THE UNDERGROUND UTILITIES EVENT
Underground Construction Technology | Jan. 29-31, 2019 | Fort Worth, TX

Lateral Grouting Technology

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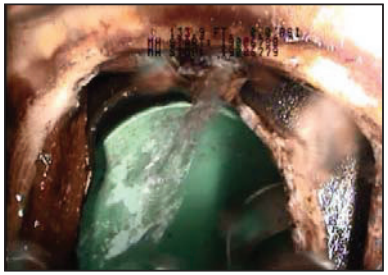
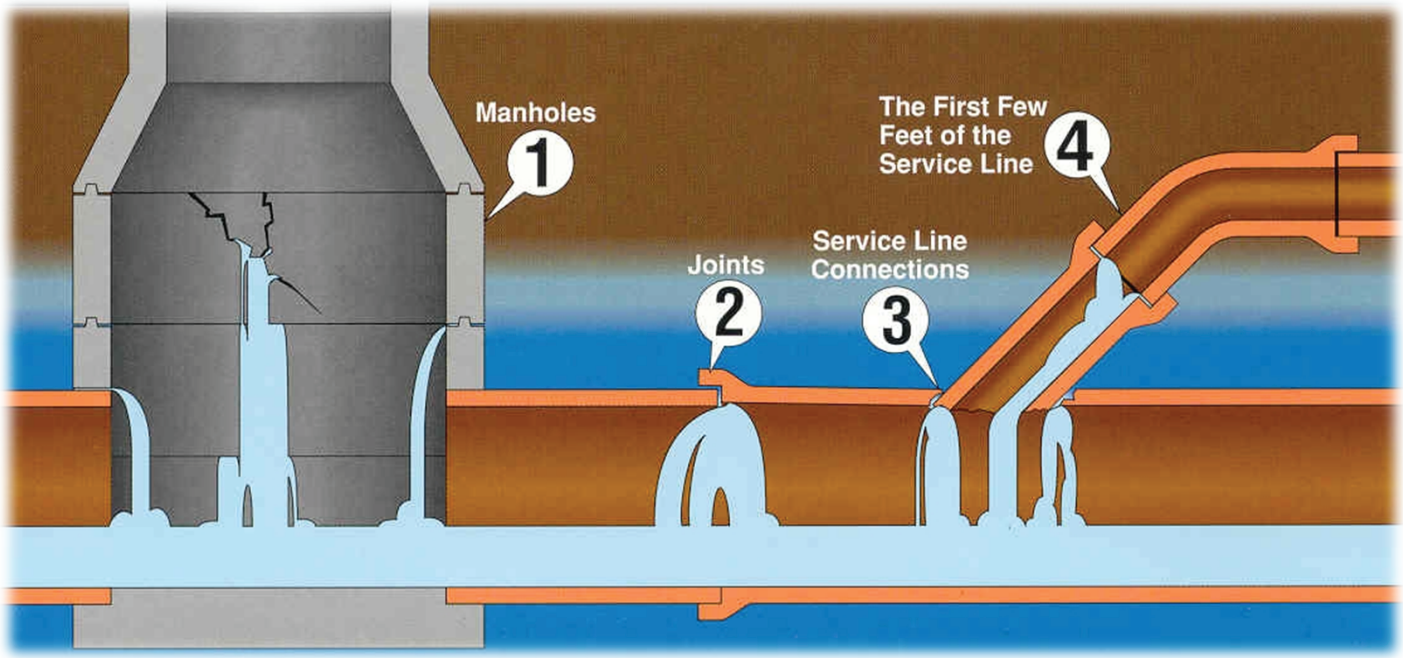
UCT 2019
Fort Worth, TX



Most Common Sources of Infiltration in Collection Systems

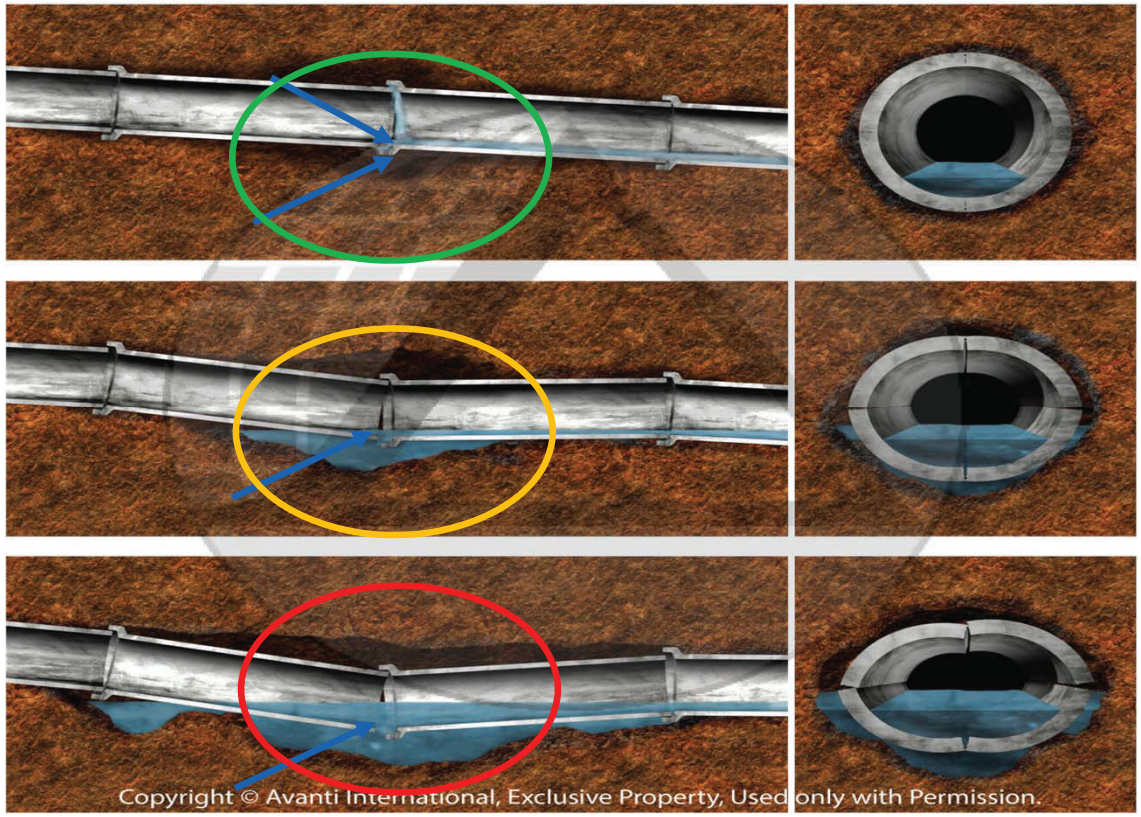


The Process of Sewer Failure

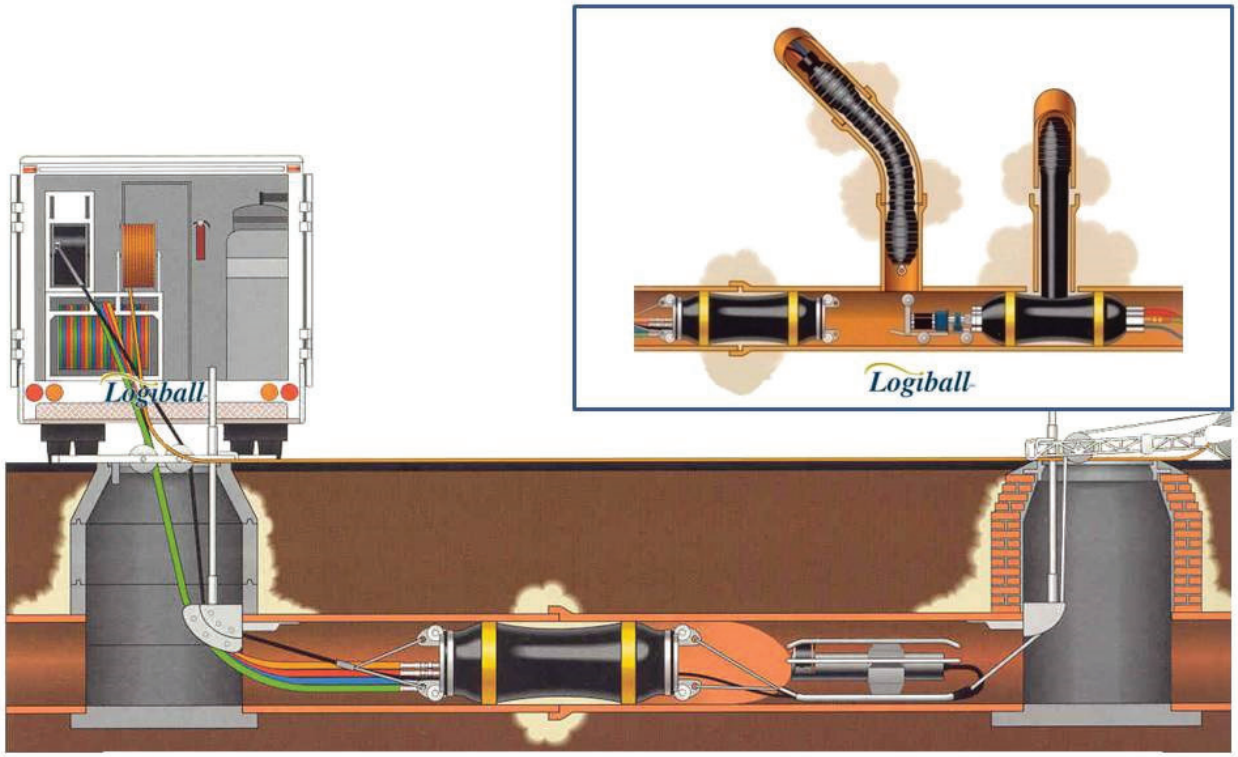
Stage 1: Initial defect, but sewer remains held in position by the surrounding soil.

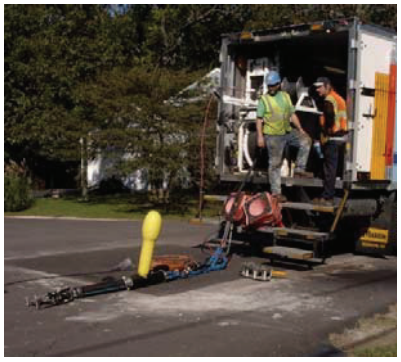
Stage 2: Development of zones of loose ground or voids caused by the loss of ground into the sewer.

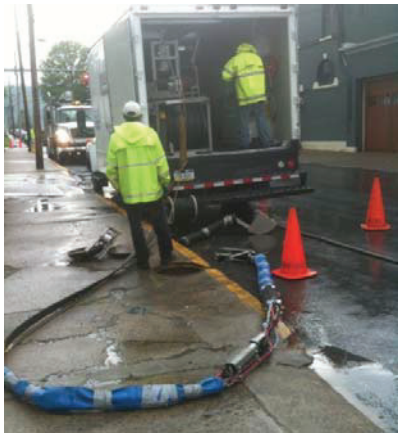
Stage 3 Failure of the sewer pipe.



Injection grouting setup for Joint & lateral testing & sealing





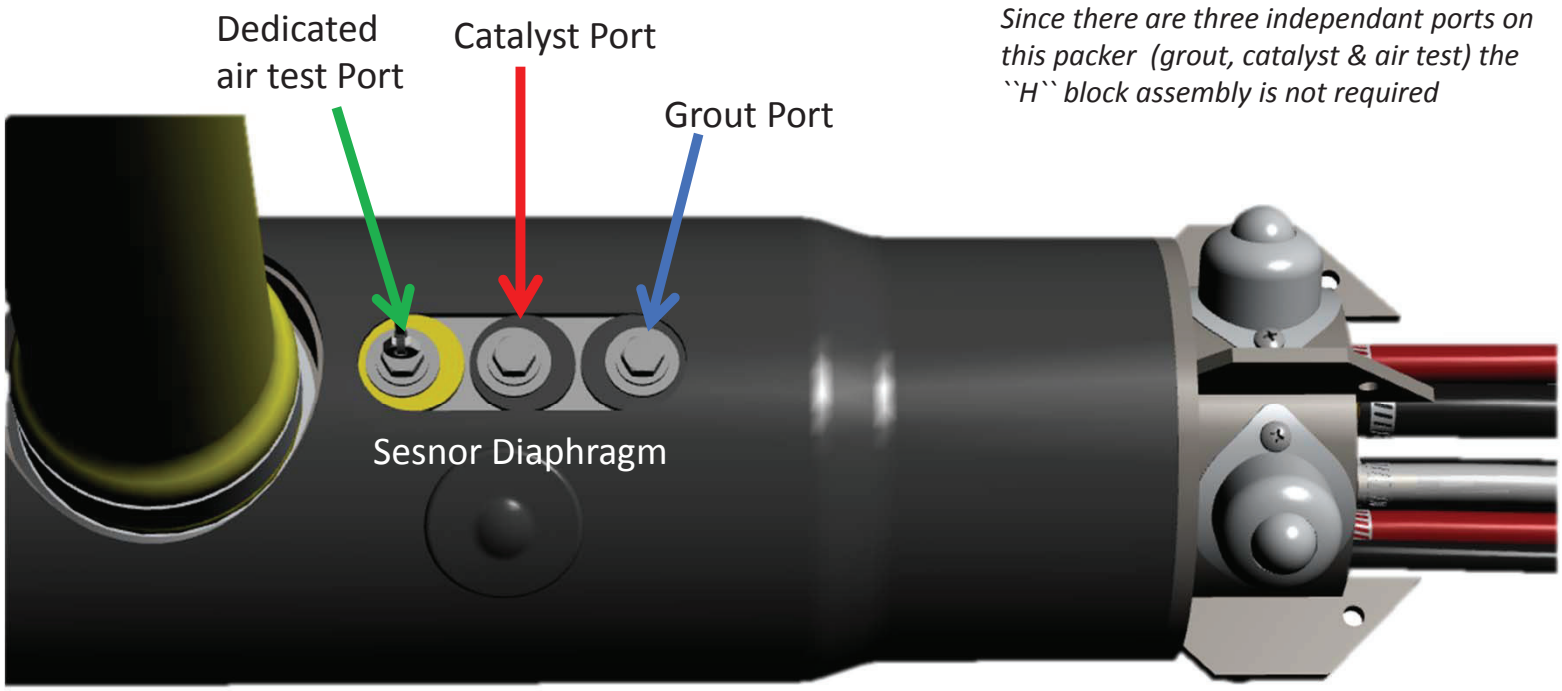


What is Chemical Grouting

- The injection of a multi-component chemical grout into soil and voids around the pipe, liner and manhole structures to seal the leak, stabilize the ground and control infiltration.
- Significantly reduces ground water infiltration into sewer systems.
- Stabilizes sewer structure backfill and bedding material stopping erosion of backfill fines with resulting misalignment.
- Not a structural repair.
- Eliminates exfiltration and cross contamination from sewers into storm mains and ground water.
- Seals annulus infiltration in lined pipe systems at lateral cut-outs and manhole terminations.
- Does not rely on any type of pipe surface preparation for bonding to be successful as the seals are achieved from the exterior of the structures.

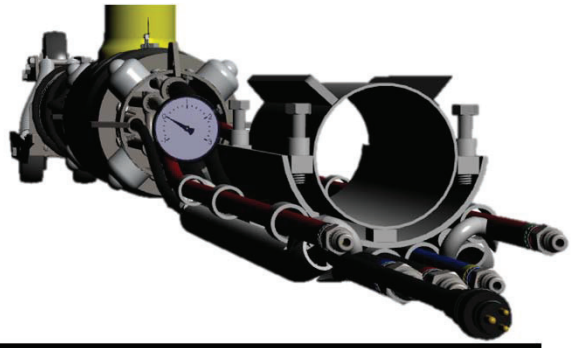
8`` Lateral Test & Seal Packer

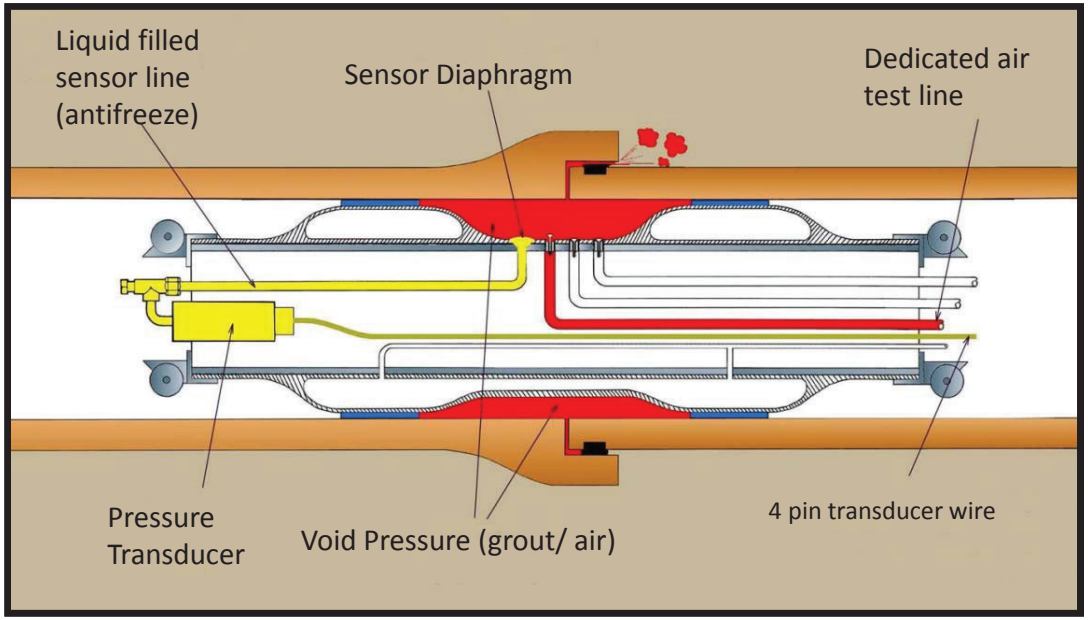
5.5-7.5 2001 LS grout &test ports with sensor diaphragm

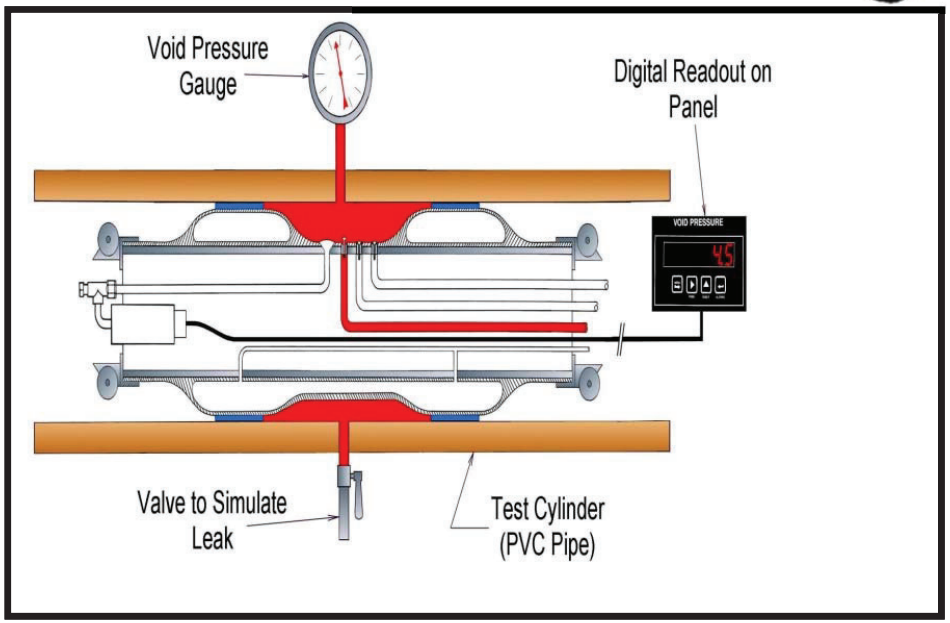


Since there are three independant ports on this packer (grout, catalyst & air test) the ``H`` block assembly is not required

Void Pressure Monitoring System (testing & sealing pressures of the void from the void)



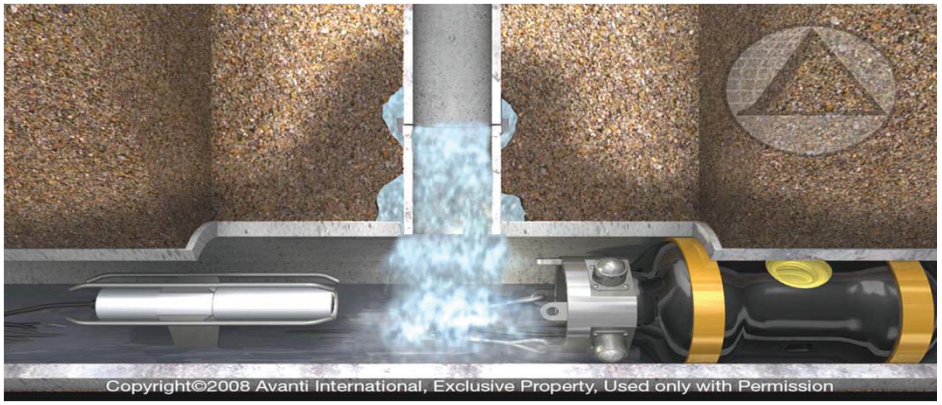


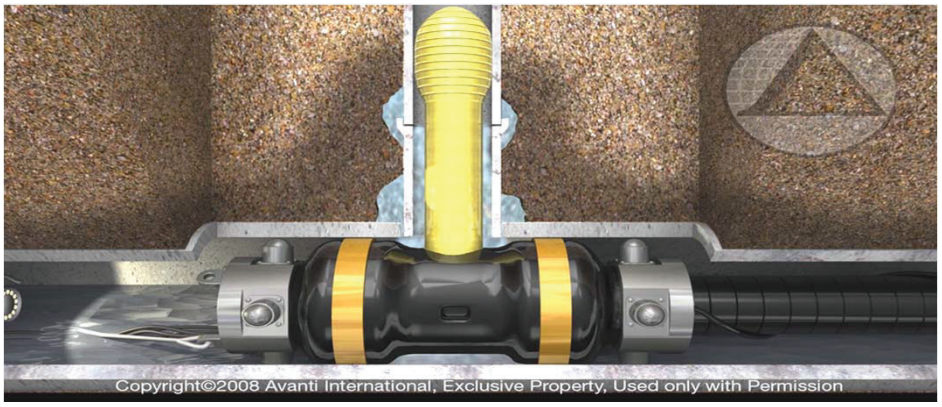


Lateral Connection Grouting Preparatory Procedures

- Cleaning of the mainline sewer.
- Videotaped CCTV inspections of the mainline & pan & tilt of the lateral.
- When grouting long distances in the lateral, it is strongly recommended to inspect the laterals, either from the mainline or other above ground access.
- Cleaning of the lateral may be required depending on the findings of the lateral inspection
- Identification of the diameter of the laterals.
- Protruding taps of more than 5/8" into the 8``mainline must be cut back.
- Roots & grease and other debris that prevent the passage or seating of the packer or lateral bladder must be removed .
- Bypass pumping: normally not an issue as only inflated for a short period of time.
- Brushing out liner cutouts (reinstated services after mainline lining)

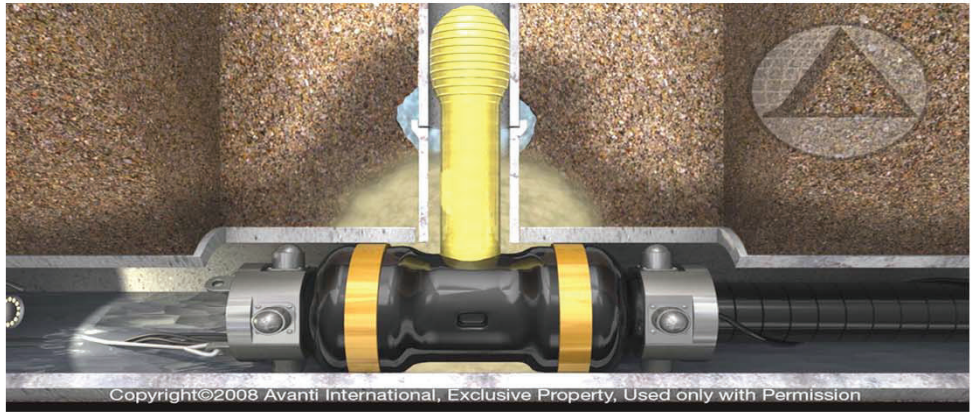
Lateral Connection Grouting

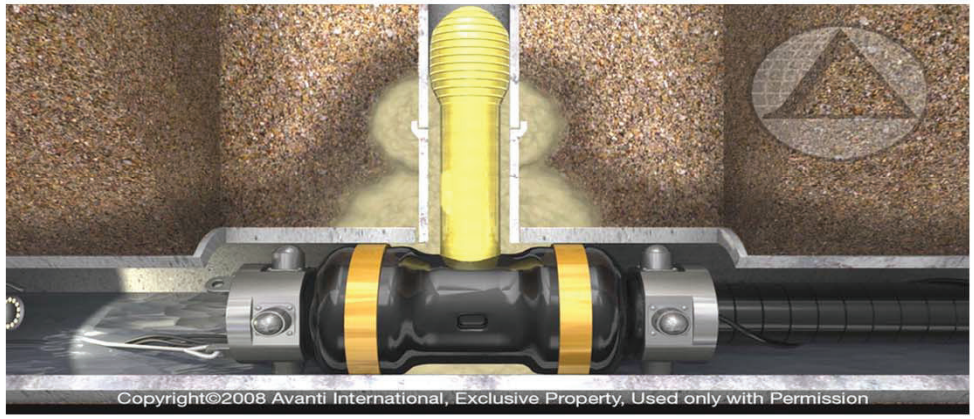




With the use of a winch and pan & tilt camera, the packer is positioned at the first lateral from the downstream manhole. The packer is rotated to align the lateral grouting plug with the service connection. Once aligned, the packer is rotated and air pressure is used to invert the lateral grouting plug from the mainline packer into the service lateral and the mainline bladders are inflated isolating the « Tee » or « Wye » section.

Lateral Connection Grouting

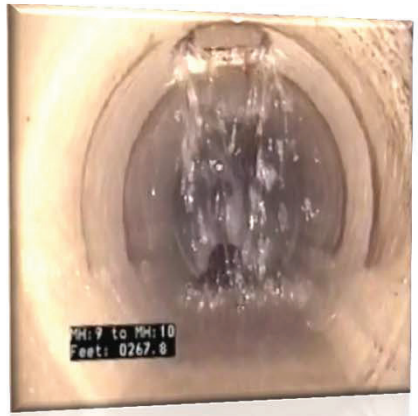


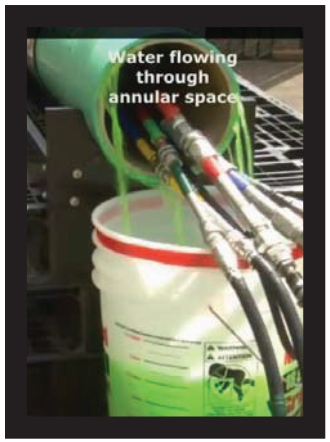


The forward end of the lateral grouting plug expands against the host lateral pipe and the remaining portion expands to a predetermined diameter creating an annulus between the inflated lateral bladder and the inside pipe wall. If no visible leaks are apparent, this area is then air tested (See ASTM F2454-05 (16))

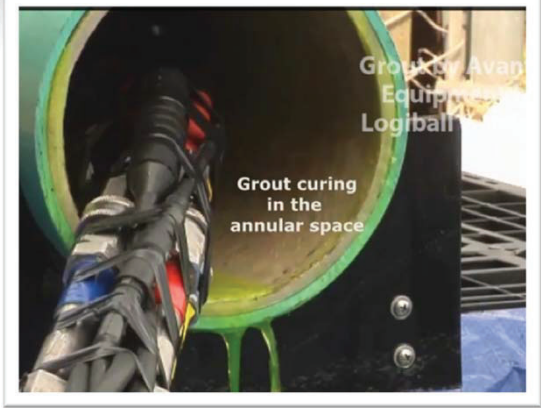
Lateral Packer above ground demonstration with dyed water

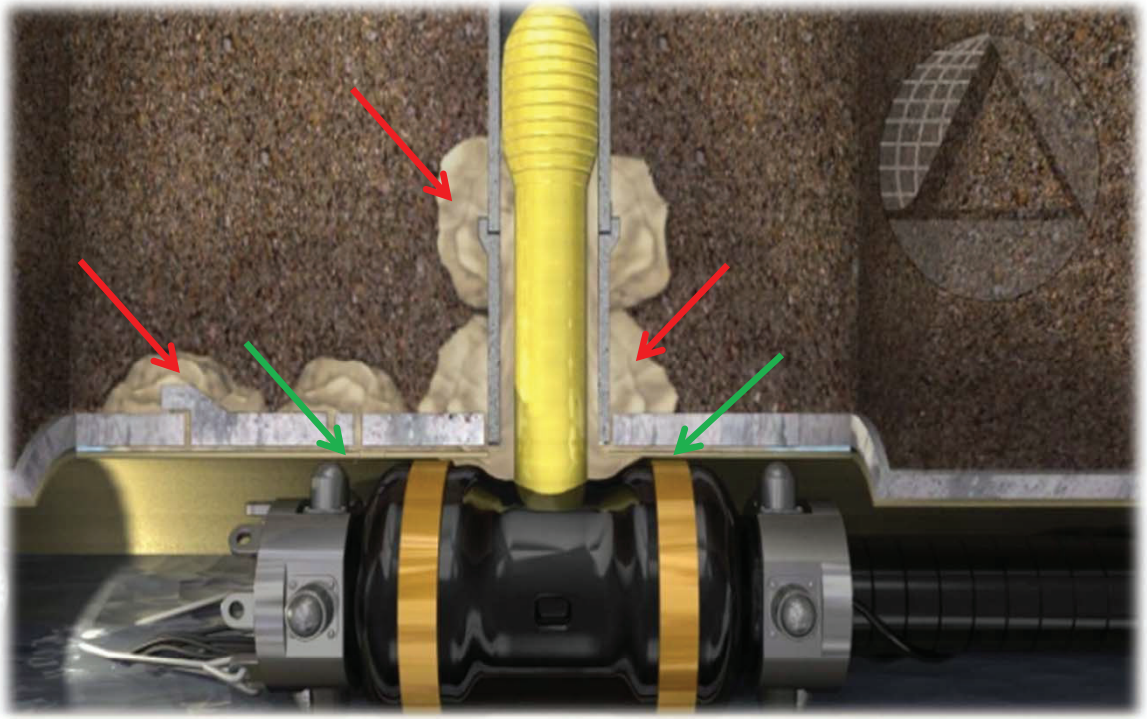
Reinstated tap connections in lined pipes are subject to infiltration through the annulus.





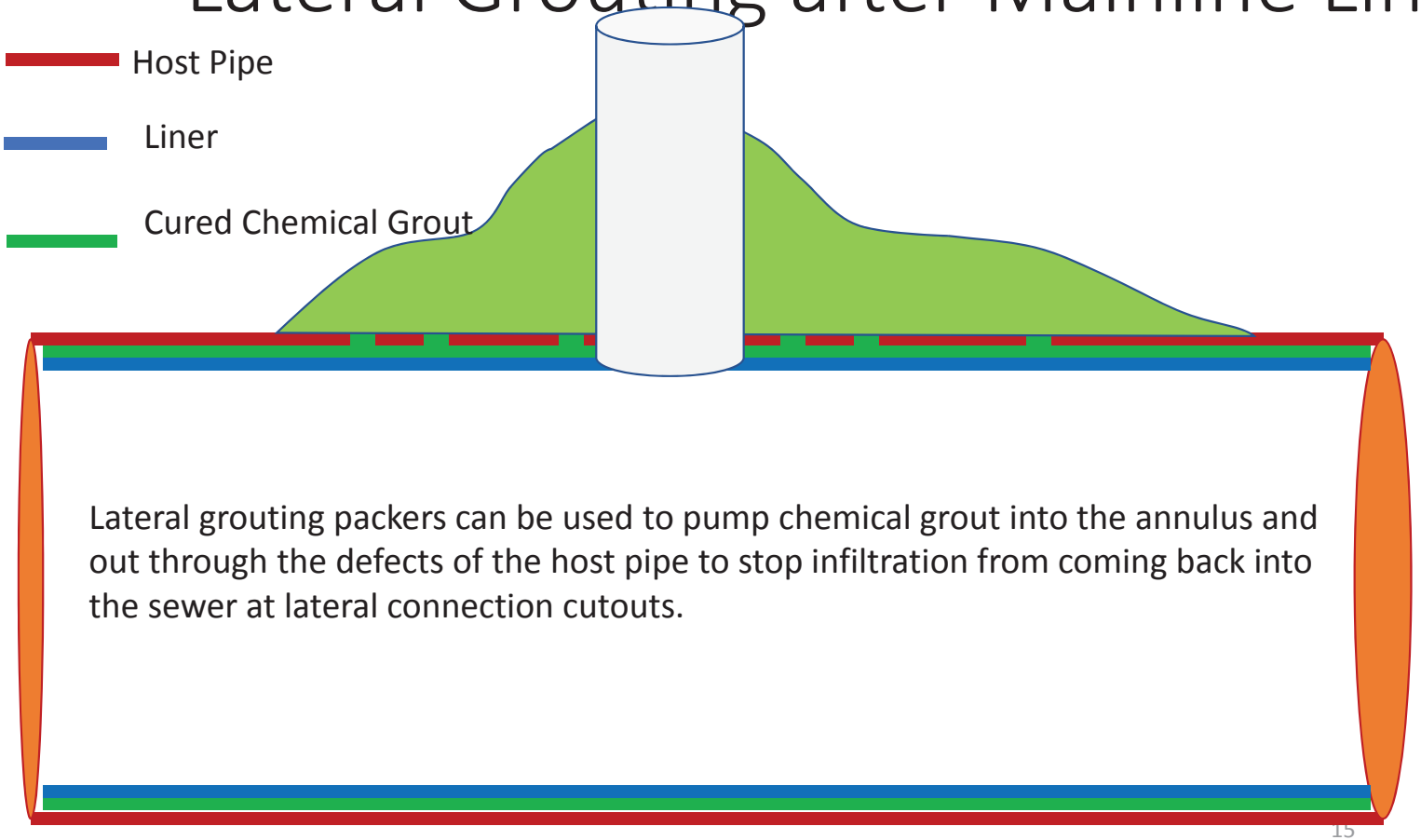
Lateral grouting packers can be used to pump chemical grout into the annulus and out through the defects of the host pipe to stop infiltration from coming back into the sewer at lateral connection cut-outs.

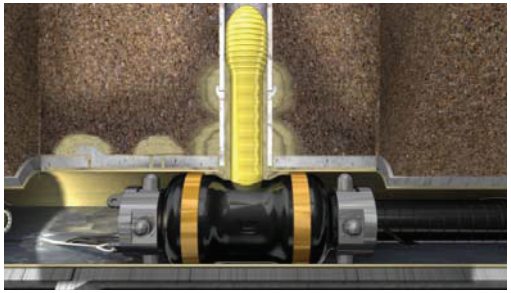




Grout travels through the annulus and defects out into the soil, obtaining a double seal.

Lateral Grouting after Mainline Lining





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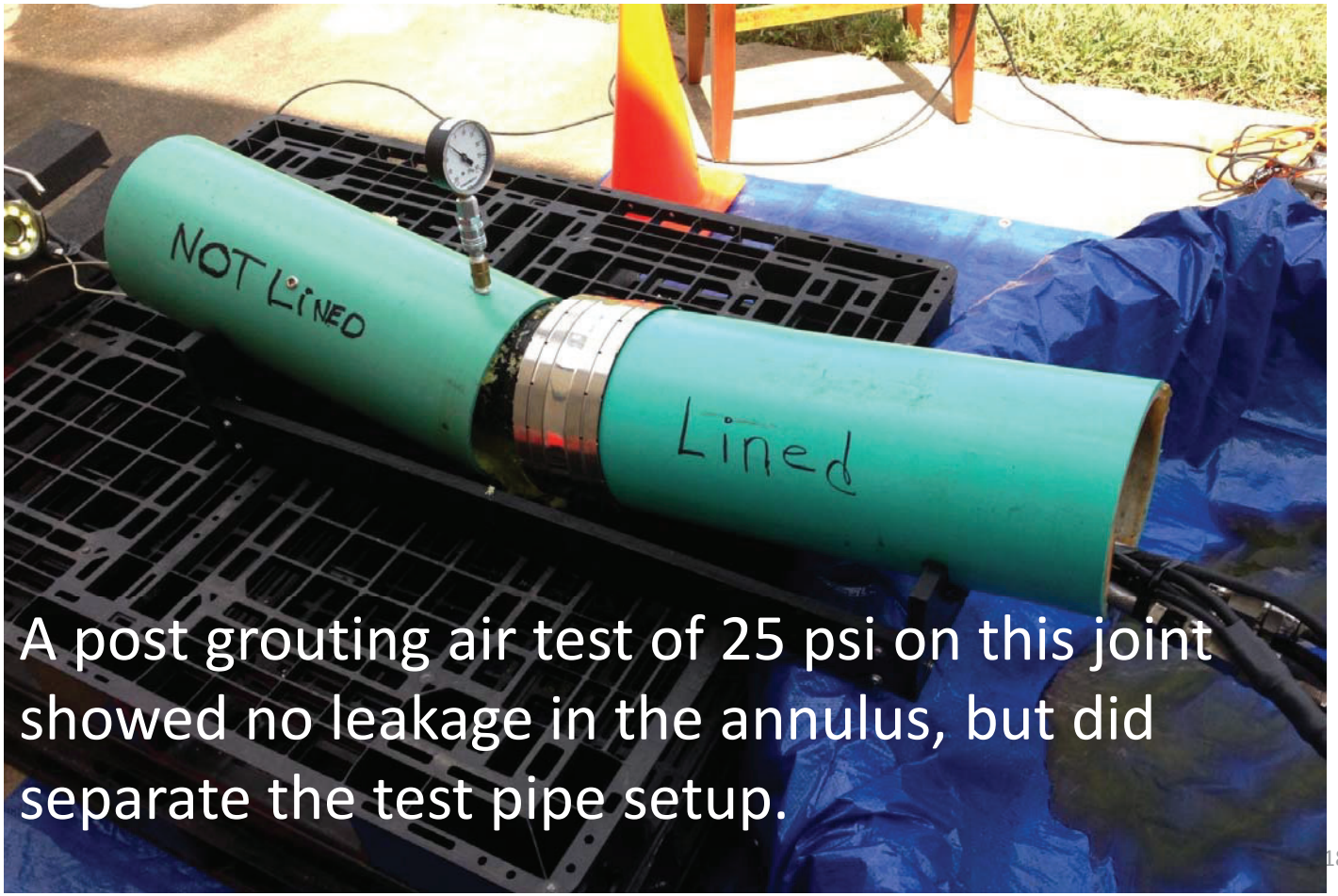
Lateral Grouting after Mainline Lining with acrylamide grout

A section of lined (CIPP) and unlined pipe are joined together. A mainline packer straddles the joint and acrylamide grout pumped at that transition.

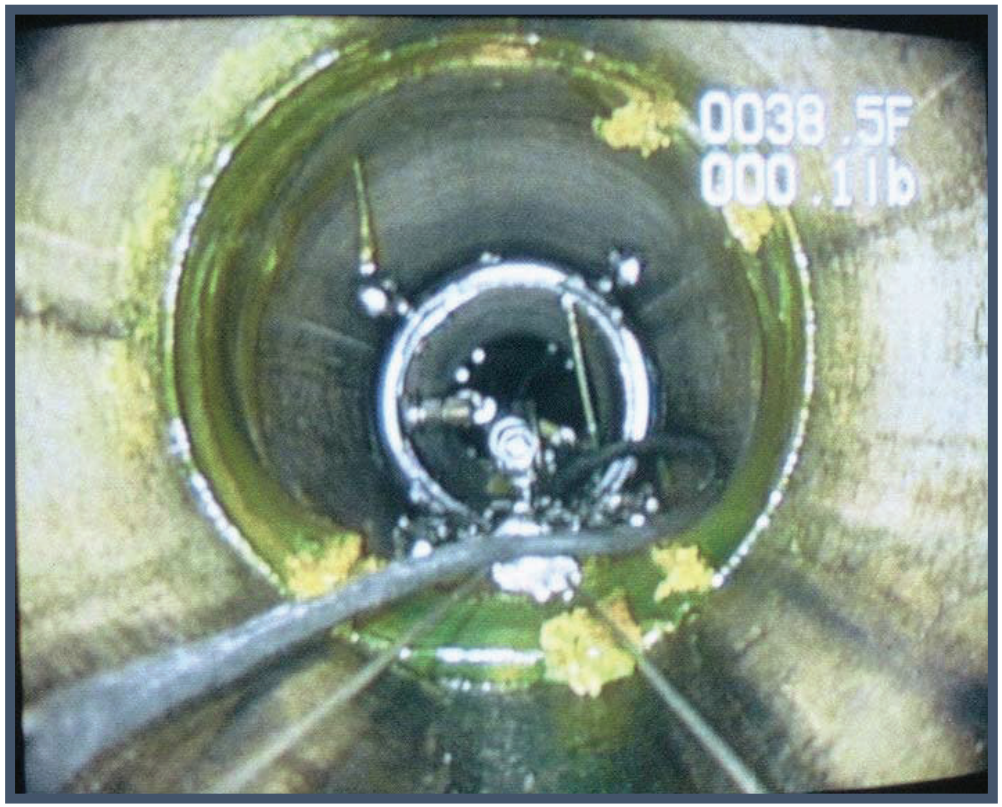
Grouting annulus in above ground setup

Post air testing of sealed annulus (with acrylamide grout) under pressures in excess of 23 psi

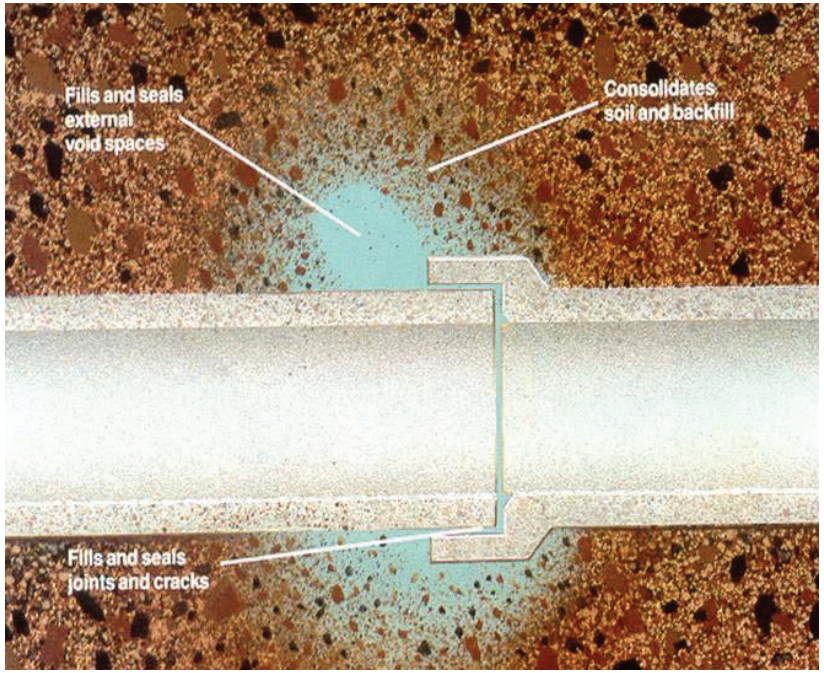


A post grouting air test of 25 psi on this joint showed no leakage in the annulus, but did separate the test pipe setup.

The seal is not achieved by the internal grout ring but by the …



...gelled grout on the exterior that has saturated and sealed the annulus in lined pipes & backfill providing a watertight repair and preventing any further fines from entering the pipe



Acrylamide grout njection in different pipe bedding soils

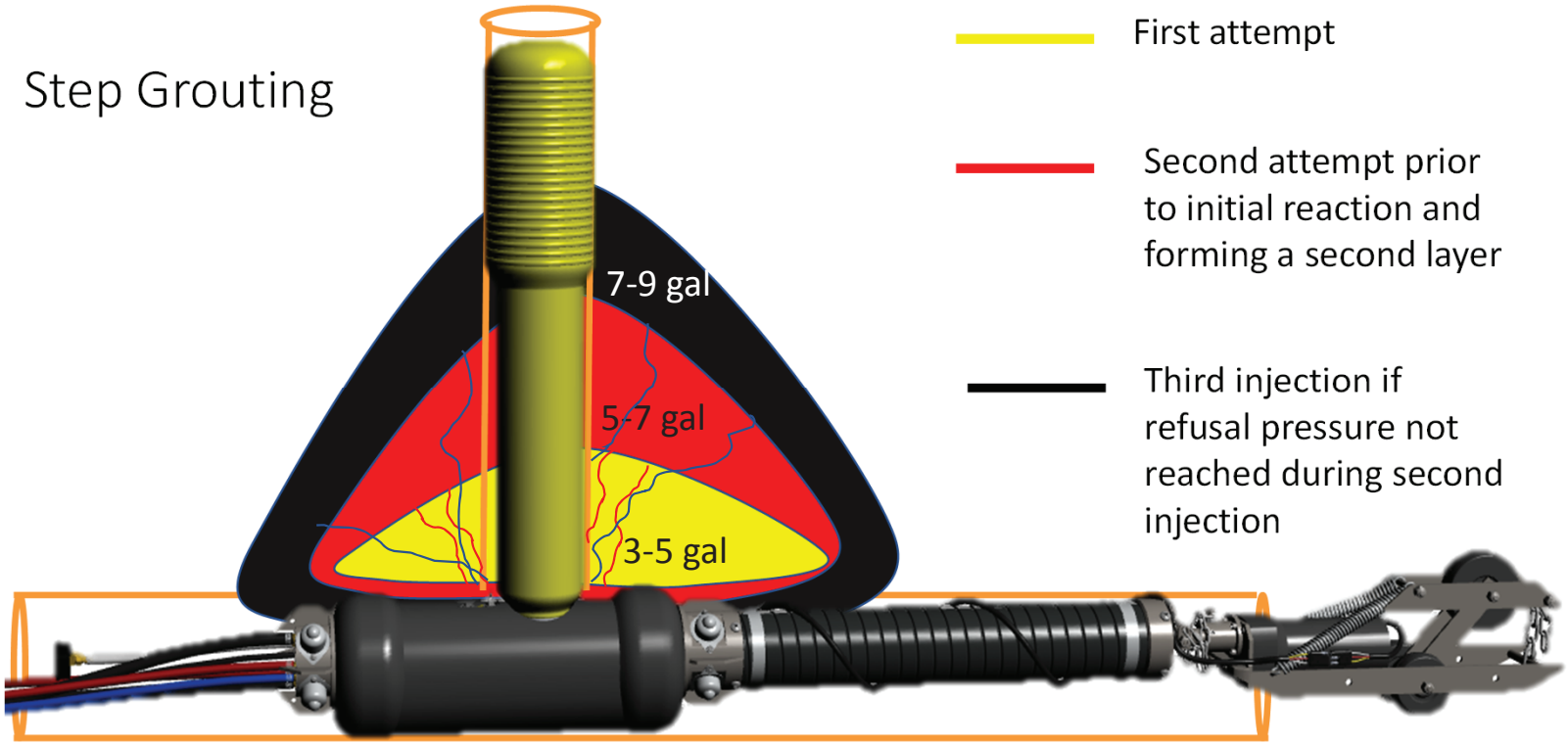
Clay Soils

Sandy Soils

Stone 57

In some cases it can become necessary to stage the grout in order to obtain a seal, as the grout consumption may become important caused by large voids behind the structures. Grouting in increments of pre-approved volumes and corresponding procedures to provide the best long term solutions. An example given below.

Step Grouting

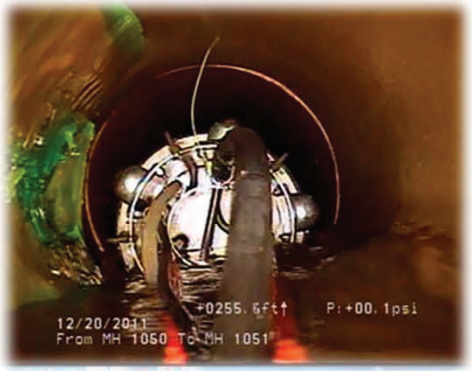


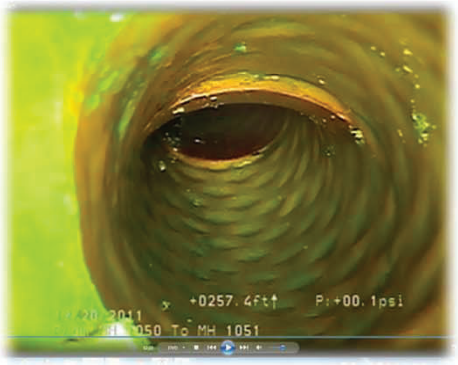
First attempt

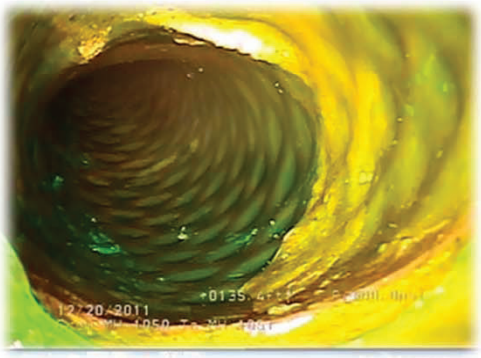
Second attempt prior to initial reaction and forming a second layer

Third injection if refusal pressure not reached during second injection

Pictures of residual grout as seen from the main and looking up the lateral. As the objective is to seal a predetermined distance into the lateral from the connection, chemical grout must travel between the lateral plug and lateral wall to achieve this distance. Residual grout, when using the right bladder and right procedures, should look somewhat like the pictures below.

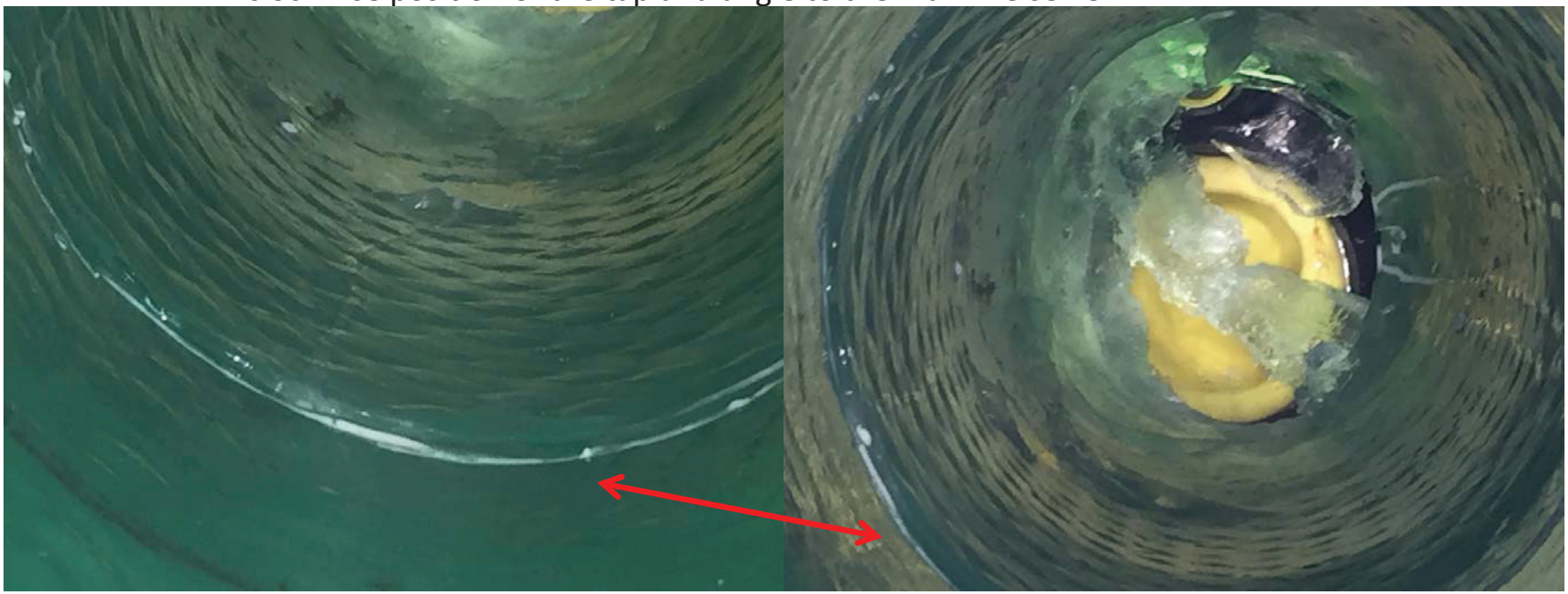






Lateral Grouting Plugs

View of residual grout ring when using appropriate sized lateral grouting plugs & injection procedures . Seen from cleanout looking down towards the tap connection. Volumes of grout are the same but the geometry of the grout ring will vary according to a wye vs tee, clockwise position of the tap and angle to the mainline sewer.

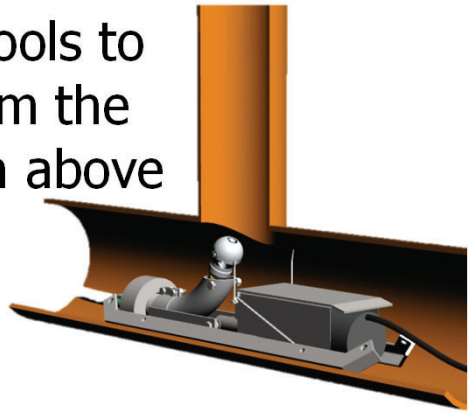


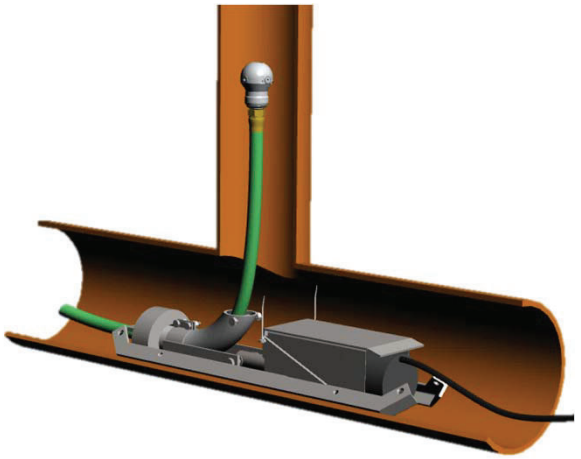
Lateral Tap Connection Grouting Capabilities

Mainline diameters from 6”-30” with effective sealing distances from 8” through 30 feet have been done. Diameter of laterals 4”, 5” or 6”.

Cleaning Laterals from The Main

There are effective tools to clean the laterals from the mainline sewer when above ground accesses are inexistant.





STANDARDS & SPECIFICATIONS

ASTM F2414-2016

Standard Practice for Sealing Sewer Manholes Using Chemical Grouting

ASTM 2304-2016

Standard Practice for the Rehabilitation of Sewers Using Chemical Grouting

ASTM 2454-2016

Standard Practice for Sealing Lateral Connections and lines from the mainline Sewer systems by the Lateral Packer Method, Using Chemical Grouting

Nassco Suggested Standard Specification for pressure testing and grouting of sewer pipe joints, laterals and lateral connections using the packer method with solution grouts (2014)

- A good set of Specifications for Lateral Sealing must include;
  - Grout concentration mix & additives required
  - Gel times vs pumping rates in relation to packer/pipe void
  - Effective sealing distances required in the lateral
  - Preparation of the lateral (pre cleaning and cctv if necessary)
  - Mainline & Lateral diameter and any transitions
  - Number of laterals within each reach or setup
  - Bid tab for gallons of grout pumped (ex: step grouting procedure in increments of 2-3 gallons)
  - Pre/Post testing
  - Bid tab for post cleaning of residual or excess grout (two different items)
  - Warranty requirements

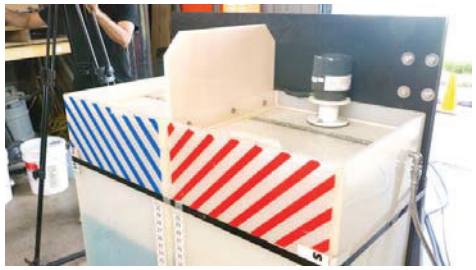
Solution Grout Mix

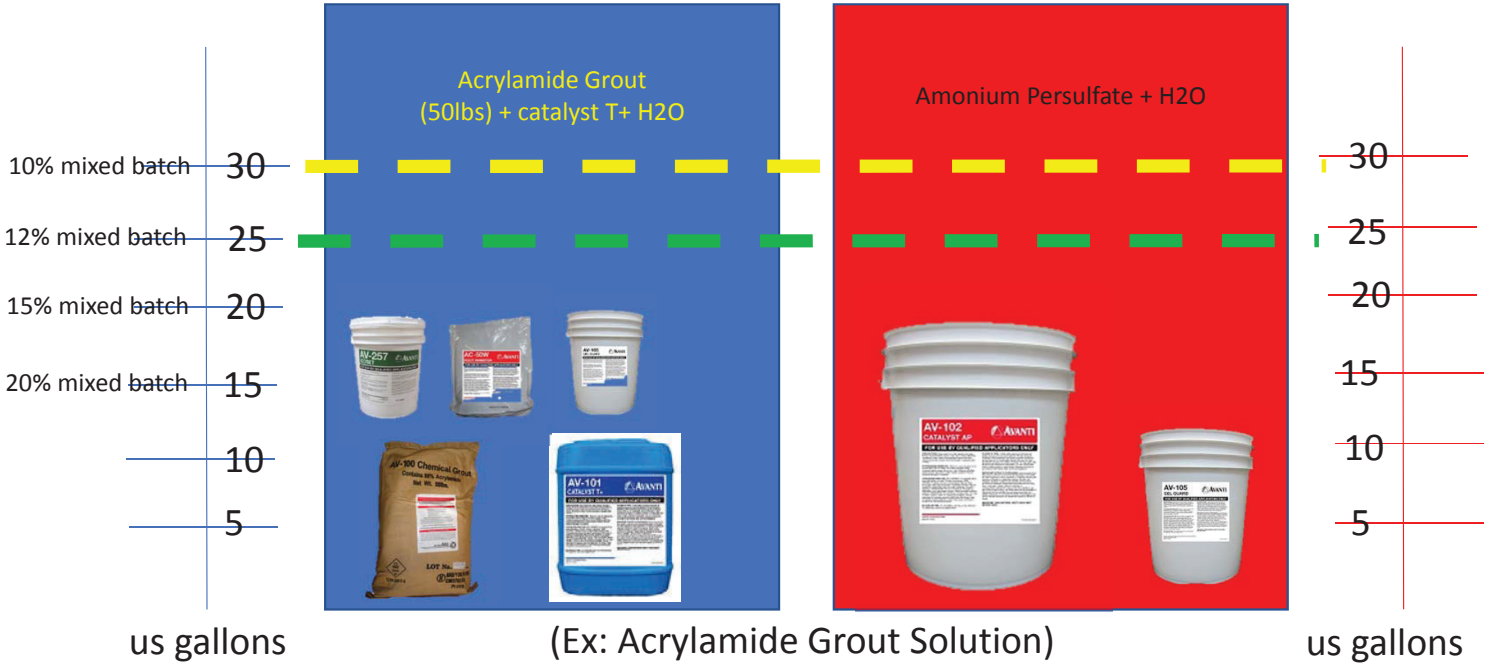
Latex strengthening agent

Root Inhibitor

Gel Guard

Most of the grouts being pumped through remotely operated packers are solution grouts (acrylamides, acrylates or acrylics)





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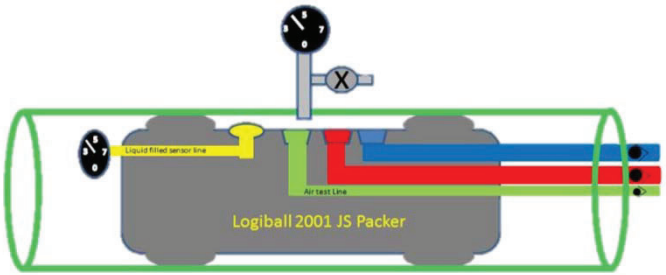
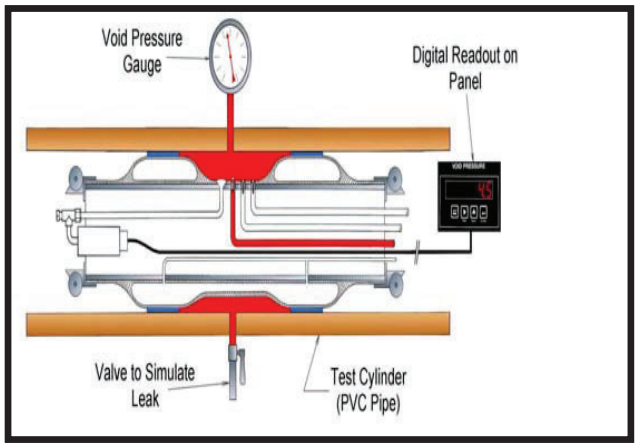
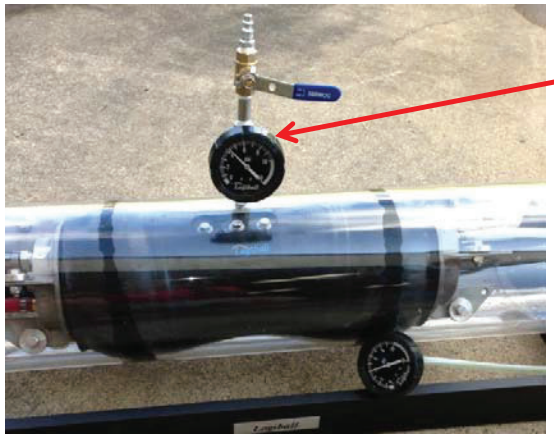


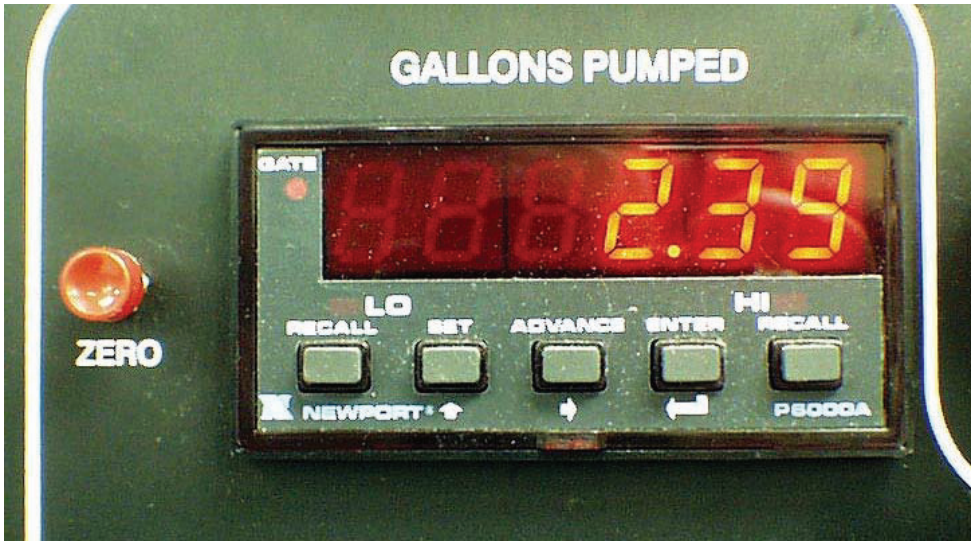
- Part 3.1 Control Tests
  - A .Packer Tests - Demonstrate the acceptable performance of air test.
  - To insure the accuracy, integrity and performance capabilities of the testing equipment, a demonstration test will be performed in an above-ground 8" nominal diameter test cylinder suitable to contain 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





Nassco Suggested Standard Specification for pressure testing and grouting of sewer pipe joints, laterals and lateral connections using the packer method with solution grouts (2014)

- 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.



Nassco Suggested Standard Specification for pressure testing and grouting of sewer pipe joints, laterals and lateral connections using the packer method with solution grouts (2014)

- 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.

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

  - 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.

Lateral Packer void volume in green

For example: an 8” pipe with a packer void space of 0.3 gallons and a 3 gpm pumping rate would provide

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

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

Time required to fill this void is 6 seconds. Suggested gel time window in this case is 21-31 seconds.

Gel Times of the Grouts

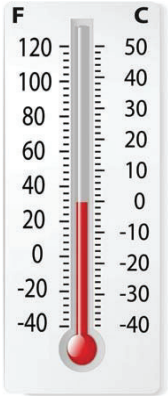
Standard cup test for gel time verification

Dilution affects gel times

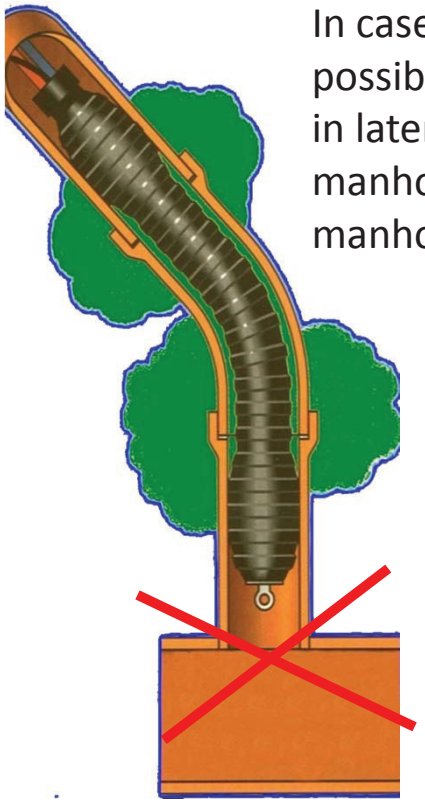
Pump delivery system ex: 3 gpm

Grout hose recirculation when necessary

Gel times of the grouts are affected by temperature & dilution. The colder it is the longer it takes for the grout to react & vice versa. The mixed grout pumped into bodies of water will usually take more time to react into a gel.

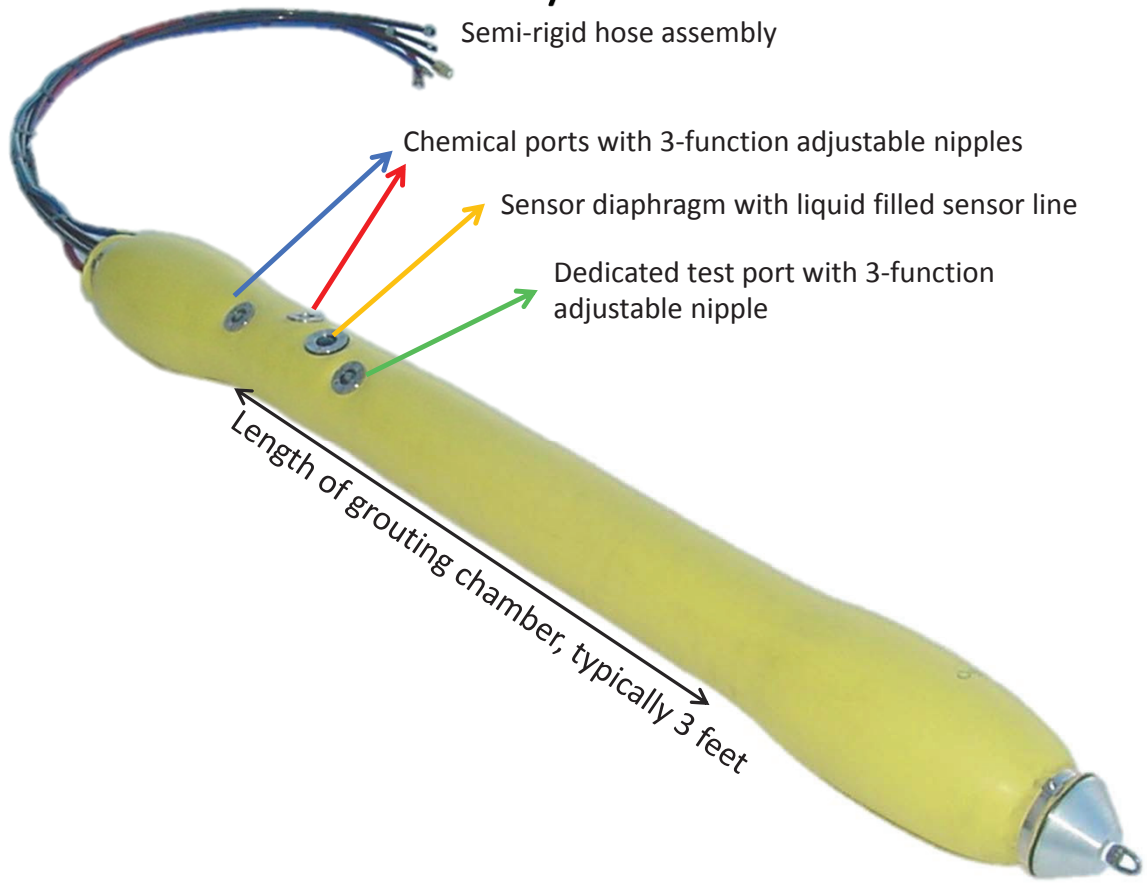


Sealing Laterals from an Above Ground & Manhole Access



In cases where above ground accesses are available, it is possible to use a flexible push/pull packer to seal leaking joints in laterals. These packers have also been used from the manholes to seal leaks in laterals that come directly into manholes.

6`` Flexible Push/Pull Packers



Flexible push/pull packers from cleanouts



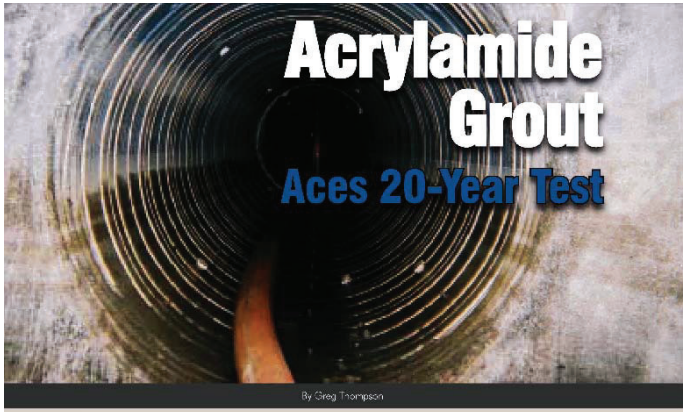



Man Entry Push Packers

Sanitary Sewer Rehabilitation Summary Matrix

Technique	Type	Estimated Service Life (USEPA, 2014)	Advantages	Disadvantages	Potential Application, Pipe Diameter	Mainline /Lateral/ Manhole
Cementitious Coatings: Shotcrete or Gunite	Structural/ Non-Structural	20 or more years	All shapes and connections accommodated,	Address active infiltration, requires confined space entry	48" and larger	Yes / No / Yes
Spun Cast Concrete	Structural/ Non-Structural	Same as concrete pipe (Army Corps of Engineers)	Robotically applied. Antibacterial additive can be added when microbiologically induced corrosion is present.	Address active infiltrations	30 – 120"	Yes / No / No
Spray Polymer Coatings	Structural/ Non-Structural	50 years	Encapsulates sewer, can be designed for structural load, can improve flow coefficient	Sags and dips in pipe remain, service interrupted, must stop active infiltration	6" and larger as long as the host pipe wall can be properly cleaned and dried.	Yes / No / Yes
Cured-in-place-pipe (CIPP)	Structural	50 years	Prevents further degradation and collapse, improves flow coefficient	Sags and dips in pipe remain, service interrupted, infiltration may follow annular space	3" to 120"	Yes / Yes / Yes
Thermo-formed Pipe (Fold and Form)	Structural	20 or more years	Prevents further degradation and collapse, improves flow coefficient	Sags and dips in pipe remain, service interrupted, Infiltration may follow annular space	4" to 30"	Yes / Yes / Yes
Injection / Pressure Grouting	Non-structural	20-25 years	Seals leaking joints, stabilize supporting soils	Offset joints or longitudinal cracks may not seal	4"and greater	Yes / Yes / Yes
Sliplining	Structural	50 years	Quick insertion, some bends are accommodated	Circular and non -circular, loss of cross sectional area	4" to 144"	Yes / Yes / No
Spiral Wound Pipe	Structural	50 years	Prevents further degradation and collapse, improves flow coefficient	Sags and dips in pipe remain, service interrupted, Infiltration may follow annular space	6" to 144", Larger sizes on case by case basis	Yes / No / No

WSEC-2017-FS-009—Collection Systems Committee—Sanitary Sewer Rehabilitation Fact Sheet



Acrylamide Grout

Aces 20-Year Test

By Greg Thompson

As the pipeline rehabilitation market has grown, more and more technologies have reached the market and jostled for primacy as the rehab solution of choice. Grouting has occasionally been thought of as a more temporary solution, a stop-gap. But recent testing of two 20-year old acrylamide grout rehab projects indicate that grout can certainly stand the test of time.

Revisiting the Seals

Located at the foot of the North Shore Mountains, the City of North Vancouver, Canada, is no stranger to groundwater remediation issues, especially with each spring thaw. As a result, city policy dictates that any water line rehabilitation be tested one year following completion. By actively monitoring its water and wastewater conveyance systems, the City can be out in front of any system failures.

Recently, Dave Adams of Superior City Services was contacted by the City to retest several sewer lines that had been rehabbed 20 years ago using acrylamide grout to seal the joints. "They asked me to have a look and wondered how the grout was holding up," Adams says. "By retesting the lines they could gauge whether to stay on course [with current grout-based rehab projects]."

The test-and-seal grouting was originally performed by MarTech.

Superior City Services utilized a CCTV setup to position a testing packer directly in the pipe joint. The packer inflates on each side of the joint to air test the seal; in this instance, typically an 8-lb test was used. "All of the seals tested really well," Adams reports. "We tested five or six lines and overall, we saw a 90 percent success rate."

Adams adds that he has seen other instances of grout-sealed joints that stood up similarly. "We've dug up old lines and the grout is still holding firm on the outside of the pipe, keeping its seal," he says.

With better than 50 years of experience in the industry, Adams understands the capabilities of acrylamide grout very well. "It's a good product," he says. "As long as it's installed properly, it will keep for at least 60 years." He further explains that it stands up well to anything it will likely encounter in the ground, from water to chemicals and really only suffers in extremely dry conditions.

"If it totally dries out — like in a desert — then it might have issues, but especially up here, we're not going to have that problem," Adams says.

Acrylamide Grout

The polymer form of acrylamide is used to treat drinking water, as well as in the manufacture of paints, plastic and water absorption products such as diapers. It is a colorless, odorless water soluble solid chemical that can be used as a soil stabilizer, stopping leaks in sewers or as a water-impeding grout in tunnels, dams and other underground construction. Its use as a grout dates back to the 1950s and has been used in situations ranging from hazardous waste containment to coal mine sandstone fault sealing.

Acrylamide grout is low-viscosity and is often deployed into situations where other grouts have not had success. Its wide range of gel times, as well as its predictability, stability and non-toxicity make it a popular solution in geotechnical engineering.

Conclusion

Chemical grouting is an infiltration / exfiltration / erosion control remediation process.

Chemical grouting has proven to be the least expensive remediation alternative for stopping leaks and infiltration in collection systems.

Seals are achieved from the outside of the pipe through existing defects.

Chemical Grouting has a 50 year history of sealing leaks.

Chemical grouting is a proven method of stopping infiltration when ***the proper*** application of chemical grouts is delivered.

In order to obtain higher flow reductions from RDII, laterals need to be addressed. The portion of the lateral to be sealed will vary amongst communities and ROI.

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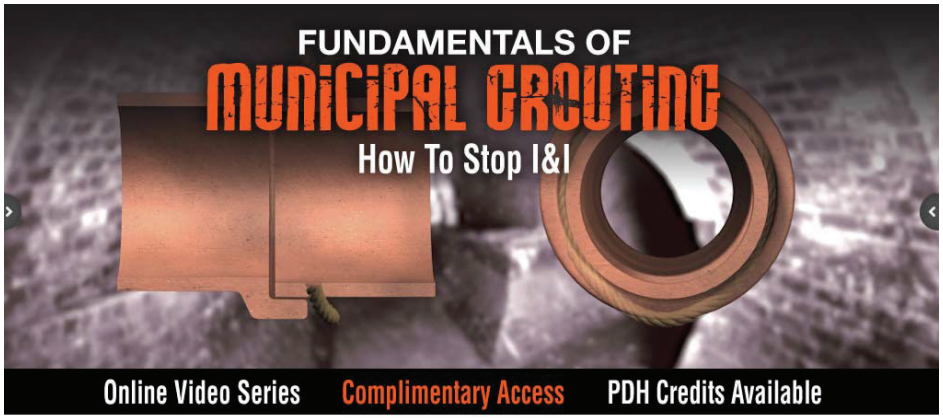

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