

# **PRESSURE TESTING AND GROUTING OF SEWER JOINTS, LATERALS AND LATERAL CONNECTIONS USING THE PACKER METHOD WITH SOLUTION GROUTS**

## **SUGGESTED STANDARD SPECIFICATION**

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## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. 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:
  - 1. Test all joints in a mainline segment
  - 2. Test all service lateral connections from the sewer main to a predetermined distance up the sewer lateral.
  - 3. Test all joints within a predetermined distance in laterals directly connected to manholes.
  
- B. 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.
  - 1. Packer injection grouting is used to reduce the infiltration within the pipeline, seal annular space between liners and host pipes at lateral connections, seal pipe joints that have failed the joint test criteria, provide external pipe support, but not a structural rehabilitation, by stabilizing soils outside the pipe and prevent further loss of pipe bedding into the pipe.
  - 2. 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.

### **1.2 REQUIREMENTS**

- A. Contract requires work in active sewers. CONTRACTOR shall follow all federal, state and local requirements for safety in confined spaces and uniform traffic controls.
  
- B. 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.

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

### 1.3 RELATED SECTIONS

To be determined by engineer.

### 1.4 QUALIFICATIONS

To be determined by engineer.

### 1.5 SUBMITTALS

- 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 ENGINEER.
- B. Equipment operating procedures and systems.
- C. Chemical Grout information:
  - 1. Description of chemical grout materials to be used per sections 2.3.
  - 2. Description of proposed additives to be used per sections 2.4.
  - 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 ENGINEER a report showing the following data for each joint and/or lateral connection tested, grouted or attempted to be grouted as required by PACP.
  - 1. Identification of the sewer pipe section tested by assigned sewer ID (if available) and length.
  - 2. Type of pipe material, diameter & depth of pipe to the surface at manholes.
  - 3. Length of pipe sections between joints.
  - 4. Test pressure used and duration of test.
  - 5. Pass/fail results for each joint/connection tested.
  - 6. Location stationing of each joint/connection tested and location of any joints/connections not tested with an explanation for not testing.
  - 7. Volume of grout material used on each joint or connection.
  - 8. Gel set time used (cup test results from tanks)
  - 9. Grout mix record of the batches mixed including amount of grout and catalyst, additives, temperature of the grout solution in tanks.

10. Operator conducting testing and sealing shall be noted on the reports.
11. Video recordings
  - a. Video recording 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.
  - b. Additional final recording, if specified, shall include inspection of the pipe or lateral after all grouting work is complete.

## 1.6 REFERENCE STANDARDS TO BE USED

- A. National Association of Sewer Service Companies (NASSCO) prepared Pipeline Assessment and Certification Program (PACP), 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)

## **PART 2 - PRODUCTS**

### 2.1 TESTING EQUIPMENT & GROUTING EQUIPMENT

- A. The basic equipment used for mainline pipe joints and for laterals connected to the mainline shall consist of a remotely operated color television camera capable of pan and tilt, joint testing device (referred to hereafter as a packer), and test 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 against the host pipe and a means for continuously measuring, viewing and recording the actual static pressure of the test medium and grout within the void area only. The packer shall be of a size less than the diameter of the host pipe, with the cables at either end used to pull it through the line and may be constructed in such a manner as to allow a restricted amount of sewage to flow at all times. Packer shall be expanded by air pressure. Packers shall be of low void space construction with void volume given by the packer manufacturer.
- B. 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 of at least **PREDETERMINED DISTANCE BY 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" to 4" in diameter, use a 4" 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.

- C. 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 within PREDETERMINED DISTANCE BY ENGINEER of the lateral or to the cleanout, whichever comes first, 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.
- D. 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.
- E. 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.
- F. 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 percent of pipe diameter unless permitted by ENGINEER.
- G. 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.
- H. Equipment for cleaning lateral blockages shall be readily available while any lateral grouting work is being performed.

## 2.2 GROUTS - GENERAL

- A. All grout materials must have the following characteristics:
  - 1. While being injected, the grout must be able to react /perform in the presence of water (groundwater).
  - 2. The ability to increase grout mix viscosity, density and gel strength by increased concentration of constituents or the use of approved additives.
  - 3. The cured grout must withstand submergence in water without degradation.

4. The resultant grout formation must be homogeneous and prevent the passage of water (infiltration) through the pipe joint.
  5. The grout must not be biodegradable.
  6. The cured grout should be chemically stable and resistant to organics found in sewage.
  7. Residual grout shall be easily removable from the sewer line to prevent blockage of the sewage flow.
- B. 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.

### 2.3 CHEMICAL GROUTS

- A. Water based chemical grouts shall have the following characteristics:
1. 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.
  2. The ability to tolerate some dilution and react in moving water during injection.
  3. A viscosity of approximately 2 centipoise, which can be increased with approved additives.
  4. A controllable reaction time from 10 seconds to 1 hour.
  5. A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, firm, flexible gel.
  6. The ability to increase mix viscosity, density and gel strength by increased concentrations of the mix constituents or by the use of approved additives.
  7. Product Manufacturer:
    - a. Avanti AV-100, Avanti AV-118; or equal.
- B. Acrylate base grout shall have the following characteristics:
1. A minimum of 10% acrylate base material by weight in the total grout mix.
  2. The ability to tolerate some dilution and react in moving water during injection.
  3. A viscosity of approximately 1-3 centipoise, which can be increased with approved additives.
  4. A controllable reaction time from 10 seconds to 1 hour.
  5. A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, firm, flexible gel.
  6. The ability to increase mix viscosity, density and gel strength by the use of approved additives.
  7. Product Manufacturer:
    - a. DeNeef AC-400, DeNeef Gelacryl SR, Avanti AV-160; or equal.

### 2.4 ADDITIVES

- A. At the CONTRACTOR'S discretion and according to field conditions, additives may be selected and used within the manufacturers recommended quantities.
- B. Strengthening Agents
  - 1. 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:
    - a. Avanti AV-257 Icoset, DeNeef Reinforcing Agent; or equal.
- C. Root Inhibitor
  - 1. When roots are present, for joint and lateral connection joint grouting, a root deterrent chemical shall be added to control root re-growth. The quantity of inhibitor shall be as recommended by the manufacturer and approved by ENGINEER.
  - 2. Product Manufacturer:
    - a. Avanti AC-50W; or equal.
- D. Dye - A manufacturer approved water soluble dye without trace metals may be added to the grout tank(s) for visual confirmation.
- E. Gel Time Modifier - A gel time extending agent may be used in accordance with the manufacturer's recommendations to extend gel time as necessary.
- F. 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.
- G. 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.

## **PART 3 - EXECUTION**

### **3.1 CONTROL TESTS**

- A. Packer Tests - Demonstrate the acceptable performance of air test.
  - 1. To insure the accuracy, integrity and performance capabilities of the testing equipment, a demonstration test will be performed in an above-ground 8" nominal diameter test cylinder suitable to contain the full length of the packer and sustain the void test pressure. The test cylinder shall be equipped with a void release valve to exercise a controlled release of pressurized air from the void area to test the packer under both sound and leaking conditions. The test cylinder shall also be equipped with a local pressure gauge (0-25 psi) within the void space.

- a. With the void release valve sealed, inflate the packer and air test void at 7-10 psi. The observed void pressure at the test cylinder pressure gauge must be within  $\pm 1.0$  psi of the reading in the control center/studio void pressure gauge and follow both up and down pressure changes (allowing time for pressure equalization).
  - b. If above test is passed, crack the release valve to simulate a very small leak. The cylinder shall be equipped with a void release valve to exercise a controlled release of the test media with the associated pressure drop to be equally displayed  $\pm 1.0$  psi of the cylinder gauge and test monitoring equipment.
2. After entering each pipeline segment with the test equipment, but prior to the commencement of joint testing, position the packer on a section of sound sewer pipe between pipe joints, and perform a test as specified. The equipment shall hold a 7-10 psi test pressure for a period of 15 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 surface or porosity conditions of the barrel of the sewer pipe cannot meet the joint test requirements, then the performance testing shall be waived or modified as determined by the ENGINEER.
  3. If air testing cannot be performed successfully, repair or otherwise modify air test equipment and repeat the tests. This test may be required at any other time during the performance of joint testing work if the ENGINEER suspects the testing equipment is not functioning properly.
- B. 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.
- C. Grout Tests - Perform and record a grout gel test in the presence of the ENGINEER by recording the grout tank solution temperature, catalyst tank solution temperature, ambient air temperature in truck, and gel time of the sample whenever the following conditions occur:
1. At the beginning of each day; the material in the hoses shall be recycled to the tanks and a sample shall be taken.
  2. When new batches of grout are mixed.
  3. Whenever the temperature in the tanks or ambient temperature have changed by more than  $\pm 10^{\circ}\text{F}$  from the previous gel test.

### 3.2 PIPE PREPARATION

- A. Prior to the application of the chemical grouting materials, the CONTRACTOR shall thoroughly clean the sewer designated to receive the chemical grouting. Cleaning shall constitute removal of all loose debris & solids which inhibit proper seating of the packer. If mineral deposits or protruding taps are present, they shall be removed and paid for per the applicable items on the Schedule of Prices. Removal of other hardened materials such as concrete shall be considered beyond the scope of this work.
- B. The OWNER shall have cleared the designated sewer line(s) of obstructions such as dropped joints, protruding lateral connections, and broken pipe / crushed pipe which will prevent the use of the grouting equipment. If the CCTV inspection reveals a condition for which an applicable pay item has not been included on the Schedule of Prices, the CONTRACTOR shall inform the ENGINEER. The ENGINEER may choose to make a point repair or will direct the CONTRACTOR to abandon the section of pipe scheduled for test & seal.

### 3.3 ROOTS AND LOOSE DEBRIS IN LATERAL CONNECTIONS

- A. Remove all roots and loose debris from laterals connected to manholes for the length of lateral to be tested/grouted.
- B. During mainline sewer cleaning or joint testing, document all lateral connections containing roots, mineral deposits or obstructive conditions that are either (a) greater than fine roots or (b) of a nature to prevent testing and sealing of connection. For each such connection, submit a screen shot image clearly showing the extent of roots or obstructive condition to the ENGINEER. Submit images in electronic format, labeled and organized in a manner to easily retrieve the image for the lateral connection in question. The list of lateral connections with roots shall include upstream and downstream manhole numbers and stationing. ENGINEER will review the list of lateral connections containing roots and obstructions and direct CONTRACTOR as to which laterals are to be (a) cleaned and grouted, (b) grouted without cleaning – in which case such lateral connection 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. Cleaning of lateral connections will be paid per the applicable item on the Schedule of Prices.

### 3.4 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 Grouting Technician 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 ENGINEER.

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

- 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

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

### 3.5 TESTING AND GROUTING DEFECTS

- A. Testing and 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.
  3. Any sections of pipe or joints that are in such poor structural condition that in the judgment of ENGINEER or CONTRACTOR, significant structural damage of the pipe would occur as a result of the pressure test.
- B. Any structurally undamaged joint that structurally fails (breaks) during testing and grouting that are documented on video to have been done under normal pressure conditions shall be the OWNER's responsibility and cost to repair.
- C. Grout all circumferential cracks and fractures or other defects as specified or as directed by ENGINEER. Do not test or grout any other pipe defects unless so specified or shown, or directed by ENGINEER to do so. Any structurally failed pipe or joint that is grouted at the ENGINEER's direction that further fails/breaks during testing and 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.

### 3.6 JOINT TESTING PROCEDURE FOR MAINLINE SEWER AND LATERALS CONNECTED TO MANHOLES

- A. Joint testing pressure shall be equal to 0.5 psi per vertical foot of pipe depth plus 2 psi; however, test pressure shall not exceed 10 psi without the approval of the ENGINEER.
- B. Test joints in laterals which are directly connected to manholes to a PREDETERMINED DISTANCE BY ENGINEER. If there is a transition in the laterals connected to manholes test the transition. Direct visual observation and measured cable lengths shall be used to position the lateral packer for laterals directly connected to manholes.
- C. Individually test each sewer pipe joint at the above-specified pressure (and retest after sealing) in accordance with the following procedure:
  - 1. Air Test Procedure
    - a. The packer shall be positioned within the pipe in such a manner as to straddle the joint to be tested.
    - b. The packer ends shall be expanded so as 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 as per manufacturer's recommendations. If all attempts to isolate the joint fail, pump grout in an attempt to seal the leak around the packer end elements. The CONTRACTOR shall be paid the unit price for grout to seal the packer unless the 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.
    - c. 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 15 seconds, the joint will have failed the test and shall be sealed.
  - D. Upon completing the 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 0.0 +/- 0.5 psi, clean the test equipment of residual grout material or make the necessary equipment repairs to provide for an accurate void pressure reading.

### 3.7 LATERAL CONNECTION TESTING PROCEDURE

- A. Lateral connection joint testing pressure shall be equal to 0.5 psi per vertical foot of pipe depth plus 2 psi; however, test pressure shall not exceed 10 psi without approval of the ENGINEER.

- B. Air testing lateral connections shall be accomplished by isolating the area to be tested with the lateral connection packer and by applying positive pressure into the isolated void area. A pan and tilt camera shall be used to position the lateral packer for laterals directly connected to the mainline sewer. The lateral 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 monitor the pressure of the packer void and will accurately transmit a continuous readout of the void pressure to the control panel at the grouting truck or to a pressure gauge on the packer recorded by the CCTV camera.
- C. The test procedure will consist of applying a controlled air pressure into each isolated void area. Air shall then be slowly introduced into the void area until a pressure equal to or greater than the required test pressure, but in no cases greater than 2 psi above the required test pressure, is observed on the pressure monitoring equipment. Once the designated pressure in the isolated void is displayed on the meter of the control panel, the application of air pressure will be stopped and a 15 second waiting period will commence. The void pressure will be observed during this period. If the void pressure drop is greater than 2.0 psi within 15 seconds, the lateral shall be considered to have failed the air test and shall be grouted and retested.
- D. After completing the air test for each individual lateral specified herein, deflate the lateral packer, with the void pressure meter continuing to display void pressure. If the void pressure does not drop to 0.0 +/- 0.5 psi, the equipment shall be adjusted to provide a zero void pressure reading at the monitor.

### 3.8 GROUTING GENERAL

- A. 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.

### 3.9 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 para.3.9.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 ENGINEER and the CONTRACTOR. Should the void pressure meter not read zero  $\pm$  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 ENGINEER.

### 3.10 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 to 1 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 ENGINEER.
- 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 ENGINEER and paid for under the unit price for post lateral connection residual grout cleaning.

### 3.11 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.

### 3.12 DISPOSAL

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

### 3.13 POST-CONSTRUCTION INSPECTION

- A. After grouting is complete, all pipe sections shall be final inspected by means of a color CCTV system. The inspection shall be conducted as per the NASSCO Pipeline Assessment and Certification Program. One set of DVD's and reports shall be submitted.

### 3.14 QUALITY CONTROL

#### ENGINEER TO CHOOSE EITHER A OR B

- A. Conduct warranty joint air testing 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. ENGINEER 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 ENGINEER.
  - 1. 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.
  - 2. Grout and/or retest all joints and lateral connections failing warranty testing at no additional compensation.
  - 3. Joints that received more than 4 gallons of grout per inch-diameter of pipe joint are exempt from the warranty testing.
- B. Conduct warranty CCTV inspection of mainline sewers on all of the pipe sections which contain joint or lateral grouting. This work shall be completed during conditions of high ground water and shall commence a minimum of 11 months after substantial completion and be completed a maximum of 18 months after final completion. Any joints or lateral connections which were originally sealed and are observed to be leaking shall be re-sealed at no cost to the OWNER.

**\*\*END OF SECTION\*\***

## **TYPICAL BID ITEMS**

- A. Preparatory Sewer Cleaning of Mainline Sewer
  - 1. Measurement: The unit for this Item will be per foot based on the entire length of the pipe segment in which pipe cleaning occurs. It will be measured from center of manhole to center of manhole horizontally along the centerline of the pipe.
  - 2. Payment: The unit price for this Item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of preparatory sewer cleaning as specified and shown.
  
- B. Reaming of Mineral Deposits in Mainline Sewer
  - 1. Measurement: The unit for this Item will be per foot based on the entire length of the pipe segment in which pipe reaming occurs. It will be measured from center of manhole to center of manhole horizontally along the centerline of the pipe.
  - 2. Payment: This payment shall only be made once for any given pipe segment, regardless of the number of reaming passes required. The unit price for this Item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of mineral deposit reaming as required.
  
- C. Cutting of Protruding Taps in Mainline Sewer
  - 1. Measurement: The unit for this Item will be per each based on the actual number of protruding taps cut.
  - 2. Payment: The unit price for this Item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of protruding tap cutting as required.
  
- D. Testing of Pipe Joints in Mainline Sewers
  - 1. Measurement: The unit for this Item will be per joint based on the number of joints tested.
  - 2. Payment: The unit price for this Item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of testing pipe joints as specified and shown. Visually leaking joints, whether tested or not, shall be paid under this Item. Payment for testing joints following chemical sealing is included under Packer Injection Grouting Item. Payment for Post Construction CCTV Inspection is under separate item.
  
- E. Packer Injection Grouting of Pipe Joints in Mainline Sewers
  - 1. Measurement: The unit for this Item will be per joint based on the number of joints chemically sealed.

2. Payment: 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.
- F. Testing of Lateral Connections in Mainline Sewers
1. Measurement: The unit for this Item will be per each based on the number of lateral connections directly connected to the mainline sewer that are pressure tested.
  2. Payment: The unit price for this Item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of testing lateral connection as specified and shown. Payment for Post Construction CCTV Inspection is under separate item. Payment for lateral cleaning and root cutting is under separate item.
- G. Packer Injection Grouting of Lateral Connections in Mainline Sewers
1. Measurement: The 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. Payment: 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.
- H. Pre-Construction Cleaning (including root removal and mineral deposit reaming) and CCTV Inspection of Laterals Connected to Manholes
1. Measurement: The unit for this Item will be per foot based on footage that is cleaned and televised. Laterals directly connected to manholes shown on the Drawings as inactive will not be included in the measurement for this Item.
  2. Payment: The unit price for this Item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of cleaning and CCTV of laterals directly connected to manholes. Payment will only be made once for each lateral, regardless of the number of preparatory cleanings required to complete the rehabilitation Work and inspect the lateral.
- I. Testing and Chemical Grouting of Laterals Connected to Manholes
1. Measurement: The unit for this Item will be per each based on the number laterals tested and/or grouted.
  2. Payment: 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 testing and 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.

J. Post Construction CCTV Inspection

1. Measurement: The quantity for this Item will be per linear foot based on the number of linear feet of pipe CCTV inspected.
2. Payment: 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.

K. Post Lateral Connection residual Grout cleaning

1. Measurement: The 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 ENGINEER and which are successfully cleaned by CONTRACTOR.
2. Payment: 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.

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

OPTION A

1. Measurement: The 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. Payment: 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.

OPTION B

3. Measurement: The unit for this Item will be per foot based on the actual footage of pipe inspected.
4. Payment: 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. 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.

- M. Contingent Cleaning (including root removal and mineral deposit reaming) of Laterals Connected Directly to the Mainline Sewer
1. Measurement: The 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 cleaning by the ENGINEER and which are successfully cleaned by CONTRACTOR.
  2. Payment: The unit price for this Item will be full compensation for providing all labor, materials, equipment, tools, and incidentals for all aspects of cleaning laterals connected directly to the mainline sewer. Payment will only be made once for each lateral, regardless of the number of preparatory cleaning passes required. No differentiation in payment shall be made between laterals of differing diameter or whether or not a cleanout is present. Due to the size and configurations of laterals, it is recognized that cleaning may not always be successful. Thus if the CONTRACTOR is directed by the ENGINEER to clean the lateral, unsuccessful cleaning attempts will be paid for at the same unit price as successful attempts.
- N. Contingent CCTV inspection of laterals connected to mainline from the mainline sewer (pre-test & seal)
1. Measurement: The unit for this item will be the number of 4-inch through 6-inch nominal diameter laterals connected directly to the mainline sewer that are authorized for CCTV inspection by the ENGINEER when the PREDETERMINED DISTANCE is greater than 8 feet or when there are doubts either about the configuration of the laterals or their condition.
  2. Payment: 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 and recordings on the PREDETERMINED DISTANCE to be sealed into the lateral from the connection.
- O. Chemical Grout (supplementary unit price)
1. Measurement: The 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. Payment: The unit price for this Item will be full compensation for providing all labor, materials, equipment, tools, and incidentals not included in Items 5, 6 & 8 required for all aspects of sealing mainline sewer pipe joints, connections, and lateral pipe joints for laterals connected directly to manholes. The payment per gallon of grout installed has been fixed by ENGINEER and is shown on the Schedule of Prices.
  3. ENGINEER will establish total gallons estimated for the bid with a stipulated unit price for each gallon. Acknowledging that all joints will not fail the air test, using 0.25 gallon/inch diameter times the total number of joints should give the ENGINEER an effective and realistic measure of units for grout at a pre-determined unit price. Consult with grout manufacturer at time of bid for current market pricing.

**SAMPLE PAYMENT SCHEDULE**

Item	Description	Quantity	Unit	Unit Price	Total Price
1	Pre CCTV & cleaning of main lines including root removal		Linear Foot		
2	Reaming of Mineral Deposits in mainlines		Linear Foot		
3	Cutting of Protruding Taps		Each		
4a	Testing of 8" pipe joints		Joint		
4b	Testing of 10" pipe joints		Joint		
4c	Testing of 12" pipe joints		Joint		
5a	Grouting 8" pipe joints		Joint		
5b	Grouting 10" pipe joints		Joint		
5c	Grouting 12" pipe joints		Joint		
6a	Testing lateral connections 8" pipe		Each		
6b	Testing lateral connections 10" pipe		Each		
6c	Testing lateral connections 12" pipe		Each		
7a	Grouting of lateral connections 8" pipe		Each		
7b	Grouting of lateral connections 10" pipe		Each		
7c	Grouting of lateral connections 12" pipe		Each		
8	Pre CCTV & cleaning of laterals connected to manholes		Each		
9	Testing & grouting of laterals connected to manholes		Each		
10	Post construction CCTV inspection		Linear Foot		
11	Post lateral connection residual grout cleaning		Each		
12a	Option A - Warranty testing of pipe joints		Joint		
12b	Option A - Warranty testing of lateral connections		Each		
12c	Option B - Warranty CCTV Inspection of mainlines grouted.		Linear Foot		
13	CCTV of laterals connected to mainline.		Each		
14	Cleaning of laterals connected to mainline		Each		

**SUPPLEMENTARY UNIT PRICES**

Item	Description	Quantity	Unit	Unit Price	Total Price
15	Chemical grout (Price to be determined by ENGINEER)		Gallon		

