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The Logic and Economics of Lateral Grouting – Decision Support Matrix Compares Trenchless Rehabilitation Technologies

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1. ABSTRACT

The US EPA makes a clear and compelling statement, "Nationwide, nearly 50% of the flow to the WWTP is clean ground water from inflow and infiltration (I&I) sources." Small municipal utilities and large sewer districts attack this problem with different methodologies and prioritizations; however the return on investment (ROI) for taking ownership of the problem can be immediate and sustainable.

Through condition assessment, the current state of a collection system (including mainline, manholes, service laterals and lateral tap connections) is revealed, but does not necessarily expose the root cause of the defects. I&I is one of the first indicators that eminent and expensive structural repairs will be needed unless proactive measures are taken to seal the system by providing an impenetrable barrier from groundwater intrusion. Injection Grouting is both a preventative maintenance practice and a non-structural rehabilitation method proven to reduce excessive flow to treatment facilities, reduce risk of SSOs, and extend the design life of existing infrastructure by stabilizing supporting soils surrounding the sewer pipe.

Service laterals and connections to mainline pipes are typical problem areas where defects may contribute a significant volume of infiltration to collection systems and are high-reward targets for reduction. Specific to service laterals, a Decision Support Matrix on trenchless alternatives provides objective asset management insight for collection system managers and consulting engineers to compare various rehabilitation options. Criteria include: Time-to-Benefit, Disruption to Rate-Payer, Cost, and Longevity. Case studies including using a Grout First approach and Injection Grouting used as a complimentary component for successful installation of other trenchless rehabilitation methods will be discussed.

2. INTRODUCTION

For this paper, we will focus on techniques for stopping the leakage of groundwater through defects in the sewer system. Injection Grouting is one methodology specifically engineered to control Infiltration at all four points of entry: Mainlines, Service Laterals, Lateral Tap Connections, and Manholes. Sometimes there is confusion between "Inflow" and "Infiltration." Inflow is defined by the US-EPA (2004) and the Water Environment Federation (2011) as:

"Water, other than wastewater, that enters a sewer system from sources such as roof leaders, cellar drains, yard drains, area drains, foundation drains, drains from springs and swampy areas, manhole covers, cross connections between storm drains and sanitary sewers, catch basins, cooling towers, storm waters, surface runoff, street wash waters, or other drainage. (Inflow does not include infiltration.)"

We will not be talking about Inflow. Alternately, Infiltration is defined by EPA as:

"Storm water and groundwater enters a sewer system through such means as defective pipes, pipe joints, connections, or manholes. (Infiltration does not include inflow.)"

In particular, we will focus on groundwater following the path of least resistance and gaining access into the system through defects in mainlines, manholes, service laterals, and lateral tap connections.

No two communities are alike, but both small villages and large sewer districts are reporting as much as 50-70% of I&I can be traced to the service laterals and lateral tap connections to mainline. Often, the property owner is responsible for the proper maintenance of the service lateral & lateral tap connection, but the municipality is paying the price for the excessive flow to the WWTP and all other associated costs. Many communities are taking ownership of I&I up to the right of way and sometimes beyond the right of way to include the foundation of the residence or commercial property.

New construction practices for installing service laterals include the use of PVC pipe which is more watertight and resistant to root intrusion than earlier products. The challenge is rehabilitating existing laterals constructed over decades consisting of small diameter (4-6") clay pipe laid in trenches that act much like a French Drain allowing groundwater to enter through faulty joints and pipe defects. One remedy is to Dig & Replace, but there are trenchless rehabilitation methodologies worthy of comparison and contrast.

3. TRENCHLESS METHODS FOR REHABILITATING SERVICE LATERALS & CONNECTIONS

There are three primary technology platforms for the rehabilitation of service laterals: Injection Grouting, Cured-In-Place Pipe (CIPP), and Pipe Bursting. Each has advantages and disadvantages. A Decision-Support Matrix (separate document) summarizes these options for owners, specifying engineers, and contractors

Injection Grouting with solution grouts: A 2-component acrylic grout can be injected from the mainline using a lateral packer with an effective grouting distance of up to 30' or from the clean-out with a push/pull flexible packer extending over 100' to reach the foundation of the residence or commercial building. The lateral is air tested for leaks before and after grouting to confirm seal. A root inhibitor (Dichlobenil) can be added to the solution to discourage root growth without destroying the vegetation. The grout is injected from within the pipe through existing joints and defects to create an external impermeable membrane, fill voids, and stabilize the supporting soils.

CIPP Lateral Lining: Also known as creating a pipe within a pipe, a resin-saturated felt tube made of polyester resin is inverted or pulled into the lateral. Service laterals are restored internally with robotically controlled cutting devices in the larger-diameter pipe. Smaller diameters (100 mm) can be opened remotely using smaller reinstating devices designed for small diameter pipe. The service lateral tap connection can be sealed with specially designed CIPP materials. It is practically impossible to perfectly clean and degrease the inside of the host pipe. Additionally, since most resins shrink, it is impossible to reliably achieve a long-term bond between the existing sewer pipe and a CIPP Liner. Therefore, an annular space exists (or will likely develop) between the new CIPP liner and the host pipe or the inside of the relined mainline CIPP. That annular space may allow continued infiltration into the collection system unless additional hydrophilic seals are provided.

Pipe Bursting: A conical bursting head is fixed to a replacement pipe line, and fed through an entry pit to the broken sewer line. The pointed bursting head breaks the existing, damaged pipe line as it travels through; this is because the bursting head's cone shape is larger at its base than the existing pipe's diameter. Using a pull rod or hydraulic power winch, the entire existing pipe is fractured and the fragments are pushed into the surrounding soil. The replacement pipe, attached behind the bursting head, is then seamlessly fed in place, filling the cavity left behind by the bursting head. The connection to the mainline requires a second pit to perform the connection of the lateral pipe to the mainline pipe.

Seldom does one solution fit every community's need. To determine the optimum answer for the rehabilitation method means answering the following questions:

- What is the condition of the exiting lateral?
  - Active infiltration, but structurally sound
  - Structurally impaired
  - Needs replacement or upsizing
- Who's responsible for paying for this rehabilitation?
  - Owner responsible
  - Cooperative--owner and municipality
  - Municipality or sewer district

Municipalities, counties, and large sewer districts are paying the price of excessive flow and all other related cost caused by I&I. The following entities chose injection grouting and for their own good reasons:

- **City of Naperville, IL**— New mandate for Grout First prior to lining mains, service laterals and manholes. Experienced flow reduction of 21% during a year of 20% increase in rainfall with no basement backups. (Conn, et al, 2017)
- **Sullivan's Island, SC**— Grout First approach with mainlines and 5-7' up the lateral in Basin #6 (highest priority) resulting in a 47% reduction in I&I, 36% reduction in flow to the WWTP. (Shelton, 2015)
- **Wauwatosa, WI**—Quote, "We wanted to completely end all basement backups," Wehrley explains. "But the bottom line is, we're paying about $500 per house when grouting, and lining would cost about $5,000 per house. And, we're already near compliance, and have improved the situation for our residents. So grouting has been a success for us — we've saved millions." (Stocking, 2015)
- **Miami-Dade, FL**— In general terms, chemical grouting is less expensive than the Cured-in-Place Lateral Lining process. For decades, MDWSD has self-performed chemical grouting in mainlines and laterals. After an extensive Condition Assessment review comparing CIPP Lining and grouting, our recommendation is to maintain current protocol. (Bedoya, 2017)

4. RESULTS

Table 1: Methods for Rehabilitation Service Laterals & Tap Connections

METHODS FOR REHABILITATING SERVICE LATERALS & CONNECTIONS				
DECISION CRITERIA	**Injection Grouting**	**CIPP Lining**	**Pipe Bursting**	**Open Cut**
Time-to-Benefit	Immediate	1-2 days	3-4 days	5 days
Disruption to Owner	None	Minimal	Moderate	Considerable
Disruption to Community	None to Minimal	Minimal	Moderate	Considerable
Cost for per lineal foot	$16-20 per lineal foot	$60-75 per lineal foot	$80-90 per lineal foot	$100 per lineal foot
Cost per lateral tap Connection	$300-400	$1,500-3,000	$1,000-1,500	$1,000-1,500
Longevity	25 years (WEF, 2017)	50 years	50 years	50 years
Advantages	Least cost, lateral trench stabilization, no reduction of capacity. Air test before and after to validate seal	Full pipe renewal, minimally invasive,	New HDPE or PVC pipe installed and upsized as necessary	New HDPE or PVC pipe installed and upsized as necessary
Disadvantages	Non-structural	High cost, may not	Costly and requires	Most disruptive

	only, no renewal of pipe	stop infiltration. Many systems require cleanout	access pits	
Other Considerations	Whether or not a structural solution is needed	Need to specify seals, clean out most likely required	Access/ disruption to surface, soil type, heave potential, surrounding utilities	Surface restoration, surrounding utilities, down time

5. CONCLUSION

Clearly, based on a community's circumstances, there is not one methodology that rules, but there are guidelines that honor priorities. Referencing the Decision Support Matrix, draw your own conclusions for the optimum trenchless methodology for rehabilitating service laterals in your community.

6. REFERENCES

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