SECTION 615.1
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SECTION 615.1 – GENERAL CONDITIONS FOR SEWER LINING AND GROUTING

615.1 – GENERAL

A. POST CONSTRUCTION TELEVISING OF WORK

The Contractor shall conduct post-construction televising and documentation per Section 614 of these City Specs as incidental to the contract unless otherwise noted in the bid items, including any deliverables.

After grouting is completed, all lateral connections shall be final inspected by means, panning and tilting to view up the lateral from the mainline, by using a color CCTV system. The inspection shall be conducted as per the NASSCO Pipeline Assessment and Certification Program. One external hard drive and hard copy of reports shall be submitted

B. BYPASS PUMPING

The Contractor shall be solely responsible for maintaining commercial and residential sewer service at all times, with the exception of the lateral that is being installed. It shall be the responsibility of the Contractor, in instances of laterals with high flow rates as determined by the Contractor, to coordinate the work with the property owner(s) and/or occupant(s) at the Contractor's expense.

The Contractor shall provide for the bypass flow of sewage around the section or sections of pipe designated for relining. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow and to allow CCTV observation of the mainline packer throughout liner installation..

The Contractor shall submit bypass pumping plans for review by the Engineer at least 3 working days prior to the installation of the bypass. The Contractor shall notify the Engineer at least 24 hours prior to commencement of the bypass pumping operation. The Contractor shall not be allowed to start bypassing operations until their plan is approved by the Engineer. The review of the bypassing system by the Engineer shall in no way relieve the Contractor of their responsibility and/or public liability for overflows and/or backups.

C. CLEANING OF SEWER LINES

The Contractor shall remove all internal debris and obstructions which will interfere with the installation of the CIPP from the existing sewer line at their own expense as incidental to lining and grouting, unless otherwise noted in the bid items. All solids or semisolids resulting from the cleaning operations shall be removed from the site and disposed of at the Contractor's expense. All materials shall be removed from the site no less often than at the end of each work day. Under NO circumstance will the Contractor be allowed to accumulate debris or any other materials on the site of work beyond the stated time, except in totally enclosed containers and as approved by the Engineer. Any hazardous waste material encountered during this project will be considered a changed condition.

1. LINE OBSTRUCTIONS

It shall be the responsibility of the installer to clear the line of obstructions such as solids, dropped joints, roots, protruding service connections and collapsed pipe that will prevent the insertion of the liner pipe. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, then the Installer shall notify the City.

The Contractor shall remove any protruding tap, root, or deposit to the inside wall of the pipe. In no case shall the pipe be less than 95% open to flow.

At all points where the liner pipe has been exposed (such as service connection fittings, or other points where the old pipe must be removed), the liner pipe and fittings shall be encased in cement-stabilized sand or other high density material as specified by the Owner to prevent deflection due to difference in subsidence.

After the encasement material is in place and accepted by the Owner's representative, backfill is placed and compacted to required finish grade in accordance with the specifications. Particular care should be taken to ensure compaction of earth beneath the lateral pipe in order to reduce subsidence and resultant bending at the lateral connection at the sewer main.

D. OWNER COODRDINATION

The Contractor shall coordinate with the property owner(s) and/or occupant(s) to access their lateral from the internal cleanout for any work which requires cleanout access, including but not limited to any televising or testing.

E. CLEANING AND DISPOSAL

After the installation work has been completed and all testing acceptable, the Contractor shall clean up the entire project area, return the ground cover to grade, and restore any disturbed areas in-kind or as indicated on the plans, at the Contractor's expense unless otherwise noted. All excess material and debris not incorporated into the permanent installation shall be disposed of by the Contractor at their expense.

F. RESPONSIBILITY FOR OVERFLOW OR SPILLS

It shall be the responsibility of the Contractor to schedule and perform his work in a manner that does not cause or contribute to incidence of overflows or spills of sewage from the sewer system. In the event Contractor's work activities contribute to overflows or spills, the Contractor shall immediately take appropriate action at their own expense to contain and stop the overflow, clean up the spillage, disinfect the area affected by the spill, and notify the Engineer and/or property owner in a timely manner.

SECTION 615.2
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SECTION 615.2 – LINING OF SEWER MAINS AND LATERALS

615.2 - SEWER RELINING

A. SCOPE

This section describes the procedures and the work necessary for the reconstruction of existing pipelines and conduits by the installation of structural cured-in-place pipes (CIPP). A CIPP is formed by the insertion of a resin-impregnated flexible felt tube into the existing pipe. The tube is expanded to tightly fit against the original conduit and then cured by circulating hot water or introducing controlled steam within the tube.

The finished CIPP shall extend over the installation length in a continuous, tight fitting, watertight, pipe-within-a-pipe. All liners shall be smooth walled when set.

The Contractor shall provide all materials, labor, equipment, cleaning, and television inspection of the sewer to be lined, installation of the liner, reconnection of service laterals, final television inspection, and testing of the lined pipe system. The Contractor shall also submit a written report of the sanitary sewer cleaning. This report shall identify the sewer segments cleaned and the type and volume of debris removed from the sanitary sewers.

The Contractor shall contact the property owner/residents and businesses within the project limits to inform them of the project and provide them with any information deemed necessary for the successful performance of the contract, and to inform them of temporary sewer service disconnections.

If the Contractor damages the sewer during construction and is unable to complete the lining in a satisfactory manner, the cost of the excavation and/or repairs shall be included in the unit price bid for the cured in place liner.

1. LATERALS

It is the intent of this specification to provide for the rehabilitation of sanitary sewer laterals.

The work to be performed under this Section includes the furnishing of all materials, parts, labor, tools, equipment, and supervision necessary for cleaning and CCTV inspection of the laterals to be lined, liner installation, all quality controls, provide samples for performance of required material tests, final CCTV television inspection, testing of lined pipe system and warranty work, all as specified.

The CIPP shall fit sufficiently tight within the existing lateral so as to not leak at the ends of the liner. If leakage occurs through the wall of the pipe, the liner shall be repaired or removed as recommended by the CIPP manufacturer.

Final approval of the liner installation will be based on lateral televising after CIPP liner installation is complete.

The installed CIPP shall have a long term (50 year) corrosion resistance to the typical chemicals found in domestic sewage.

All materials furnished, as part of this contract shall be marked with detailed product information, stored in a manner specified by the manufacturer and tested to the requirement of this contract.

When cured, the liner shall extend to the downstream-most lateral pipe joint.

The new CIPP lateral shall be a structurally sound, joint-less, corrosion resistant, watertight, and free of all defects that will affect the long-term life and operation of the pipe. The Contractor is responsible for proper, accurate and complete installation of the CIPP.

Neither the CIPP system, nor its installation, shall cause adverse effects to any of the property owner's or City's processes or facilities. The use of the product shall not result in the formation or production of any detrimental compounds or by-products at the receiving wastewater treatment plant. The Contractor shall notify the Engineer and identify any by-products produced as a result of the installation operations, test and monitor the levels, and comply with any and all local waste discharge requirements.

The Contractor shall cleanup, restore existing surface conditions and structures, and repair any of the CIPP system determined to be defective at their own expense unless otherwise noted in the bid items.

The Contractor shall conduct installation operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, businesses, and property owners or tenants.

B. REFERENCES - LINING

This specification references American Society for Testing and Materials (ASTM), National Association of Sewer Service Companies (NASSCO), and American Water Works Association (AWWA) standards which are made part hereof by reference, and shall be the latest edition and revision thereof. If there is a conflict between these standards and this specification, this specification will govern. The ASTM testing specifications referenced are as follows:

1. ASTM D543 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

2. ASTM D638 Standard Test Methods for Tensile Properties of Plastics

3. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

4. ASTM D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

5. ASTM D903 Standard Test Methods for Delamination of Plastic Composites

6. ASTM D2290-17 Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics

7. ASTM F1216 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Insersiton and Curing of Resin-Impregnated Tube

8. ASTM F1743 Standard Practice for Rehabilitation of Existing Pipelines and Condutis by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe

9. ASTM D5813 Standard Specification for Cured-in-Place Thermosetting Resin Sewer Pipe

C. QUALITY CONTROL

Though the process may be licensed, no change of material, design values, or procedures may be made during the course of the work without the prior written approval of the Engineer. All liner to be installed under this contract may be inspected at the point of manufacture for compliance with these specificaitons by

the Engineer. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of the plant inspection shall be the responsibility of the Engineer.

At the time of manufacture, each lot of liner shall be inspected for defects. At the time of delivery, the liner shall be homogeneous throughout, uniform in color, and free of cracks, holes, foreign materials, blisters, or deleterious faults.

The Contractor shall have a Quality Control Plan or Procedure in place which allows the Engineer to monitor the resin impregnation process.

D. WARRANTY

All lining work, including any lateral lining, shall be guaranteed for a period of 3 years from the date of substantial completion granted in writing by the Engineer unless otherwise stipulated in writing by the City. During this period, all defects discovered by the City shall be removed and replaced by the Contractor in a satisfactory manner at no cost to the City. The City may conduct independent

television inspections, at its own expense, of the lining work at any time prior to the completion of the warranty period.

E. SUBMITTALS

1. QUALIFICATIONS FOR INSTALLERS OF APPROVED LINING MATERIALS

The Contractor shall submit all required pre-qualification product, manufacturer, and installer documents to the Engineer. For an installer to be accepted, the installer must satisfy all of the following:

a. Insurance, financial and bonding requirements of the City

b. Minimum of three (3) years of active experinece in the commercial installation of the product proposed

c. Successfully installed at least 500 cured-in-place service laterals of the proposed product in sewer systems in the United States

d. Must have minimum three (3) years of experience in the installation of lateral cured-in-place lining

e. The Contractor shall employ a minimum of 1 foreman and 2 crew members with experience of at least 50 liner installations

f. The Contractor shall have the equipment available for the installation and testing of the lateral liner from inside the internal cleanout

g. Acceptable documentation of these minimum requirements shall be submitted to the Engineer, and any intentional misrepresentation of references will be grounds for disqualification

h. Contractor/Manufacturer submit evidence of installer training, testing, and/or certification of being trained to install the product by the Contractor/Manufacturer for the product.

2. PRODUCT QUALIFICATION

Sewer rehabilitation products submitted for approval shall provide third-party test results supporting the short-term and long-term performance, as well as the structural strength of the product. No product will be approved without independent third-party testing verification. The tube and resin manufacturers shall be third-party certified by United States recognized organizational standards. Proof of certification shall be required for approval.

Sewer rehabilitation products submitted for approval must provide third-party test results supporting the short-term and long-term performance as well as

the structural strength of the product. No product will be approved without independent third-party testing verification. The tube and resin manufacturers shall be third-party certified by United States recognized organizational standards. Proof of certification shall be required for approval.

a. ENHANCERS – The use of proven materials that serve to enhance the pipe performance specified herein will be allowed. Proven materials must have passed independent third-party laboratory testing, not excluding long-term structural behavior testing, and must have been successfully installed to repair failing host pipes in the U.S. for at least two (2) years.

b. TESTING – Submit certified test reports demonstrating that the exact resin/liner combination to be used for this project meets the requirements for initial structural properties (performed in accordance with ASTM F1216 and ASTMD790) and chemical resistance (performed in accordance with ASTM F1216 – Appendix X2). Also submit certified test reports demonstrating that the exact resin and comparable liner to be used for this project has been tested for long term flexural modulus of elasticity and long-term flexural strength (i.e. 10,000-hour creep testing performed in accordance with ASTM D2990 for design conditions applicable to this project).

3. PROOF OF PRODUCT USAGE

Only cured-in-place lining products with a proven track record of successful installations will be approved. For cured-in-place liner product to be accepted, it must meet or exceed the following criteria:

a. The product must have been used in three successful cured-in-place lateral lining installation contracts of similar size and scope in the United States.

b. CIPP FOR LATERALS – The product must have been successfully used and installed in a minimum of 2,000 lateral liner installations, and the product must be capable of being installed and tested from the internal cleanout.

Proven materials must have passed independent third-party laboratory testing, not excluding long-term structural behavior testing, and must have been successfully installed to repair failing host pipes in the United States for at least two (2) years. For a product to meet prequalification as a commercially acceptable product, a minimum of 100,000 feet of successful waste water collection system installations in the US must be documented to assure commercial viability of the process.

c. LIMITATION OF UNPROVEN TECHNOLOGY: The use of proven materials that serve to enhance the pipe performance specified herein will

be allowed at the discretion of the Engineer. To limit the City's exposure to unproven pipe reconstruction or rehabilitation products while permitting the establishment and growth of such new product technologies where warranted, the City has established the following parameters:

i. YEARLY FOOTAGE RESTRICTION: If the new product Contractor/Manufacturer does not have a minimum of 2 years of commercial experience in installing/manufacturing the proposed rehabilitation product for essentially trenchless pipeline reconstruction in the United States, the maximum of that Contractor's/Manufacturer's new product footage that will be installed in City's system during any 12-month period will not exceed 5% (at the time of the bid) of the total footage of that Contractor's/Manufacturer's new product installed and accepted in US sewer systems.

ii. DOCUMENTATION: Footage in b.1. above will be documented by the Contractor/Manufacturer of the proposed product. Documentation will include the name, address and reference phone numbers of the users, length and diameter of the product, contract number or name, and official acceptance date by the user.

iii. FINAL ACCEPTANCE: The limitations in b.1. above and documentation requirements in b.2. will be dropped after 3 years of successful performance/maintenance of the City's system and as the product is deemed successful by the Engineer.

iv. TRIAL INSTALLATION: Contractor/Manufacturer may be required to install a minimum test section of approximately 300 feet under the supervision of the Engineer for his review prior to the award of Contract. The test section is to be designated by the Engineer and paid for by the City at 75% of the unit or lump sum prices bid.

4. DESIGN GUIDE SUBMITTAL

Contractor/Manufacturer shall submit the Engineering design guide and quality control procedures for the liner manufacture and installation, including detailed inspection, testing of physical properties, retention of production samples, and taking of field samples. Test results from 10 previous installations must be submitted and shall meet the City's current standards and requirements.

a. DESIGN CALCULATIONS – submit structural design calculations and specification data sheets listing all parameters used in the liner

design and thickness calculations based on Appendix XI of ASTM F1216 for each pipe segment/lateral.

See Section 615.2 G for more details.

5. INSTALLATION QUALITY CONTROL PLAN

   Submit plan or procedures that ensure proper materials and procedures are used in liner shipping and storage and in the resin impregnation process. Submit installation and quality control plan, including mainline sewer and lateral cleaning plan and cleanliness requirements, liner shot plan and sequence, liner installation standard procedures, temperature monitoring plan, and plan to manage flow to/from laterals during lining. The Contractor’s Quality Control Plan shall be submitted for review by the Engineer at least 2 weeks prior to the first CIPP installation.

6. CONTINGENCY PLAN

   Submit plan that includes methods and equipment to be used to repair unacceptable liner defects, for removing failed liners, and for availability and accessibility of backup equipment such as air compressors and boilers.

7. MATERIALS AND CURING DETAILS

   The Contractor shall provide submittals on all lining materials and resins and shall furnish manufacturer certification that the lining materials are in compliance with the specifications, codes, and standards referenced herein. The submittals shall include details of all component materials and construction details including complete manufacturer's recommendations for storage procedures and temperature control (step curing temperature/hours at each stage for each section thickness and length) handling, inserting the liner and curing details.

8. BYPASS PUMPING

   The Contractor shall submit bypass pumping plans for review by the Director of Public Works at least 3 working days prior to the work. The Contractor shall notify the Director of Public Works 24 hours prior to commencement of the bypass pumping operation. The Contractor’s plan for bypass pumping shall be approved by the Director of Public Works before the Contractor will be allowed to start bypass pumping.

9. CIPP FIELD SAMPLES

   To verify physical properties, the Manufacturer shall submit a minimum of 10 test results from previous field installations of the same resin system and tube materials as proposed for the actual installation. These test results must verify

that the CIPP physical properties specified herein have been achieved in previous field applications.

10. DOCUMENTATION OF LINER INSTALLATION

The Contractor shall submit installation reports for resin impregnation and a curing log of each CIPP (see Section 615.2 J. and K. for details). Installation documentation shall be submitted weekly.

F. MATERIALS

The minimum length of the CIPP shall be that deemed necessary by the Contractor to produce a finished pipe tightly formed to the existing pipe and which effectively spans the distance from the inlet to the outlet of the respective manholes.

The wall color of the interior pipe surface of the pipe after installation shall be a light reflective color so that a clear detail examination with closed circuit television inspection equipment may be made.

1. TUBE

The tube material and design considerations shall meet the requirements of ASTM F1216, Section 5.1. and modified as follows:

a. The tube shall consist of one or more layers of absorbent fabric capable of carrying resin, and capable of withstanding installation pressures and curing temperatures. The tube shall be compatible with the resin system used.

b. The tubes shall have a uniform thickness that, when compressed at installation pressures, will equal the specified nominal tube thickness.

c. The tube shall be fabricated to a size that, when installed, will tightly fit the internal circumference and length of the original pipe. The tube material shall be able to stretch to fit irregular pipe sections and negotiate bends. Allowance should be made for circumferential stretching during inversion.

d. The outside layer of the tube (before inversion) shall be plastic coated with a translucent flexible material that clearly allows inspection of the resin impregnation (wetout) procedure. The plastic coating shall not be subject to delamination after curing. The coating shall be compatible with the resin system used.

e. The tube shall be homogeneous across the entire wall thickness, containing no intermediate or encapsulated elastomeric layers. No

materials shall be included in the tube that are subject to delamination in the CIPP.

f. The wall color of the interior pipe surface of the CIPP after installation shall be white or light brown so that a clear detail examination with closed circuit television inspection equipment may be made.

g. For pull-in methods of lining, the resin soaked felt tube shall have an outer plastic lining that effectively prevents the scrape off or wash off of resin. The outer layer shall have slits cut into the plastic just prior to the pull-in that allow outward migration of resin.

h. The bond between all CIPP layers shall be strong and uniform. All layers, after cure, must form one homogeneous structural pipe wall with no part of the tube left unsaturated by resin. Delaminations in the test samples will be cause for rejection of the line segment rehabilitated. If, in the opinion of the Director of Public Works, the video of the finished liner fails to show similar delamination, then more sampling and retesting of the CIPP liner may be done by the Contractor to verify or refute the previous tests. Costs of the retests shall be the responsibility of the Contractor.

2. RESIN

The resin used shall be a thermoset resin system that is compatible with the CIPP installation. The resin shall be able to cure in the presence of water and the initiation temperature for cure shall be less than 180°F. The resin shall be a corrosion resistant polyester, vinyl ester, or epoxy resin and catallyst system that, when properly cured within the composite liner assembly, meets the requirements of ASTM F1216 and these City Specs.

Thixotropic agents that enable the resin system to possess pseudo plastic fluid flow properties, and that do not interfere with visual inspection, shall be added for viscosity control and to minimize resin washout. Resins may contain pigments that do not interfere with visual inspection of or the physical testing of the CIPP. Filler proprietary materials may be added as long as the final pipe product can meet or exceed the minimum standards set forth in these City Specs.

a. RESIN IMPREGNATION

The tube shall be vacuum-impregnated with resin (wet-out) under controlled conditions. The volume of resin used shall be sufficient to fill all voids in the tube material at nominal thickness and diameter. The volume shall be adjusted by adding excess resin for the change in resin volume due to polymerization, and to allow for any migration of resin into the cracks and joints in the original pipe. A roller system shall be used to uniformly distribute the resin throughout the tube.

Unsaturated areas of the impregnated tube that are to be installed in the host pipe (the downstream turn back and the downtube are excluded) will be cause for rejection. Should the unsaturated section of the tube be noticed before inversion, then the unsaturated area of the tube shall be re-impregnated with resin using methods developed by the Contractor and to the satisfaction of the Engineer.

The Contractor shall designate a location where the CIPP will be vacuum-impregnated prior to installation. The Contractor shall allow the Engineer to inspect the materials and procedures used to vacuum-impregnate the tube.

3. LATERAL LINING

   a. LINER ASSEMBLY – The liner assembly shall be continuous, and contiguous, in length and consist of one or more layers of absorbent needle punched felt, circular knit or circular braid that meet the requirements of ASTM F1216 and ASTM D5813 Sections 6 and 8. No intermediate or encapsulated elastomeric layers shall be in the textile that may cause delamination in the CIPP. The textile tube and sheet shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe segments, and flexibility to fit irregular pipe sections. The resin saturated textile tube and sheet shall meet ASTM F1216, 7.2 as applicable, and the tube shall have 5% to 10% excess resin distribution (full resin contact with the host pipe) that when compressed and cured will meet or exceed the design thickness.

   b. LATERAL LINER TUBE – The exterior of the lateral liner tube shall be laminated with an impermeable, translucent flexible membrane. Longitudinal seams in the tube shall be stitched and thermally sealed. The lateral tube will be continuous in length. The lateral tube will be capable of conforming to offset joints, bends, bells and disfigured pipe sections. For pipe configurations that contain pipe diameter transitions, the transition liner tube must be formed by the manufacturer prior to installation to ensure proper wall thickness per ASTM F1216.

   c. BLADDER ASSEMBLY – The liner assembly shall be surrounded by a second impermeable, inflatable, invertible, flexible translucent membrane bladder that will form a liner/bladder assembly. The translucent bladder shall facilitate vacuum impregnation while monitoring the resin saturation process.

   d. WATER – Water is only available from select hydrants as identified by the City of Wauwatosa Water Department. See Section 605.1.02(A) for further details.

G. DESIGN CONSIDERATIONS

1. BUCKLING

The Contractor shall be responsible for all aspects of the design of the liner pipe. The Contractor shall guarantee that the installed liner is capable of sustaining outside loads, resisting chemical attack that normally occurs in sanitary and storm sewers, and will maintain hydraulic characteristics over a 50 year design life. No design shall rely on bonding to the existing pipe or rely on the remaining strength of the existing pipe. The minimum acceptable design criteria follows.

The Liner Pipe shall be designed to fit the existing sanitary or storm sewer. Provisions shall be made in the manufacturing process such that the SDR's will be achieved after the pipe has been expanded to the existing pipe.

The existing sewer shall be considered to be in a fully deteriorated gravity pipe condition, and that the original pipe is not structurally sound and cannot support soil and live loads. The CIPP shall be designed to support hydrostatic, soil and live loads. The CIPP liner shall be designed in accordance with ASTM1216, Appendix X1 and the following design conditions:

a. H_w = height of water above top of pipe, ft. (lesser of 12 ft. or exist. cover)

b. H = height of soil above top of pipe, ft. (use maximum existing cover)

c. C = reduction factor for long term effects = 0.50 to 0.66

d. N = factor of safety = 2.0

e. E'_s = modulus of soil reaction, psi = 1,250 psi

f. E_L = long term (50 year) flexural modulus of elasticity (per ASTM D790) = 200,000 psi (minimum)

g. Existing Soil Density, lb./cu.ft. = 130 pcf

h. Live Load, lb./sq.ft. = AASHTO H_{20} Wheel Load of 16,000 lb.

i. Initial Flexural Strength (per ASTM D790) = 4,500 psi

j. Long-Term Flexural Strength (per ASTM D790) = 2,250 psi

k. Minimum ovality of host pipe = 3%

l. Assume no bonding to original pipe.

m. E = initial flexural modulus of elasticity (ASTM D790) = 400,000 psi

NOTE: Flexural modulus has been reduced for long term loading in accordance with the recommendations contained in AASHTO Standard Specifications for Highway Bridges, Section 18, "Soil-Thermo Plastic Pipe

Interaction System." The Director of Public Works has selected this source for 50 year design life. The Contractor may submit other third-party source information for consideration. The Director of Public Works will be the sole judge of the parameters used in design.

EXCLUSIONS: Any layers of the tube that are not saturated with resin prior to the insertion into the existing pipe shall not be included in the structural CIPP wall thickness. No factors of design relating to adhesion to the existing pipe will be allowed in the design.

2. HYDRAULIC CAPACITY

Overall condition of the pipeline system shall be maintained with its hydraulic profile as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Offsets of two adjacent pipe sections more than 25% of the diameter of the pipe shall be repaired by grinding and/or straightening the offset to be a usable shape in a manner mutually acceptable between the Contractor and the Director of Public Works.

3. LATERAL TUBES

The CIPP design for the lateral tube shall assume no bonding to the original pipe. The resin saturated lateral tube shall place the resin in full contact with the host pipe. The cured liner shall provide coating on the interior of the sewer mainline or lateral piping for an improved flow rate. The liner shall be smooth and have an average roughness coefficient “n” factor of 0.013 or lower.

H. TESTING REQUIREMENTS

1. CHEMICAL RESISTANCE

The Contractor shall certify that the CIPP meets the chemical resistance requirements of ASTM F1216, Appendix X2. Samples for testing shall be taken of tube and resin system similar to that proposed for actual construction. It is required that samples with and without plastic coating meet these chemical testing requirements.

2. HYDRAULIC CAPACITY

The Contractor shall certify that the CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition. The roughness coefficient of the CIPP shall be verified by third party test data.

3. SAMPLING AND TESTING

The Contractor shall obtain samples and perform the tests as specified in ASTM F 1216 Section 8 to verify that the actual installation meets the required property specifications. Also refer to these City specifications for requirements.

I. INSTALLATION RESPONSIBILITIES FOR INCIDENTAL ITEMS

1. SAFETY

The installer shall carry out his operation in strict accordance with all OSHA and manufacturers' safety requirements. Particular attention is drawn to those safety requirements involving entering confined spaces.

2. TRAFFIC CONTROL

Traffic Control shall be the responsibility of the Contractor and shall conform to MUTCD and other portions of these specifications and the contract Special Provisions. The Contractor shall maintain traffic during working periods. During nonworking periods, the Contractor shall open the entire roadway to traffic.

3. ACCESS

It will be the responsibility of the owner to locate and designate all manhole access points open and accessible for the work, and provide rights of access to these points. If a street must be closed to traffic because of the orientation

of the sewer, the Contractor shall institute the actions necessary to do this for the mutually agreed time period.

4. WATER USAGE

Water is available from specific City hydrants for cleaning, inversion and other work items requiring water. However, the Contractor shall secure permission from the Water Dept. and obtain the necessary permits and pay the fees associated with the permit. Special reference is made to Section 610.1.03A of these City specs.

5. INSPECTION OF PIPELINES

Inspection of pipelines shall be performed by NASSCO PACP certified personnel trained in locating breaks, obstacles and service connections by closed circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the impregnated tube including, but not limited to,

protruding taps, collapsed or crushed pipe, and reductions in cross sectional area of more than 20%. Televising and related documetntation shall be per section 614 of these City Specs.

J. INSTALLATION OF CIPP IN MAINLINE SEWERS

1. INSTALLATION

a. The wet out tube shall be inserted through an existing manhole or approved access point by means of an inversion process and the application of a hydrostatic head sufficient to extend it to the next designated manhole or termination point.

b. Tube installation forces or pressures shall be limited so as not to stretch the tube longitudinally by more than 5% of the original length.

c. Before the installation begins, the tube manufacturer shall provide the minimum pressure required to hold the tube tight against the existing conduit, and the maximum allowable pressure so as not to damage the tube. Once the installation has started, the pressure shall be maintained between the minimum and maximum pressures until the installation has been completed.

d. The CIPP liner shall not be installed at a rate over two feet per second as gauged at the point of insertion at the top of the water column.

e. The existing conduit shall be dewatered for any CIPP installation that does not use an inversion method to expand the tube against the pipe wall.

f. For *pull-in methods*, a proofing section shall be pulled through the existing conduit prior to installation. The proofing section shall consist of the materials proposed for rehabilitation. The minimum length of the proofing section shall be 5 feet in length and shall be of like diameter and thickness. If proofing section is damaged, point repairs shall be made to the existing conduit. The proofing process shall be repeated using a new proofing section to verify effective point repairs. Repeat proofing and point repair process until proofing results in no damage to proofing section. Installation of CIPP using pull-in methods can begin after successfully proofing the existing conduit .

g. The standard inversion technique involves the release of any entrapped air or vapor from the turn back end of the uncured CIPP. Typically, this process requires the cutting of the outer plastic lining to allow the air/vapor to escape prior to the submergences of the turn back end of the uncured CIPP. The cuts in the plastic shall be repaired with suitable tape and glue prior to the submergence of the turn back end in the inversion column.

h. The use of a lubricant during inversion is recommended to reduce friction. This lubricant should be poured into the water in the downtube or applied directly to the tube or inflation bladder. Lubricant shall not be used in process where impermeable coatings are perforated prior to tube installation. The lubricant used should be a nontoxic, oil-based product that has no detrimental effects on the tube or boiler and pump system, will not support the growth of bacteria, and will not adversely affect the fluid to be transported.

i. Should and instance arise where two liners are overlaped, the area where they meet shall be sealed with a hydrophilic O-ring or other suitable material approved by the Engineer.

j. The City will entertain proposals for other methods of installation provided the Contractor submits adequate documentation supporting the method. The Director of Public Works will have the final determination of acceptability any installation method. The Contractor shall base his bid on the specified installation methods.

2. CURING

a. After installation is completed, a suitable heat source and water or steam recirculation equipment are required to circulate heated water throughout the pipe. The equipment should be capable of delivering hot water or steam throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin. Water temperature in the line during the cure period should be as recommended by the resin manufacturer.

b. The heat source should be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge should be placed between the impregnated tube and the pipe invert at the termination to determine the temperatures during cure.

c. Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature recommended by the resin manufacturer. The post-cure temperature should be held for a period as recommended by the resin manufacturer, during which time the recirculation of the water and cycling of the boiler to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

3. COOL-DOWN

The CIPP should be cooled to a temperature below 100°F (38°C) before relieving the hydrostatic head. Cool-down may be accomplished by the introduction of cool water into the CIPP to replace water being drained from a small hole made in the downstream end. Care should be taken in the release of the static head so that a vacuum will not be developed that could damage the newly installed pipe.

4. INFLATION BLADDER REMOVAL

For pulled-in place installation techniques where the inflation bladder is designed to not bond to the CIPP, all portions of the bladder material must be removed from the CIPP.

K. INSTALLATION OF CIPP LATERAL LINING

1. EXISTING LATERAL INSPECTION AND PIPE PREPARATION

Inspect lateral prior to lining operations per Section 614 of these City Specs. This initial inspection will determine if the lateral is a candidate for lining rehabilitation. Any issues discovered during this initial investigation that may have an effect on the lining process needs to be discussed with the Engineer to determine how we will proceed. This initial inspection is incidental to the lateral lining bid item.

Cleaning of the lateral in preparation for the lining process is incidental to the lining pay items in this contract. Pipe preparation should be in accordance with manufacturer’s specifications to ensure the host pipe is best prepared to

receive the new lateral liner. The lateral shall be cleaned using industry standard cleaning heads, and provide a sufficient cleaned length to ensure existing lateral is prepared for the CIPP lining. It is the responsibility of the Contractor to verify, prior to installation, that all internal debris has been removed from the sewer lateral.

If the lateral has obstructions that the Contractor believes require the use of alternative cleaning and preparation techniques, the Contractor shall notify the Engineer. The Engineer may authorize in writing the use of contingent items for the heavy cleaning of the lateral.

The Contractor is also responsible for contacting the Engineer in case of debris or defects in the mainline sewer that would prohibit the CIPP lining of the specified lateral. The Engineer may authorize in writing the use of

contingent items to perform heavy cleaning of the mainline sewer and/or perform a mainline spot repair.

Inspect and confirm the inside diameter, alignment, length and condition of each lateral to be lined. Field measure lateral diameters, including transitions in lateral diameters, and identify exact locations of fittings and bends. All dimensions shall be field verified by the Contractor prior to delivery of the liner. If unknown physical conditions in the work area that differ materially from those ordinarily encountered are uncovered during the investigation, the Contractor shall notify the Engineer.

If the existing lateral between the mainline sewer and the internal cleanout is found to be damaged through no act of the Contractor, contains an obstruction that cannot be removed by the conventional cleaning equipment, or contains a sag that is unacceptable to the Engineer, submit inspection documentation to the Engineer. The Engineer may authorize the use of contingent bid items to repair the defects in the lateral.

2. RESIN IMPREGNATION

The liner assembly is encapsulated within the translucent bladder (liner/bladder assembly)the entire liner shall be saturated with the resin system (wet-out) under controlled vacuum conditions. The volume of resin used shall be sufficient to fill all voids n the textile lining material at nominal thickness and diameter. The volume shall be adjusted by adding 5-10% excess resin for the change in resin volume due to polymerization and allow for any migration of resin vume due to polymerization and to allow for any migration of resin into the cracks and joints in the original pipe. No dry or unsaturated area in the lateral tube shall be acceptable upon visual inspection. The Contractor shall complete a wet-out process control sheet for every lining completed. The control sheets shall provide, at a minimum, the following information:

- Liner Manufacturer
- Liner Diameter
- Number of Layers
- Resin Amount
- Resin Type
- Resin Manufacturer
- Batch Number (Resin)
- Hardener Name
- Batch Number (Hardener)
- Mixing Ratios
- Vacuum Pressure of Impregnation Process
- Wet-Out Start Time and Date

3. LINER INSERTION

The lateral tube and inversion bladder shall be inserted into the launching device. The launching device is inserted into the pipe and pulled to the point of repair. The pull is complete when the lateral tube is exactly aligned with the lateral pipe connection. The lateral tube is completely protected during the pull. The liner assembly shall not be contaminated or diluted by exposure to dirt or debris during the pull.

4. CURING

After insertion is complete, apply a suitable recirculation system capable delivering air, steam, or water, as required by the liner system manufacturer (or ambient temperature curing), uniformly throughout the section to achieve a consistent cure of the resin. Maintain the curing temperature as recommended by the liner system manufacturer. Prevent excessive temperatures that could scald or bubble the liner.

a. WATER INVERSION PROCESS – If water is used to accomplish the inversion process, the Contractor shall complete an installation process control sheet for every lining completed. The control sheets shall provide the following information:

- Liner Length
- Hydrostatic Head at Point of Inversion
- Hydrostatic Head at Termination Point
- Time When Inversion Process Starts
- Time When Curing Begins and Ends

b. AIR INVERSION PROCESS – If air is used in the inversion process, liner manufacturer shall provide the minimum pressure required to hold the tube tightly against the host pipe, and the maximum pressure allowable to not damage the tube. Once the inversion has started, the pressure shall be maintained between the recommended pressure ranges until the inversion has been completed. Should the pressure deviate from within this range, the installed liner shall be removed. The Contractor shall complete an installation process control sheet for every lining completed. The control sheets shall provide the following information:

- Liner Length
- Minimum Pressure
- Maximum Pressure
- Time and Pressure When Inversion Process Started (and every 10 minutes until inversion process completes)
- Time When Curing Begins and Ends

5. COOL-DOWN

   The CIPP shall be cooled to a temperature below 100°F (38°C) before relieving the hydrostatic head. Cool-down may be accomplished by the introduction of cool water into the CIPP to replace water being drained from a small hole made in the downstream end. Care shall be taken in the release of the static head so a vacuum will not be developed, which could damage the newly installed pipe.

6. REMOVAL

   After the curing process is complete, the Contractor shall remove all installation and curing equipment from the host pipe. No material other than the cured CIPP shall remain in the host pipe. Remove any excess liner material protruding into the sewer main or manhole by remote robotic cutting equipment, or manual means, in accordance with the manufacturer's instructions. Provide a finished CIPP that is continuous and as free as commercially practicable of visual defects, including but not limited to foreign inclusions, dry spots, pinholes, delamination, and wrinkles in any location in excess of 5% of the host pipe's inside diameter.

L. REINSTATEMENT OF BRANCH CONNECTIONS

After the pipe has been relined and tested (refer to Section 610.3.06.K) only existing active service connections as shown on the plans shall be reconnected. The reconnection of services shall be done without excavation, unless otherwise specified by Owner; this will be accomplished from the interior of the pipeline by a television camera directed cutting device. The location of the service shall be made by inspection of the preconstruction TV tape and other proven detection

methods. The Contractor shall remove and dispose of any pieces or shavings of the liner that result from the opening of the service connection.

All recut service connection shall be brushed smooth and free of burrs and frayed edges, or any restriction preventing free wastewater flow and shall be reinstated to 90% of the original opening. Overcutting of the opening will be cause for rejection. In the event of overcutting or other defect, the Contractor shall either make an open cut saddle type point repair or use an approved method of short-lining of the service that overlaps the overcut or defective portion of the sewer liner.

M. ANNULAR SEAL AT MANHOLES

All manhole to CIPP seals shall be of the hydrophilic elastomer type capable of forming a watertight seal in the presence of water that will fill the annular space without gaps. The material used shall be either Hydrotite or an approved equal.

N. TESTING

1. For each inversion length designated by the Engineer in the contract documents or purchase order, one CIPP sample shall be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been inverted through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags. (Note: In areas with limited space and larger diameter pipes, other sampling techniques may be required). In pipes greater than 18-inches in diameter, other sampling and curing techniques may be required. All samples shall be labeled before shipment to the testing laboratory and a duplicate sample shall be provided to the Engineer.

2. The sample should be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing and also for tensile testing, if applicable. The full CIPP sample wall thickness shall be tested, whenever possible. If the sample is irregular, distorted, or of such thickness that proper testing is inhibited, then the wall thickness shall be machined away from the inside pipe face of the sample only. Thus, the test specimen shall be cut from the outside pipe face of the CIPP sample. For specimens greater than 1/2 inch (12.70 mm) depth, the width-to-depth ratio of the specimen shall be increased to a minimum of 1:1 and shall not exceed 4:1. Test specimens shall be oriented on the testing machine with the interior surface of the CIPP in tension. The following test procedures should be followed after the sample is cured and removed.

    a. FLEXURAL (BENDING) PROPERTIES – The initial tangent flexural modulus of elasticity and flexural stress should be measured for gravity and pressure pipe applications in accordance with Test Method D 790, Test Method I Procedure A, and should meet the requirements of these City Specs.

    b. TENSILE PROPERTIES – The tensile strength should be measured for pressure pipe applications in accordance with Test Method D 638 and must meet the requirements of these City Specs.

3. GRAVITY PIPE LEAKAGE TESTING

Leakage testing of the CIPP shall be conducted after cure and prior to the reinstatement of laterals while under hydrostatic pressure. The downstream (turn back) end of the liner pipe shall be cut out to within two inches of the manhole wall. A standard inflatable sewer plug shall be inserted into the liner pipe and inflated to a pressure that will withstand the static head provided by the water filled down tube. The liner pipe shall then be refilled with water. The water level of the downtube will be observed for five minutes by the Engineer or their representative. The change in water elevation, if any, will be noted, the water loss rate calculated and compared to the acceptable leakage standard for new pipes. The test results shall be judged against the exfiltration limits shown in Table 5 of Section 3.7.2 of the Standard Specs and in general conformance with Section 3.7.4.

4. DELAMINATION TEST

For all CIPP products, a delamination test should be performed on each installation length. The sample shall be fabricated from material taken from the tube and the resin/catalyst system used and cured in a clamped mold placed in the downtube. Delamination testing shall be in accordance with ASTM D 903 with the following exceptions:

a. The rate of travel of the power-actuated grip shall be 1 inch (25 mm)/minute.

b. Five test specimens shall be tested for each inversion specified.

c. The thickness of the test specimen shall be minimized but should be sufficient to adequately test delamination of nonhomogeneous CIPP layers.

d. The peel or stripping strength between any nonhomogeneous layers of the CIPP laminate should be a minimum of 10 lb/in. (178.60 g/mm) of width for typical CIPP applications.

O. INSPECTION & ACCEPTANCE

After all testing and work is completed, the contractor shall internally inspect the CIPP installation by closed circuit television and provide the City with video showing the completed work including the restored conditions. The connections and seals at manholes shall be visually inspected.

1. The relining pipe shall be continuous, without joints over the entire length of the pipe. The liner shall be free of all visual and material defects except those resulting from pre-lined conditions (such conditions shall be brought to the attention of the owner prior to relining). There shall be no pits, pinholes, cracks or crazing, lifts, dry spots or delamination. The surface shall be smooth and free of waviness throughout the pipe.

   Any defects or unacceptable liner determined by the television inspection, test reports for structural values or thickness that will affect the structural integrity of the reconstructed pipe shall be repaired or the Liner replaced at the Contractor's expense. The methods and materials used for the repair or replacement of the failed liner shall be reviewed by the Director of Public Works.

2. WRINKLES

   Wrinkles in the finished liner pipe that are larger than 5 percent of the pipe diameter are unacceptable and shall be removed and repaired by the Contractor at the Contractor’s expense.

3. ANNULAR VOID

   It is the City’s responsibility to demonstrate that a void between the liner pipe and the host pipe wall exists. If so shown, the Contractor shall either devise a method to grout the void to the satisfaction of the Engineer of repair or replace that section of pipe at the Contractor’s expense. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for review. The City may demonstrate the existence of the void by dye water flooding of the upstream manhole and viewing the downstream pipe annular space for tracking. Annular voids shall be considered nonconforming work.

4. CIPP samples shall be prepared and tested in accordance with ASTM F1216, Section 8.1 using either method proposed.

5. Visual inspection of the CIPP shall be in accordance with ASTM F1216, Section 8.4.

6. THIRD PARTY TESTING

   All material testing referred to in this contract specification shall be done by an accredited Third Party testing laboratories. The Contractor shall inform the Engineer at the preconstruction meeting of the laboratory that the Contractor intends to use for the tests. All costs for the testing shall be included in the contract unit prices for the relining work.

7. DIGITAL MEDIA AND WRITTEN REPORTS

The Contractor shall perform pre-installation and post-installation inspections of the pipeline by means of remote controlled closed circuit television in accordance with Section 614 of these City Specs. These inspections shall be recorded on an external USB hard drive. The Contractor shall document these inspections in writing and submit all written reports and video to the Engineer. This work shall be considered incidental to any lining or grouting, except where called out as a separate bid item in the contract documents.

Pre-installation inspection of any pipe run shall be performed not more than 3 calendar days before the start of the lining of that pipe run. If the pre-installation inspection reveals any deficiencies in the cleaning or removal of obstructions, the deficiencies shall be corrected and the pre-installation inspection shall be performed again at no additional cost to the City.

The Contractor shall also submit a written report of the sanitary sewer cleaning. This report shall identify the sewer segments cleaned and the type and volume of debris removed from those sanitary sewers.

8. CIPP LATERAL ACCEPTANCE

All CIPP shall be continuous in length and wall thickness shall be uniform. Installed thickness of the CIPP lateral liner shall be within minus 10 percent and plus 15 percent of the design. The Contractor shall take into account any necessary allowance for longitudinal and circumferential expansion when sizing and installing the liner. The contact tolerance is 1.0 mm. Where any space or gap between the outside surface of the liner and the inside surface of the existing pipe exceeds 1.0 mm, the liner fit will be deemed deficient and corrective action will be required.

Where irregularities of the existing pipe exists such as offset joints, protrusions, bumps, and deformations, and the irregularities remain after the sewer has been prepared in accordance with the Contract Documents, exception to the contact tolerance will be allowed in the irregularity zone at the discretion of the Engineer. The exception shall not present an obstruction to sewage flow.

Acceptance of the CIPP lateral liner will be based on the Engineer’s evaluation of the resin impregnation quality control reports, CIPP temperature curing logs, and post construction inspection video, which shall demonstrate:

a. Observed infiltration of the liner is zero
b. All active service connections are open, clear and watertight.
c. There is no evidence of excessive wrinkles, cracks, lifts, scalds, blisters, or delamination in the CIPP.

If any defective CIPP is discovered after it has been installed, it shall be removed and replaced with either a sound liner or a new lateral at no additional cost to the City. Obtain approval of the Engineer for method of repair, which may require field or workshop demonstration.

P. CLEANUP

After the installation work has been completed and all testing acceptable, the Contractor shall clean up the entire project area and return the ground cover to grade. All excess material and debris not incorporated into the permanent installation shall be disposed of by the Contractor. Sidewalk, driveway, street surfaces and lawn areas shall be restored to its preconstruction condition at the Contractor's expense.

615.2.1 – LATERAL LINING SYSTEM

A. GENERAL

These specifications include the minimum requirements for the rehabilitation of lateral connections and their interface with the mainline pipes via CIPP, as shown on the plans and included in the contract documents. The length and type of CIPP installed shall be as specified in the contract documents or as directed by the Engineer.

Lateral CIPP shall be installed from the mainline pipe and extending to the specified length as shown or stated in the contract documents, or as directed by the Engineer. Cleanouts are required where shown on the plans. The installed lateral CIPP system shall be free of all defects that will affect the design, service life, and operation of the lateral interface with the mainline sewer and the specified length of the lateral pipe.

The liner may be inverted or pulled into place from the mainline sewer.

The installed system shall eliminate water leakage into the sewer system over the entire rehabilitated length of sewer.

The prices submitted by the Contractor shall include all costs fot he various bid items necessary for furnishing and installing, complete and in place, the system in accordance with these specifications, except as otherwise directed by the Engineer.

The furnished and installed system shall include all materials, manufacturer’s recommended equipment, and manufacturer’s installation procedures.

The installed system shall be free of all defects that will affect the design, service life, and operation of the lateral and applicable portion of the mainline. The installed system shall eliminate infiltration and exfiltration over the entire length of the system.

The system shall be designed against corrosion and typical chemicals found in domestic sewage or as directed by the Engineer. The manufacturer of the system shall provide testing data that supports the chemical resistance in accordance with ASTM F1216.

The mainline and lateral portion of the system shall be designed to support groundwater loads and structurally replace the host pipe completely. Wall thickness design calculations stamped by a registered professional engineer shall be included with the Contractor's submittals. All design must be supported by third party testing and documentation for the exact product being submitted.

All materials furnished as part of this contract shall be marked with detailed product information, which shall be made available to the Engineer at their request, including any Manufacturer's testing data.

See Section 615.1 of these City Specs for requirements of bypass pumping and other general construction requirements.

B. SUBMITTALS

Product data submittals required for all rehabilitation lateral lining systems proposed for installation under this contract shall include:

- System material type and manufacturer to be used, including catalog data sheets, ASTM references, material composition, manufacturer's recommended specifications, component physical properties, and chemical resistance.
- Manufacturer's detail description of the recommended procedures for handling and storing materials.
- All quality assurance documentation and test reports for the system materials, and testing results of the physical properties, corrosion resistance, and sealing method.
- CIPP wall thickness design calculations based on ASTM F1216, stamped by a registered professional engineer.
- Wetout/cure logs per liner providing details pertaining to the resin type and quantity, catalyst type and quantity, tube type, installation pressures, temperatures and times (as applicable to the curing lateral lining system utilized).
- Qualifications of the Contractor installing the system.

C. QUALITY CONTROL PLAN

A detailed quality control plan (QCP) shall be submitted to the Engineer that fully represents and conforms to these specifications. At a minimum, the QCP shall include the following:

- How the system is prepared for installation
- How the system is installed
- How the completed system is confirmed to be in compliance with the requirements of the contract documents
- Training/Qualifications of personnel preparing and installing the system

Proposed procedures for quality control, product sampling, and testing shall be defined. Proposed methods and procedures for system repair and replacement in the events of product defects or failure shall also be included.

The Contractor shall not receive any additional compensation for the repair or replacement of a system deemed non-conforming to these contract documents by the Engineer.

D. SAFETY

The Contractor shall conform to all work safety requirements of pertinent regulatory agencies, and shall secure the site for working conditions in compliance with those requirements, including confined space entry. This includes the posting of such signs and/or other devices as are necessary for the safety of the work site for both the Contractor and the Public.

E. WARRANTY

All lateral lining work shall be guaranteed for a period of 3 years from the date of substantial completion granted in writing by the Engineer unless otherwise stipulated in writing by the City. During this period, the Engineer reserves the right to inspect and/or test, at their own expense, any and all work performed as part of this contract. Any actionable defects documented during this period by the Engineer shall be repaired or replaced by the Contractor at no additional cost to the City. The Engineer shall have until the end of the warranty period to report the findings of their inspection(s) and/or testing to the Contractor, and the Engineer shall negotiate a reasonable repair schedule for any actionable items found. The warranty shall cover lining repair due to hydrostatic leaks (infiltration) as defined per NASSCO PACP infiltration definitions, and any other work directed by the Engineer to make the finished product meet these specification requirements.

F. MATERIALS

1. GENERAL

“Top-Hat” style liner systems shall NOT be allowed under these specifications without the express written permission of the Engineer.

The system seals the point of connection from the mainline pipe to a connecting lateral pipeline and is normally installed without excavation by the installation of resin-impregnated, flexible laminate installed into the existing service lateral, lapping over the mainline pipe, and sealing the connection.

The portion of the system installed over the mainline pipe shall, at a minimum, extend from one end of the wye fitting to the other, and shall encompass the entire cross section of the pipe, from 12 o’clock to 12 o’clock (“full wrap”). For other lateral connection fitting types, including break-ins, the mainline portion of the system shall extend a minimum of 1-foot in each direction, measured from the center of the lateral pipe, and shall also encompass the entire cross section of the mainline pipe from 12 o’clock to 12 o’clock (“full wrap”).

The distance the lateral system extends up the lateral shall be as noted in the contract documents or as directed by the Engineer. The system shall extend continuously from the sewer main into the lateral and up the lateral to the designated length. The system shall be capable of sealing lateral connections of various types and angles. The resin shall be cured to for the tube into a hard, impermeable pipe-within-a-pipe.

When cured, the system shall seal the connection of the lateral to the mainline in a continuous, tight fitting, watertight pipe-within-a-pipe to eliminate any visible leakage between the lateral and mainline, and shall provide a leak-proof seal to prevent root intrusion, infiltration, and exfiltration between the liner and host pipe.

Systems that use polyester and vinylester resins shall include a method of sealing the connection and the end of the lateral liner as recommended by the manufacturer of the system. The product used in the sealing method shall be installed in accordance with manufacturer’s recommendations.

Systems that use silicate or epoxy shall prepare the host pipe in accordance with the manufacturer’s recommendations. Third party testing data shall be provided to prove the bond strength between the resin and surface to which it is to bond.

The installation of the system will require the product to be capable of being installed without access to the upstream side of the lateral pipe, and capable of navigating bends or other transitions in the lateral.

2. REFERENCES

ASTM F1216 – Standard practice for rehabilitation of existing pipelines and conduits by the inversion and curing of a resin-impregnated tube.

ASTM F1743 – Standard practice for rehabilitation of existing pipelines and conduits by pulled-in-place installation of cured in place thermosetting resin pipe.

ASTM D543 – Practices for evaluating the resistance of plastics to chemical reagents.

ASTM D790 – Test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials.

ASTM D5813 – Specification for cured in place thermosetting resin sewer piping systems

ASTM F2019 – Standard practice for rehabilitation of existing pipelines and conduits by the pulled in place installation of glass reinforced plastic (GRP) cured in place thermosetting resin pipe.

NASSCO Guideline Specification for the installation of cured in place pipe (June 2011)

NASSCO Guideline Specifications for cleaning and televising pipelines

3. MATERIAL TYPES

a. Non-Woven Fabric Tube

The fabric tube shall consist of one or more layers of absorbent non-woven felt fabric, felt/fiberglass or fiberglass and meet the requirements of ASTM F1216, ASTM F1743, ASTM D5813, and ASTM F2019. The fabric tube shall be capable of absorbing and curing temperatures and have sufficient strength to bridge missing pipe segments, and stretch to fit irregular pipe sections.

The wet-out fabric tube shall have a uniform thickness and excess resin distribution that when compressed at installation pressures will meet or exceed the design thickness after cure.

The fabric tube shall be manufactured to a size that when installed will tightly fit the internal circumference, meeting applicable ASTM standards or better, of the original pipe or the existing lined pipe. Allowance shall be made for circumferential stretching during installation. The tube shall be properly sized to the diameter of the existing pipe and the length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends. The Contractor shall determine the minimum tube length necessary to effectively span the designated run. The Contractor shall verify the lengths in the field prior to ordering and prior to impregnation of the tube with resin, to ensure that the tube will have sufficient length to extend the entire length of the run. The contractor shall also measure the inside diameter of the existing pipelines in the field prior to ordering liner so the liner can be installed in a tight-fitted condition.

The outside and/or inside layer of the fabric tube (before installation) shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate vacuum impregnation and monitoring of the resin saturation during the resin impregnation (wetout) procedure.

No material shall be included in the fabric tube that may cause de-lamination in the cured CIPP. No dry or unsaturated layers shall be acceptable up on visual inspection as evident by color contrast between the tube fabric and the activated resin containing a colorant.

The wall color of the interior pipe surface CIPP after installation shall be a light reflective color so that a clear, detailed examination with closed circuit television inspection equipment may be made. The huge of the color shall be dark enough to distinguish a contrast between the fully resin saturated felt fabric and dry or resin lean areas.

Seams in the fabric tube, if applicable, shall meet the requirements of ASTM D5813 H.

The outside of the fabric tube shall be marked with the name of the manufacturer of the CIPP lateral lining system, manufacturing lot and/or production footage, as applicable. The print must be visible during final CCTV inspection.

The minimum length of the fabric tube shall be that deemed necessary by the installer to effectively span the distance specified in the contract documents or as directed by the Engineer.

The nominal fabric tube wall thickness shall be of a dimension to provide a watertight CIPP and a complete structural replacement for the host pipe, without causing an unreasonable reduction in cross section size.

The liner shall be constructed with transitions where applicable.

b. Resin

Theresin shall be corrosion resistant polyester, vinylester, silicate, or epoxy resin and catalyst system and hardener system that, when properly cured within the tube composite, meets the requirements of ASTM F1216, ASTM F1743 or 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 these specifications.

The method of cure may either be from a manufacturer recommended heat source or UV light cure. Method of cure instructions along with a cure log shall be on site at all times.

The resin to tube ratio, by volume, shall be furnished as recommended by the manufacturer.

c. Structural Requirements

The physical properties and characteristics of the finished liner will vary considerably, depending on the types of resin and tube used. It shall be the responsibility of the Contractor to provide a CIPP lateral lining system which meets or exceeds the minimum properties specified herein.

The CIPP shall be designed per ASTM F1216. The CIPP design shall assume no bonding to the original pipe wall

The lateral CIPP shall be designed assuming the following minimum design data, unless otherwise directed by the Engineer:

- Factor of Safety = 2
- Soil Modulus = 1,000 psi
- Soil Density = 120 pcf
- Live Load = H20
- Depth of Cover = as specified
- Groundwater = ½ depth of cover
- Ovality = 2%

The designer of the CIPP system shall set the long term (50 year extrapolated) Creep Retention Factor at 50% of the inidial design flexural modulus as determined by ASTM D-790 test method. This value shall be used unless the Contractor submits long term test data (ASTM D 2990) to substantiate a different retention factor.

The CIPP shall, at a minimum, meet or exceed the structural properties, as listed below:

- Flexural modulus of elasticity: 250,000 psi
- Flexural strength: 4,500 psi

The structural performance of the finished pipe shall be adequate to accommodate all anticipated loads throughout its design life. No CIPP rehabilitation technology will be allowed that requires bonding to the existing pipe for any part of its structural strength.

G. EXECUTION OF LATERAL SEALS

1. GENERAL

Lateral seals shall be installed from the mainline sewer with the lateral CIPP portion that extends up the lateral at the distance specified in the contract documents or as directed by the Engineer. If a clean out is required for installation, the type and location shall be as directed by the Engineer.

2. PREPARATION

Preparation, cleaning, inspection, sewage bypassing, and public notification shall be the responsibility of the Contractor. The Contractor shall clean the interior of the existing host pipe prior to installation of the system. All debris and obstructions that will affect the installation and the final product shall be removed and disposed of off site. All preparation shall be in accordance with the manufacturer’s written installation procedures.

The system shall be constructed of materials and methods that, when installed, shall provide a jointless and continuous, structurally sound CIPP able to withstand all imposed static and dynamic loads on a long term basis.

The Contractor shall only use existing manholes as access points unless given the express written permission of the Engineer, or as shown on the plans.

a. Pre-Cleaning CCTV

If a cross-bore is found, the Contractor shall, at their own expense, request utility locating to identify the cross-bore. Prior to cleaning, the Contractor shall, to all extents possible, televise the service lateral to confirm that cleaning the lateral will not damage or breach a conflicting utility bored through the sewer lateral.

b. Cleaning of Pipe Lines

The Contractor shall remove all internal debris from the pipe line that will interfere with the installation and the final product delivery of the system as required in these specifications. The Contractor shall make use of commercially available industry standard cleaning equipment to prepare the pipe for system installation. Solid debris and deposits shall be removed from the pipeline, if possible, and disposed of properly by the Contractor, in accordance with all federal, state, and local laws. Precaution shall be taken by the Contractor in the use of cleaning equipment to avoid damage to the existing pipe. If the pipe cannot be cleaned sufficiently using industry standard cleaning equipment, the Contractor shall not continue cleaning efforts without the express written permission of the Engineer.

c. Post-Cleaning CCTV

Contractor shall perform post-cleaning video inspections of the pipe(s). Only PACP certified personnel trained in locating breaks, obstacles, and service connections by CCTV shall perform the inspection. The Contractor shall provide the Engineer a copy of the pre- and post-cleaning video and reports as part of the project deliverables.

d. Existing Sewage Flows

If ordinary bypass operations will not suffice for installation, the Contractor, at their own expense, shall contact and work with the property owner and/or upstream property owner(s) to create a plan for reducing water/wastewater use in order to allow for successful installation. Interruptions to flow shall be coordinated with the property owner(s) no fewer than 7 calendar days in advance, and the Contractor shall notify the Engineer of all such plans immediately.

e. Bypass Existing Sewage Flows

The Contractor shall, at their own expense, be responsible for the creation, execution, and management of a bypass plan to allow for proper and successful installation of the lateral CIPP system. See Section 615.1 of these City Specs for further bypassing requirements.

f. Line Obstructions

Contractor, at their own expense, shall be responsible for clearing the line(s) of obstructions which will interfere with the installation and long-term performance of the CIPP system. If pre-installation inspection reveals defects which will not allow for proper CIPP installation and which cannot be rectified with trenchless means, the Contractor shall immediately notify the Engineer of the issues. The Contractor shall NOT perform any open-cut repairs without the express written permission of the Engineer.

g. Locating
The Contractor shall be responsible for confirming the locations of all branch service connections prior to installing and curing the CIPP. Each connection shall be dye tested at the Contractor's expense to determine whether the connection(s) is active or abandoned. Abandoned connections shall be lined through and not reinstated. In the event the status of a service connection cannot be adequately verified through dye testing or televising, the connection shall be reinstated unless otherwise directed in writing by the Engineer.

3. INSTALLATION

The entire liner shall be wetout using vacuum impregnation, including the lateral and mainline portions. A roller table shall also be used for the installation process.

The System shall be loaded inside and/or on a pressure apparatus. The pressure apparatus, attached to a robotic device, shall be positions in the mainline pipe at the service connection. The robotic device, together with a CCTV camera, shall be used to align the lateral portion of the system with the service connection opening. Air pressure, supplied to the pressure apparatus through an air hose, shall be used to invert or expand the resin impregnated CIPP into the lateral pipe, and push the mainline portion of the system against the mainline pipe. The pressure shall be adjusted to the manufacturer's recommended installation pressure to fully install the CIPP into the lateral pipe and hold the system tight to the pipe walls. Care shall be taken during the curing process not to over-stress the tube.

After lateral CIPP installation is completed, the manufacturer's recommended pressure is maintained on the impregnated CIPP for the duration of the curing process. Curing method shall be compatible with the resin selected and shall be in accordance with the manufacturer's recommendations. The initial cure shall be deemed complete when the CIPP has been exposed to the cure source for the time period specified by the manufacturer.

The Contractor shall cool (as applicable) the hardened CIPP before relieving the pressure in the apparatus. Cool-down may be accomplished by the introduction of cool air into the pressure apparatus. Care shall be taken to maintain proper pressure throughout the cure and cool-down period.

If cured by the ambient-cure process, the Contractor shall maintain bladder pressure until the CIPP has completely cured per the manufacturer's recommendations before relieving the pressure in the pressure apparatus.

The finished CIPP shall be free of dry spots, lifts, and de-lamination. The system shall not inhibit the CCTV post lining video inspection of the mainline or service lateral pipes. Frayed ends of the system shall be removed prior to acceptance.

The Contractor shall maintain a visible, written log of all activities in accordance with manufacturer's recommendations, and shall include time/location of wetout, time of insertion, time/location of lateral insertion, bladder pressure requiremetns, required cure time, actual cure time, and cool down duration.

After the work is complete the Contractor shall provide the Engineer with videos and reports showing pre- and post-lining inspections.

4. FINISH

The installed system shall be continuous over the specified length of the sewer line section (including mainline and lateral), and be free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles, and de-lamination. The system shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.

Any defect, which will or could affect the structural integrity or strength of th system or allow leaks, shall be repaired by the Contractor at their expense.

The system shall provide a watertight seal at the connection to the mainline pipe and for the length of the lateral which was CIPP lined. The following methods are recommended for ensuring a watertight seal:

- 100% Solids Epoxy providing an adhesive bond between the system and the host pipe, installed/applied per the manufacturer's recommendations
- Hydrophilic materials installed/applied per the manufacturer's recommendations

Branch lateral connections or any other pre-existing connection to the service lateral shall be reinstated by a remote controlled robotoic cutting device, either from within the pipeline or externally through a cleanout (where applicable). The reinstated connection shall be brushed to allow for a smooth edge.

The Engineer reserves the right to request CIPP samples for third party materials testing of the physical properties, through the entire duration of the warranty period. Samples shall be furnished at the Contractor’s expense, and testing shall be carried out at the Engineer’s expense.

SECTION 615.3
CONTENTS

615 - SEWER LINING AND GROUTING

SECTION 615.3 – LINING OF MANHOLES

615.3 – MANHOLE RELINING

A. GENERAL

This specification shall govern all labor, materials, equipment and appliances necessary for the sanitary sewer manhole interior rehabilitation for the purpose of eliminating infiltration and inflow, providing corrosion protection, repair of cracks and voids and restoration of the structural integrity of the manhole as a result to the application of a monolithic fiber-reinforced structural/structurally enhanced cementitious liner to the wall and bench surfaces of concrete, block, brick, or any other masonry construction material.

B. REFERENCES

1. ASTM C78 – Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
2. ASTM C109 – Compressive Strength of Hydraulic Cement Mortars (Using 2-inch Cube Specimens).
3. ASTM C321 – Bond Strength of Chemical – Resistant Mortars.
4. ASTM C496 – Splitting Tensile Strength of Cylindrical Concrete Specimens.
5. ASTM C596 – Drying Shrinkage of Mortar Containing Hydraulic Cement.
6. ASTM C952 – Bond Strength of Mortar to Masonry Units.

C. SUBMITTALS

Submit manufacturer’s material data and application and installation instructions for all products used.

Provide documentation that the proposed manhole rehabilitation process has a minimum 5-year history for reconstruction of sanitary sewer manholes on projects of similar size and scope.

D. QUALITY ASSURANCE

Use, mix, apply, and cure all products in accordance with the manufacturer's recommendations and instructions.

Provide recommended daily or lot test specimens for compressive strength and other testing per applicable ASTM standards.

E. MATERIALS

1. PATCHING MATERIAL

A quick setting, fiber-reinforced, high early strength, corrosion resistant, hand mixed and hand applied calcium aluminate based, cementitious material for patching and filling voids and cracks.

Material shall have the following minimum requirements:

Compressive Strength	ASTM C-109	6 hr 1,400 psi
Shrinkage	ASTM C-596	0% at 90% R.H.
Bond	ASTM C-321	28 day 150 psi
Cement		Sulfate resistant
Density, when applied		105 ± pcf

2. INFILTRATION CONTROL MATERIAL

A rapid-setting high early strength, hand-applied cementitious product specifically formulated for infiltration control and making repairs to concrete, block, brick, or other masonry structures.

Material shall have the following minimum requirements:

Compressive Strength	ASTM C-109	1hr 600 psi
Compressive Strength	ASTM C-109	24hr 1,800 psi
Bond	ASTM C-321	1hr 30 psi
Bond	ASTM C-321	24hr 80 psi

3. GROUTING MATERIAL

A rapid setting cementitious grout specifically formulated for stopping very active infiltration and filling voids.

A rapid setting chemical grout specifically formulated for stopping very active infiltration.

4. LINER MATERIAL

   Material shall be Strong Seal MS-2A or approved equal.

   A corrosion resistant, fiber-reinforced, cementitious liner material shall be wet mixed and low-pressure spray applied to form the structural/structurally enhanced monolithic, cementitious liner covering all interior manhole surfaces.
   Material shall be pre-mixed and specially formulated to withstand abrasion in sewer networks. Mortar shall be made with Type I or Type III Portland cement. Material shall be sulfate resistant and suitable for application in environments with pH level 3.0 or higher.

   Material shall have the following minimum requirements at 28 days:

Compressive Strength	ASTM C-109	9,000 psi
Tensile Strength	ASTM C-496	900 psi
Flexural Strength	ASTM C-78	1,400 psi
Shrinkage	ASTM C-596	0% at 90% R.H.
Bond	ASTM C-952	2,000 psi
Density, when applied		130±5 pcf

5. BONDING COMPOUND

   Material shall be a modified cementitious bonding compound material that protects exposed reinforcement steel and enhances bond of overlay to substrate.

6. WATER

   Water shall be clean and potable.

F. EXECUTION

1. MANHOLE AND MANHOLE INTERIOR SURFACE PREPARATION

   Prepare surfaces in accordance with manufacturer’s instruction and recommendations.

   a. Place covers over sewer inverts to prevent extraneous material from entering the sewer lines.

b. Remove foreign, loose and unsound concrete and masonry material from the interior surfaces of the manhole by means of high-pressure (1,500 psi minimum) water spray.

c. Loose, unsound, and protruding concrete and masonry material not able to be removed by high pressure water spray may require the use of mason's or mechanical tools for removal.

d. Clean the interior surfaces of the manhole with high-pressure (1,500 psi minimum) water spray, using detergent, muriatic acid, antibacterial agent, or other chemicals to remove grease, oil, and other contaminants that would prevent good bond between the existing manhole interior surface and the liner material.

e. Active hydrostatic leaks (infiltration) shall be stopped using the rapid-setting, specially formulated infiltration control material.

f. Very active hydrostatic leaks (infiltration) shall be stopped using one of the rapid-setting grouting materials specially formulated for control of very active infiltration.

g. Clean and prepare exposed reinforcement steel, and apply and cure bonding compound material, in accordance with the product manufacturer's instructions and recommendations.

h. Prepare cracks and voids to be patched and filled, and apply and cure patching material, in accordance with the product manufacturer's instructions and recommendations.

i. Prepare, clean, and repair manhole

2. LINER APPLICATION, CURING, AND TESTING

Prepare manhole surfaces, wet batch-mix liner material, low pressure spray apply liner mix to manhole wall and bench surfaces and allow liner to cure in accordance with the product manufacturer's instructions and recommendations.

Liner application shall be ½ inch minimum thickness. The application shall be completed with a minimum of two coats. The first coat shall be applied at a thickness adequate to cover the substrate and be troweled to compact the material into voids and set the bond. The second coat shall be applied to ensure complete coverage at the specified ½ inch minimum thickness.

Inverts shall be lined with patching mix, trowel applied in one coat to ½ inch minimum thickness.

Prepare, label, and submit recommended daily or per lot test specimens for testing.

3. CLEANING

Protect upstream and downstream sewers from excess chemical grout and other construction debris. Clean manhole interiors and remove all construction-related materials, equipment, and appliances from the manholes prior to reinstatement of the manholes to service.

4. ACCEPTANCE TESTING

Upon completion of liner application, curing and cleaning, all manholes shall be visually inspected by Contractor in presence of Owner's Representative.

Visual inspection shall determine if the manhole is free from leaks and defects.

Any leak or defect shall be corrected by the Contractor at no additional cost to Owner.

5. WARRANTY

All lining work shall be guaranteed for a period of 1 year from the date of substantial completion granted in writing by the Engineer unless otherwise stipulated in writing by the City. During this period, all defects discovered by the City shall be removed and replaced by the Contractor in a satisfactory manner at no cost to the City. The City may conduct independent inspections, at its own expense, of the lining work at any time prior to the completion of the warranty period. The warranty shall cover liner repair due to hydrostatic leaks (infiltration).

SECTION 615.4
CONTENTS

SECTION 615.4 – GROUTING OF SEWER MAINS AND LATERALS

615.4 - SEWER GROUTING

A. GENERAL

Provide all labor, materials, tools, equipment and incidentals as shown, specified, and required for testing sewer pipe joints by applying a positive air pressure to the joints, monitoring and recording the pressure in the void. The intent of joint & connection testing is to identify those sewer joints, lateral connections and laterals that are not watertight and that can be successfully sealed by packer injection grouting. This document can be utilized for the following applications:

Test all service lateral connections from the sewer main to a predetermined distance up the sewer lateral.

Test all joints within a predetermined distance in laterals directly connected to manholes.

Provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to grout pipeline joints, joints in laterals connected to manholes and lateral connections to the mains using the packer injection method.

Packer injection grouting shall be used to reduce groundwater and rainfall induced infiltration flow into the pipeline, seal annular space between liners and host pipes at lateral tap connections, seal pipe joints and tap connections that have failed the test criteria, seal certain defects, prevent further loss of pipe bedding into the pipe, impede the migration of groundwater in the pipe trench, and stabilize the pipe and pipe bedding.

Packer injection grouting shall be accomplished by pressure injection of chemical grout into the soils outside the pipe. Grouts shall be designed to be injected into the soil surrounding the pipe, which stabilizes the pipe bedding and forms an impermeable seal, and into the annular space between close fit liners and host pipes. Adequate volumes of grout must be injected to form an effective seal. This

application will be through joints and penetrations from within the pipe (packer method) and through certain defects in the pipe wall in tandem with a closed-circuit television inspection system.

1. SITE EVIRONMENTAL CONDITIONS

    a. The site is characterized by a water table that is seasonally above the joints but does experience extended periods when the pipe bedding becomes unsaturated.
    b. All pipes are active sewers and have continuous moisture levels to promote consistent hydration of hydrophilic chemical grouts.
    c. There are no freeze/thaw concerns at the depth of the sewers involved in this Work.
    d. There are pipes that are subject to periods of soil dryness.

2. The various pipeline component items subject to these test and seal methods include:

    a. Main Line Joint (MLJ) - joints in mainline segment connected to a manhole at each end. MLJ is defined by the “J” or Joint field in the Pipeline Assessment Certification Program (PACP) Details Section inspection form.

    b. Lateral Tap Connection (LTC) – Tap connection of lateral to mainline sewer, including a defined length of lateral from the tap and any annular space that might be present between a liner and the host pipe in situations where the main line has been lined. LTC is defined within the Tap group of PACP. Appropriate descriptors and modifiers need to be applied per PACP definitions to further define the asset. The Manhole Assessment Certification Program (MACP) and Lateral Assessment Certification Program (LACP) define Tap differently than PACP. Consult a certified PACP/MACP/LACP user for information on providing the appropriate observation code for these applications.

    c. Cured in Place Pipe Liner Annular Space Tap (AST) – Annular space opening at tap cut between liner and host pipe in situations where the main line has been lined. AST is defined within the Tap group of PACP. Appropriate descriptors need to be applied per PACP definitions to further define the asset. MACP and LACP define Tap differently than PACP. Consult a certified PACP/MACP/LACP user for information on providing the appropriate observation code for these applications.

    d. Laterals Connected to Manholes (LCM) – Lateral pipe directly connected to and reached from manhole. LCM is defined within MACP. Consult a certified PACP/MACP/LACP user for information on providing the appropriate observation code for these applications.

    e. Outside Drop Connections (ODC)2 – Drop pipes connected to mainline sewer and manhole including a defined length of drop pipe from the main.

ODC is defined within PACP as Access Point observations. Appropriate descriptors and modifiers need to be applied per PACP definitions to further define the asset. MACP defines this observation differently. Consult a certified PACP/MACP user for information on providing the appropriate observation code for these applications.

f. Longitudinal Fracture Defects (LFD) – Longitudinal or multiple fractures and crack within a pipe.4 LFD is defined within PACP/ LACP as a Structural observation. Appropriate descriptors and modifiers need to be applied to the observation to further define the asset. Consult a certified PACP/LACP user for information on providing the appropriate observation code for these applications

3. GROUT VOLUME GOAL

The calculated volume of grout to be pumped outside the pipe defect to stabilize the pipe bedding and provide a long-lasting seal against groundwater and pipe bedding fine infiltration.

B. REQUIREMENTS

Contract requires work in active sewers. The Contractor shall follow all federal, state and local requirements for safety in confined spaces and uniform traffic controls.

Conduct worker safety training prior to and within one year of start of work that includes reviewing the hazards associated with hoses, pumps, tanks, couplers, compressors, bottles, motors, and all other related application apparatus. Additional safety considerations including safely handling, mixing, and transporting of chemical grouts should be provided by the grout manufacturer/supplier, and should include safe operating practices and procedures, appropriate personal protective equipment (PPE) for the various grouting operations, and proper storage, transportation, mixing, and disposal of grouts, additives, and their associated containers.

Require completion of grout handling and mixing training certification from the grout manufacturer/supplier for personnel working with chemical grouts and additives.

C. SUBMITTALS

Manufacturer’s information and installation procedures for chemical grout shall be submitted to the Engineer prior to performing the grouting. This shall include,

but not be limited to, product data, material samples, sealant mixture design, application/packing procedures, test data, and a detailed description of

equipment and operational procedures used to accomplish the chemical grout sealing. A detailed time schedule shall also be submitted. The Contractor shall provide a minimum 48 hour advance written notice of proposed testing schedules and testing procedures for review and concurrence of the Engineer.

1. QUALIFICATIONS FOR INSTALLERS OF APPROVED GROUTING MATERIALS

   The Contractor shall submit all required pre-qualification product, manufacturer, and installer documents to the Engineer. For an installer to be accepted, the installer must satisfy all of the following:

   a. All MLJ work shall be supervised by a technician. A technician is required for each crew. Technician qualifications shall include:
      i. Previously performed pressure testing and injection grout sealing of a minimum of 3,000 MLJs and 250 LTC/ASTs.
      ii. Successfully completed safety training recommended by grout material and grout equipment suppliers.
      iii. Successfully completed a 16 hour minimum pipeline packer capital grouting field training conducted by a multi-vendor consortium of packer, rig, and grout material vendors

   b. LFD work shall be supervised by a foreman having the following qualifications in addition to those listed in paragraph A above. A foreman is required for each LFD crew. Foreman qualifications are:
      i. Previously performed pressure testing and chemical grout sealing of a minimum of 15 LFDs.
      ii. Successfully completed safety training recommended by grout material and grout equipment suppliers.
      iii. Successfully completed a 16 hour minimum pipeline packer capital grouting field training conducted by a multi-vendor consortium of packer, rig, and grout material vendors.

   c. LCM work shall be supervised by a foreman having the following qualifications in addition to those listed in paragraph A above. A foreman is required for each LCM crew. Foreman qualifications are:
      i. performed pressure testing and chemical grout sealing of a minimum of 30 LCMs.
      ii. Successfully completed safety training recommended by grout material and grout equipment suppliers.
      iii. Successfully completed a 16 hour minimum pipeline packer capital grouting field training conducted by a multi-vendor consortium of packer, rig, and grout material vendors.

d. ODC work shall be supervised by a foreman having the following qualifications in addition to those listed in paragraph A above. A foreman is required for each ODC crew. Foreman qualifications are:
    i. Previously performed pressure testing and chemical grout sealing of a minimum of 10 ODCs.

    ii. Successfully completed safety training recommended by grout material and grout equipment suppliers.
    iii. Successfully completed a 16-hour minimum pipeline packer capital grouting field training conducted by a multi-vendor consortium of packer, rig, and grout material vendors.

e. Insurance, financial and bonding requirements of the City

f. The Contractor shall employ a minimum of 1 foreman and 2 crew members with experience of at least 50 grout installations

g. The Contractor shall have the equipment available for the installation and testing of the grout from inside the internal cleanout

h. Acceptable documentation of these minimum requirements shall be submitted to the Engineer, and any intentional misrepresentation of references will be grounds for disqualification

i. Contracor/Manufacturer submit evidence of installer training, testing, and/or certification of being trained to install the product by the Contractor/Manufacturer for the product

2. CHEMICAL GROUT INFORMATION

Materials submittals shall include a description of chemical grout materials to be used, a description of proposed additives to be use, the manufacturer's recommended procedures for storing, mixing, testing, and handling of chemical grouts, and MSDS sheets for all materials to be used. The Contractor shall also identify the manufacturers and models of the packers to be utilized in performing the work.

Grout information shall also include:

a. Third party testing grout component chemical composition, including primary chemical percentages.

b. Grout mixture ratio (including additives).

c. Procedure for adjusting grout gel time during initial preparation and when it should be adjusted.

d. Procedures for adjusting grout gel time as temperature changes, and at which temperature intervals the grout set times need to be adjusted.

e. Curves of grout gel time versus temperature.

f. Instructions for addition of components.

g. Safety Data Sheets

3. DOCUMENTATION OF GROUT INSTALLATION

Upon completion of each pipe segment, submit to Engineer a report for each joint and/or lateral connection tested, grouted or attempted to be grouted as required by PACP. Televising and documentation shall be in accordance with Section 614 of these City Specs and as required by PACP regulations and Section 33 01 30.16 of NASSCO specifications. Data shall include but not be limited to the following:

- Identification of the sewer pipe section tested by assigned sewer ID (if available) and length.
- Type of pipe material, diameter & depth of pipe to the surface at manholes.
- Length of pipe sections between joints.
- Test pressure used and duration of test.
- Pass/fail results for each joint/connection tested.
- Location stationing of each joint/connection tested and location of any joints/connections not tested with an explanation for not testing.
- Volume of grout material used on each joint or connection.
- Gel set time used (cup test results from tanks).
- When the last cup test was taken. Cup tests shall be done throughout the day to ensure the desired set time is being maintained.
- Grout mix record of the batches mixed including amount of grout and catalyst, additives, temperature of the grout solution in tanks.
- Operator conducting testing and sealing shall be noted on the reports.
- Equipment operating procedures and systems to be used, including manufacturer’s literature on grout pumps (including pump curve demonstrating compliance with required pumping rates), operating pressures, packers, skins, packer mounted gauges, pressure readings on screen, and lateral blockage clearing equipment.
- Packer to pipe void volume between the packers and host pipe and maximum packer end element inflation pressure when new.
- Spare parts list.

- List and corresponding digital images of lateral taps containing roots or other obstructive conditions, in accordance with Section 33 01 30.16, paragraph 3.3 of NAASCO specifications.

Televising shall include testing and sealing operations for each joint/lateral (including inflation and deflation over the joint/lateral) displaying the final air test of joints or laterals. Additional final recording, if specified, shall include inspection of the pipe or lateral after all grouting work is complete.

Upon completion of grouting each segment, submit to the Engineer a report showing the following data for each item tested, grouted, or attempted to be grouted:

- Location of the pipeline segment/lateral address/lateral parcel number in which the testing was done.
- Stationing.
- Location of any items not tested and the reason for not testing.
- Time, date, and temperature.
- Grout mixture formulation, including additives.
- End seal pipe-packer contact pressure and seal pressure.
- Test pressure achieved and the duration of test maintained for each item passing the air test.
- End-of-hoses pump rates.
- In situ packer pumping rate
- Gel time(s) from cup testing and when the last cup test was performed.
- Quantity of grout used to seal each item.
- Step grouting practice, including pump on and off cycle times and volumes, if applicable.
- Post-grout pressure test results.
- Regrouting and retesting giving above data as required.
- Video recording cross-reference index

Documentation of Post-Construction Inspection shall be in accordance with Section 33 01 30.16 of NASSCO Specifications, or in accordance with Grout and Seal codes and reporting per PACP Manual, latest version is a Television Inspection of Sewers specification.

Documentation of Warranty Inspection (if applicable) shall be in accordance with Section 33 01 30.16 of NASSCO Specifications, or in accordance with Grout and Seal codes and reporting per PACP Manual, latest version is a Television Inspection of Sewers specification

D. REFERENCE STANDARDS TO BE USED

National Association of Sewer Service Companies (NASSCO), Inc. prepared Pipeline Assessment and Certification Program (PACP) Reference Manual, latest version.

ASTM F2304 Standard Practice for Rehabilitation of Sewers using Chemical Grouting (latest revision).

ASTM F2454 Standard Practice for Sealing Lateral Connections and lines from the Mainline Sewer Systems by Lateral Packer Method, Using Chemical Grouting (latest revision).

E. PRODUCTS

1. TESTING EQUIPMENT & GROUTING EQUIPMENT

The basic equipment shall consist of a remotely operated television camera capable of pan and tilt, testing and grouting devices (referred to hereafter as packers), grout preparation tanks (Tank A –Base Chemical and Additives and Tank B – Oxidizer Only) and monitoring equipment. The equipment shall be constructed in such a way as to provide means for introducing air under pressure into the void area created by the expanded ends of the packer and a means for continuously measuring the actual static pressure of the test medium and grout within the void area only. Packers shall be expanded by air pressure.

All packers shall be fitted with a void pressure sensor (either a transducer or gauge) mounted on the packer. If using a void gauge as the pressure sensor, the maximum top range shall be 15 psi and readable using the television camera. There can be no check valve between the void space and the pressure sensor. Packer void pressure shall be shown either on- screen or captured on-video. The air test gauge in the control panel in the studio may not be used for air testing or post-grouting pressure confirmation because the length of hose and the presence of check valves renders this technique unreliable and inaccurate at pressures below 12 psi.

Grout control panel shall have gauges for monitoring packer element pressure. Packer element pressure gauges shall have a range of 0-60 psi.

MLJ packers shall have void volume less than 0.3 gallons for 8-inch packers, 0.4 gallons for 10-inch packers and 0.5 gallons for 12-inch packers.

LTC and AST packers shall have mainline void space volume less than 0.75 gallons and sock void space less than 0.2 gallons per foot for 4” diameter socks and 0.25 gallons per foot for 6” diameter socks.

LTC and AST packers shall consist of inflatable mainline end elements and a lateral grouting sock and plug that creates a void area extending beyond the tap or drop connection. Whenever possible, use a lateral sock sized to match the diameter of the lateral being grouted. Effective sealing length shall be feet20., unless required by transition or pipe configuration less than this, otherwise indicated on the plans, or as directed by the Engineer. Where the lateral or drop is capped, utilize alternate lateral grouting plug or equipment sized appropriately for the capped lateral. If the lateral transitions from 6” to 4” in diameter within the view of the mainline camera and less than 2 feet from the tap, use a 4” lateral grouting plug. Maintain a variety of lengths of lateral grouting plugs and adjust length of lateral grout plug as required.

LCM, LACO, ODC, and LFD packers shall consist of a flexible push-pull- type packer. LCM, LACO, and LFD packers shall be sized for the diameter and pipe joint spacing found in the field, have void spaces commensurate with their duty, and be acceptable to the ENGINEER. The packer shall be able to test the items specified and be able to negotiate fittings associated with the pipe construction. If the lateral contains a transition, CONTRACTOR may change out diameters of push packer or grout using a smaller diameter packer but no relief for excess residual grout will be provided nor payment for the extra wasted grout.

Packers operating in concrete, iron, or steel pipe shall obtain airtight seals against surfaces characterized as PACP SAV and as PACP SAP with protrusion less than 3/32” 21using proper packer diameter as determined against actual pipe diameter so long the pipe maintains a near circular geometry using either special skins or by grouting the packer in place. Pipes with mushroom shapes due to chemical attack or invert loss due to erosion are generally not sealable with remote packers.

Grouting equipment shall consist of the packer, hoses, and pumping systems capable of supplying an uninterrupted flow of sealing materials to completely fill the voids. Pump systems shall be sized to deliver a minimum of 3 gpm during end- of-hose pumping tests and achieve at least a 3 gpm uninterrupted pumping rate over a 5-minute period.

A tiger tail, boot, or downhole roller, manhole frame roller, and truck step grid plate or pavement tail or slide are required to protect hoses from chafing.

Equipment for cleaning lateral blockages shall be present on-site while any grouting work is being conducted.

Provide at least one back up bladder or packer on-site for each packer scheduled for work on any given day.

Provide the following spare parts on site, or demonstrate the ability to get these to the site within 24 hours:

- Compressor
- Replacement belts for compressor
- Generator and shore power cable
- Camera
- Crawler and camera repair kit
- Tag winch
- Tag winch motor and tag winch transformer
- Ball valves
- Hose ends
- Pump/pump parts
- Video cable ends
- Chemical hose check valves and stainless steel quick disconnects
- Crawler motor
- LTC packer motor
- Winch motor
- Nozzle
- Root cutter
- Jetter hose ends and swedge kit
- Void pressure transducer or Packer mounted pressure
- gauge (2), depending on packer setup
- Spare lateral grouting sock
- Patch repair kit for lateral grouting sock
- Packer sensor membrane for sensor system
- 3-function rubber check-valves for packer (3)

The device for testing lateral connections shall consist of inflatable mainline end elements and a lateral grouting plug that creates a void area extending beyond the main connection. Whenever possible, use a lateral grouting plug sized to match the diameter of the lateral being grouted with an effective sealing length as shown on the plans or as directed by the Engineer. Where the lateral is capped, utilize alternate lateral grouting plug or equipment sized appropriately for the capped lateral.

In cases were the lateral transitions from 6 inch to 4 inch in diameter, use a 4 inch lateral grouting plug. However, it is possible that due to physical restrictions the lateral plug may not launch and thus the service may not be able to be grouted.

The basic equipment for 4 inch and 6 inch laterals connected to manholes shall consist of a flexible push-type packer and mini-push camera. The device for testing lateral pipe connected to the manhole shall be capable of testing

the joints to the distance shown on the plans or as directed by the Engineer from the manhole toward the building. If the lateral contains a transition, Contractor may change out diameters of push packer or grout lateral using only a 4 inch push packer.

Void pressure data shall be transmitted from the void area to the monitoring equipment or video picture of a pressure gauge mounted on the packer and connected to the void area. All test monitoring shall be above ground and in a location to allow for simultaneous and continuous observation of the televising monitor and test monitoring equipment.

Grouting equipment shall consist of the packer, appropriate pumping and hosing systems capable of supplying an uninterrupted flow of sealing materials to completely fill the voids. Grout pumping system shall be sized to deliver a mixed volume of grout at a minimum of 3 gpm and 30 gallons of uninterrupted flow within 10 minutes.

Volume of mixed grout pumped must be capable of being measured and recorded for each grouted joint/connection. Generally, the equipment shall be capable of performing the specified operations in sewers where flows do not exceed 25% of pipe diameter unless permitted by Engineer.

Connection and lateral service sealing shall be accomplished using the lateral grouting plugs and push packers specified above. Provide back-up bladders for each packer on-site at all times during grouting procedures.

Equipment for cleaning lateral blockages shall be readily available while any lateral grouting work is being performed.

2. GENERAL GROUTS

All grout materials must have the following characteristics:

a. Able to react /perform in the presence of water (groundwater) with minimal dilution while being injected.
b. Maintain a constant viscosity during the pumping process prior to gelling.
c. Prevent the passage of water (infiltration) into the pipe.
d. Not be subject to shrinkage from water loss in conditions where relative humidity in soil is present.
e. Be moderately flexible, yet rigid enough to stand under its own weight.
f. Be chemically stable and resistant to acids, alkalis, and organics found in sewage.
g. Be easily removable from inside the sewer line after gelling.
h. Cause no upset of treatment or pumping system downstream of the grouting location.

Handle, mix, and store grout in accordance with the manufacturer's recommendations. The materials shall be delivered to the site in unopened original manufacturer's containers.

All grout materials used shall meet the following minimum application requirements:

a. All component materials shall be transportable by common carriers.
b. Packing of component materials shall be compatible with field storage requirements.
c. Grout components shall be packed in such a fashion as to provide for maximum worker safety when handling the materials and minimize spillage when preparing for use.
d. Gel initiation shall take place at the point of injection/repair.
e. Cleanup shall be done in accordance with the manufacturer recommendations.

3. CHEMICAL GROUTS

Acrylamide based grout shall have the following characteristics:

a. 95% acrylamide and 5% Methylene-bis acrylamide (MBA).
b. A minimum of 12% acrylamide base material by weight in the total grout mix. A higher concentration of acrylamide base material may be used to increase strength or offset dilution during injection.
c. A viscosity of approximately 2 centipoises, which can be increased with additives.
d. A controllable reaction time from 10 seconds to 5 minutes.

4. ADDITIVES

Additives shall be used within the manufacturers recommended quantities.

When using non-soluble additives the grout tanks must have mechanical mixing devices to keep the additives in suspension and maintain a uniform solution of grout and additive.

a. LATEX

Add Avanti AV 57 (or Engineer approved equal) to increase compressive and tensile strength of grouts to protect against shrinkage, enhance flexibility, and strengthen the grout. Latex shall not contain any organic solvents. The quantity of latex added shall be in accordance with the manufacturer's recommendations and shall take the place of the same volume of water normally added in a non-latex grout batch on the A Tank

(grout tank). The quantity of latex shall be doubled for grouting non-circular defects. Follow manufacturer's recommendations for product handling and mixing. Latex additive shall have the following characteristics:

Solids Content	49% minimum	ASTM D-1010
Viscosity	100-130 cps @ 77oF max	ASTM D-1638
Solvent	Water	

b. FREEZE INHIBITOR

Ethylene glycol may be added to the A and/or B tanks to reduce the freezing temperature35 of the liquid grout during winter operations when the truck interior and hoses cannot be kept above freezing temperatures. Ethylene glycol shall replace the same volume of water normally added to the tanks. Follow manufacturer's recommendations for product handling and mixing to prevent freezing.

c. DYE

When not using latex, add a fluorescent blue dye to the A side grout tank and a fluorescent yellow dye to the B side tank so that pump balance issues can be discerned and so a visual residual layer of green-colored grout remains to provide confirmation that mixed grout was pumped.

d. GEL TIME MODIFIER

Add gel time extending agent in accordance with the manufacturer's recommendations to extend gel time as necessary. Completely dissolve chemical crystals in water before introducing to the grout tank.

615.4.1 - EXECUTION

A. CONTROL TESTS

1. PACKER TESTS

Demonstrate the acceptable performance of packers in the presence of the Engineer by conducting demonstration tests:

a. Conduct this test weekly. For pipe less than or equal to 18 inches in diameter, provide a straight pipe of appropriate diameters and ovality and sufficient length to test MLJ, LTC, LACO, LFD, and LCM packers of

appropriate. The test cylinder shall be equipped with a void release valve to exercise a controlled release of pressurized air to test the packer under both sound and leaking conditions. The test cylinder shall also be equipped with both a local pressure gauge (0-30 psi) and a connection to the packer test control center/studio; these shall both indicate the pressure in the packer void space.

b. With release valve sealed, inflate packer until it contacts the pipe; record this packer-pipe contact pressure. Inflated packer to 15 psi greater than the packer-pipe contact pressure. Generate a void pressure of 10 psi. The equipment shall hold at this test pressure for a period of 60 seconds with a pressure drop of less than 1 psi.

c. If above test is passed, crack the release to simulate a very small leak. After ~20 seconds, seal the release and confirm that a pressure drop has occurred and that the local gauge is within ±1.0 psi of the reading in the control center/studio

d. Conduct this test every segment for MLJ and LTC packers, and every 5th lateral for LCM and LACO packers. After entering each pipeline segment with the MLJ and LTC packer, but prior to the commencement of testing, position the packer on a section of sound sewer pipe between pipe joints, and perform a test. The equipment shall hold a 10-psi test pressure for a period of 30 seconds with a pressure drop of less than 1 psi. In the event of a failed test, repair any defective equipment and re-test to verify proper operation of all equipment at no additional compensation. Should it be found that the barrel of the sewer pipe will not allow valid in situ barrel test requirements due to corrosion or other barrel defects, then the performance testing shall be waived or modified as determined by the Engineer. LFD packers do not need to do this test.

If air testing equipment cannot be performed successfully, repair or otherwise modify air test equipment and repeat the tests until the results are satisfactory to the Engineer. The in-situ barrel test may be required at any other time during the performance of testing work if the Engineer suspects the testing equipment is not functioning properly.

2. PUMP TESTS

At the start of the job and once monthly or every 1000 gallons of grout pumped, whichever is more frequent, pump grout in uninterrupted flow for full 5 minutes to demonstrate the pumping system can operated continuously at a minimum 3 gpm rate and deliver a minimum of 9 gallons within 3 minutes.

At the beginning of each day prior to application of grout, perform a pump test to determine if equal ratios are being pumped from the grout component tanks at the proper rates and to measure pump rates. Pump 1 gallon of grout from each tank into two separate volumetric measuring containers. Take corrective action if unequal quantities are being pumped. Repeat the pump test until equal quantities are pumped from the grout tanks. Record the amount of time required to pump the two gallons and, when using air pumps, count the pump strokes to confirm the number of pump strokes required to achieve the delivery rate.

3. IN-SITU PUMPING CAPACITY TESTS

   Once inside the pipe and pumping grout through the packer into the first defect of the segment, record the in-situ pumping rate delivered, and modify the grout gel time as appropriate. Check in situ pumping rate each time the packer is reconnected to the hoses.

4. GROUT GEL TIME TESTS

   Perform a grout gel test in the presence of the ENGINEER to determine the grout mixture gel time. If packer is not in the pipe, recycle into the respective tanks or properly dispose any grout remaining in the hoses. Run mixers for a minimum of 1 minute, then allow entrained air to release from the grout tanks a minimum of 5 minutes before collecting grout samples in disposable cups. Ensure equal portions of Tank A and Tank B are collected prior to mixing. If foam is present on surface of tank, collect sample from below the foam. Determine gel time by taking cup samples from each tank:

   a. Prior to grouting each day

   b. Prior to grouting when a different gel time is required

   c. When new batches of grout are mixed

   d. When the temperature of the solutions in either of the tanks have changed by more than 5°F from the previous gel test

5. GROUT CONCENTRATION TESTS

   When grout is not mixed under the observation of the Engineer, perform a grout concentration test using a Contractor-provided hydrometer or refractometer, temperature gauge, and a grout concentration: temperature chart on demand of the Engineer to determine the grout concentration.

B. PIPE PREPARATION

Clean sewer and remove roots in mainline sewer except minor hair roots prior to testing.

Cut back or otherwise remove any portions of laterals that protrude more than 5/8-inch into the mainline to avoid interference with the testing and sealing equipment.

Install all excavated point repairs specified for the pipe segment prior to conducting any grouting work.

Clean laterals in accordance with ROOTS AND OBSTRUCTIONS IN LATERALS.

In accordance with the Details, plug LCMs that are shown on the drawings as inactive.

Clean all LTCs, ODCs, LCMs, ASTs and LACOs in the project area that are not marked as inactive on the drawings.

Following cleaning, televise all MLJs, LTCs, ODCs, LCMs, LFDs, and LACOs that are not marked as inactive on the drawings. Unless otherwise specified or indicated, LTC inspections will be limited to pan and tilt inspection from mainline camera.

Submit Pre-Construction Inspection for any LTC, LCM, AST, LFD, ODC, or LACO that is found to be inactive or in a condition that cannot be tested and grouted

C. ROOT AND OBSTRUCTIONS IN LATERALS

Remove roots and debris that prohibit testing/grouting from LCMs, and LACOs for the length of lateral to be tested/grouted.

During mainline sewer and/or lateral inspection, document all LTCs containing roots and obstructive conditions that are visible from the mainline pan and tilt camera and present (a) roots greater than fine roots or (b) roots or defects of a nature to prevent testing and sealing of LTC. Engineer will review the LTCs containing roots and obstructions and direct Contractor as to which LTCs are to be (a) cleaned and grouted, either from the main or from the cleanout, (b) grouted without cleaning – in which case such lateral tap would be excluded from warranty testing, or (c) removed from the scope of work – in which case no payment for such lateral will be made. Successful cleaning of LTCs (i.e. such that

the LTC can be effectively grouted and no more than fine hair roots remain) will be paid per the applicable item on the Schedule of Prices. No payment will be made for unsuccessful attempts to clean LTCs.

For each such LTC, submit a screen shot image clearly showing the extent of roots or obstructive condition to Engineer. Submit images in electronic format, labeled and organized in a manner to easily retrieve the image for the LTC in question. The list of LTCs with roots shall include upstream and downstream manhole numbers, station, property address served, plan sheet number where tap is located and photograph of outside cleanout, if present.

D. GROUT PREPARATION

Follow the manufacturer's recommendations for the mixing and safety procedures to protect personnel from any adverse effects of the grouting compounds. Add and mix base components and additives at rates that will eliminate the formation of lumps within grout tanks solutions. Use accurate scale(s) or volumetric containers to measure the various non-water grout solution components as concentrations specified. Thoroughly mix all components in the appropriate tanks. Provide accurate thermometers to verify temperature of grouting components in tanks. Where practical, add majority of needed water to both grout tanks and mix

the base acrylamide into Tank A the evening before to allow the endothermic reaction to complete and ambient temperature to be achieved and mix the latex to allow the surfactant to dissipate and minimize foaming before using grout.

Add gel time extending agent or cool the grout component tanks and/or hoses as necessary to compensate for changes in temperature in grout component tanks or hoses resulting from changes in ambient conditions. The addition of dilution water to extend gel times is only acceptable using the B (non-grout) tank so that the resulting grout still achieves minimum base material concentrations.

During the grouting process, monitor the grout component tanks to make sure that proper ratios are being pumped. If unequal levels are noted in the tanks, repeat the pump test, grout concentration test, and grout gel time test as described above.

E. GROUT VOLUME GOALS AND GEL TIME

Grout Volume Goal: Use the NASSCO Grout Volume and Gel Time Calculator, which considers pipe material, bedding depth, bedding material, and joint spacing, to determine grout volume per defect goals.

1. Vitrified clay pipe (VCP), clay tile pipe (CT), asbestos cement pipe (AC) and unreinforced concrete pipe (CP) are more prone to break/fracture and therefore require bedding grouting as well as defect grouting to provide long-term seal stability. These pipes should use the VCP/CP Grout Volume and Gel Time.

2. Polyvinyl chloride pipe (PVC), ductile iron pipe (DIP), reinforced concrete pipe (RCP), and other flexible pipes are less prone to break/fracture and therefore require less stabilization as well as defect grouting to provide long-term seal stability. These pipes should use the PVC/RCP/DIP Grout Volume and Gel Time.

3. Bedding depth: Assume 3” unless otherwise shown or specified on plans or in specifications or field knowledge provides specific information.

4. Bedding material: Assume sand unless otherwise shown or specified on plans or in specifications or field knowledge provides specific information.

Gel Time:

1. MLJ, LCM, and LACO for VCP, CT, AC, and CP: Calculate gel time using the below formula and NASSCO Calculator.

$$Gel\ Time = \left(\frac{\{Annular\ Space + CouplingSpace\ (gal)\} + \{Grout\ Volume\ Goal * .75\}}{Pumping\ Rate(gpm)}\right)\left(\frac{60sec}{1min}\right)$$

2. MLJ, LCM, and LACO for PVC, RCP, and DIP: Calculate gel time using the below formula and NASSCO Calculator

$$Gel\ Time = \left(\frac{\{Annular\ Space + CouplingSpace\ (gal)\} + \{Grout\ Volume\ Goal * .5\}}{Pumping\ Rate(gpm)}\right)\left(\frac{60sec}{1min}\right)$$

3. LTC for AC, CT, CP, and VCP: Calculate gel time using the below formula and NASSCO Calculator.
   - For CT and CP laterals, assume joint failure rate is 90% and joint spacing is 3’.
   - For VCP and AC laterals, assume joint failure rate is 60% and joint

- spacing is 4’

$$\text{Gel Time} = \left(\frac{\{\text{SockAnnular Space} + \text{Mainline void space(gal)}\} + \{\{[\text{roundup}(1 + (\text{Sock Length} / \text{joint spacing}))] \text{ x \#\% joint failure rate}\} \text{ x Grout goal per joint}] * .75\ (\text{gal})\}\}}{\text{Pumping Rate(gpm)}}\right)\left(\frac{60\text{sec}}{1\text{min}}\right)$$

4. LTC for PVC, DIP, and RCP: Calculate gel time using the below formula and NASSCO Calculator:
   - For PVC and DIP laterals, assume joint failure rate is 25% and joint
   - spacing is 5’

$$\text{Gel Time} = \left(\frac{\{\text{SockAnnular Space} + \text{Mainline void space(gal)}\} + \{\{[\text{roundup}(1 + (\text{Sock Length} / \text{joint spacing}))] \text{ x \#\% joint failure rate}\} \text{ x Grout goal per joint}]\ (\text{gal})\}\}}{\text{Pumping Rate(gpm)}}\right)\left(\frac{60\text{sec}}{1\text{min}}\right)$$

5. LFD for VCP, CT, AC, and CP: Calculate gel time using the below formula:

$$Gel\ Time = \left(\frac{\{Annular\ Space\ (gal)\} + \{Grout\ Volume\ Goal * .33)\}}{Pumping\ Rate(gpm)}\right)\left(\frac{60sec}{1min}\right)$$

6. LFD for PVC, DIP, and RCP: Calculate gel time using the below formula:

$$Gel\ Time = \left(\frac{\{Annular\ Space\ (gal)\} + \{Grout\ Volume\ Goal * .5\}}{Pumping\ Rate(gpm)}\right)\left(\frac{60sec}{1min}\right)$$

7. Annular Space Grouting: Calculate gel time using the below formula:

$$Gel\ Time = \left(\frac{\{Annular\ Space\} * \{Perimeter\ of\ pipe\} + \{Sealing\ Distance\ from\ tap\ x\ 2\} * 7.48 + Void\ Space\ (gals)}{Pumping\ Rate(gpm)}\right)\left(\frac{60sec}{1min}\right)$$

OR, if only addressing pipes with diameters ≤ 18":

1. Grout Volume Goal for pipe diameters less than 18"

    a. VCP, AC, CT, and CP: 0.75 gallons per inch diameter for VCP and CP
    b. PVC, DIP, and RCP: 0.5 gallons per inch diameter for VCP and CP

2. Gel Time: Gel times shall be within 10 seconds of the following unless field conditions dictate otherwise and with approval of Engineer.

    a. MLJ, LCM, and LACO: Calculate gel time using the below formula and NASSCO Gel Time Table.

$$Gel\ Time = \left(\frac{\{Annular\ Space + CouplingSpace\ (gal)\} + \{PipeDiameter(inch)x\#groutgoal(gpin - dia\}}{Pumping\ Rate(gpm)}\right)\left(\frac{60sec}{1min}\ \text{x}\ 1.2\right)$$

    b. LTC: Calculate gel time using the below formula and attached Gel Time Table. Assume lateral joint failure rate is:

        - For CT and CP laterals, assume joint failure rate is 90% and joint
        - spacing is 3'
        - For VCP and AC laterals, assume joint failure rate is 60% and joint
        - spacing is 4'
        - For PVC and DIP laterals, assume joint failure rate is 25% and joint
        - spacing is 5'

$$\text{Gel Time} = \left(\frac{\{\text{SockAnnular Space (gal)}\} + \{\{[1 + (\text{Sock Length (ft)}/\text{joint spacing})]\ \text{x \#\% joint failure rate}\}\ \text{x [Pipe Diameter (inch) x \# grout goal (gpin-dia)] + Mainline void space (gal)}\}\}}{\text{Pumping Rate(gpm)}}\right)\left(\frac{60\text{sec}}{1\text{min}}\right)$$

    c. LFD: Calculate gel time using the below formula:

$$Gel\ Time = \left(\frac{\{Annular\ Space\ (gal)\} + \{PipeDiameter(inch)x0.25(gpin - dia - ft)x(PipeLength + 2\}}{Pumping\ Rate(gpm)}\right)\left(\frac{60sec}{1min}\right)$$

Where groundwater is entering the pipe from multiple locations near the point of grouting or where grout consistently enters back into the pipe from adjacent joints, lower gel time and/or modify grouting procedures to allow faster grout set times and minimize grout wash-in through adjacent defects. Consult with Engineer before proceeding with any site-specific measures.

F. TESTING AND GROUTING DEFECTS

At the discretion of the Engineer, testing and grouting will not be required on pipes exhibiting defects which can damage equipment or pose a risk of failure during grouting operations. The Contractor shall provide the Engineer with evidence of the defects when they are discovered, and the Engineer shall have the final say as to whether the defect is able to be grouted.

Low-pressure grouting shall be performed where indicated on the plans and as directed by the Engineer. The Engineer reserves the right to direct the Contractor to perform low-pressure grouting on the defects described above.

Test and seal manhole outside drop connection joints using a push packer appropriately sized for diameter and length of outside drop pipe. Test and seal as much of the outside drop connection from the main to the manhole as practical using ODC packer.

Position packers over joints or defects by means of a closed-circuit television camera in the line.

For each joint/lateral/defect tested/grouted, record exact location and volume of grout placed in PACP Remarks field.

For each segment, record ambient temperature, grout tank temperature, gel set test time, and packer inflation pressure in PACP header in appropriate fields.

Specifically identify each tap and break location on the grout report to aid in properly locating joints during warranty testing.

G. JOINT TESTING PROCEDURE FOR MAINLINE SEWER AND LATERALS CONNECTED TO MANHOLES

Joint testing target pressure before grouting shall be equal to ½ psi per vertical foot of pipe depth plus 3 psi; however, target test pressure shall not exceed 12 psi nor be lower than 6 psi unless directed by the ENGINEER. Control test equipment to ensure the specified test pressure is not exceeded by more than 2 psi.

If void pressure gauge is not working or not visible/readable and less than 1/3rd the remaining items to test remain, CONTRACTOR may complete segment using panel gauge but test pressures shall be increased by 5 psi and test time by 5 seconds (to overcome the check valves and regulators in the plumbing). No additional work may be conducted beyond this until the void pressure gauge is working properly.

Test joints on LCMs from the manhole to the distance as shown on the plans or as directed by the Engineer. If there is a transition in the LCM, test the transition unless its offset prevents packer insertion and seal. Direct visual observation shall be used to position the packer.

Test joints on LACOs from the cleanout to the main, to previously grouted joints done during LTC grouting, or until the lateral diameter increases beyond the sealing capabilities of the LACO packer, whichever comes first. Direct visual observation shall be used to position the packer.

Do not test joints with visible longitudinal, spiral, or multiple fractures or cracks or where the packer cannot be seated because of tap connection. Note reason for not testing on the log.

Individually test each MLJ, LACO, ODC, and LCM joints at the above-specified pressure (and retest after sealing) in accordance with the following procedure:

1. The packer shall be positioned within the pipe in such a manner as to straddle the joint to be tested. If uncertain, pump small amount of grout to confirm the void space is properly located (spitting) before inflating the packer.

2. The packer ends shall be expanded to isolate the joint from the remainder of the pipe and create a void area between the packer and the pipe joint. The ends of the testing device shall be expanded against the pipe with sufficient inflation pressure to contain the air within the void without leakage past the expanded ends. Record end seal pipe-packer contact pressure and seal pressure used.

    a. Packer end seal pressures for visually sound VCP shall not be greater than 15 psi more than the required packer-pipe contact pressure.

    b. Packer end seal pressures for VCP with joint defects shall use low pressure MLJ techniques such that the end element pressures shall not be greater than 8 psi more than the required packer-pipe contact pressure.

c. For rough surface pipe such as corroded concrete pipe58, use grout to seal the leaks around the packer end if airtight seal cannot be achieved. Gel time may be reduced to half the normally specified time under these circumstances with the approval of ENGINEER. The CONTRACTOR shall be paid the unit price for grout to seal the packer unless ENGINEER determines that the sewer was inadequately cleaned or the packer is not performing properly but will not be paid the unit price for joint grouting for this activity.

3. Air shall then be slowly introduced into the void area until a pressure equal to the required test pressure is observed on the pressure monitoring equipment. Control inflation rate of the packer to minimize over-pressurization of the void space by adjusting the quick inflate timer to stop rapid inflation before the packer contacts the pipe.

4. After the void pressure is observed to be equal to the required test pressure, the air flow shall be stopped. If the void pressure as measured at the packer decays by more than 1.0 psi below the required test pressure within 15 seconds, the joint will be deemed to have failed the test and shall be sealed.

5. If the void is over pressurized and the void pressure decays, the 15 second period shall begin once the test pressure is achieved. If the void is unavoidably but significantly over pressurized from water or residual grout (e.g., 2x the target test pressure) and the void pressure decays, use a 10 second period to determine if the joint(s) pass or fail.

6. If testing after grouting and the void pressure is unavoidably but significantly over-pressurized from water or residual grout (e.g., 2x the target test pressure) and the void pressure decays, add an additional 2 psi of pressure and use a 10 second period to determine if the joint(s) pass or fail

7. Upon completing the successful testing of each individual joint, the packer shall be deflated with the void pressure meter continuing to display void pressure. Should the void pressure meter fail to drop to ±1 psi, clean the test equipment of residual grout material or make the necessary equipment adjustments to provide for an accurate void pressure reading.

H. LTC TESTING PROCEDURE

LTC void pressure shall be equal to ½ psi per vertical foot of pipe depth plus 3 psi; however, test pressure shall not exceed 10 psi nor be lower than 6 psi unless directed by the ENGINEER. Control test equipment to ensure the specified test pressure is not exceeded by more than 2 psi.

If void pressure gauge is not working or not visible/readable and less than 1/3rd the remaining items to test remain, CONTRACTOR may complete segment using panel gauge but test pressures shall be increased by 5 psi and test time by 5 seconds (to overcome the check valves and regulators in the plumbing). No additional work may be conducted beyond this until the void pressure gauge is working properly.
Air testing LTCs shall be accomplished by isolating the area to be tested with the packer and by applying positive pressure into the isolated void area. A pan and tilt camera shall be used to position the lateral packer. The bladder shall be inverted from the mainline assembly into the lateral pipe and inflated. The mainline elements shall then be inflated to isolate the lateral connection and the portion of the lateral to be tested. A sensing unit shall be located within the void area and will accurately and continuously transmit void pressure readout to the control panel or pressure gauge viewable with CCTV camera.

The test procedure will consist of applying air pressure into each isolated void area. A sensing unit shall be located within the void area and will accurately transmit continuous pressure readout to the control panel. Air shall then be slowly introduced into the void area until a pressure equal to the required test pressure is observed on the pressure monitoring equipment.

After the void pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the void pressure decays by more than 1.0 psi within 20 seconds, the LTC will have failed the test and shall be sealed. If the void is over pressurized and the void pressure decays, the 20 second period shall begin once the test pressure is achieved.

After completing the air test for each individual LTC specified herein, deflate the packer, with the void pressure meter continuing to display void pressure. If the void pressure does not drop to ±1 psi, clean the test equipment of residual grout material or make the necessary equipment adjustments to provide for an accurate void pressure reading.

For laterals capped less than two feet from the main, the Contractor may use a mainline packer to test the lateral tap.

Length of lateral to be tested shall be as shown or indicated.

I. LFD AND ANNULAR SPACE TAP TESTING PROCEDURES

Do not test LFDs and annular tap spaces.

J. GROUTING – GENERAL

The pumps, meter, and packer shall be integrated so that grout component proportions, quantities, and pressures can be monitored and regulated in accordance with the type and size of the leak, percentage of voids being filled, type of soil surrounding the pipe, and the rate of flow of the grout in relation to the back pressures.

Grout all MLJ, LTC, LCM and LACO joints that failed the pressure test, that are visibly leaking at a rate classified as ID (dripper) or greater by PACP, or that have fracture, crack, or chipped joint defects originating at the joint and terminating within 8 inches of the joint by the packer injection method. Grout all LFDs or other pipe defects specified or directed without testing. Generally, this shall be accomplished by forcing grout through a system of pumps and hoses into and through the joints of the sewer from the packer within the sewer pipe. Jetting or driving pipes from the surface shall not be allowed.

Record in the Additional Comments fields60 of the PACP header the assumed bedding depth, assumed bedding material, calculated grout volume goal, in situ pump rate, gel time entered calculated by the Grout Volume and Gel Time Calculator, actual initial gel time, and adjusted gel time and time of correction.

When grouting VCP joints with defects originating at the joint, use a low-end element technique (LEET) whereby the end elements are inflated to only 8 psi above pipe-packer contact pressure. Specifically note in the grouting record each joint that has a defect originating from it.

If less than three times the void space or less than 1 gallon of grout above the packer void space is pumped outside the pipe (i.e., not blown by the end elements), whichever is less, the joint will be marked as passing; grout used in this circumstance will not be paid for.61 However, note in the grouting record the volume of grout in excess of void space and blow-by utilized.

If a packer with a higher void space than specified is used, the additional grout used to fill this larger void space shall not be paid for.

After each time pumping grout at one of the above items, if the void space pressure drops faster than the allowable rate at the defined target test pressures, then continue pumping grout in accordance with these procedures. If the void space pressure does not drop, deflate the packer, purge air test line/valve, then re-inflate and retest at target test pressure.

When using grout to seat the packer, retest as above except do not deflate the packer first.

If the item fails this air test, repeat the grouting procedure at no additional cost to

Engineer. Repeat this sequence of air testing, grouting, and subsequent air testing until either the item is sealed, or it is determined that the grout consumption is too high. The final determination to stop subsequent attempts to seal an item will be made jointly between Engineer and Contractor.

Generally, pump to refusal or in accordance with step grouting procedures. Refusal shall mean the mixed grout has flowed through the void space, through any joint failure or defect, into any annular space or surrounding soil; gelled or filled the available void space, annular space, and soil pore space; formed a cohesive seal stopping further grout flow; and an air test as described above is successfully passed.

If grout is observed to enter the pipe upstream or downstream of the packer through defects, taps, liner cut, or joints, either cut pumping rate in half or adjust gel time to half the proscribed rate. Continue to adjust until grout pass-by is no longer an issue. Readjust grout time and pump rate back to proscribed rate if determined warranted by Engineer.

If blow-by occurs before achieving minimum grout volume goal, lower the pumping rate to allow a slower introduction of grout into the void space by decreasing air pressure/feed to air pumps, turning down the pump rate of electric pumps, or manually using a 5-10 second break between each pump stroke. Adjust gel time accordingly if this happens on more than half the items being grouted.

In the grouting record, record in the comments field for each item:

1. Volume of grout in excess of void space and/or blow by pumped into pipe bedding at each joint
2. Step grout increments
3. Whether max grout volume was reached
4. Final test pressure after completion of grouting
5. If joint has J code defect
6. If packer was grouted in place
7. All taps, breaks, and fractures for the purposes of aligning grouting records during warranty testing.

Grouting Packer In Place - Gel time may be reduced from the normally specified time in halves until a testable seal is achieved if pipe wall conditions do not allow a valid packer to successfully seal with the approval of Engineer. The gel time will be established in trials in the presence of Engineer using the adjacent pipe wall where no crack, fracture, or breaks are present.

If the item fails to seal, continue the grouting procedure. Repeat this sequence of grouting and testing until either the item is sealed, or it is determined that the grout consumption is too high. The final determination to stop subsequent attempts to seal an item will be made by Engineer after consultation with Contractor.

For pipes whose crowns are less than 4 feet below grade, provide an observer to monitor for grout short circuiting or piping to the surface.

Remove all grout from pipe that obscures the pipe wall, joint, or defect when conducting post-grouting inspections. Excess grout does not need to be removed from inactive laterals.

All decisions regarding excess grout shall be made by the Engineer based on the Post-Construction Inspection and shall be final.

K. JOINT GROUTING

Stop pumping grout after pumping grout volume goal, wait 1 gel set cycle time (or longer at Contractor's discretion), retest, and if the joint does not pass the air test, then continue grouting by pumping additional grout in 1.5 gallon increments for pipe diameters 4-6 inches, in 2 gallon increments for 8-12, in 2.5 gallon increments for pipe diameters 14-21 inches, and in 3 gallon increments for pipe diameters greater than 21 inches, or until refusal. If necessary to prevent packer blowby, pump in smaller increments. After each step, wait 1 gel set cycle time (or longer at Contractor's discretion) before retesting, and, if needed, continuing with additional grout steps until successful test, until maximum grout volume is reached, or until directed to stop by Engineer.

Curtail grouting when grout rate exceeds twice the Grout Volume Goal.

Where using low end element technique (LEET) for joints with defects, increase the maximum grout per joint by 33%. Notify Engineer verbally and via email of intended changes before making this change.

If more than 16% of the joints (1 in 6) are not passing at Max Grout when using in step grouting procedure, cut your gel time in half. Notify Engineer verbally and via email of intended changes before making this change.

If more than 25% of the joints (1 in 4) need Max Grout volumes using step grouting procedures to achieve seal, cut your gel time in half. Notify Engineer verbally and via email of intended changes before making this change.

Invoke and repeat this process until a gel time of 15 seconds is reached. Do not use gel times less than 15 seconds for MLJs, LCMs, or LACOs.

For any given joint that does not seal at Max Grout, move packer forward to the

next joint, complete test and seal work on that second joint, then return to the joint that did not pass, retest it, and if necessary, pump additional grout using step grouting procedures for up to an additional 4 gallons of grout. This second test shall be considered a verification test.

If after reaching the Max Grout plus four gallons additional grout, the joint continues to fail the air test, note “Max Grout Fail” within the comments for that joint observation.

If after decreasing gel time it is found that grout volume goals are consistently not being met, gel time will be judged to be too short and gel times will be incrementally increased until grout volume goals are consistently achieved. Seek and follow instructions from ENGINEER on when to return to original gel times.

After the final post-grout pressure testing of each joint, move the packer forward, wiping away the excess grout that extends into the pipe, reduces the pipe diameter, or restricts flow. Leave the sealed joints reasonably flush with the existing pipe surface.

For LCM or LACO grouting, confirm through camera inspection lateral flow after completing all sealing of each lateral. If a grout blockage is evident, clear the lateral.

L. LTC AND ODC GROUTING

Grout LTCs or ODCs that do not pass the air test, shows evidence of leakage, or where Contractor has been directed to grout a tap that contains visible roots.

Stop pumping grout after pumping grout volume goal, wait a 1 gel cycle, retest, and if the LTC does not pass the air test continue grouting by pumping additional grout in 2-gallon increments, waiting 1 gel set cycle time between steps, retesting, and, if needed, continuing with additional 2-gallon grout steps until successful test or until directed to stop by Engineer. Record the amount of grout pumped on the sealing log.

Curtail grouting when grout volume reaches thrice the grout volume goal.

If after reaching the Max Grout, the LTC fails the air test, note “Max Grout Fail” within the comments for that LTC observation.

If greater than 20% of LTCs won’t seal when utilizing step grouting and achieving the above maximum grout volume per LTC above, cut gel time in half and maintain pump rate. Invoke this process until a gel time of 20 seconds is reached. Do not use gel times less than 20 seconds for LTCs without approval of Engineer.

If after decreasing gel time it is found that grout volume goals are consistently not

being met, gel time will be judged to be too short and gel times will be incrementally increased until grout volume goals are consistently achieved. Seek and follow instructions from Engineer on when to return to original gel times.

Air tests after grouting LTCs containing roots is not required.

Blockages in the lateral that are not the result of grouting operations shall not be the responsibility of the Contractor.

Confirm lateral flow after sealing of each lateral tap. This can be accomplished by one of the below methods:

1. Visually inspecting the entire length of the grouted lateral

2. With the lateral packer in position, retract the inversion tube and inject air pressure into the lateral. Should a pressure build in the lateral and not drop to approximately zero immediately after the pressurized air is turned off, it will be assumed that the building sewer connection is substantially blocked with grout and the Contractor shall immediately clear the lateral at no additional cost to the Engineer.

3. With the camera viewing the connection point, attempt to obtain a water flush by the occupant. If no water is viewed during this procedure, it will be assumed that the building sewer connection is substantially blocked with grout and the Contractor shall immediately clear the lateral at no additional cost to Engineer

M. LONGITUDINAL FRACTURE DEFECT GROUTING

Pump until refusal or until the grout pumped exceeds 125% of grout volume goal, at which time modify grouting procedure to step grouting by pumping additional grout in 2-gallon increments until refusal, air test pass, maximum grout volume is achieved, or directed to stop or continue by ENGINEER. Record the amount of grout pumped on the sealing log.

Generally, stop grouting when grout rate exceeds 200% of grout volume goal, unless approved by Engineer.

N. VERIFICATION TESTING

Conduct verification testing as directed by ENGINEER for quality control purposes. Engineer will select the MLJs, LTCs, LCMs, or LACOs for pull back testing.

Test on a given line segment or lateral:

1. 5% of the grouted MLJs (minimum of two),
2. 2% of MLJs that passed testing without grouting (minimum of one)
3. 5% of LCM joints (minimum of two)
4. 5% of LACO joints (minimum of two)
5. 10% of the grouted LTCs on a given segment (minimum of one, excluding taps with roots not removed)

Within a sewer line segment or lateral, if any tested items fail the pullback test, retest an additional 10% of said items in that sewer line segment or lateral at no additional cost to Engineer. If any of these tested items fail the pullback test, retest all the remaining said items in that sewer line segment or lateral at no additional cost to Engineer.

O. POST-CONSTRUCTION INSPECTION

Conduct Post-Construction Inspection of all pipes, taps, and laterals tested and/or grouted in accordance with Section 33 01 30.16, Television Inspection of Sewers. Any items found to leak that are not specifically excluded for the purposes of Warranty Testing shall be sealed prior to conducting Post-Construction Inspections. Remove from the pipe wall and bottom any excess grout. Collect and remove from the sewer all excess grout removed from the pipe wall.

P. WARRANTY

All grouting work shall be guaranteed for a period of 1 year from the date of substantial completion granted in writing by the Engineer unless otherwise stipulated in writing by the City. During this period, the Engineer reserves the right to inspect and/or test, at their own expense, any and all work performed as part of this contract. Any actionable defects documented during this period by the Engineer shall be resealed by the Contractor at no additional cost to the City. The Engineer shall have until the end of the warranty period to report the findings of their inspection(s) and/or testing to the Contractor, and the Engineer shall negotiate a reasonable repair schedule for any actionable items found. The warranty shall cover grout repair due to hydrostatic leaks (infiltration) as defined per NASSCO PACP infiltration definitions, and any other work directed by the Engineer to make the finished product meet these specification requirements. Any and all warranty inspections and/or warranty work shall be incidental to this contract.

1. Main Line Joint (MLJ) Warranty Testing

Conduct warranty testing on 15% of MLJs regardless of whether they passed or failed the pre- or post-grouting air test or a minimum of two sewer line segments, whichever is greater, 18 to 24 months after Substantial Completion. ENGINEER will select the pipe segments to be warranty tested, with the selection of pipe segments representative of the inventory of diameters and materials originally tested.

If more than 10% of the warranty tested MLJs fail, test an additional 15% of the pipe segments or two additional sewer line segments, whichever is greater, will be warranty tested at no additional compensation. If more than 10% of the second group of warranty tested MLJs fail, test the MLJs in 50% of the remaining untested pipe segments at no additional compensation. If more than 10% of the warranty tested MLJs fail, test all MLJs in the remaining untested pipe segments at no additional compensation.

Grout and retest all MLJs failing warranty testing regardless of whether they passed or failed the pre- or post-grouting air test at no additional compensation. Grout gel time for warranty testing grouting shall be 30 seconds.

For each pipe warranty tested, perform a Warranty Inspection.

MLJs that received maximum grout volume, regardless of whether achieved a successful post-grouting air test originally or which had joint originating defects, will be tested and, if needed, regrouted, but are exempted from the warranty testing percentages.

2. Laterals Connected to Manholes (LCM), Outside Drop Connections (ODC), and Lateral Accessed from Cleanout (LACO) Warranty Testing

   Conduct warranty testing on 15% of the LCM, ODC, and LACO joints regardless of whether they passed or failed the pre- or post-grouting air test 18 to 24 months after Substantial Completion. ENGINEER will select the LCMs, ODCs, and LACOs to be warranty tested, with the selection of laterals representative of the inventory of diameters and materials originally tested.

   If more than 10% of the warranty tested LCM and LACOs joints fail, test an additional 15% of the LCMs, ODCs, and LACOs at no additional compensation. If more than 10% of the second group of warranty tested LCM, ODCs, and LACOs joints fail, test 100% of the remaining, untested, LCMs, ODCs, and LACOs at no additional compensation.

   Grout and retest all LCM, ODC, and LACO joints failing warranty testing regardless of whether they passed or failed the pre- or post-grouting air test

at no additional compensation. Grout gel time for warranty testing grouting shall be 20 seconds.

Perform a Warranty Inspection of all LCM, ODCs and LACO joints that are warranty tested.

LCM, ODC, and LACO joints that received maximum grout volume, regardless of whether achieved a successful post-grouting air test originally or which had joint originating defects, will be tested and, if needed, regrouted, but are exempted from the warranty testing percentages.

3. Lateral Tap Connection (LTC) Warranty Testing

   Conduct warranty testing on 15% of the LTCs (excluding grouted taps that contained roots) regardless of whether they passed or failed the pre- or post-grouting air test 18 to 24 months after Substantial Completion. ENGINEER will select the LTCs to be warranty tested, with the selection of pipe segments representative of the inventory of diameters and materials originally tested.

   If more than 10% of the warranty tested LTCs fail, test an additional 15% of the LTCs at no additional compensation. If more than 10% of the second group of warranty tested LTCs fail, test 100% of the remaining, untested, LTCs at no additional compensation.

   Grout and retest all LTCs failing warranty testing regardless of whether they passed or failed the pre- or post-grouting air test at no additional compensation. Grout gel time for warranty testing grouting shall be 45 seconds.

   Perform a Warranty Inspection of all LTCs that are warranty tested.

   LTCs that received maximum grout volume, regardless of whether achieved a successful post-grouting air test originally or which had joint originating defects, will be tested and, if needed, regrouted, but are exempted from the warranty testing percentages.

4. Longitudinal Fracture Defects (LFD) Warranty Testing

   Conduct warranty testing on 15% of the LFDs (excluding grouted taps that contained roots) 18 to 24 months after Substantial Completion. ENGINEER will select the LFDs to be warranty tested, with the selection of pipe segments representative of the inventory of diameters and materials originally tested. Warranty testing will consist of visual examination for leakage.

If more than 10% of the warranty tested LFDs fail, test an additional 15% of the LFDs at no additional compensation. If more than 10% of the second group of warranty tested LFDs fail, test 100% of the remaining, untested, LFDs at no additional compensation.

Grout and retest all LFDs failing warranty testing at no additional compensation. Grout gel time for warranty testing grouting shall be 60 seconds.

Perform a Warranty Inspection of all LFDs that are warranty tested.

LFDs that received the maximum grout volume or which did not achieve a successful post-grouting air test originally will be tested and, if needed, regrouted, but are exempted from the warranty testing percentages.

5. CIPP Liner Annular Space Tap (AST) Warranty Testing

Conduct warranty testing on 15% of the ASTs (excluding grouted taps that contained roots) 18 to 24 months after Substantial Completion. ENGINEER will select the ASTs to be warranty tested, with the selection of pipe segments representative of the inventory of diameters and materials originally tested.

If more than 10% of the warranty tested ASTs fail, test an additional 15% of the ASTs at no additional compensation. If more than 10% of the second group of warranty tested ASTs fail, test 100% of the remaining, untested, ASTs at no additional compensation.

Grout and retest all ASTs failing warranty testing at no additional compensation. Grout gel time for warranty testing grouting shall be 30 seconds.

Perform a Warranty Inspection of all ASTs that are warranty tested.

SECTION 615.5
CONTENTS

615 - SEWER LINING AND GROUTING

SECTION 615.5 – GROUTING OF MANHOLES

615.5 - MANHOLE GROUTING

A. GENERAL

This section includes the material and procedures required for the repair of sanitary sewer manholes by chemical grouting. The Contractor shall provide all labor, materials and equipment to perform the work in accordance with these specifications. Equipment shall include pumps, hoses, gauges, drills, compressors, personal protective equipment and all other items as necessary to complete the work. The Contractor's equipment shall be of a type, capacity and mechanical condition suitable for doing the work in an effective and efficient manner.

1. WORK REQUIRED

Sealing leaks in precast manholes will be accomplished by drilling holes in the area of the leak and injecting chemical grout. If the leak is in a precast joint of the manhole barrel, the entire joint will be grouted by drilling at least three injection holes. If the leak is in the connection to a sewer, the leak will be grouted with an injection hole above the crown and another at the leak. If the leak is located within the frost zone, within 6 feet from the surface or if above bottom cone joint, urethane grout is to be used.

2. DEFINITIONS

CHIMNEY: The cylindrical variable height portion of the manhole structure used to support and adjust the finished grade of the manhole frame. The chimney extends from the top of the corbel or cone to the base of the manhole frame.

CONE OR CORBEL: That portion of the manhole structure, which slopes upward and inward from the barrel of the manhole to the required chimney or frame diameter. "Corbel" refers to a section built of brick or block, while "cone" refers to a precast section.

BARREL: That portion of the manhole structure from the bench to the cone.

PRE-APPROVED EQUAL: A product that meets the applicable material, performance and design life requirements of this specification and has been approved by the Engineer for use on this project a minimum of 7 calendar days prior to bid opening.

DEFECT: A joint that is leaking including the entire circumference of the manhole, each stain or active leak, or cluster of leaks within one square foot in a precast manhole.

3. QUALITY ASSURANCE

Sealing shall be performed by a crew under the direct supervision of a superintendent who has documented experience in the sealing procedures as specified herein and as considered standard in the sewer manhole sealing industry.

Storage, mixing, handling and use of all materials and compounds shall be in strict accordance with manufacturer's instructions and specifications.

a. STANDARDS: National Association of Sewer service Companies (NASSCO) specification guidelines for sewer collection system maintenance and rehabilitation, eighth edition.

4. SUBMITTALS

Manufacturer's information and installation procedures for chemical grout will be submitted to the Engineer prior to performing the grouting. This shall include, but not be limited to, product data, material samples, sealant mixture design, application/packing procedures, test data and a detailed description of equipment and operational procedures to accomplish the chemical grout sealing. A detailed time schedule shall also be submitted.

B. PRODUCTS

1. CHEMICAL GROUT

Water based chemical grouts shall have the following characteristics:

a. A minimum of 10% acrylamide base material by weight in the total grout mix. A higher concentration of acrylamide base material is recommended to increase strength or offset dilution during injection.

b. The ability to tolerate some dilution and react in moving water during injection.

c. A viscosity of approximately 2 centipoise, which can be increased with approved additives.

d. A controllable reaction time from 10 seconds to 1 hour.
e. A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, firm, flexible gel.

f. The ability to increase mix viscosity, density and gel strength by increased concentrations of the mix constituents or by the use of approved additives.

g. Product Manufacturer: Avanti AV-100, Avanti AV-118, or equal.

2. ADDITIVES

At the Contractor's discretion and according to field conditions, additives may be selected and used within the manufacturers recommended quantities.

a. STRENGTHENING AGENTS

For joint grouting, a latex or “diatomaceous earth” additive may be added to increase compressive and tensile strength. The quantity of strengthening agent additive shall be as recommended by the manufacturer and approved by Engineer. Product Manufacturer: Avanti AV-257 Icoset, DeNeef Reinforcing Agent, or equal.

b. DYE: A manufacturer approved water soluble dye without trace metals may be added to the grout tank(s) for visual confirmation.

c. GEL TIME MODIFIER: A gel time extending agent may be used in accordance with the manufacturer’s recommendations to extend gel time as necessary.

d. FREEZE/THAW: In those lines where the grouting material may be exposed to a freeze-thaw cycle, ethylene glycol or other Engineer approved additive shall be used to prevent chemical grout cracking once set.

When using non soluble additives the grout tanks must have mechanical mixing devices to keep the additives in suspension and maintain a uniform solution of grout and additive.

C. EXECUTION

1. CHEMICAL GROUT PREPARATION

Mix grout in plastic or metal pail. Concrete or wood containers are not allowed. Add accelerator to grout if required and stir to an even consistency.

Utilize positive displacement pumps in accordance with manufacturer's recommendations to inject chemical grout. Pumps must be flushed with washing agent in accordance with manufacturer's recommendations for at least 2 minutes before and after grouting operation.

2. CHEMICAL GROUT INJECTION

Manhole sealing may be accomplished only where the manholes are structurally sound. No sealing shall be attempted where the leakage is unconfinable, such as in brick manholes or where the structural integrity of the manhole has been lost. All manhole sealing shall be done during high groundwater conditions. The properties and characteristics of chemical sealing materials used for manhole sealing shall be as specified.

Manhole grouting shall not be performed until the repair of the manhole frame and grade rings or any other structural manhole repairs are complete. Manhole preparation work shall consist of the removal of any loose debris, grease, slime or old sealants from the manhole cracks, joints or gaps to be sealed. The Contractor shall cut, trim, and/or otherwise remove all roots within the manhole before beginning the grouting and sealing process. Preparation shall also include removal of manhole steps as required. All

foreign and loose material shall be removed by water blasting and/or by hand scraping with a steel wire brush (or other approved tool).

a. Drill injection holes for injection from within the manhole at the rate recommended in the manufacturer's written recommendations. Carefully drill holes through structure wall at 45° angles to intersect the crack at the approximate midpoint of thickness of the wall. Drill injection holes shall extend through the entire manhole wall.

b. Insert a packer and remove grease fitting to allow water to flow through the open packer. Inject chemical grout from the lowest elevation and proceed upward from packer to packer to ensure continuous flow of grout through the crack. Use potable water if necessary to speed the reaction for inactive leaks and/or dry cracks.

c. In cases where there are multiple leaks around the circumference of the manhole, fewer holes may be drilled – providing all leakage is stopped from these holes. Into the previously drilled holes, chemical sealant injection devices shall be placed in such a way that they will provide a watertight seal between the holes and the injection device. A hose, or hoses, shall be attached to the injection device from an injection pump. Chemical sealing materials as specified shall then be pumped through the

hose until material refusal is recorded on the pressure gauge mounted on the pumping unit, or a predetermined quantity of sealant has been injected. Chemical injection pumps shall be equipped with pressure meters that will provide for monitoring pressure during the injection of the chemical sealants. When necessary, fluid bypass lines equipped with pressure-regulated bypass valves shall be incorporated into the pumping system.

d. Care shall be taken during the pumping operation to insure that excessive pressures do not develop and cause damage to the manhole structure. Upon completion of the injection, the devices shall be removed and the remaining holes filled with mortar and troweled flush with the surface of the manhole walls or other surfaces. The mortar used shall be of the “fast-set” type with “non-shrinking” characteristics.

After the manhole sealing operation has been completed, the manhole shall be visually inspected for the elimination of excessive infiltration by the Contractor in the presence of the Owner’s Representative.

All sealed manholes shall be re-inspected 3 months after completion and resealed, if necessary, at no cost to the Owner.

3. PATCHING INJECTION HOLES

Remove excess grout and sealing material from structure surface. Patch injection holes with a quick setting, fiber-reinforced, high early strength, corrosion resistant, hand mixed and hand applied calcium aluminate based, cementitious material for patching and filling voids and cracks.

Material shall have the following minimum requirements:

Compressive Strength	ASTM C-109	6 hr 1,400 psi
Shrinkage	ASTM C-596	0% at 90% R.H.
Bond	ASTM C-321	28 day 150 psi
Cement		Sulfate resistant
Density, when applied		105 ± pcf

4. CHEMICAL GROUT ACCELERATOR

Resin may be mixed with the accelerator as recommended by the manufacturer. Adjust the amount of accelerator as necessary in a manner approved by the manufacturer.

5. CLEANUP

Protect upstream and downstream sewers from excess chemical grout and other construction debris. Remove excess material from omitted surfaces before the material hardens. Use drop cloths or other protective coverings when necessary. Chip away hardened globules, spatter, and excess materials from surfaces, which are not intended to be covered. Prior to demobilization from the site, the Contractor shall remove all construction debris, stabilize any spill areas, and wash roadway areas affected by the sealing operation.

6. WARRANTY

All grouting work shall be guaranteed for a period of 1 year from the date of substantial completion granted in writing by the Engineer unless otherwise stipulated in writing by the City. During this period, all defects discovered by the City shall be removed and replaced by the Contractor in a satisfactory manner at no cost to the City. The City may conduct independent inspections, at its own expense, of the grouting work at any time prior to the completion of the warranty period. The warranty shall cover liner repair due to hydrostatic leaks (infiltration).

SECTION 615.6

NAASCO SPECIFICATIONS FOR CURED-IN-PLACE-PIPE (CIPP) LATERAL SEALS

Begin section 615.6 on the following page.

Cured-In-Place-Pipe (CIPP) LATERAL SEALS

PERFORMANCE SPECIFICATION GUIDELINE

October 2016

Thanks to the following participants for the development of this document:

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Disclaimer

These Specifications were prepared by a Committee comprised of representatives of NASSCO members and peer-reviewed by industry professionals. These Specifications are not specific to any one product, project, or job site, and should be considered a guideline only. Conditions for use may require additions, deletions or amendments to these guidelines so as to conform to project-specific site conditions and to comply with applicable laws, regulations, and ordinances. NASSCO does not guarantee, certify or assure any result and assumes no liability as to content, use and application of these guidelines.

CONTENTS

PART 1 - GENERAL

1.1 Description of work and product delivery

1.1 A. These Specifications include the minimum requirements for the rehabilitation of lateral connections and their interface with the main-line pipes via Cured-In-Place-Pipe (CIPP) as shown on the plans and included as part of these [contract documents]. The lateral seal will include an Owner specified length of lateral pipeline that will also be rehabilitated in conjunction with the lateral/mainline connection, as a one piece integrated system.

1.1 B. The rehabilitation of lateral connections and a portion of the lateral pipeline shall be accomplished by the installation of a Cured-In-Place-Pipe (CIPP) system installed from the main-line pipeline extending up the specified length of the lateral. The system may or may not require the use of cleanouts on the lateral pipeline. The installed system shall be free of all defects that will affect the design, service life and operation of the lateral interface with the main-line and the specified length of the lateral pipe.

1.1 C. The liner may be inverted or pulled into place from the mainline sewer.

1.1 D. The installed system shall eliminate water leakage into the sewer system over the entire rehabilitated length of sewer.

1.1 E. The prices submitted by the Contractor, shall include all costs for the various bid items necessary for furnishing and installing, complete and in place, the system in accordance with these specifications, except for those specified otherwise by the Owner.

1.1 F. The furnished and installed system shall include all materials, manufacturer's recommended equipment and manufacturer's installation procedures.

1.1 G. At the discretion of the Owner, the system manufacturer may submit to the Owner, a minimum of 14 calendar days in advance of a bid date, all required product information to obtain pre-approval system status. Those systems that have been pre-approved will not need to be re-submitted as required in the submittal section of these specifications unless any of the system components have changed from those pre-approved by the Owner. All other component products will be required to meet the submittal requirements as contained herein.

1.1 H. At the discretion of the Owner, the system installer may submit to the Owner, a minimum of 14 calendar days in advance of a bid date, all required qualifications information to obtain pre-approval system installer status. Those system installers that have been pre-approved will be allowed to bid on the specified project scope.

1.1 I. The installed system shall be free of all defects that will affect the design, service life and operation of the lateral and applicable portion of the main-line.

1.1 J. The installed system shall eliminate infiltration and ex-filtration over the entire length of the system.

1.1 K. The system shall be designed against corrosion and typical chemicals found in domestic sewage, unless otherwise specified in the detailed section of the contract documents. The manufacturer of the system shall provide testing data that supports the chemical resistance in accordance with ASTM F1216.

1.1 L. The mainline and lateral portion of the system shall be designed for Partially or Fully Deteriorated design conditions per ASTM F1216 as specified by the Owner. Partially deteriorated designs conditions assume the CIPP liner is designed to support groundwater loads, while fully deteriorated design conditions assume the CIPP liner is designed to structurally replace the host pipe completely. Wall thickness design calculations stamped by a registered professional engineer shall be submitted. All design must be supported by third party testing and documentation for the exact product that is being submitted.

1.1 M. Flow entering the lateral or main-line shall be bypassed if necessary for the installation of the system.

1.1 N. All materials furnished as part of this contract shall be marked with detailed product information, stored in a manner specified by the manufacturer and tested to the requirements of this contract.

1.1 O. Testing shall be executed by the owner or by the contractor in the presence of the owner. Testing requirements will be provided by the Owner.

1.1 P. Warranty inspections shall be executed by the Owner or its representative. Any defects found shall be repaired or replaced by the Contractor according to manufacturer's recommendations.

1.2 Performance Work Statement (PWS) Submittal

1.2 A. The Contractor shall submit, to the Owner, a Performance Work Statement (PWS) package at a predetermined time set by the Owner, which clearly defines the proposed system delivery in conformance with the requirements of the contract documents.

1.2 B. Clearly indicate that the system will conform to the project requirements as outlined in the Description of Work, Scope of Work Included and as further delineated in these contract documents.

1.2 C. Certify at the time of the bid, that the designated items included in the contract documents were visited, inspected and evaluated by the Contractor or Contractor's Representative, prior to submitting a bid.

1.2 D. Where the scope of work is specifically delineated in the contract documents, a detailed installation plan describing all preparation work, cleaning operations, pre-inspections, sewage flow maintenance, traffic control, installation procedure, method of curing, quality control, testing to be performed, final inspection, warrantees furnished and all else necessary and appropriate for a complete system installation, shall be submitted.

1.2 E. A detailed installation schedule shall be prepared, submitted and conform to the requirements of these contract documents.

1.2 F. The manufacturer's description of the system materials is to be furnished for the project. Material descriptions shall be sufficiently detailed in the submittals to verify conformance to these specifications and/or shall conform to the pre-approved system submission.

1.2 G. The Contractor's experience with the system proposed for use in this contract. The name and experience of each lead individual performing work on this contract shall be submitted. If personnel are substituted after bid submittal the name and experience of the individual shall be submitted to the Owner for approval before starting any work.

1.3 Submittals (after contract award)

1.3 A. Product data submittals required for all rehabilitation lateral lining systems proposed for installation under this contract shall include:

1. System material type and manufacturer to be used including: catalog data sheets, ASTM references, material composition, manufacturers recommended specifications, component physical properties and chemical resistance.

2. Manufacturer's detailed description of the recommended procedures for handling and storing materials

3. Manufacturers detailed description of the recommended system installation process

4. Copies of independent testing performed on the CIPP liner composite verifying the product meets the requirements as specified in these contract documents and the manufacturers design.

5. By-Pass Pumping Plan if applicable to the system being installed.

6. Traffic Control plan, if applicable for the system being installed.

7. Certified statement, from the manufacturer, that the contractor/installer is an approved installer of the system with certificates of completed training for each crew member involved. This requirement shall comply with the specific system requirements specified in the contract documents

8. Submittal of all quality assurance documentation and test reports for system installed. (After Rehabilitation Completion)

9. CIPP wall thickness design calculations based upon ASTM F1216 assuming either Fully or Partially Deteriorated conditions, as specified by the owner. The designs will be stamped by a Professional Engineer if required by the Owner.

10. Wetout/cure logs per liner providing details pertaining to the resin type and quantity, catalyst type and quantity, tube type, installation pressures, temperatures and times (as applicable to the curing lateral lining system utilized), and pertinent Owner/User project specific data.

11. Third party testing of the physical properties, corrosion resistance and sealing method.

12. Health and Safety plan detailing the site specific safety requirements.

13. Qualifications of the Contractor to install the system.

14. Qualifications of the proposed system to meet the requirements of the Contract.

1.4 Quality Control Plan (QCP)

1.4 A. A detailed quality assurance plan (QCP) shall be submitted to the Owner that fully represents and conforms to the quality control requirements of these specifications. At a minimum the QCP shall include the following:
   1. How the system is prepared for installation
   2. How the system is installed
   3. How the completed system is confirmed to be in compliance with the requirements of the Contract.
   4. Training/Qualifications of personnel preparing and installing the system

1.4 B. Proposed procedures for quality control, product sampling and testing shall be defined.

1.4 C. Proposed methods for product performance controls, including method of and frequency of product sampling and testing as applicable.

1.4 D. Proposed methods and procedures for system repair or replacement, (as defined in Section 1.6) in the event of product defects or failure.

1.5 Lateral Lining System repair/replacement

1.5 A. Due to defects in preparation and/or installation, systems will occasionally need to be repaired or partially replaced. The Manufacturer shall outline specific repair or replacement procedures for potential issues that may occur during the installation of the system. Repair/replacement procedures shall be as recommended by the system manufacturer and shall be submitted as part of the PWS.

1.5 B. Issues, that may not affect the operation and long term life of the product, shall be identified and defined by the Manufacturer.

1.5 C. Repairable issues that may occur in the system shall be specifically based on Manufacturer's recommendations, including a detailed step-by-step repair procedure, resulting in a finished product meeting the estimated life cycle of the component and requirements of these contract specifications.

1.5 D. Un-repairable issues that may occur in the system shall be clearly defined based on the Manufacturer's recommendations. The Contractor, together with the manufacturer, shall define the best recommended procedure for the total removal and replacement of the system.

1.5 E. The Contractor shall receive no additional compensation for the repair or replacement of system deemed non-conforming to the requirements of these contract documents and unacceptable by the Owner.

1.6 Safety

1.6 A. The Contractor shall conform to all work safety requirements of pertinent regulatory agencies, and shall secure the site for working conditions in compliance with the same. The Contractor shall erect such signs and other devices as are necessary for the safety of the work site.

1.6 B. The Contractor shall perform all of the Work in accordance with applicable OSHA safety standards. Emphasis shall be placed upon the requirements for entering confined spaces.

1.6 C. The Contractor shall have on the job site at all times at a minimum the following safety equipment:

1. Gas monitor capable of testing and detecting for combustible gas, oxygen deficiency and hydrogen sulfide.
2. Confined space access and retrieval winch system.
3. Ventilating fans with large diameter ventilating hose.
4. Safety harness and life lines.
5. Other equipment as may be required for a specific project
6. All equipment to be available for use, in sufficient quantity, by the Contractor, Engineer and Owner for the duration of the project.

1.6 D. All entries into or work within confined spaces shall be conducted in accordance with the U.S. Department of Health and Human Services/National Institute for Occupational Safety and Health [DHHS (NIOSH)] Publication No. 87-113, A Guide to Safety in Confined Spaces.

1.7 Warranty

1.7 A. The materials used for the project shall be certified by the manufacturer for the specified purpose. The manufacturer shall warrant the SYSTEM materials to be free from defects in raw materials for one (1) year after installation or from the date of acceptance by the Owner, whichever is later. The Contractor shall warrant the system for a period of one (1) year.

1.8 Warranty Inspections

1.8 A. The Owner shall perform, at its own cost, warranty inspections with its own personnel or personnel independent of the installation contractor.

1.9 Measurement and payment

1.9 A. Typical bid items consist of:
1. Clean and CCTV of specified lateral, including specified length of lateral pipeline, per Each
2. Furnish and install system, including Owner specified length of CIPP lateral liner, per EA
3. Furnish and install CIPP lateral liner extending beyond item 2, per LF

1.9 B. Measurements for each item furnished and installed to the satisfaction of the Owner shall be at the units of measure contained in the Bid Proposal.

1.9 C. Payment for each item shall be in accordance with the contract documents at the unit or lump sum prices bid therefore in the Bid Proposal.

PART 2 - LATERAL LINING PRODUCTS

2.1 Lateral seals

2.1 A. General

1. The system seals the point of connection from a main-line pipe to a connecting lateral pipeline and is normally installed without excavation by the install of a resin-impregnated, flexible laminate installed into the existing service lateral, lapping over the main-line pipe, sealing the connection.

2. The system can be specified one of the following:
   (a) Tee/full wrap section with a full circumferential CIPP liner inside the main pipe and a tube which shall extend continuously from the sewer main into the lateral for an Owner specified distance
   (b) Flange/brim CIPP connection seal and tube which shall extend continuously from the sewer main into the lateral for an Owner specified distance.
   (c) A system that is similar to those listed above and acceptable to the Owner.

3. The system shall extend an Owner specified length into the lateral.

4. The Contractor will determine the need for a clean out on the lateral(s) specified for rehabilitation.

5. The system shall be capable of sealing a combination of “tees” and “wyes” of varying angles. The resin shall be cured to form the tube into a hard impermeable pipe-within-a-pipe.

6. When cured, the system shall seal the connection of the lateral to the mainline in a continuous tight-fitting, watertight pipe-within-a-pipe to eliminate any visible

leakage between the lateral and mainline and shall provide a leak-proof seal to prevent root intrusion, infiltration, and ex-filtration between the liner and host pipe.

7. Systems that use polyester and vinylester resins shall include a method of sealing the connection and the end of the laterals liner as recommended by the manufacturer of the system. The product used in the sealing method shall be installed in accordance with manufacturer's recommendations. The sealing method shall be tested by simulating groundwater pressure using a third party and stamped by an engineer.

8. Systems that use silicate or epoxy shall prepare the host pipe in accordance with manufacturer's recommendations. Third party testing shall be provided to prove the bond strength between the resin and surface it is to bond to.

9. The installation of the system will require the product to be capable of installing without access to the upstream side of the lateral pipe and capable of navigating bends or other transitions in alignment as identified by the owner in the contract bid documents.

2.1 B. References

1. ASTM F1216 – Standard practice for rehabilitation of existing pipelines and conduits by the inversion and curing of a resin-impregnated tube.

2. ASTM F1743 – Standard practice for rehabilitation of existing pipelines and conduits by pulled-in-place installation of cured in place thermosetting resin pipe.

3. ASTM D543 – Practices for evaluating the resistance of plastics to chemical reagents.

4. ASTM D790 – Test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials.

5. ASTM D5813 – Specification for cured in place thermosetting resin sewer piping systems.

6. ASTM F2019 – Standard practice for rehabilitation of existing pipelines and conduits by the pulled in place installation of glass reinforced plastic (GRP) cured in place thermosetting resin pipe.

7. NASSCO Guideline Specification for the installation of cured in place pipe (June 2011).

8. NASSCO Guideline Specifications for cleaning and televising pipelines

2.1 C. Materials

1. Non-woven fabric tube

   (a) The fabric tube shall consist of one or more layers of absorbent non-woven felt fabric, felt/fiberglass or fiberglass and meet the requirements of ASTM F 1216, ASTM F 1743, ASTM D 5813 & ASTM F2019. The fabric tube shall be capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures and have sufficient strength to bridge missing pipe segments, and stretch to fit irregular pipe sections.

   (b) The wet-out fabric tube shall have a uniform thickness and excess resin distribution that when compressed at installation pressures will meet or exceed the design thickness after cure.

   (c) The fabric tube shall be manufactured to a size that when installed will tightly fit the internal circumference, meeting applicable ASTM standards or better, of the original pipe or the existing lined pipe. Allowance shall be made for circumferential stretching during installation. The tube shall be properly sized to the diameter of the existing pipe and the length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends. The Contractor shall determine the minimum tube length necessary to effectively span the designated run. The Contractor shall verify the lengths in the field prior to ordering and prior to impregnation of the tube with resin, to ensure that the tube will have sufficient length to extend the entire length of the run. The Contractor shall also measure the inside diameter of the existing pipelines in the field prior to ordering liner so that the liner can be installed in a tight-fitted condition.

   (d) The outside and/or inside layer of the fabric tube (before installation) shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate vacuum impregnation and monitoring of the resin saturation during the resin impregnation (wetout) procedure.

   (e) No material shall be included in the fabric tube that may cause de-lamination in the cured CIPP. No dry or unsaturated layers shall be acceptable upon visual inspection as evident by color contrast between the tube fabric and the activated resin containing a colorant.

   (f) The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made. The hue of the color shall be dark enough to distinguish a contrast between the fully resin saturated felt fabric and dry or resin lean areas.

   (g) Seams in the fabric tube, if applicable, shall meet the requirements of ASTM D5813. H.

   (h) The outside of the fabric tube shall be marked with the name of the manufacturer of the CIPP lateral lining system, manufacturing lot and/or production footage, as applicable. The print must be visible during final CCTV inspection.

(i) The minimum length of the fabric tube shall be that deemed necessary by the installer to effectively span the distance specified by the Owner.

(j) The nominal fabric tube wall thickness shall be constructed, as a minimum, to the nearest 0.5 mm increment, Wall thickness transitions, in 0.5 mm increments or greater as appropriate, may be fabricated into the fabric tube between installation entrance and exit access points. The quantity of resin used in the impregnation shall be sufficient to fill all of the felt voids for the nominal felt thickness.

(k) The liner shall be constructed with transitions where applicable.

2. Resin

(a) The resin shall be a corrosion resistant polyester, vinyl ester, silicate or epoxy resin and catalyst system and hardener system that, when properly cured within the tube composite, meets the requirements of ASTM F1216, ASTM F1743 or 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.

(b) The method of cure may either be from a manufacturer recommended heat source, light cure or by ambient temperature. Method of cure instructions along with a cure log shall be on-site at all times.

(c) The resin to tube ratio, by volume, shall be furnished as recommended by the manufacturer.

3. Structural requirements

(a) The physical properties and characteristics of the finished liner will vary considerably, depending on the types of resin and tube used. It shall be the responsibility of the Contractor to provide a CIPP lateral lining system which meets or exceeds the minimum properties specified herein.

(b) The CIPP shall be designed per ASTM F1216. The CIPP design shall assume no bonding to the original pipe wall.

(c) The lateral CIPP shall be designed assuming the following minimum design data, unless otherwise modified by the Owner:

(i) Factor of Safety = 2
(ii) Soil Modulus = 1,000 psi
(iii) Soil Density = 120 pcf
(iv) Live Load = H20
(v) Depth of Cover = as specified
(vi) Groundwater = ½ depth of cover
(vii) Ovality = 2%

(d) The design engineer shall set the long term (50 year extrapolated) Creep Retention Factor at 50% of the initial design flexural modulus as determined by ASTM D-790 test method. This value shall be used unless the Contractor submits long term test data (ASTM D2990) to substantiate a different retention factor.

(e) The cured pipe material (CIPP) shall, at a minimum, meet or exceed the structural properties, as listed below.

(i) Flexural modulus of elasticity: 250,000 psi
(ii) Flexural strength: 4,500 psi

4. The structural performance of the finished pipe shall be adequate to accommodate all anticipated loads throughout its design life. No cured-in-place pipe rehabilitation technology will be allowed that requires bonding to the existing pipe for any part of its structural strength.

PART 3 - EXECUTION

3.1 Lateral seals

3.1 A. General

1. Lateral seals are typically installed from the lined main-line with a lateral CIPP portion that extends up the lateral at an Owner specified distance.

2. Clean-outs are recommended but not always required to successfully install a lateral seal. Clean-outs shall be installed at the Owners' discretion. If the Owner decides clean outs are preferred, the owner shall specify the type of cleanout.

3.1 B. Preparation

1. Preparation, cleaning, inspection, sewage by-passing and public notification are the responsibility of the Contractor, with the assistance of the Owner. The Contractor shall clean the interior of the existing host pipe prior to installation of the system. All debris and obstructions, that will affect the installation and the final product shall be removed and disposed of. All preparation shall be in accordance with the manufacturer's written installation procedures.

2. The system shall be constructed of materials and methods, that when installed, shall provide a jointless and continuous structurally sound CIPP able to withstand all imposed static and dynamic loads on a long-term basis, as specified by the Owner.

3. The Contractor may, under the direction of the Owner, utilize any of the existing manholes in the project area as installation access points or excavate access points at predetermined locations.

4. Pre-Cleaning CCTV – The Contractor shall request utility locating (as required by the Owner or local Government) to identify potential cross-bore utilities within the proximity of the service lateral to be cleaned for rehabilitation, if applicable. Prior to cleaning, the Contractor shall to all extents possible, televise the service lateral to confirm that cleaning the lateral will not damage or breach a conflicting utility bored through the sewer lateral (such as natural gas or power) when the utility locate indicates a potential conflict.

5. Cleaning of Pipe Lines - The Contractor shall remove all internal debris from the pipe line that will interfere with the installation and the final product delivery of the system as required in these specifications. The Contractor shall make use of commercially available industry standard cleaning equipment to prepare the pipe for system installation. Solid debris and deposits shall be removed from the pipeline, if possible, and disposed of properly by the Contractor. Precaution shall be taken, by the Contractor in the use of cleaning equipment to avoid damage to the existing pipe. If the pipe cannot be cleaned sufficiently using industry standard cleaning equipment then additional cleaning will be considered changed conditions.

6. Post-Cleaning CCTV – Upon completion of the cleaning, the Contractor shall then perform a Post-Cleaning CCTV Inspection, which typically acts as the Pre-rehabilitation CCTV Inspection.

7. Existing Sewage Flows – The Contractor shall provide flow diversion or stoppage requirements to the owner to assist in developing plan including notifying upstream users to temporary stop using their water/wastewater during the system installation.

8. Bypass Existing Sewage Flows - When circumstances require continuous service, for the flow of the service connection (such as medical facilities or laboratories), the Contractor will install a temporary sewage by-pass system, if required by the Owner. Once the rehabilitation process has begun, existing sewage flows shall be maintained, until the system is fully installed. The Contractor shall coordinate sewer bypass and flow interruptions with the Owner at least 7 days in advance and with the property owners and businesses at least 1 business day in advance. The pump and bypass lines shall be of adequate capacity and size to handle typical flows.

9. Contractor shall perform post-cleaning video inspections of the pipelines. Only PACP certified personnel trained in locating breaks, obstacles and service connections by closed circuit television shall perform the inspection. The Contractor shall provide the Owner a copy of the pre-cleaning and post-cleaning video and suitable log, and/or in digital format for review prior to installation of the CIPP and for later reference by the Owner, if specifically required by the Owner.

10. Line Obstructions - It shall be the responsibility of the Contractor to clear the line of obstructions that will interfere with the installation and long-term performance of the system. If pre-installation inspection reveals an obstruction, misalignment, broken or collapsed section or sag that was not identified as part of the original

scope of work and will prohibit proper installation of the system, the Contractor may be directed by the Owner to correct the problem(s) prior to installing the system by utilizing open cut repair methods. This work will be considered changed conditions, or if there is an existing bid item for this work, the Contractor shall be compensated under the particular pay item designated for open cut point repairs.

11. The Contractor shall be responsible for confirming the locations of all branch service connections prior to installing and curing the CIPP. If required in the contract documents, each connection will be dye tested to determine whether or not the connection is live or abandoned. The cost for dye testing of existing service connections shall be compensated at the unit price bid. In the event the status of a service connection cannot be adequately defined, the Owner will make the final decision, prior to installation and curing of the liner, as to the status. Typically only service connections deemed “active” shall be reopened by the Contractor. Reinstatement in small diameter pipes typically requires a cleanout for external reinstatement.

12. The Contractor shall be allowed use water from an owner-approved fire hydrant in the project vicinity. Use of an approved double check backflow assembly shall be required, unless an open gap exists in the Contractor’s equipment. Contractor shall provide his own approved assembly. Contractor shall pay current market price for all water usage, unless otherwise specified by the Owner.

3.1 C. Install

1. The entire liner shall be wetout using vacuum impregnation including the lateral and mainline portions.

2. The system shall be loaded inside and/or on a pressure apparatus. The pressure apparatus, attached to a robotic device, shall be positioned in the mainline pipe at the service connection. The robotic device, together with a CCTV camera, shall be used to align the lateral portion of the system with the service connection opening. Air pressure, supplied to the pressure apparatus through an air hose, shall be used to invert or expand the resin impregnated CIPP into the lateral pipe, and push the main-line portion of the system against the main-line pipe (typically lined pipe). The pressure shall be adjusted to the manufacturer’s recommended installation pressure to fully install the CIPP into the lateral pipe and hold the system tight to the pipe walls. Care shall be taken during the curing process not to over-stress the tube.

3. After lateral CIPP installation is completed, manufacturer’s recommended pressure is maintained on the impregnated CIPP for the duration of the curing process. Curing method shall be compatible with the resin selected and shall be in accordance with manufacturer’s recommendations. The initial cure shall be deemed to complete when the CIPP has been exposed to the UV light, heat source or held in place for the time period specified by the manufacturer.

4. The Contractor shall cool (if heat cured) the hardened CIPP before relieving the pressure in the apparatus. Cool-down may be accomplished by the introduction of

cool air into the pressure apparatus. Care shall be taken to maintain proper pressure throughout the cure and cool-down period.

5. If cured by ambient-cure process, the Contractor shall maintain bladder pressure until CIPP has completely cured per manufacturer's recommendations before relieving the pressure in the pressure apparatus.

6. The finished CIPP shall be free of dry spots, lifts and de-lamination. The system shall not inhibit the closed circuit television post video inspection of the mainline or service lateral pipes. Frayed ends of the system shall be removed prior to acceptance.

7. Contractor shall maintain a visible, written log of all activities in accordance with manufacturers' recommendations and shall include time/location of wet out, time of insertion, time/location of lateral insertion, bladder pressure requirements, required cure time, actual cure time, and cool down duration.

8. During the warranty period, any defects which will affect the integrity of strength of the system and allow leaks shall be repaired at the Contractor's expense in a manner mutually agreed upon by the Manufacturer, City and the Contractor.

9. After the work is completed, the Contractor will provide the City with the specified video format showing the completed work including the restored conditions.

3.1 D. Finish

1. The installed system shall be continuous over the specified length of the sewer line section (including main-line and lateral) and be free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles and de-lamination. The system shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.

2. Any defect, which will or could affect the structural integrity or strength of the system or allow leaks, shall be repaired at the Contractor's expense,

3. The system shall provide a watertight seal at the connection to the main-line pipe and for the length of the lateral CIPP lined. The following methods/materials are recommended for ensuring a water tight seal:

   (a) 100% Solids Epoxy providing an adhesive bond between the system and the host pipe, installed/applied per the manufacturer's recommendations.

   (b) Hydrophilic materials installed/applied per the manufacturer's recommendations

4. Branch lateral connections or any other pre-existing connection to the service lateral shall be reinstated by a remote controlled robotic cutting device, either from within the pipeline or externally through a cleanout. The reinstated connection shall be brushed to allow for a smooth edge.

5. Cured samples of the CIPP may be required for testing physical properties in accordance with the requirements specified herein. The test shall be performed by an independent 3rd party laboratory, if required by the Owner and as recommended by the system manufacturer.

END OF SECTION 615.6