flexible gel.
 - viii. The ability to increase mix viscosity, density, and gel strength by the use of additives, e.g.: diatomaceous earth.
- d) Urethane base foam chemical sealing material requirements, properties, and characteristics:
- i. Approximately 1 part of urethane prepolymer thoroughly mixed with 1 part of water by weight (50% prepolymer).
 - ii. A liquid prepolymer having a solids content of 82% to 88%, specific gravity of 1.1 (9.15 pounds per gallon), and flash point of 20°F.
 - iii. A liquid prepolymer having a viscosity of 300 to 500 centipoise at 72°F that can be pumped through 500 feet of 1/2-inch hose with a 500-psi head at a 1 ounce/second flow rate.
 - iv. A cure time of 15 minutes at 40°F, 8.2 minutes at 70°F, and 4.6 minutes at 100°F when the prepolymer is reacted with water only.
 - v. A cure time of 15 minutes at 40°F, 3.5 minutes at 70°F, and 2.6 minutes at 100°F when the prepolymer is reacted with water containing 0.4% accelerator.
 - vi. During injection, foaming, expansion, and viscosity increase take place.
 - vii. Physical properties of the cured foam of approximately: 14 pounds per cubic foot density, 80 to 90 psi tensile strength, and 700% to 800% elongation when a mixture of 50% prepolymer and 50% water undergoes a confined expansion to five times its initial liquid volume.
- e) Urethane base gel chemical sealing material requirements, properties, and characteristics:

- i. 1 part urethane prepolymer thoroughly mixed with between 5 and 10 parts of water by weight. The recommended mix ratio is 1 part urethane prepolymer to 8 parts of water (11% prepolymer).
- ii. A liquid prepolymer having a solids content of 77% to 83%, specific gravity of 104 (8.65 pounds per gallon), and flash point of 0°F.
- iii. A liquid prepolymer having a viscosity of 600 to 1200 centipoise at 70°F that can be pumped through 500 feet of 1/2-inch hose with a 1000 psi head at 1 ounce/second flow rate.
- iv. The water used to react with the prepolymer should be in the pH range of 5 to 9.
- v. A cure time of 80 seconds at 40°P, 55 seconds at 60°P, and 3 seconds at 80°P when 1-part prepolymer is reacted with 8 parts of water only. Higher water ratios give longer cure times.
- vi. A cure time that can be reduced 5 to 10 seconds for water temperatures of 40°P to 80°P when 1-part prepolymer is reacted with 8 parts of water containing gel control agent.
- vii. A relatively rapid viscosity increase of the prepolymer/water mix. Viscosity increases from about 10 to 60 centipoise in the first minute for 1 to 8 prepolymer/water ratio at 50°P.
- viii. A reaction (curing) which produces a chemically stable, non biodegradable, tough, flexible gel.
- ix. The ability to increase mix viscosity, density, gel strength, and resistance to shrinkage by the use of additives to the water.

4. Monolithic Manhole Liners

When directed by the Department of Public Works, the Contractor shall install one of the following materials in manholes. The use of each of these methods is based upon the integrity of the manhole and the method will be as directed by the Department of Public Works.

a. Cured-in-Place Bag Liners.

- 1) Seamless manhole formed in place, within existing manhole extending from channel to frame.
 - a) Structurally independent of existing manhole structure.

- b) Liner thickness: Designed by manufacturer related to location, loads, water table and condition of manhole.
- 2) Multiple structural layers of fiberglass with non-porous membrane layer between fiberglass or Polyvinyl Chloride/Polyester (PVCP) liner.
 - a) Fiberglass layer formed to manhole interior under pressure and cured with heat.
- 3) Liner fabricated to match manhole dimensions for custom fit.
 - a) Continuous length from bench to manhole frame, just below cover seat.
 - i. Pieced together length: Not acceptable.
 - ii. Separate lining allowed for channel: Compatible with bag liner.
 - b) Stencil material type and name on liner: Viewable from inside.
- 4) Epoxy resin.
 - a) Polyamide Bisphenol "A" Epichlorodhydrin for use with fiberglass liner.
 - b) Modified epoxy resin for use with PVCP liner.
- 5) Approved Manufacturers.
 - a) Triplex Technologies.
 - i. Triplex Liner System.
 - b) Or Equal.
- b. Spray on Epoxy Liners.
 - 1) Seamless manhole formed in place, within existing manhole extending from channel to frame.
 - 2) Two or three part epoxy coating.
 - 3) Existing wall preparation: Follow manufacturer's recommendations.
 - 4) Thickness:
 - a) Structurally independent of existing manhole structure or sufficient to form protective barrier when used with Cementitious Manhole Restoration.

- b) Designed by manufacturer related to location, loads, water table and condition of manhole.
- 5) Minimum Tensile Strength (ASTM C307): 2,500 psi.
- 6) Minimum Flexural Strength (ASTM C580): 4,600 psi.
- 7) Approved Manufacturers.
- a) Sauereisen
 - i. Sewer Gard No. 210 Sprayable
 - ii. Sewer Gard No. 210 Rotary Spray
 - iii. Sewer Gard No. 210G (Non-Structural Application Only)
 - iv. Sewer Gard No. 210 FS
 - v. Hi-Build Filler Compound No. 209HB (Non Structural Application Only).
 - b) Raven
 - i. Raven 400S (Non Structural Application Only)
 - c) AP/M Permaform
 - i. Cor+Gard (Non Structural Application Only)
 - d) SprayRoq, Inc.
 - i. SR6100 (Non Structural Application Only)
 - e) Warren Environmental, Inc.
 - i. S-301-14 Epoxy Spray System
 - ii. M-301-18 Epoxy Trowel-On Mastic System
 - iii. S-301-20 Thermaflex (Non Structural Application Only)
 - iv. SG-201 Injection Grout (Non Structural Application Only)
 - f) WBE Dorcas, Inc., Colorado Springs, CO
 - i. Dinjer SG Mastic – Two Part Epoxy
 - g) Epoxytec CPP – Sprayable
 - h) Parson Environmental Products
 - i. Parsonpoxy SEL-80
 - ii. Parson RPM
 - iii. Parson Quick Plug
 - i) Madewell Products Corporation
 - i. Mainstay® DS-5™
 - j) Or Equal.

- c. Spray on Polyurethane Liners.
 - 1) Seamless manhole formed in place, within existing manhole extending from channel to frame.
 - 2) Two part 100% WOC-free self priming polyurethane lining.
 - 3) Thickness:
 - a) Dependent to manhole location, loads, water table and condition of manhole.
 - b) Structurally independent of existing manhole structure, minimum 1/10 of an inch (100mils)
 - 4) Minimum Tensile Strength (ASTM D638): 7,450 psi.
 - 5) Minimum Compressive Strength (ASTM D695): 18,000 psi.
 - 6) Approved Manufacturers.
 - a) SprayRoq Inc.
 - i. SprayWall
 - ii. SprayShield Green II
 - b) Or Equal.
- d. Cementitious Reconstruction for Manhole Restoration.
 - 1) Quick setting (under 20 minutes), high strength, sulfide resistant, calcium aluminate-based or Portland cement material.
 - 2) Suitable for troweling or rotary spray application to inside of manhole.
 - 3) Use additives to increase corrosion resistance or bond strength at manufacturer's direction and with Engineer's approval.
 - 4) Initial set time per manufacturer's recommendation and per project conditions.
 - 5) Density when applied: 135 lb/cf +/- 5 lb/cf.
 - 6) Compressive strength (ASTM C109) at 1 day.
 - a) Per manufacturer's recommendation.
 - b) Minimum acceptable: 2,000 psi.
 - 7) Compressive strength (ASTM C109) at 28 days.
 - a) Per manufacturer's recommendation.
 - b) Minimum acceptable: 5,500 psi.

- 8) Bond Strength (ASTM C882) at 28 days.
 - a) Per manufacturer's recommendation.
 - b) Minimum acceptable: 1,640 psi.

- 9) Flexural Strength (ASTM C78) at 28 days.
 - a) Per manufacturer's recommendation.
 - b) Minimum acceptable: 1,500 psi.

- 10) Shrinkage (ASTM C596) at 28 days: 0 percent.

- 11) Approved Manufacturers.
 - a) IPA systems, Inc.
 - i. Octocrete (trowel).
 - ii. Drycon (brush or trowel) (Non-Structural Application only).
 - iii. Drycon SM (spray gun).
 - iv. Drycon SMF fiber reinforced.

 - b) The Strong Company, Inc.
 - i. Strong-Seal MS-2A.
 - ii. Strong-Seal MS-2C (mild corrosion resistance).
 - iii. Strong-Seal High Performance (high corrosion resistance).

 - c) AP/M Permaform
 - i. Permacast MS-10,000 (corrosion resistant).
 - ii. Permacast MS-10,000 with Con-Shield (anti-bacterial additive).
 - iii. Permacast CR-9,000 (calcium aluminate cement) (trowel).

 - d) Sauereisen
 - i. F-120 Underlayment (calcium aluminate cement) (trowel).
 - ii. F-120 FC Fast Setting Underlayment.
 - iii. F-121 Substrate Resurfacer.

 - e) QuadEx
 - i. Aluminaliner (calcium aluminum cement).

 - f) WBE Dorcas, Inc.
 - i. Dinjer CMS 10K-A

 - g) Parson Environmental Products, Inc.
 - i. Parson CA liner 100+
 - ii. Parson MH Liner
 - iii. Parson Environmental Ca Liner 100
 - iv. Parson Environmental MH Liner

 - h) Madewell Products Corporation
 - i. Mainstay® ML-72™
 - ii. Mainstay® ML-CA™

iii. Mainstay® ML-PF™

i) Or Approved Equal.

- e. Sewpercoat - Made of 100% calcium aluminate cement, is pre-packaged fiber reinforced, high strength wet shotcrete material. This product does not contain crystalline silica. Sewpercoat shall be applied according to manufacturer's recommendations; the application thickness would be in 1/2"-3/4" lifts to reach the original manhole wall thickness + 1/8" for additional manhole protection.

Compressive Strength, 24 hours (ASTM C-109)	>5,500 psi
Tensile Strength (ASTM C-496)	>900 psi
Flexural Strength, 24 hours (ASTM C-293)	>1,300 psi
Shrinkage, 24 hours (ASTM C-596) @ 90% relative humidity	<0.04 psi
Bond, Slant Shear (ASTM C-882)	>2,300 psi @ 25 days
Hydraulic cement to meet the following requirements:	
Set time (ASTM C-191)	60 seconds
Sulfate resistance, Passed (ASTM C-86)	25 cycles/min.
Freeze-Thaw Resistance, Passed	62 cycles
Shrinkage/Expansion (ASTM C-157)	+0.02
Pull Out Strength, lbs. (ASTM C-234)	12,000 lbs.
(4# bar imbedded in 6 inches in a cement pocket of 1.5 in diameter)	

5. Polyethylene (PE) Pipe

- a. PE sewer liner pipe and fittings shall be manufactured from a polyethylene compound conforming to ASTM D 1248 and meeting the materials requirements for Type III, Class C, Grade Category 5.
 - 1) Pipe made from this compound must have a long-term hydrostatic strength rating of 1,600 psi or more, in accordance with ASTM D 2837.
 - 2) When the environmental stress crack resistance (ESCR) of the compound is measured in accordance with ASTM D 1693, Condition C, the compound shall withstand not less than 1,000 hours in 100% solution Igepal CO-630 at 1008F before reaching a 20% failure point (F20).
- b. The liner pipe shall be manufactured in accordance with ASTM D 3035 or ASTM F714.
- c. Liner Pipe Dimensions: The outside diameter and minimum wall thickness shall conform to dimensions listed in Table I when measured in accordance with ASTM D 2122. Where construction difficulties prevent use of these pipe sizes, other sizes may be specified.

TABLE I
(all dimensions are in inches)

Size of Sewer	OD of Liner	Nominal OD	Minimum Wall Thickness			
			SDR 32.5	SDR 26	SDR 21	SDR 17
4	3.500	3" IPS	---	---	.167	
6	4.500	4" IPS	---	---	.214	
6	5.375	5.375"	.165	.207	.256	.316
8	6.625	6" IPS	.204	.255	.315	.390
8	7.125	7.25"	.219	.274	.339	.419
10	8.625	8" IPS	.265	.332	.411	.507
12	10.75	10" IPS	.331	.413	.512	.632
15	12.75	12" IPS	.392	.490	.607	.750
15	13.38	13.380"	.412	.515	.637	.787
18	16.00	16" IPS	.492	.615	.762	.941
21	18.00	18" IPS	.554	.692	.857	1.059
21	18.70	18.700"	.575	.719	.890	1.100
24	22.00	22" IPS	.677	.846	1.048	1.294
27	24.00	24" IPS	.738	.923	1.143	1.305
30	28.00	28" IPS	.862	1.077	1.333	1.647
36	32.00	32" IPS	.985	1.231	1.524	1.882
42	36.00	36" IPS	1.108	1.385	1.714	
42	40.00	40" IPS	1.231	1.538		
48	40.00	40" IPS	1.231	1.538		
48	42.00	42" IPS	1.292	1.615		
54	48.00	48" IPS	1.477	1.846		

NOTE: The wall thickness tolerance shall be within plus 12%. The Standard Dimension Ratio of the pipe to be used shall be as specified in the Special Provisions.

6. Reinforced Plastic Mortar (RPM) Pipe

Reinforced Plastic Mortar (RPM) Pipe for liner in existing sewers shall be manufactured in accordance with ASTM D 3262 or ASTM D 3754 as specified. The pipe shall be manufactured by first applying a liner over a solid surface steel mandrel. The liner shall contain a thermosetting polyester, selected for the intended service, and surfacing veil as reinforcement. No aggregate shall be used in the liner. After the liner is applied, circumferentially oriented continuous glass filaments shall be wound around the liner to provide hoop strength and longitudinally oriented filaments shall be added to provide axial strength. Silica sand-resin mortar shall be added to provide correct ring stiffness. Wall thickness shall remain essentially constant regardless of pressure class. The bell of the pipe shall be manufactured as an integral part of the pipe. The basis of design shall be long-term hydrostatic testing and regression analysis. Long-term hydrostatic testing shall be done in accordance with procedures in ASTM D 2992. Circumferential tensile strengths shall be obtained in accordance with ASTM D 2290.

7. Cured-in-Place Pipe Liner

All materials and procedures used in the inversion process shall be the manufacturer's current standards.

- a. Resin: The resin shall be a corrosion resistant polyester or vinyl ester resin and catalyst system that when properly cured within the tube composite meets the requirements of ASTM F1216, ASTM F1743 or ASTM F2019, the physical properties herein, and those, which are to be utilized in the design of the CIPP for this project. The resin shall produce CIPP which will comply with or exceed the structural and chemical resistance requirements of this specification.

1) Resin-Catalyst-Colorant-Additive Mixture:

Tested to certify liner material follows design standards before wet out. Quantity of resin used for tube impregnation: Sufficient to fill volume of air voids in felt tube with additional 10 to 15 percent allowances for polymerization shrinkage and loss of resin through cracks and irregularities in original pipe wall.

- a) Heat cured liners, required amount of resin mixture: Vacuumed into felt liner material.
 - i. Point of vacuum: No further than 25 feet from point of initial resin introduction to ensure thorough resin saturation throughout the length of the felt tube.
 - ii. Vacuum point: No further than 75 feet from the leading edge of resin after vacuum in tube is established.
- b) UV cured liners, fiberglass liner: Saturated with appropriate resin using resin bath to minimize air entrapment and delivered to site ready for installation.
 - i. Vacuum methods: As recommended by the manufacturer.
- c) Leading edge of resin slug:
 - i. As near to perpendicular as possible.
 - ii. Wet-out liner is fed onto the conveyor system and through roller gap set following design (minimum 2.3 x lining thickness in mm).
 - (1) Ensure uniform distribution of resin throughout the pre-cured liner.
 - (2) Pack pre-cured liner on ice within automatically monitored refrigerated truck with ice bags between pre-cured liner folds.
 - iii. Alternate resin impregnation method: Proven, inspected, and with Engineer's approval. Colorant: Dark yellow.

- (1) Add to catalyst before mixing catalyst with resin.
 - (2) Pigmentation: Produces color that is clearly distinguishable from dry felt.
 - (3) Wall color of interior pipe surface of CIPP after installation: Light reflective color to allow clear detailed examination with closed circuit television inspection equipment.
- 2) Additives for resin enhancement, viscosity control, safety, chemical resistance, physical resistance, or extending shelf life are permitted with Engineer's approval.
- b. The felt tubular material shall be lined on one side with a waterproof coating such as polyurethane or polyvinyl chloride (PVC), and fully impregnated with a liquid thermosetting resin as specified. The tubing shall be properly sized to the diameter and length of the sewer pipeline to be rehabilitated. The material thickness shall generally be a minimum of 0.236 inches with a tolerance of .0625 inch plus or minus. The nominal specified thickness for each pipe section shall be designated on the plans. The cured pipe material shall conform to the following minimum structural standards:

Follow ASTM F1216, ASTM F1743 and ASTM F2019 as appropriate to insertion method, liner tube material and resin material proposed for fully deteriorated pipe condition.

Wet-out liner material in a controlled factory environment.

c. Thickness

The Contractor shall calculate the recommended liner thickness for each manhole-to-manhole section. Calculations for determination of the liner thickness required shall be prepared by a licensed Professional Engineer and submitted to the County for review and approval. Each liner shall be designed to withstand internal and/or external loads as dictated by site conditions or as directed by the County. Thickness shall be based on trench loadings as they may occur in an existing piped trench for the installed depth and H20 truck loading for live load design. The submitted pipe lining method shall have enough structural strength to support all dead loads, live loads, and ground water loads imposed with the assumption that the existing pipe cannot share any loading or contribute to structural integrity of the liner. For bidding purposes, the contractor shall assume the following values: 2% minimum ovality, soil modulus of 1000 psi, and water table at manhole rim height.

The thickness to be used for submitting a Bid for this Contract shall be the largest thickness as determined by calculations for the following parameters:

- Thickness Required for Deflection.

- Thickness Required for Stiffness.
- Thickness Required for Ring Bending.
- Thickness Required for Buckling.

Thickness as determined by the largest value of 1, 2, 3, or 4 above is to be used for bidding purposes. The Unit Price bid per linear foot of Liner shall be based on the largest thickness required, as determined above and the minimum thickness noted below.

Layers of cured CIPP: Uniformly bonded.

Structural Properties: Use deteriorated design condition, following design equations in appendix of ASTM F1216. If the equation is less than the liner thickness noted on the table below use the minimum liner thickness on the table below use minimum as noted.

- 1) Design Assumptions.
 - a) Water table: At manhole rim
 - b) Buckling resistance: AWWA M45, Appendix A
 - c) Design Safety Factor: 2.0
 - d) Ovality: 2 percent
 - i. Live Load: H20 Highway

Felt Liner and Ambient Temperature, Steam, or Hot Water Cure	
Host Pipe Diameter	Minimum Thickness
6"	6 mil
8"	6 mil
10"	6 mil
12"	8 mil
15"	10 mil

Fiberglass Felt, or and UV Liner	
Host Pipe Diameter	Minimum Thickness
6"	4" mil
8"	4" mil
10"	4" mil
12"	6" mil
15"	6" mil

d. Capacity

To maximize the capacity of the reconstructed pipe, the inside diameter must be as large as possible. As part of the Contractor’s submittal process, prior to commencement of work, the submittal shall clearly define and set expectations to the client regarding the resulting inner diameter of the pipe available to convey flow.

e. Sizing

Allowance for longitudinal and circumferential stretching of the liner during installation shall be made by the Contractor.

The Contractor shall design the length of the liner to effectively carry out insertion and sealing at end points. The County will provide the grade and length of each pipe segment if such information is available. The Contractor shall verify these measurements before designing and reconstructing the pipe.

f. Deflection Allowances

The liner shall be designed to withstand negotiation of offsets, gaps, angles, and grades without damage to the liner during the insertion process.

g. End Seals

The liner shall be terminated and sealed at each end of lined segment using an engineered end solution that is appropriate for the installation based on the pressures, flows, host pipe condition and materials. Grouting only, is not an acceptable end seal

A hydrophilic waterstop around the exterior of the liner material at the liner termination shall be required regardless of insertion method in accordance with Section 02565.02.I of these specifications.

h. Finish

The finished lining shall be continuous over the entire length of an insertion run between the starting and terminating manholes and be as free as commercially practicable from visual defects. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to the inside of the lined pipe, and from behind the liner at manholes and service connections.

The liner, when installation is completed, shall conform tightly to the wall of the existing pipe with absolutely no annular space between the liner and the wall of the existing sewer pipe.

Any defects that will affect, as determined by the County, the integrity or strength of the lining shall be repaired, or the liner replaced at the Contractor's expense.

i. General

The liner shall be constructed of a material which, when installed, shall provide a structurally sound liner able to withstand all imposed static, dynamic, and hydrostatic loads. The liner shall be fabricated from materials which will be chemically resistant to internal exposure of sewage containing normal levels of hydrogen sulfide, carbon monoxide, carbon dioxide, methane, traces of mercaptans, kerosene, naphthalene, methylene chloride, trichloroethylene, gasoline and dilute sulfuric acid. The materials must also withstand saturation with moisture and external exposure to soil bacteria and any chemical attack that may be due to materials in the surrounding ground.

Projected changes in the ground water level, temperature, and other loading factors shall cause no significant changes in the service characteristics or service life of the reconstructed pipe. In the event of unsuitable chemical residue remaining on the pipe walls after cleaning, the Contractor shall either provide a material resistant to those residues or a neutralizing barrier material so that the chemical does not have a deleterious effect on the liner. Provide stenciling on the liner interior as follows:

- 1) Locate markings such that they are legible from access locations.
- 2) Markings shall include:
 - a) The liner manufacturer.
 - b) Diameter (inches).
 - c) Contract number.
- 3) Pipeline lettering shall:
 - a) Be one third (1/3) of the pipe outside diameter, but not larger than four (4) inches in height.
 - b) Consist of stenciling with a high-quality paint.

The liner material used shall be able to inhibit the penetration of tree roots into the sewer main.

All materials used in the reconstruction process shall be of their best respective kinds and to the satisfaction of the County. All wet out liners will be splice-free. Wet out shall occur at the factory. Any materials not approved by the County for use in the reconstruction shall then be replaced with approved materials at the Contractor's expense.

The Contractor shall obtain and transfer to the County a warranty from the liner manufacturer to the effect that the liner has been manufactured specifically for lining a sewer pipe and that the design life of the liner materials is fifty (50) years under the conditions normally in existence in a sewer pipe containing domestic sewage.

The apparent low bidder shall submit within ten (10) calendar days of bid opening, a Letter of Certification from the Liner Manufacturer in which all mechanical properties of the liner material to be used for design calculations shall be certified. The mechanical properties to be certified shall include, as a minimum, the following:

<u>Property</u>	<u>Standard</u>
Tensile Strength (psi)	ASTM D-638
Flexural Modulus of Elasticity (psi)	ASTM D-790
Flexural Strength (psi)	ASTM D-790

The pipe design shall have enough structural strength for the entire 50-year design life to support all dead loads, live loads, and groundwater loads imposed. The design shall not rely on the host pipe for structural integrity. The pipe shall be designed to withstand operating pressures, have enough strength to bridge missing pipe, and stretch to fit irregular pipe sections. If the host pipe is in disrepair and unsuitable for lining, the County and Contractor will collaboratively determine the best method of pipe rehabilitation.

j. Cured-in-Place Pipe Lining

Cured-in-Place Pipe Lining material shall be a general purpose, unsaturated, polyester resin and catalyst system compatible with the reconstruction inversion process that provides a minimum Tensile Strength of 2,500 psi as detailed in ASTM D-638, a minimum Flexural Modulus of Elasticity of 250,000 psi as detailed in ASTM D-790, and a minimum Flexural Strength of 4,500 psi as detailed in ASTM D-790.

1) Liner Tube.

a) Felt Tubes.

i. Seams as described herein.

(1) Liner to run continuously from manhole to manhole.

(2) Does not use overlapping section of liner felt tube or longitudinal seams that cause lumps in the final product.

ii. Impermeable, flexible membrane outside layer that will contain resin and monitor resin saturation at factory during resin impregnation procedure.

- b) Fiberglass Tubes.
 - i. Consist of flexible fiberglass tubes made spirally or by overlapping layers.
 - ii. Include exterior and interior film that contains resin in tube, are impervious to airborne styrene and serves as ultraviolet blocking material.
- 2) Cured Liner: 50-year life span.
 - a) Chemically resistant to internal exposure to sewage containing small quantities of hydrogen sulfide, carbon dioxide, methane, mercaptans, kerosene, moisture, and diluted sulfuric acid.
 - b) Chemically and physically resistant to external exposure of soil bacteria, moisture, roots, and chemical attack, that may be due to material in surrounding ground.
- 3) Approved Manufacturers:
 - a) Inliner Technologies, LLC
 - b) Insituform Technologies Inc.
 - c) National Liner
 - d) Novapipe
 - e) Premier Pipe
 - f) Reline America Blue-Tek Liner
 - g) Saertex MultiCom
 - h) LightStream LP, StreamLiner
 - i) UV Liner
 - j) Perma-Lateral by Perma-Liner Industries, LLC FerraTex
 - k) Or equal
- 8. Storage and Handling
 - a. Protect, store, and handle materials during transportation and delivery, while stored on-site, and during installation following manufacturer's recommendations.
 - b. Continuously monitor liner materials during transport and storage with temperature recorder and data storage or strip printer.
 - 1) Furnish Engineer with recorder readings before installation.
 - 2) Material exposed to temperatures outside of manufacturer's limits: Rejected.

- c. Material found to be defective or damaged due to manufacture or shipment:
 - 1) When Engineer deems repairable: Repair following manufacturer's recommendations.
 - 2) When Engineer deems not repairable: Rejected, removed from Contract site, and replaced under Engineer's direction.
 - 3) Repair or replacement of defective or damaged material will be at no additional cost to the County.

- 9. Lateral-Mainline Interface Seal
 - a. ASTM F2561-06 following mainline CIPP wetout requirements.
 - 1) T Liner.
 - a) Approved manufacturers.
 - i. LMK Enterprises Inc.
 - ii. BLD Services, LLC.
 - iii. Or equal.
 - b. Resin injection process following manufacturer's recommendations. Injected resin without the use of grout.
 - 1) Approved manufacturers:
 - a) Janssen Process Company.
 - b) ProKasro.
 - c) Or Equal.
 - c. Follow Section 02965 for lateral-mainline interface sealing by chemical grout.

- 10. Internal Spot Repair: Follow ASTM F1216 and as noted herein.
 - a. Tube fabricated from resin impregnated fiberglass/carbon patch sheet to a size which, when installed will closely approximate the internal circumference of the conduit specified. Make allowance for changes in circumference of the conduit by free overlap during inflation of the tube.
 - b. Minimum Length: Determined to effectively span the designated defective section, plus one foot at either end. Verify lengths in the field before pulling the tube into the pipe.
 - c. Thickness of the mechanical seal liner within pipe: Designed to conform to actual field conditions.
 - d. Approved Manufacturers: Easy-Liner LMK Enterprises EPROS Drain Packer Repair System Pipe Patch by Source 1 Environmental, LLC Infrastructure Point Repair System Or equal.

11. Miscellaneous Materials

- a. Finishing material for transitioning, filling, and sealing liners entering manholes.
 - 1) Chemically inert, non-shrinking, and able to cure in presence of water.
 - 2) Material: Quickset H2S resistant, epoxy resin or mortar.
 - 3) Design mix: Minimum 500-psi compressive strength in 28 days.
 - a) Additives may be added to improve flow properties when minimum compressive strength requirements are met, with Engineer's approval.

12. Pipeline Replacement

- a. Pipe shall be as specified in Section 02561.02.

13. Manhole Rehabilitation and Replacement

- a. Flexible plastic gaskets shall be as specified in Section 02562.02.
- b. Cast-in-place concrete shall be as specified in Section 03300, Mix Number as indicated on the Standard Details or the Plans.
- c. Precast concrete sections and grade rings shall be as specified in Section 03400. In addition to the requirements of Section 03400, materials need to be hydrogen sulfide resistant. HDPE grade rings shall be as required in Section 02562.
- d. Mortar for placing precast concrete grade rings shall be as specified in Section 04100.02.
- e. Brick for manhole inverts shall be sewer brick as specified in Section 04200.02.
- f. Manhole frames, covers, and steps shall be as specified in Section 05500.02. Covers shall be in accordance with the Standard Details.
- g. Waterproofing and bentonite for manhole exterior shall be as specified in Section 07130.02.
- h. Curing compound shall be as specified in Section 02562.02.

02565.03 EXECUTION

A. Manhole Preparation

Following approved submittals for rehabilitation products used.

1. Divert flow from channel.
2. Prevent extraneous material from entering sewer lines during cleaning and rehab work.
 - a. Filter solids-laden water through an approved de-silting device. No material shall be allowed to go downstream.
3. Clean interior surface of manhole of debris, dirt, oil, grease, remains of old coating materials, and any other extraneous materials.
4. Pressure wash interior of manholes to remove loose mortar, concrete and debris.
5. Repair irregularities and missing material in manhole forming smooth surface.
6. Stop leakage into manhole.

B. Chemical Grouting for Leakage Control

1. Provide 48 hour notice to the Engineer prior to start of work for equipment inspection and testing.
 - a. Allow measurements to be taken.
 - b. Demonstrate acceptable grout volumetric measuring technique.
2. Adjust chemical mixing ratios required for specific application.
 - a. Minimum gel time 30 seconds or as directed by Engineer.
3. Do not block pipes entering/exiting manhole with grout.
 - a. Use mirror or camera to confirm pipes are not blocked.
4. Do not damage manhole structure during operations.
 - a. Repair damage as directed by Engineer.
5. Protect area of manhole below repair work.
 - a. Do not allow solid material to enter sewage flow.
 - b. Remove protective devices as soon as practical.
6. Manhole Sealing: Follow ASTM F2414 and as specified herein.
 - a. Brick manholes.
 - 1) Drill only the amount of holes necessary to stop leakage following industry standards and chemical grout manufacturer's recommendations.

- 2) Proceed with manhole reconstruction using reconstruction processes specified herein.
- b. Precast manholes.
 - 1) Seal pipe connections as specified by drilling between pipe and manhole opening and injecting grout.
 - 2) When specified, seal precast manhole base by drilling holes at leakage points along bench to wall, and in channel.
 - 3) At precast joints inject grout through holes drilled at leaking joint.
7. Hydraulic Water Plugs: Following approved submittals.
 - a. Provide mechanical key by undercutting or square cutting opening and removing loose materials.
 - b. Mix, handle, place and cure material.
 - c. Finish surface as required for other rehabilitation work.
8. Oil-Free Oakum Water Plugs: Following approved submittals.
 - a. Saturate oakum with resin.
 - 1) Use additives as required.
 - b. Place, pack and cure material.

C. Manhole Rehabilitation

1. Locate Existing Manhole.
 - a. Using available records, drawings, land surveying, GPS, metal detectors or other technology and techniques, locate, excavate and expose existing manhole.
2. Reset/Replace and Adjust manhole frame and cover, following Section 02530 and Standard Details.
3. Chemical Grouting: As specified herein, following ASTM F2414 and specified herein.
4. Cementitious Reconstruction: Following approved submittals and as specified herein.
 - a. Mix and handle materials.
 - b. Apply materials using rotary spray equipment or spray gun.

- c. Apply beginning at bottom of brickwork and work up to bottom of frame.
 - d. Seal around pipe connections and steps.
 - e. Do not allow material to enter sewage flow.
 - f. Apply.
 - 1) Maximum applied thickness: 300 mils.
 - 2) Minimum applied thickness: 150 mils.
 - 3) Confirm with pictures and gauge.
 - g. Trowel and brush for smooth finish.
 - h. Cure using curing compound when recommended by manufacturer.
 - 1) Do not allow flow in manhole or traffic over manhole, until manufacturer's minimum cure times have been achieved.
5. Manhole Liners: Following approved submittals.
- a. Cured in Place Liners.
 - 1) Custom fabricate liner to individual manhole dimensions.
 - 2) Line bench and channel area with compatible epoxy or resin material placed
 - 3) in bottom of manhole. Extend minimum 6 inches up manhole wall.
 - 4) Remove manhole steps.
 - 5) Saturate liner with resin, place in manhole, pressurize with air or water and
 - 6) cure with hot water, steam or hot air.
 - 7) Finish liner.
 - 8) Finished liner: Forms monolithic structure from manhole frame to bench.
 - b. Epoxy Liners.
 - 1) Mix and apply material.
 - a) Sagging of material is not permitted.
 - 2) Seal around pipe connections and steps.
 - 3) Cure.
 - 4) Finished liner: Forms monolithic structure from manhole frame to channel.
 - c. Prior to application of Sewpercoat, Contractor to apply hydraulic cement compound such as Parsons Quick Plug, for example, to fill the manhole riser section joints and other large circumferential cracks.
 - 1) Sewpercoat application shall be in accordance with the manufacturer's recommendations and as specified below.
 - a) Surface preparation - Provide brush-off abrasive blast cleaning to remove loose surface concrete and contaminants and provide "tooth" for good coating

adhesion. Repair all interior surface imperfections with epoxy mortar in accordance with the manufacturer's recommendations. Remove all dust from surface to receive the interior coating. All concrete surfaces shall be dry.

- b) Apply cementitious liner according to manufacturer's recommendations.

D. Field Testing

1. Follow Section and specified herein.
 - a. Monitor, record, and report to Engineer defects or damage to materials during installation.
 - b. Collect, label, and store representative product samples.
 - 1) Submit product samples specified herein.
 - 2) Additional product samples maybe required, as directed by Engineer.
 - 3) Store and maintain products samples until contract maintenance bond has expired.
 - c. Verify required testing is performed by approved laboratory.
 - d. Engineer may inspect pre-rehabilitation work, rehabilitation operations, and post rehabilitation work.
2. Video Inspections of post-rehabilitation condition of manhole.
 - a. See Section for video inspection requirements.
 - b. Submit to Engineer within 10 days, following Section
3. Visual Inspection: Determine integrity of rehabilitation materials and water-tightness.
 - a. Verify no inflow or infiltration.
 - b. Verify services are reinstated and unobstructed.
4. Defects.
 - a. When Engineer Deems Repairable: Repair defect, replace liner, install new manhole at no additional cost to the Commission.
 - b. Document with CCTV recording following Section 02956
5. Manhole Lining: Test for continuity following ASTM D4787 and approved submittals.
 - a. Conduct holiday test and gauge depth test on spray-on liners.
 - b. Perform CCTV inspection of liner following Section 02956.
 - c. Conduct pull test with embedded bolt or tab.
 - d. Repair holes and discontinuities following manufacturer's recommendations.

6. Grout and Concrete: Test for compressive strength following ASTM C109.

E. Warranty Inspections

1. Conduct visual inspection prior to expiration of warranty to determine integrity of rehabilitation materials and water-tightness.
 - a. Complete post inspection during first high groundwater period (spring or fall) following acceptance of work.
 - b. Contractor will accompany Engineer on inspections.
 - c. Inspect 25 percent of manholes rehabilitated at locations selected by Engineer.
 - 1) Infiltration and Inflow: None
 - 2) Structural Repair: Sound
 - 3) If more than one manhole fails warranty inspection, inspect all manholes with similar characteristics.
 - 4) Repair defects in accordance with Warranty
2. Sewer Pipe Cleaning

- a. General

The intent of sewer pipe cleaning is to remove foreign materials from the sewer and restore the pipeline to a minimum of 95% of the original pipe diameter or cross-section as required for proper seating of internal pipe joint sealing packers or as required for installation of pipe liners. It is recognized there are some conditions such as broken pipe and major blockages that prevent cleaning from being accomplished or where additional damage would result if cleaning were attempted or continued. Should such conditions be encountered, the Contractor shall notify the Engineer of the location and nature of obstruction. The Engineer will evaluate the obstruction and will direct the Contractor as to the amount and method to be used to clean those specific pipe sections if cleaning is determined by the Engineer to be feasible. If in the course of normal cleaning operations, damage results from preexisting and/or unforeseen conditions such as broken pipe, the Contractor will notify the Engineer of the location and nature of the damage. The Contractor will be required to make repairs at his cost only when the Engineer has determined the contractor was negligent in performance of his cleaning operations.

It shall be the responsibility of the Contractor to clean debris out of the sewer line in accordance with the National Association of Sewer Service Companies (NASSCO) Specifications for Sewer Collection System Maintenance and Rehabilitation prior to the television inspection and subsequent reconstruction.

Selection of the equipment used shall be determined by the Contractor and be based on the conditions of lines at the time work commences. The equipment and methods selected shall be satisfactory to the Engineer. The equipment shall be capable of removing dirt, grease, rocks, sand, roots, and other materials and obstructions from the sewer lines and manholes. If cleaning of an entire section cannot be successfully performed from one manhole, the equipment shall be set up on the other manhole and cleaning again attempted. If the Contractor cleans the pipe then leaves the site and returns later to complete, any additional cleaning required prior to lining shall be considered incidental and be performed at no additional cost to the County.

All equipment used for cleaning operations shall be equipment designed to do that type of work which is specified. When at all possible, the equipment shall be a self-contained unit to handle all operations.

The following procedures shall be adhered to unless otherwise approved by the County prior to notice-to-proceed. The Contractor shall provide full restoration of areas affected by construction. All costs associated with such restoration shall be included in the bid Item for that major item of work.

Upon completion of the cleaning operations, the Contractor shall clean all debris out of the manhole and from the ground around the manhole. The Contractor shall dispose of all debris in a sanitary landfill or other approved method of disposal. The Contractor shall protect downstream facilities from debris.

Cleaning will be done in a careful manner as not to damage the existing pipe. All damage to the sewer pipe structure or flow characteristics due to the cleaning process shall be repaired by the Contractor at his expense.

If there is no manhole in the vicinity where the cleaning process is to commence, the contractor shall excavate and provide adequate access to the pipe to carry out the required task. This work shall be performed at no additional cost to the County. The County will assist in identifying the access excavation location.

b. Cleaning Equipment

1) Hydraulically Propelled Equipment

- a) Equipment used for gravity pipelines shall be of a movable dam type and be constructed in such a way that a portion of the dam may be collapsed at any time during the cleaning operation to protect against flooding of the sewer. The movable dam shall be equal in diameter to the pipe being cleaned and provide a flexible scraper around the outer periphery to ensure removal of grease.
- b) Pressure pipelines may be cleaned by use of pipe pigs specifically designed for the condition, size, and type of pipe being cleaned.
- c) If sewer cleaning fails or other equipment which cannot be collapsed is used, special precautions to prevent flooding of the sewers and public or private

property shall be taken.

- 2) High-Velocity Jet (Hydrocleaning) Equipment: All high-velocity sewer cleaning equipment shall be constructed for ease and safety of operation. The equipment shall have a selection of two or more high-velocity nozzles. The nozzles shall be capable of producing a scouring action from 15 to 45 degrees to the axis of the pipe for all size lines designated to be cleaned. Equipment shall also include a high-velocity gun for washing and scouring manhole walls, benches and inverts. The gun shall be capable of producing flows from a fine spray to a solid stream. The equipment shall carry its own water tank, auxiliary engines, pumps, and hose reel. The NASSCO Jetter Code of Practice shall be consulted as a guide for the selection of different type nozzles and recommended pressure applications for various cleaning requirements.
- 3) Mechanically Powered Equipment
 - a) Bucket machines shall be in pairs with sufficient power to perform the work in an efficient manner. Machines shall be belt operated or have an overload device. Machines with direct drive that could cause damage to the sewer will not be allowed.
 - b) Power rodding machines shall be either sectional or continuous rod type capable of holding a minimum of 750 feet of rod. The rod shall be fabricated of heat-treated steel.

3. Root Removal

- a. Roots shall be removed in sections where root intrusion is a problem. Special attention should be used during the cleaning operation to assure almost complete removal of roots from pipe joints. Any roots, which could prevent seating of the packer, the insertion of a pipe liner, or proper application of chemical crack or joint sealants, shall be removed. Root removal techniques may include use of mechanical equipment such as rodding machines, bucket machines or winches using root cutters, and porcupines; equipment such as high-velocity jet cleaners; or chemical root treatment at the option of the Contractor and final approval of the County.
- b. To aid in removal of roots, manhole sections identified to have root intrusion may be subjected to a chemical root treatment with an approved herbicide. The application of herbicide to the roots shall be done in accordance with the manufacturer's recommendations in a manner as to preclude damage to surrounding vegetation or affecting any treatment processes at any water reclamation facility. Any damaged vegetation identified by the Engineer shall be replaced by the Contractor at no additional cost to the County. All safety precautions recommended by the chemical manufacturer shall be observed by the Contractor during handling and application of the herbicide. Please note: application of chemical root treatment shall not occur within 5,000 linear feet, as measured along the pipe alignment, of a County Water

Reclamation Facility (WRF).

4. Material Removal

All sludge, dirt, sand, rocks, grease, and other solid or semisolid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing of material from manhole section to manhole section, which could cause line stoppages, accumulations of sand in wet wells, or damage to pumping equipment, will not be permitted.

5. Force Main Cleaning

Force mains shall be cleaned using hydraulically propelled or mechanically powered equipment. Hydraulically propelled pigs shall be inserted into the force main at designated locations or at other approved locations. Mechanically pulled scrapers may be used when conditions warrant. Equipment selected shall be capable of removing dirt, grease, sand, and other materials and obstructions from the lines.

6. Disposal of Materials

All solids or semisolids resulting from the cleaning operations shall be removed from the site transported in watertight vehicles, and disposed of at an approved disposal facility site obtained by the Contractor. All materials shall be removed from the site, transported in watertight vehicles, no less often than at the end of each workday. Under NO circumstances will the Contractor be allowed to accumulate debris, etc., on the site of work beyond the stated time, except in totally enclosed containers approved by the County.

F. Sewer Flow Control

1. Flow Reduction

When sewer line depth of flow at the upstream manhole of the manhole section being worked is above the maximum allowable for television inspection, joint testing, and/or sealing; the flow shall be reduced to the level indicated below by operation of pumping stations, plugging or blocking of flow, or by pumping and bypassing of flow as required.

2. Depth of Flow

Depth of flow shall not exceed that indicated below for the respective pipe sizes as measured in the manhole when performing television inspection, joint testing, and/or sealing.

- a. Maximum depth of flow for television inspection:

6" - 10" Pipe	20% of pipe diameter
12" - 24" Pipe	25% of pipe diameter
27" & up Pipe	30% of pipe diameter

- b. Maximum depth of flow for joint testing/sealing:
- | | |
|----------------|----------------------|
| 6" - 12" Pipe | 25% of pipe diameter |
| 15" - 24" Pipe | 30% of pipe diameter |
| 27" & up Pipe | 35% of pipe diameter |

3. Plugging or Blocking

A sewer line plug shall be inserted into the line upstream of the manhole section being worked. The plug shall be so designed that all or any portion of the sewage can be released. During TV inspection, testing, and sealing operations, flow shall be reduced to within limits specified above. After the work has been completed, flow shall be restored to normal.

4. Pumping and Bypassing

When pumping and bypassing is required, the Contractor shall furnish temporary pumps, conduits, and other equipment to divert the flow of sewage around the manhole section in which work is to be performed. The bypass system shall be of sufficient capacity to transport existing flow plus additional flow that may occur during a rainstorm. The Contractor will be responsible for furnishing the necessary labor and supervision to set up, operate the pumping and bypassing system and man the bypassing operation on a 24-hour, 7-day per week basis until bypass operations are completed. Pump engines shall be equipped with exhaust silencers and/or enclosures to keep noise to a minimum. The system shall be so constructed as to prevent spills from leaving the immediate vicinity of the site. Any spillage that occurs shall be immediately cleaned up and the site returned to a clean sanitary condition. Bypassing plans to be reviewed and approved by the County prior to setup. County Utility Operations to be prior notified of the extent of bypassing operations.

The Contractor shall bypass the sewage around the segment of the line to be reconstructed. The bypass shall be made by plugging an existing upstream manhole, if necessary, and pumping the sewage into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. In situations where bypass is not feasible, the Contractor, at no additional cost, shall provide tankers and/or vactor trucks as necessary to control sewage flows during rehabilitation.

The pumps used by the Contractor shall not produce noise levels above 65 dBA from 7:00am to 9:00pm and 55 dBA from 9:00pm to 7:00am. If directed by the County, the Contractor shall replace the pumps in use with a quieter model of the same quality and specifications.

The Contractor shall submit a plan to bypass the sections of line that are to be reconstructed for approval by the County three (3) weeks prior to beginning the reconstruction. The Contractor shall maintain back-up equipment in the form of spare pump(s) and other incidental equipment to ensure no interruption to the bypass operation in the event of equipment failure. The Contractor shall demonstrate to the County that this spare equipment is operable and capable of maintaining the bypass.

The Contractor shall not use flexible pipe as part of the bypass operation when 6” or larger bypass lines are required to carry the flow, except when authorized by the Engineer. For bypass installations 4” and smaller, layflat flexible hose may be used on streets with speed limits less than or equal to 30 mph. Layflat flexible hose will not be allowed for major road crossings or intersections. All other uses will be evaluated by the County on a case by case basis.

This work shall be considered as part of the Sanitary Sewer Lining using Cured in Place Liner. No additional costs will be granted to the Contractor associated with the bypass piping or pumping. As part of the site investigation, the Contractor shall evaluate and pre-plan the anticipated routing of bypass piping for this contract, recognizing that the linear feet of required bypass piping may exceed the linear feet of the sewer main to be lined.

Under no circumstances will the dumping of raw sewage on private property or on County or State roads be allowed.

The bypass system shall be tested and continuously monitored by the Contractor to ensure the system is operating as intended and leak-free. The Contractor shall report any sewage spills to the appropriate County and State agencies.

All provisions for the installation of bypass shall be considered as included in the base bid for this contract. Roads, sidewalks, parking lot, and/or stream crossings (minor and major) shall be anticipated and included in the base bid. Contractor shall plan for these crossings and include appropriate bends, excavation, additional length of pipe and other appurtenances as required to successfully bypass line sections as acceptable to the County.

5. Flow Control Precautions

When flow in a sewer line is plugged, blocked, or bypassed; sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. In addition, precautions must be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved.

G. Television Inspection

1. Pipe designated for inspection shall be examined by closed circuit television techniques.
2. CCTV internal inspection sequence:
 - a. Perform CCTV after completion of sewer cleaning. Engineer shall review and approve to indicate the sewer main is ready for lining.
 - b. Pre-lining: protruding taps and offset joints shall be removed to the satisfaction of the Engineer.
 - c. Pre-lining: Mandrel shall be used to indicate main is acceptable for lining.
 - d. External point repairs shall be completed.

3. Before visual inspection, the pipe shall be cleaned as specified in Section 02565.03, "Sewer Pipe Cleaning".
4. The inspection will be done one pipeline section (between two manholes) at a time. The flow in the section being inspected will be controlled as specified in Section 02565.03, "Sewer Flow Control".
5. The television camera used for inspection shall be specifically designed and constructed for such inspection. Lighting for the camera shall be sufficient to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing a picture quality satisfactory to the Engineer. Unsatisfactory equipment shall be removed, and no payment will be made for an unsatisfactory inspection.
6. The camera shall be moved through the pipeline in either direction at a moderate rate, stopping and panning when necessary to permit proper documentation of the sewer's condition and at every house connection from which flow is evident. The camera shall remain at that location until the flow from the connection stops or until the sources of the flow has been determined. In no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions shall be used to move the camera through the sewer line. If, during the inspection operation, the television camera will not pass through the entire pipe section, the Contractor shall reset his equipment so the inspection can be performed from the opposite manhole. If, again, the camera fails to traverse the entire pipe section, the Engineer shall determine if the pipe is obstructed and if the Engineer determines the pipe is obstructed, the inspection work shall be considered complete, the pipe designated as obstructed, and no further inspection work will be required in that pipeline section.
7. When manually operated winches are used to pull the television camera through the line, suitable means of communications shall be set up between the two manholes of the section being inspected to ensure good communications between members of the crew.
8. The importance of accurate distance measurements is emphasized. Measurement for location of defects shall be made above ground by a meter device. Marking on the cable, or the like, which would require interpolation for depth of manhole, will not be permitted. Accuracy of the distance meter shall be checked by use of a walking meter, roll-a-tape, or other suitable device before beginning the inspection work.
9. Contractor shall conduct an internal inspection of designated sewers using a digital-based closed-circuit television camera. The resulting high-quality video image shall be a signal suitable for visual inspection using adequate lighting, regular lens cleaning, and appropriate speed as necessary to determine the condition of the pipe. The Contractor shall television and videotape clean pipe ("before lining") and lined pipe ("after lining").

10. The television camera shall be moved through the sewer line at a rate not to exceed 30 feet per minute (fpm). Where deficiencies and leaks are noted, the camera shall be stopped to observe the condition and record information. 360-degree panning shall be performed at all manholes and any other specific location as directed by the County.
11. Inspection equipment and software used by the Contractor must be compliant with NASSCO (National Association of Sewer Service Companies) coding. Software shall create a NASSCO PACP compliant database.
12. The Contractor shall televise the sewer after the completion of the cleaning operations to determine the location of any conditions that may prevent proper liner installation. Visual leaks shall be grouted and sealed prior to lining. Use of a pre-liner shall be subject to Engineer approval. No lining shall be performed until the County has reviewed and approved the sewer to be lined. Lining shall be performed immediately following the pre-television operation and subsequent County approval.
13. The Contractor shall also clean all debris from the sewer prior to the performance of the post-construction television inspection.
14. A report will be submitted for each lining run listing the following information: liner material, liner maker, resin material, resin maker, undercut size, thickness, date wet out, method of inversion (steam or water), direction of inversion, and details of any problems encountered during set up and processing.
15. Documentation of the television results shall be as follows:
 - a. Television Inspection Logs: Inspection logs to be provided both as hard copies in a binder, and electronically, in PDF format. One copy of typed location records shall be prepared from field inspection logs maintained by the Contractor which clearly indicate the location, in relation to an adjacent manhole, of each infiltration point and its estimated quantity of leakage observed during inspection. In addition, other points of significance such as locations of building sewers, unusual conditions, roots, storm sewer connections, broken pipe, obstructions, presence of scale and corrosion, and other discernible features will be recorded. The Contractor shall provide a television inspection log that contains enough information to populate the County's inspection log and computer systems. Coordination between the Contractor's information collection system and the County's shall be included as part of this contract. It will include identification of the section of pipe and size of the pipe. Records shall include location of reference points, point of entry of service connections via the clock system, observed running service connections, bad joints, dips in pipes, and other evidence or indications of potential problems.
 - b. The coding used on reports or logs shall be coordinated with the County's pipe classification and condition assessment designations. All reports or logs shall display and include a legend that defines the coding used.

- c. The Contractor shall bear all responsibility to ensure access for his vehicles, equipment and manpower. It is his responsibility to accurately measure the length of liner required.
- d. Photographs: Digital photos, instant developing, 35 mm, or other standard size photographs of the television picture of problems shall be taken by the Contractor, and furnished the County as a part of the Inspection Logs. Digital images shall be provided as hard copy and on a portable storage drive.
- e. A report will be submitted for each lining run listing the following information: liner material, liner maker, resin material, resin maker, undercut size, thickness, date wet out, method of inversion (steam or water), direction of inversion, and details of any problems encountered during set up and processing.
- f. Videotape Recordings:
 - 1) The videotaped recording shall be transferred to DVD format for viewing on either a computer or on a TV. DVDs to be supplied in a hard sleeve; DVD to be labeled with date, time, manhole reach (MH# to MH#). Contractor to use County manhole numbering.
 - 2) The purpose of tape recording is to supply a visual and audio record of the entire length of pipeline inspected. Videotaped recording playback shall be at the same speed as recorded. Slow motion or stop-motion playback features may be supplied at the option of the Contractor. Title to the tape shall remain with the Contractor; however, the County shall be provided a copy of all tapes/DVDs at the completion of the project as part of inspection documentation. The Contractor shall have all videotapes and necessary playback equipment readily accessible for review by the County during the project until a record copy has been made, after which time the tapes may be erased at the Contractor's option.
 - 3) Defects shall be documented and quantified verbally by the audio portion of the videotapes by the Contractor as well as in the written inspection logs. Approximate stationing shall be shown on the screen and will be reflected in the inspection log.
 - 4) The DVDs will be reviewed by the Engineer for focus, lighting, clarity of view, and technical quality. The Contractor shall maintain sharp focus, proper lightening, and clear, distortion free viewing during the camera operations. Failure to maintain these conditions will result in rejection of the videotape by the Engineer. Any videotape not acceptable to the Engineer will be re televised at no expense to the County.
 - 5) The County has standardized on the NASSCO's PACP program for pipe evaluation. The Contractor must use PACP protocols and standards for the pipe inspection. Contractor to provide proof of NASSCO certification in PACP and at least five (5) years of experience in closed-circuit television sewer and manhole inspection.

- 6) Both the pre- and post-television inspection DVDs and logs shall be submitted to the County for approval using software compliant with the County's CCTV software requirement.
- 7) Collected data shall be provided to the County in both hard copy and digital format (DVD or data file). VHS tapes or other analog forms of data will not be accepted by the County. No hand-written records will be accepted.
- 8) Data collected shall be neatly compiled in a 3-ring binder and shall include the following information at a minimum:
 - a) Title page giving name and location of project, project number, contract number, General Contractor (name address and phone number), and date.
 - b) Table of Contents
 - c) Tabbed index dividers for each section.
 - d) Tabular summary list of all work completed in the project.
 - e) All work orders given to the Contractor by the County. Identify on the work orders those completed or not. If a work order was not completed, as approved by the County, provide the reason on the work order.
 - f) TV logs in both Pipe Graphic Report form and tabular form.
 - g) DVDs containing CCTV sewer inspection videos placed in binder sleeves. Provide index to clearly identify what each disc contains.
 - h) Digital still picture of major pipe defects such as broken pipes, large I/I source, severe offset joints, etc.
 - i) At the County's request, within a four (4) hour timeframe on the same business day, the Contractor shall respond with a CCTV Crew and all appropriate equipment to televise sanitary sewer lines up to twelve (12) inches in diameter.
- 9) Television inspection and reports/logs must be done in accordance with NASSCO requirements. To ensure compatibility with the County's RJN CassWorks Software, the following requirements must be met:
 - a) Firms must be NASSCO certified
 - b) TV Inspection Software must be NASSCO and PACP certified.
 - c) CCTV camera operator must be PACP certified.
 - d) The Contractor, within ten (10) days of notice to proceed, shall demonstrate compatibility by supplying to the County sample data to verify conversion

capabilities.

H. Sewer Pipe Joint Testing

1. Before pipe joint testing, the pipe section to be tested shall be cleaned as specified in Section 02565.03, "Sewer Pipe Cleaning".
2. Before starting the pipe joint testing phase of the work, a two-part control test shall be performed as follows:
 - a. To ensure accuracy, integrity, and performance capabilities of the testing equipment, a demonstration test shall be performed in a test cylinder constructed in a manner that a minimum of two known leak sizes can be simulated. This technique will establish test equipment performance capability in relationship to the test criteria and ensure there is no leakage of the test medium from the system or other equipment defects that could affect the joint testing results. If this test cannot be performed successfully, the Contractor shall repair or otherwise modify his equipment and re-perform the test until the results are satisfactory to the Engineer. This test may be required at any other time during the joint testing work, if the Engineer suspects the testing equipment is not functioning properly.
 - b. After entering each manhole section with the test equipment, but before commencement of joint testing, the test equipment shall be positioned on a section of sound sewer pipe between pipe joints, and a test performed as specified. This procedure will demonstrate reliability of the test requirement, as no joint will test in excess of the pipe capability. Should the barrel of the sewer pipe not meet the joint test requirements, the requirements may be modified as necessary.
3. Pipe joint testing will be performed on a pipe section (between two manholes) basis.
4. The Contractor shall control flow in the pipe section undergoing crack and joint sealing in accordance with Section 02565.03, Article B, "Sewer Flow Control".
5. Sewer pipe joints visibly leaking will not require pressure testing but shall be classified as defective and designated for repair. Each sewer pipe joint not visibly leaking shall be individually tested at a test pressure equal to 0.5 psi per vertical foot of pipe depth below the ground surface plus 1 to 2 psi (not exceeding a test pressure of 10 psi) in accordance with one of the following procedures:
 - a. Liquid Test Procedure
 - 1) The testing device shall be positioned within the pipeline in a manner to straddle the pipe joint to be tested.
 - 2) The testing device ends (end elements, sleeves) shall be expanded to isolate the joint from the remainder of the line and create a void area between the testing

device and pipe joint. The ends of the testing device shall be expanded against the pipe with sufficient pressure to contain a minimum of 10 psi within the void without leakage past the expanded ends.

- 3) Water or an equivalent liquid shall then be introduced into the void area until a pressure equal to or greater than the required test pressure is observed by the void pressure monitoring equipment. If the required test pressure cannot be developed (due to joint leakage), the joint will fail the test and will be classified as defective.
- 4) The flow rate of the test liquid shall then be regulated to a rate at which the void area pressure is observed to be the required test pressure. A reading of the test liquid flow meter shall then be taken. If the flow rate exceeds 1/4 gallon per minute (due to joint leakage), the joint will fail the test and will be classified as defective and designated for repair.

b. Air Test Procedure

- 1) The testing device shall be positioned within the line in a manner to straddle the pipe joint to be tested.
 - 2) The testing device ends (end elements, sleeves) shall be expanded to isolate the joint from the remainder of the line and create a void area between the testing device and pipe joint. The ends of the testing device shall be expanded against the pipe with sufficient pressure to contain a minimum of 10 psi or the test pressure whichever is greater within the void without leakage past the expanded ends.
 - 3) Air shall then be introduced into the void area until a pressure equal to or greater than the required test pressure is observed with the void pressure monitoring equipment. If the required test pressure cannot be developed (due to joint leakage), the joint will fail the test and will be classified as defective and designated for repair.
 - 4) After the void area pressure is observed to be equal to or greater than the required test pressure, the airflow shall be stopped and a 5 second stabilization period shall commence. If the void area pressure decays by more than 0.5 psi within 20 seconds (due to joint leakage), the joint will fail the test and will be classified as defective and designated for repair.
6. During the joint testing work, records shall be maintained by the Contractor which indicate:
- a. Identification of the pipe section tested;
 - b. Test method used;
 - c. Test pressure used;
 - d. Location (footage) of each joint tested; and
 - e. A statement indicating the test results (passed or failed) for each joint tested.

I. Sewer Pipe Joint Sealing

1. General

The intent of sewer pipe joint sealing work is to seal sewer pipe joints, which have been designated as defective using the internal joint sealing method. It is recognized this method may only be used on sewer pipe sections in sound physical condition. Longitudinally cracked or broken pipe will not be sealed. When bell cracks or chips are evident from pipe section offset, sealing may be undertaken where the offset is small enough to allow proper seating of the sealing packer on both sides of the joint to be sealed.

J. Point Repairs / Line Obstructions

1. It shall be the responsibility of the Contractor to clear the line of obstructions, solids, dropped joints, protruding services, sags, offset joints or collapsed pipe that will prevent the lining of the sewer line. If inspection reveals an obstruction (a badly dropped or misaligned joint, or service protrusion) that cannot be removed by conventional sewer cleaning equipment, the Contractor shall remove or repair the obstruction. The Contractor must have the equipment, experience and labor available to make such repairs. It is the County's intent to minimize point repair excavations to uncover and remove or repair the obstruction. The County encourages the use of remote or trenchless techniques wherever possible, such as remote trenchless internal protrusion removal equipment. The Contractor shall be solely responsible to make all repairs to existing facilities to allow for the satisfactory installation of his liner. The County takes no responsibility for stuck equipment.

When required and as authorized by the County, this work shall be paid through the allowance amount established in the Contract. The Contractor will submit a proposal prior to performing the work for approval by the County.

K. Liner Installation

1. The liner shall be installed in accordance with the Liner Manufacturer's recommended installation procedure and ASTM F1216 Section 7 or ASTM F1743 Section 6. The installation procedure shall be submitted by the apparent low bidder to the County for review no later than ten (10) calendar days upon request by the County. The installation procedure shall give a detailed description of all work and materials required for the liner installation. The description shall include, as a minimum, a detailed description of the following:
 - a. The work and material required to accomplish all required point repairs.
 - b. The work and material required to accomplish bypass pumping.
 - c. The work and material required to insert the liner into the existing sanitary sewer through an existing manhole or excavation. If the proposed method of inserting the

liner requires the modification of a manhole, the cost to modify and repair the manhole shall be included in the unit price bid for the actual linear foot of structural rehabilitation liner installed. If the proposed method of inserting the liner requires excavation, a sketch of excavation must be provided and the cost to perform such work shall be included in the unit price bid line item for the linear foot of pipe to be rehabilitated.

- d. The work and material required to reform the liner until it fully forms within the existing pipe. The equipment shall be able to provide the temperatures and pressures required and as specified by the manufacturer to fully form the liner. The pressures and temperatures shall be monitored at each manhole where the liner is being formed to ensure that the recommended pressures and temperatures are available to fully form the liner over the entire length of the liner run. Boiler logs shall be submitted for each lining run.
- e. The work and material to cool the liner (and relieve the pressure) and the recommended time to maintain the temperatures and pressures to fully form the liner.
- f. The work and material required to reestablish service laterals.
- g. Construction method used at bends in pipe shall permit full inner diameter (ID) of pipe liner to be maintained. If lining through the bends is not feasible to meet this requirement or if subsequent video inspection (by the Contractor) determines that there is buckling, folds or wrinkles in the liner, the Contractor shall be responsible for excavating and replacing the pipe segments as part of the Contract.
- h. The County will not reimburse the Contractor for any unused or defective liner.
- i. Ultraviolet cured lining products are acceptable for this item of work.
- j. The Contractor may use one accessible manhole and extend through manholes to line consecutive sewer segments in difficult to access right-of-way. CIPP liner with lengths exceeding 500 LF need special consideration by the Contractor to ensure complete curing of the CIPP liner.
- k. Process Monitoring Sensors.
 - 1) Used to monitor and maintain curing temperature and internal pressure throughout the length of liner following manufacturer's recommendations.
 - 2) Heat Source: Fitted with suitable monitors to gauge temperature of incoming and outgoing heat exchanger circulating water.
 - 3) Placement: Between tube and host pipe in downstream manhole at or near bottom. Extra temperature gauges: Inside tube at invert level of each end.
 - 4) Electronically record continuous or specified pressure and temperature reading on printout. Start time. Gradual build up to curing period with maximum temperature and pressure. Time of gradual dropping of curing temperature. Cool down duration

along with relaxing temperature and pressure. Start time of gradual release of curing pressure. Ending time.

- 5) If electronic recording fails, record temperature and pressure readings on log every 10 minutes starting before pressure is added to liner and ending 20 minutes after pressure is relieved.
- 6) Provide digital thermometer or other means of accurately and quickly checking the temperature of exposed portions of the liner.

L. Sealing Liner at Manholes

1. Liners shall be sealed where the liner enters and exits each manhole. The end seal shall be a hydrophilic pipe end sealing product by Insignia™ End Seal from LMK Technologies, or approved equal, specially designed for the junction of a main or lateral pipe and a manhole. The end seal shall provide a full circle compression seal at the ends of a pipe rehabilitated by lining. The hydrophilic sealing product shall be intended for use in conjunction with inverted CIPP liners. If any annular space exists between the pipe and the liner at either manhole, the annular space shall be sealed for a distance of at least one pipe diameter inside the host pipe. Foam sealant should not protrude into the manhole and should be finished over with a quick-set, non-shrink cement grout. Finishing inside the manhole shall be accomplished using a quick-set cement type grout to raise the manhole trough to the invert of the liner pipe. Only the upstream seal should be made prior to connecting services.

M. Failure of Structural Rehabilitation Liner

1. If the liner fails to form, the Contractor shall be required to remove the failed liner at no additional cost, and shall include all material, excavation, backfilling, cutting, concrete, bracing, pipe shoring, temporary pavement, permanent pavement, and any other incidental work required to remove the liner from the existing pipe. There shall be no direct payment for this work. The Contractor shall be required to repair the existing pipe to a satisfactory condition before a second attempt is made to insert the structural rehabilitation liner. No additional bypass costs will be paid.
2. Corrections of failed new pipe or new pipe deemed unacceptable, because of the post video inspection, and/or test reports for structural values, thickness, chemical resistance, etc., shall always be the responsibility of the installer, at no extra cost to the County. Method of correction/repair shall be approved by the Engineer with prior field demonstration, if required. It shall be understood that minimum criteria of the specification shall not be lowered to compromise with lower than the required values, unless approved in writing.
3. Wrinkle & Fin Evaluation
 - a. Wrinkles and fins, in a CIPP, are a function of the host pipe's variability in circumference along the reach of sewer that is being lined and the head pressure used

by the installation team during installation of the CIPP or from a variability from an oversized liner. The generally accepted maximum height of a wrinkle or fin, in a CIPP, is 5% of the host pipe inside diameter. Wrinkle/fin material should be fully cured and solid throughout.

Wrinkles outside the flow line:

- Wrinkles/fins in height up to a maximum of 5% of the inside diameter of the host pipe, may be deemed acceptable by the Engineer.
- Wrinkles/fins over 5%, particularly those of a longitudinal configuration, must be evaluated by the project engineer for acceptance, on a case-by-case basis. If the Engineer deems the wrinkles/fins are unacceptable and repair is required, the Contractor must repair at no additional cost to the County.

Wrinkles in the flow line:

- Wrinkles/fins projecting more than 5% into the flow that are generally longitudinal in their orientation may be deemed acceptable by the Engineer on a case-by-case basis by considering any potential operation and maintenance issues that would result from their being left in place. If the Engineer deems the wrinkles/fins are unacceptable and repair is required, the Contractor must repair at no additional cost to the County.
- Wrinkles/fins in the lower third (flow line) of the finished CIPP (based upon the depth of flow) that are generally circumferential in their orientation shall not exceed 3% of the host pipe I.D. or 0.5-inches, whichever is smaller. Acceptability of larger wrinkles/fins meeting this characterization shall be on a case-by-case basis by the Engineer with consideration given to potential operations and maintenance issues that would result from their being left in place. If the Engineer deems the wrinkles/fins are unacceptable and repair is required, the Contractor must repair at no additional cost to the County.

b. Repair when wrinkles/fins are removed:

- When wrinkles/fins are removed from the installed CIPP, the pipe wall should be fully cured and homogeneous and no further repair required. If a repair is required, the manufacturer should be contacted and shall provide the recommended repair procedure for approval. The Contractor shall make necessary repairs at no additional cost to the County.
- To minimize wrinkles/fins, it is essential that the correct size liner be used for each pipe section. The Contractor shall field measure all pipe to be lined prior to ordering of liner material. Tapered liners are not required. Pipe shall be measured at the manhole of the pipe section to be lined. These measurements should be provided to the liner manufacturer so that the proper liner size is supplied. The Contractor shall submit a spreadsheet to the County showing pipe size for each segment and liner size being ordered for each segment. Spreadsheet shall be included in liner submittal.

N. Lateral Reconnection

1. After the structural rehabilitation liner has been installed, each existing active lateral connection shall be opened through the liner. The laterals shall be reconnected to provide a capacity not less than 90 percent. It shall be the Contractor's responsibility to verify which connections are active, the cost of which shall be included in the various bid items. The opening shall generally be made without excavation from the interior of the pipeline by means of a television camera-directed cutting device. Where holes are cut through the liner, they shall be neat and smooth to prevent blockage at the service connections. All cut edges shall be completely free of all burrs, frayed edges or other protrusions. All coupons must be captured and removed from the pipeline. The County Inspector will count coupons for each segment to confirm all are captured. Contractor shall have a minimum of two (2) complete and functioning lateral cutters (including new spare parts) on the jobsite before each installation or within one-hour radius of the jobsite.
2. If an active service connection is missed, it shall be the Contractor's responsibility to reconnect said service with no additional payment above the unit price bid for reconnecting service laterals. The cost of reconnecting service laterals shall be in accordance with the Contract. If service reinstatements result in openings that are greater than 100 percent of the service connection opening, the Contractor shall install a CIPP type repair, sufficiently in size to completely cover the over-cut service connection. No additional compensation will be paid for the repair of the over-cut service.
3. If the Contractor must excavate to reconnect lateral service connections, the Contractor shall bear all costs for the work, including but not limited to material, excavation, backfilling, temporary pavement, permanent pavement, and any other incidental work required to restore service lateral connections back to service. No direct payment shall be made for the work described in this paragraph. Cost shall be included in the unit price bid for reconnecting service laterals.
4. Using the Contractor's schedule, the County will notify the property owners of impending work and the approximate start and completion dates and times at least forty-eight (48) hours before commencement of the work. A notification form shall be attached to the front door of each home or building for which laterals will be reconnected. This notification to the occupant shall state that the lateral servicing this listed address will be reconnected as part of the lining process. The occupant will be directed to contact Anne Arundel County Department of Public Works if any blockage of sanitary flow occurs.

02565.04 METHOD OF MEASUREMENT

Sanitary sewer rehabilitation will not be measured for payment.

02565.05 BASIS OF PAYMENT

Payment for sanitary sewer rehabilitation will be included in the price bid for sewer pipe cleaning, sewer flow control, television inspection, sewer pipe joint testing, sewer pipe joint sealing, sewer manhole sealing, sewer manhole rehabilitation, sewer manhole lining, slip lining, cured-in-place pipe lining, pipe and fitting replacement, and sewer manhole replacement.

END OF SECTION