SECTION 817

CHEMICAL GROUTING

I. GENERAL

1.1 DESCRIPTION OF WORK

A. The Work specified in this Section includes all labor, materials, accessories, equipment and tools necessary for chemical grouting for sealing and air testing in active sanitary sewer pipe and lateral joints.

B. Packer injection grouting shall be accomplished by pressure injection of chemical grout into the soils encompassing the exterior of pipe joint. Chemical grouts shall be designed to be injected into the soil surrounding the pipe, which stabilizes the soil and forms a permanent impermeable seal called a grout/soil ring, and into the annular space between liners and host pipes. Adequate volumes of grout must be injected to form an effective seal. Adequate amounts of grout are based generally upon pipe size and field conditions. This application will be through structurally sound joints and lateral connections through penetrations from within the pipe by using the packer method in tandem with a closed circuit television (CCTV) inspection system.

C. Products shall conform to Section 200.

D. The Contractor shall perform all required permanent landscape restoration of disturbed areas on private property and within locality or VDOT right-of-way upon completion of the grouting to the satisfaction of the Owner.

E. Contractor shall follow all federal, state and local requirements for safety in confined spaces and uniform traffic controls.

F. 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.

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

1.2 SUBMITTALS

Submittals shall be made by the Contractor in accordance with the procedures set forth in Section 105 - Control of Work, and as described below.

A. The Contractor shall provide a minimum 48-hour advance written notice of proposed testing schedules and testing procedures for review and concurrence of the Owner.

B. Equipment operating procedures and systems.

C. Chemical Grout information:

1. Description of chemical grout materials to be used.

2. Description of proposed additives to be used.

3. Manufacturers recommended procedures for storing, mixing, testing and handling of chemical grouts.

4. MSDS sheets for all materials to be used.

D. Identify the manufactures & models of the packers to be utilized on the project.

E. Upon completion of each pipe segment, submit to Owner a report showing the following data for each joint and/or lateral connection tested, grouted or attempted to be grouted as required by PACP/LACP.

1. Volume of grout material used on each joint or connection.

2. Gel set time used (cup test results from tanks)

3. Grout mix record of the batches mixed including amount of grout and catalyst, additives, temperature of the grout solution in the tanks.

1.3 RELATED DOCUMENTS

A. National Association of Sewer Service Companies (NASSCO) prepared Pipeline/Lateral Assessment and Certification Program (PACP/LACP), TV inspection form and sewer condition codes.

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

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

II. EXECUTION

2.1 GENERAL

A. Joint Testing and Cleaning

See Section 816 - Sewer Pipe and Lateral Joint Testing

B. Leak Sealing

Sources, or possible sources, of infiltration within the sewer system, are to be sealed to eliminate infiltration. Such sources are to be identified by visual confirmation of an active leak (documented on CD or DVD), or by failure of a joint test. Grouting shall provide a watertight joint.

The application of the sealing grout within the pipe shall be by means of remote-

controlled equipment designed to be positioned at the specific joint or crack to be sealed and to apply the grout under sufficient pressure for the grout to pass through the opening and fill voids outside the pipe as well as the opening in the pipe wall. The method of sealing used shall not damage the pipe or change pipe alignment, and the original cross sectional area shall not be permanently reduced or changed.

C. Void pressure data shall be transmitted electrically and without the use of the test medium or hoses. All test monitoring shall be above ground and in a location to allow for simultaneous continued observation of the television monitor and test monitoring equipment by the Contractor. The Owner shall witness the testing operation.

D. Sewer line joint testing shall be accomplished before and after the grouting operation in accordance with Section 816 - Sewer Pipe and Lateral Joint Testing.

2.2 JOINT SEALING EQUIPMENT

A. The basic equipment shall consist of a closed circuit television system, necessary chemical sealant containers, pumps, regulators, valves, hoses, etc., and joint sealing packers for the various sizes of sewer pipe. The packer shall be a cylindrical case of a size less than pipe size, with the cables at either end used to pull it through the line. The packer device shall be constructed in such a manner as to allow a restricted amount of sewage to flow at all times. Generally, the equipment shall be capable of performing the specified operations in lines where flows do not exceed the maximum line flows as specified in Section 812 - Bypass Pumping. When the packer is inflated, two widely spaced annular bladders shall be formed, each having an elongated shape and producing an annular void around the center portion of the packer. 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.

B. 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 Owner.

C. 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.

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

2.3 JOINT SEALING PROCEDURE

A. In the preparation and application of the sealing grout, the recommendations of the manufacturer of the grout materials shall be followed.

B. Gel Test: At the beginning of each day, each time a new batch of grout chemicals is mixed or whenever the temperature in the tanks or ambient temperature have changed by more than +/- 10°F from the previous gel test, the gel time should be checked. A small quantity of the chemicals should be taken from the ends of the packer hose and mixed in a paper cup and witnessed by the Owner. The gel time should be within the range specified by the manufacturer. If the grout does not gel per the

manufacturer's recommendations, the Contractor shall discard the batch and create a new batch at the Contractor's expense. The grout tank solution temperature, catalyst tank solution temperature, ambient air temperature in truck, and gel time of the sample shall be recorded.

C. Barrel Test: A test cylinder shall be constructed by the Contractor to simulate the barrel of a sewer pipe, so the grouting equipment can be tested above ground. This allows the test cylinder to be positioned where the pressure reading on both the test cylinder gauge and the void pressure monitoring gauge can be continuously observed together during the test. The reading on both gauges should be the same throughout the test. This test will also verify whether or not the packer is capable of holding adequate pressure under ideal conditions

During the test, the packer sleeves shall be inflated to the pressure recommended by the manufacturer. Then, the test medium (either air or water) is to be injected into the packer void until the maximum pressure used to test the actual pipe joints is reached. This pressure is to be held for at least one minute to verify that the packer will hold pressure. After one minute the shutoff valve should be opened to simulate a leak. Both gauges should quickly return to zero. This test shall be repeated at least three times in the presence of an Owner's representative. No actual test/seal operations will be performed until the equipment has been demonstrated to pass this test.

D. Pump Tests - At the beginning of the contract, prior to application of grout, perform a pump test to determine if proper ratios are being pumped from the grout component tanks at the proper rates and to measure pump rates. Use separate containers to capture the discharges from each of the grout component hoses, to simulate the actual volumes of each component through the interconnect hoses, hose reel and length of grout hose and confirm accuracy of grout pump totalizer. Take corrective action if ratios or rates are not within manufacturer’s recommended standards.

E. Joint sealing shall be accomplished by forcing chemical sealing materials into or through infiltration points by a system of pumps, hoses, and sealing packers. Jetting or driving pipes from the surface that could damage or cause undermining to the pipe lines, will not be allowed.

Excavating the pipe, which would disrupt traffic, undermine adjacent utilities and structures, will not be allowed. The packer shall be positioned over the area of infiltration by means of a metering device and the closed circuit television in the line. It is important that the procedure used by the Contractor for positioning the packer be accurate to avoid over-pulling the packer and thus not effectively sealing the point of infiltration. The packer sleeves shall then be expanded using precisely controlled pressures. The pneumatically expanded sleeve or elements shall seal against the inside periphery of the pipe to form a void area at the point of infiltration, now completely isolated from the remainder of the pipe line. Into this isolated area, sealant materials shall be pumped through the hose system at controlled pressures which are in excess of groundwater pressures. The pumping, metering, and packer device shall be integrated so that the proportions and quantities of materials can be regulated in accordance with the type and size of the leak being seated.

F. Upon completing the sealing of each individual joint, the packer shall be deflated; with the void pressure meter reading zero pressure, then reinflated and tested in accordance

with Section 816 - Sewer Pipe Joint Testing. Should the void pressure meter not read zero, the Contractor shall clean his equipment of residual grout material or make the necessary equipment repairs to provide for an accurate void pressure reading. Joints that fail to meet the specified test criteria shall be resealed and retested until the test criteria can be met in order to receive payment.

G. All testing shall be performed by the Contractor in the presence of the Owner. It shall be the responsibility of the Contractor to completely seal every leak authorized for sealing to the extent determined by the Owner. If, in the Owner's opinion, it is not necessary to continue with a particular leak, the crew shall move to the next joint or leak. The Contractor shall remove any small excess sealing grout inside the sewer line. Contractor shall operate his equipment with care and shall be responsible for any damage to the sewer system or other facilities caused by his operations, and shall repair such damage at his expense and without delay as instructed by the Owner.

2.4 CLEANING

Cleaning as indicated in Sections 810 - Sewer Line Cleaning, is required for all grouted lines.

2.5 GROUT PREPARATION

A. Follow the manufacturer's recommendations for the mixing and safety procedures.

B. Adjust gel time as necessary to compensate for changes in temperature in grout component tanks or hoses. The addition of dilution water to extend gel times is not acceptable unless resulting base grout tank only material exceeds 20% by weight for solution grouts.

C. During the grouting process, the Contractor shall 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 as described above and correct any defective equipment.

D. Gel times shall be calculated using the following formula unless Contractor experience and/or field conditions dictate otherwise. Any alterations of the gel time formula shall be approved by the Owner.

$$Gel\ Time = \left(\frac{\left(\frac{Volume\ of\ Pipe}{Packer\ Void\ Space\ (gal)} \right)}{Pumping\ Rate\ (gpm)} \right) \left(\frac{60\ sec}{1\ min} \right) + 20\ \text{sec}(+/-5sec)$$

E. Packer/Pipe void shall be defined as the volume between the inflated packer and the inside pipe wall when the packer is inflated per manufacturer recommendations. For example: an 8" pipe with a packer void space of 0.3 gallons and a 3 gpm pumping rate would provide

$$Gel\ Time = \left(\frac{.3(gal)}{3(gpm)} \right) \left(\frac{60sec}{1min} \right) + 20sec = 26\text{sec}(+/-5sec)$$

2.6 GROUTING GENERAL

Grout all joint and lateral connections that failed the pressure test by the injection method. 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. Remove excess grout from pipe and laterals. Excess grout shall be defined as a thickness of grout that given its location, size and geometry, could cause a blockage. Flush or push forward to the next downstream manhole, remove from the sewer system, and properly dispose of excess grout.

2.7 GROUTING OF PIPE DEFECTS

A. Grouting will not be required on pipe exhibiting the following conditions or characteristics:

1. Longitudinally cracked, fractured or broken pipe.

2. Sections of the pipe with structural defects between joints.

B. Grouting will not be required on any sections of pipe or joints that are in such poor structural condition that, in the judgment of Owner, and in consideration of the Contractor's written recommendation, significant structural damage of the pipe would occur as a result of the pressure test.

C. Any structurally undamaged joint that structurally fails (breaks) during grouting that are documented on video to have been done under normal pressure conditions shall be the Owner's responsibility and cost to repair.

D. Grout all circumferential cracks and fractures or other defects as specified or as directed by Owner. Do not grout any other pipe defects unless so specified or shown, or directed by Owner to do so. Any structurally failed pipe or joint that is grouted at the Owner's direction that further fails/breaks during grouting that are documented on video to have been done under normal pressure conditions shall be the Owner's responsibility and cost to repair. Promptly repair any other sewer damage resulting from the Contractor's operations at no additional compensation.

2.8 PIPE JOINT SEALING BY PACKER INJECTION GROUTING FOR MAINLINE SEWERS AND LATERALS CONNECTED TO MANHOLES

A. Position the mainline packer over the joint or defect to be sealed by means of a CCTV camera in the line. Position the push/pull packer over the joint or defect to be sealed by a means of visual observation, marked push rod, or where a cleanout is available, through a CCTV camera in the lateral. For push packers, start work at the most distant point to be grouted. Take an accurate measurement of the location of the defect to be sealed using a portion of the packer as a point of reference for positioning the injection area of packer over the defect. Pneumatically expand the packer sleeves such that they seal against the inside periphery of the pipe to form a void area at the joint now completely isolated from the remainder of the pipe line.

B. Pump grout materials, in stages if needed, into this isolated area to refusal until and the void or surrounding soil has been filled or solidified with the goal of applying 0.25 to 0.5 gallons of grout per inch-diameter per pipe joint. Refusal is when the packer void pressure during grout pumping instantaneously rises or "spikes" by 4 to

5 psi or more above the normal void pressure experienced during grout pumping operation. Refusal may also be revealed when pumping void pressure exceeds the holding pressure of the packer end elements as evidenced by "blow-by" past the packer sealing end elements. Refusal shall mean, when the joint will not accept any more grout because it has flowed throughout the void, through any joint failure and into the surrounding soil; gelled or filled the available void space; and formed a cohesive seal stopping further grout flow, then the joint will have then been sealed. Record the amount of grout pumped on the sealing log. If sealing is not achieved refer to paragraph 2.8.D.

C. Upon completion of the injection, deflate the packer to break away from the ring of gel formed by the packer void. The packer should then be re-inflated and the joint retested at a pressure equal to the initial test pressure. If the joint fails this air test, repeat the grouting procedure at no additional cost to the Owner, except for the additional grout used. Repeat this sequence of air testing, grouting and subsequent air testing until either the joint is sealed or it is determined that the grout consumption is too high (see Section 3.9.D). The final determination to stop subsequent attempts to seal a joint will be made jointly between the Owner and the Contractor. Should the void pressure meter not read zero ± 0.5 psi, clean the equipment of residual grout or make the necessary equipment repairs/adjustments to produce accurate void pressure readings.

D. If a mainline or lateral joints require more than 0.5 gallon of grout per inch-diameter per pipe joint, modify grouting procedure to perform stage grouting by pumping additional grout in up to 4 gallon increments, waiting 1 gel set cycle time or 1 full minute, whichever is greater between stages. Maximum number of stages shall not exceed two stages of 4 gallons each unless approved by Owner.

2.9 LATERAL CONNECTION SEALING FROM THE MAINLINE BY PACKER INJECTION GROUTING

A. Lateral connection sealing begins if the lateral connection does not pass the air test, shows evidence of leakage, has been successfully cleaned to remove roots, or where Contractor has been directed. The lateral packer shall remain in position during the pressure test, thus maintaining the isolated void. Pressure inject grout through the lateral packer into the annular space between the lateral grouting plug and the lateral pipe.

B. When pumping grout, operate the pumps until the mixed grout has flowed through any joint failure, through any annular space, and into the surrounding soil; gelled or filled the available void space; formed a cohesive seal stopping further grout flow; and minimum of 8 psi back pressure is achieved while pumping. As grout pumping continues the void pressure will slowly rise to a range of about 2 to 4 psi, continue pumping until a point where there is a sudden increase in the void pressure. This increase from 2 to 4 psi to over 8 to 10 psi takes place in a matter of a few seconds. If the grout pumped exceeds 1 gallon per foot of lateral bladder plus 3 gallons, it will be suspected that there are significant voids on the outside of the pipe or that the packer is not properly sealed. Check that the packer is sealed properly. If it is, modify grouting procedure to stage grouting by pumping additional grout equivalent to1 gallon plus 0.25 gallon per foot of lateral bladder, waiting 1 full minute, and retesting. The maximum number of stages shall not exceed two stages unless authorized by Owner.

C. Upon completion of the lateral connection sealing procedure, deflate the lateral bladder, re-inflate and air test the lateral connection a second time to confirm the sealing of the connection in accordance with the air testing procedure. If the lateral connection fails this air test, repeat the grouting procedure at no additional cost to the Owner, except for the additional grout used. Air tests after grouting laterals containing roots is not required.

D. Confirm lateral flow after sealing of each lateral connection. If a grout blockage exists, the Contractor shall immediately clear the lateral at no additional cost to the Owner. Blockages in the lateral that are not the result of grouting operations shall not be the responsibility of the Contractor.

E. After grouting lateral connections (with the appropriate size lateral bladder), a thin residual grout film may be present inside the lateral wall. The amount of residual grout film present is dependent on the lateral bladder used, geometry of the lateral and positioning of the packer. This thin layer of cured grout is normal and will eventually peel off the sidewall of the pipe. The residual chemical grout film is not "sandwiched" between two structures and will eventually peel off the sidewall of the pipe. This residual chemical grout film is not considered excess grout. Removal of residual grout shall be requested by the Owner and paid for under the unit price for post lateral connection residual grout cleaning.

2.10 JOINT SEALING VERIFICATION

A. Record grouting of joints in conjunction with the testing of joints. Record the void pressure drop continuously on video and in writing immediately before sealing, and immediately after grouting. After the packer is deflated and moved, record on video the visual inspection of the joint.

B. Use of standardized test and seal data sheets and PACP data codes is highly recommended.

2.11 DISPOSAL

Collect and properly dispose of cleaning materials used in the cleaning of the grouting equipment.

2.12 TELEVISION SURVEY

Television survey, as indicated in Section 811 - Television Inspection, is required for all grouted lines.

2.13 WARRANTY INSPECTION

Conduct warranty joint air testing per Section 816 on all of the joints and lateral connections successfully sealed in 10% of the sewer pipe segments or a minimum of two sewer line segments, whichever is greater, approximately 11 months after Substantial Completion. Owner will select the pipe segments to be warranty tested. Contractor will be provided with a 60-day notice of the warranty testing. Conduct all warranty tests in the presence of the Owner.

A. If more than 10% of the warranty tested joints or lateral connections fail, warranty

test an additional 15% of the pipe segments or two additional sewer line segments, whichever is greater. If more than 10% of the second group of warranty tested joints or lateral connections fail, warranty test 100% of the joints or lateral connections sealed in the remaining untested pipe segments at no additional compensation.

B. Grout and/or retest all joints and lateral connections failing warranty testing at no additional compensation.

C. Joints that received more than 4 gallons of grout per inch-diameter of pipe joint are exempt from the warranty testing.

III. MEASUREMENT FOR PAYMENT

Unit prices will constitute full payment for all setups, testing, maintenance, transportation, labor, Work, materials or any other costs associated with chemical grouting of the sewer joints. No additional payment shall be made for verification testing of any joints. This cost shall be included in the sealing of joints.

A. Packer Injection Grouting of Pipe Joints in Mainline Sewers

1. The measurement unit for this item will be per joint based on the number of joints chemically sealed.

2. The unit price for this item will be full compensation for providing all labor, materials (except grout), equipment, tools, and incidentals for all aspects of chemically sealing and immediate re-testing of pipe joints as specified. Payment for chemical grout is under separate item. Payment for Post Construction CCTV Inspection is under separate item.

B. Packer Injection Grouting of Lateral Connections in Mainline Sewers

1. The measurement unit for this item will be per each based on the number of lateral connections directly connected to the mainline sewer that are grouted.

2. The unit price for this item will be full compensation for providing all labor, materials (except grout), equipment, tools, and incidentals for all aspects of packer injection grouting of lateral connections as specified and shown. Payment for chemical grout is under separate item.

C. Chemical Grouting of Laterals Connected to Manholes

1. The measurement unit for this item will be per each based on the number laterals grouted.

2. The unit price for this item will be full compensation for providing all labor, materials (except grout), equipment, tools, and incidentals for all aspects of packer injection grouting of laterals directly connected to manholes as specified and shown, including all necessary cleaning and root removal. Payment for chemical grout is under separate item. Payment for Post Construction CCTV Inspection is under separate item.

D. Chemical Grout

1. The measurement unit for this item will be the number of gallons of grout used for sealing mainline sewer pipe joints, lateral piping, and lateral connections.

2. The unit price for this item will be full compensation for providing all labor, materials, equipment, tools, and incidentals not included in items A, B, and C required for all aspects of sealing mainline sewer pipe joints, connections, and lateral pipe joints for laterals connected directly to manholes

E. Post Construction CCTV Inspection

1. The measurement unit for this item will be per linear foot based on the number of linear feet of pipe CCTV inspected.

2. The payment for this item will be full compensation for all labor, materials, equipment, tools and incidentals required to complete post construction CCTV inspection of the pipe, including laterals. Payment will be made upon receipt of acceptable Post Construction CCTV Inspection of all Work.

F. Post Lateral Connection Residual Grout Cleaning

1. The measurement unit for this item will be per each based on the number of 4- inch through 6-inch nominal diameter laterals connected directly to the mainline sewer that are authorized for residual grout cleaning by the Owner and which are successfully cleaned by Contractor.

2. The unit price for this item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of removal of residual grout from laterals after lateral connection grouting.

G. Warranty Testing Mainline / Lateral Pipe Joints and Lateral Connections.

1. The measurement unit for this item will be per joint based on the number of joints tested and per lateral based on the number of lateral connections.

2. The unit price for this item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of CCTV inspection, re-testing and sealing pipe joints, lateral connections, and laterals directly connected to manholes that fail the warranty testing as specified. No additional compensation will be provided for repairs and post-repair inspections completed during the warranty period. Pipe cleaning, if necessary, will be charged at the unit price for Preparatory Sewer Cleaning of Mainline Sewer.

End of Section