The URETEK™ Advantage for Public and Private Infrastructures

A URETEK USA/ICR White Paper
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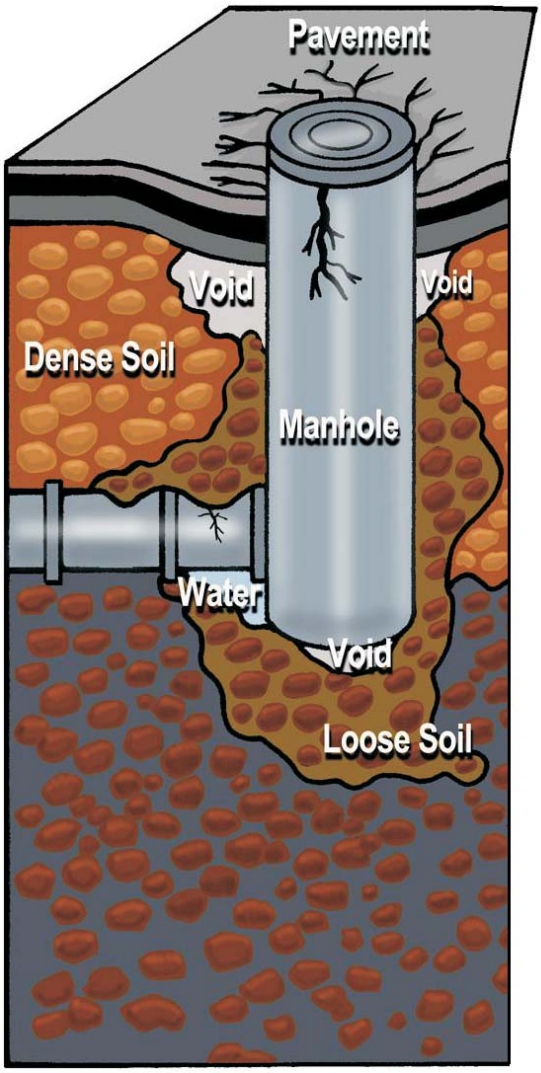
Introduction

Surface and sub-surface infrastructures are the life blood of our modern society. Pipes, conduits, culverts, and manholes all provide the essentials that make our day-to-day life easier. Examples of infrastructure include concrete sewers that carry away waste products, storm drains that distribute surface runoff, and catch basins and conduits that provide protection for the cables and wiring running beneath our cities. Old manholes and catch basins, which are typically of pre-cast concrete construction today, were made of brick and mortar in the past and most are well past their design life. Add to this, innumerable box culverts, corrugated steel culverts, pipes of all conceivable materials and buried utilities of various age and construction and the maintenance challenges necessary to keep them functioning are often overwhelming.



As with any materials exposed to the ravages of time and the natural environment, these facilities settle, crack, erode, corrode, off-set, deteriorate, vibrate, become saturated, voided, or collapse creating sub-surface and surface repair work to be paid for by ever stressed maintenance budgets. Each year, state governments, municipalities, cities, towns and counties are faced with the perplexing problem of how to address the issue of finding the resources and the effective methods to solve these infrastructure problems that are so common today. This paper addresses some of the more common problems:

Water Infiltration - If a pre-cast manhole settles because of weak base soils, then there's a real possibility that the pipe draining into or out of the manhole will crack and/or break (see diagram). If the manhole is of the old brick and mortar variety, then wall cracks may develop where mortar lines have deteriorated. The result of such sewer manhole conditions is the possibility of additional storm water entering the system, yielding higher water treatment costs downstream. With time and erosion, roadway surfaces around manholes and catch basins can sink, creating opportunities for large amounts of soil and water to infiltrate.

Water Exfiltration (Leaching) - When concrete, plastic, clay and even steel pipes that carry waste water and sewage crack, they can seep pollutants and harmful bacteria such as e-coli into surrounding ground soils. This situation can have a devastating impact on the environment. Over time, these pollutants can penetrate underground aquifers impacting municipal drinking water supplies. Areas of concern for these seepage problems include entry and exit piping for water treatment plants, storm drains, and sewer pipes. These infrastructures must be sealed against waste water seepage as municipalities comply with strict rules imposed by the EPA concerning the disposal of waste products and storm water runoff.

Communication and Data Systems - As communities transition their underground communication assets from standard wiring to fiber optic cabling, the influence of water into the conduits that encase these assets can have damaging results. Many public and private agencies are taking steps to insure that the conduits and vaults that protect these assets are sealed and protected from water infiltration. The same holds true for subway and underground rapid transit tunnels and stations as well as underground pedestrian walkways and commercial areas.

In this next section, we will review some of the various ways local governments and municipalities have dealt with the issue of infrastructure maintenance.

Traditional Methods for Handling Infrastructure Problems

Departments of Transportation, Departments of Public Works, local and national transportation and airport authorities have tried many ways to handle the issue of infrastructure repair and maintenance. Some of these have included:

1. Cementitious Compaction Grouting - With this method, a cement mixture, under uncertain hydraulic pressure, is used to fill ground voids. The cementitious mixtures are water based and require several days to cure. Often the extent of the voids below ground is at best uncertain. Large amounts of the grouting material are used to fill these unknown voids and once this material hardens, such grouts add significant weight burden to an already stressed soil condition. Shrinkage of these mixtures during the drying process is yet another problem that can complicate the repair process.

2. Chemical Grouting - Another material frequently used with mainline sewer joint or lateral joint repair is water soluble chemical grout. Since this gel material is applied from inside the pipe, the exact location of the crack or leak must be determined, usually involving the insertion of a surveillance camera into the pipe or conduit. Once the location is identified, the material must be injected and tested using specialized equipment. Since this is a water based material it can shrink and break its seal in dry conditions, thereby compromising any repair.

3. Fiberglass or Polyurethane Linings - The use of fiberglass or polyethylene linings is usually an expensive solution for an infrastructure leak. If the infrastructure repair is along or under a heavily congested street, traffic is often disrupted. To address the leak, fiberglass or polyethylene inserts are fitted as liners, which are affixed or ballooned to the inner wall of the pipe or conduit using adhesives or heat. In many cases, these repairs are both costly and time prohibitive.

4. Infrastructure Replacement - In instances where the extent of the damage is widespread, some municipalities have opted for complete replacement of the section containing the leak. To be effective, a standard excavation rule requires the crew to remove the surrounding soil at three to four times the diameter of the targeted infrastructure. For example, if a pipe has a 4-foot diameter a corresponding 12 to 15-foot trench has to be excavated. This quickly becomes a costly project for the municipality, contributing to lengthier completion timeframes and an extensive disruption of surrounding traffic and neighboring utility services.

Managing infrastructures is an ongoing task for most local governments and municipalities. As towns and cities grow, local infrastructures must expand to keep up with this growth. In areas with fast paced population growth, new infrastructures must be built, while existing, older sections must be rehabilitated.

The URETEK Advantage for Infrastructures

URETEK USA effectively puts counties, cities and municipalities in control of their aging infrastructures by saving them both time and money. Using URETEK's patented pavement lifting and soil stabilization technology, municipal decision makers have a clear choice on how to handle their infrastructure maintenance and repair problems. URETEK USA's accurate, precise rehabilitation methods provide a cost effective solution for any state, county, city or municipality that has infrastructure challenges.

Central to the URETEK advantage for infrastructures is the use of the URETEK 486 polymer material. This high density expanding polymer offers superior advantages over less effective traditional methods and materials. The URETEK 486 polymer fills, densifies, and stabilizes low-density compressible soils to depths of 30 feet and beyond. It is ideal for sealing manholes, pipes, sewers, and conduits, as well as box culverts, and storm drains that have leakage problems. The expanding material is specially formulated to be fast acting and hydro-insensitive, ensuring that it is unaffected by any water or wet soil that may exist around the immediate area. URETEK 486 polymer is also highly effective for stabilizing infrastructures from additional deterioration or movement. Pavements near or above can be easily lifted or stabilized with the same process and, if necessary, at the same time.

A summary of the benefits derived from the URETEK 486 polymer material includes:

Expansive - When the URETEK 486 polymer material is injected into soils, it can expand up to 20 times its original liquid volume, filling any voids or fissures in its path while further compressing and densifying the surrounding strata. With its unique expansive capability, work crews repairing an infrastructure leak can be assured that the problem area is fully enveloped and sealed.

Hydro-Insensitive - The patented URETEK 486 polymer material displaces trapped water and is not compromised by wet conditions during or after the installation. Once the curing process is complete, the hardened material retards further water infiltration. The material can also be used to seal underground pipes by effectively surrounding the leaking joint.

Faster Installation - Using the URETEK sealing system and URETEK 486 material, time requirements for the repair process is reduced to hours instead of the days or weeks for alternative techniques. As a result, projects are completed on time and on budget.

Lightweight - The URETEK 486 material is extremely lightweight, weighing less than 10% of a comparable quantity of cementitious-based grouts. The polymer adds only a minimum amount of overburden weight into a project area which already has experienced a distressed base and sub-base soils.

Long Lasting - The URETEK 486 polymer is guaranteed for ten years against any loss of dimensional stability or deterioration. The longevity of the material means that the repair system will remain in service long after other methods have failed.

Safe - The cured URETEK 486 polymer material is inert, environmentally neutral and does not contribute to soil or water contamination, leaching, or pollution. The material is also impervious to mildew and fungi. As an additional note, the polymer neither appeals to nor provides nourishment for insects or rodents.

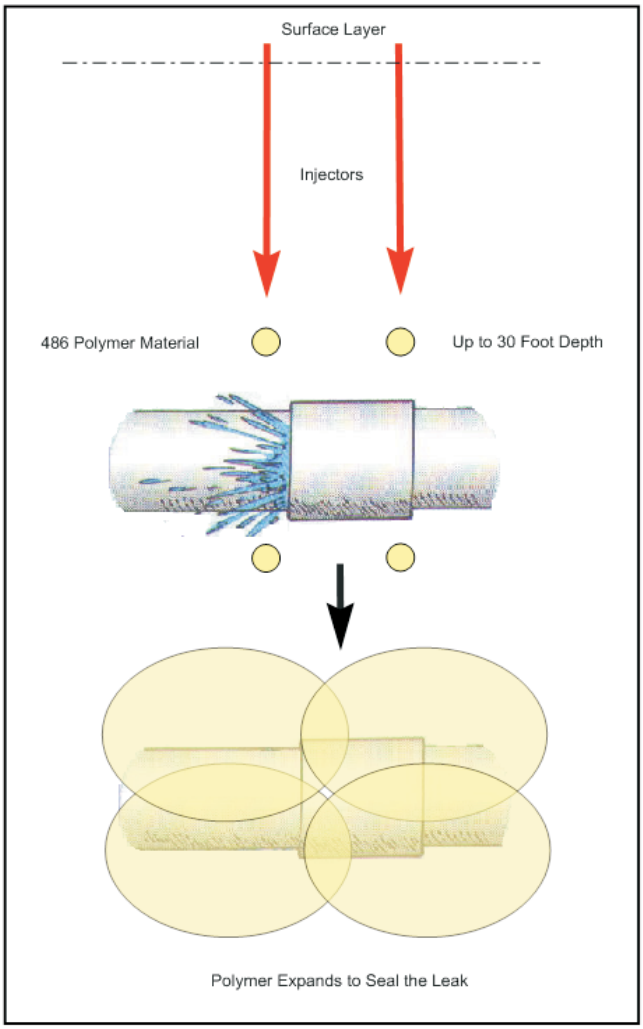
The URETEK patented process provides three important benefits that are useful for *Sealing, Stabilizing*, and *Lifting* a wide variety of public and private infrastructures.

Sealing

Sealing joints and cracks from water leakage and seepage is one of the most important and frequently recurring problems facing many infrastructures today. The combination of the patented URETEK Deep Injection Process and the 486 polymer material is ideal for environments that are influenced by both fresh and waste water such as:

- *Storm Water Transmission Lines*
- *Waste Water Transmission Lines*
- *Subterranean Conduits and Vaults*

To seal leaks in these environments, the patented URETEK polymer material is strategically injected on either side of the offending area at depths up to 30 feet below the surface. Injections form a pattern 3 to 4 feet apart from each another as necessary to surround the leak or crack. Once the placement of the material is complete, it begins its expansion process. Since the 486 polymer material can expand up to 20 times its original size, the material seeks out and fills any sub-surface voids, fully enveloping and collaring the area, sealing the leak.



The expansion of the polymers and the hydro-insensitive nature of the material combine to compress the adjacent soil, push out any water in its expansion path, and prevent any additional water from returning to that location. When the material fully cures, within mere minutes, it provides a strong, stable and long-lasting seal.

For infrastructures such as conduits or vaults that encase cabling or wiring, the 486 polymer material can be injected from either outside (the positive side of the leak) or inside of the enclosure (the negative side of the leak) to seal cracks and protect the assets from further water intrusion. The process eliminates any disruption to the surrounding surface areas or to any of the other gas, fiber optic, or telephone lines contained within adjacent conduits or storage vaults.

Stabilizing

Stabilizing involves reinforcing and adding support to the structural integrity of sub-surface infrastructures by preventing displacement or incremental movement that can lead to cracks and leaks. The structural challenges inherent with underground manholes provide an excellent example of how the URETEK process can be a valid stabilizing solution.

Since the structural composition of many older manholes is made up of brick and mortar, hydrogen sulfide gas (H_2S) can seep into the open areas between the bricks leading to deterioration of the mortar. Over time, this degradation causes cracks and shifting, exposing the bare dirt wall behind them. With the influence of water, this soil may seep into the manhole, clogging pipes and equipment located between the manhole and downstream water processing plants.

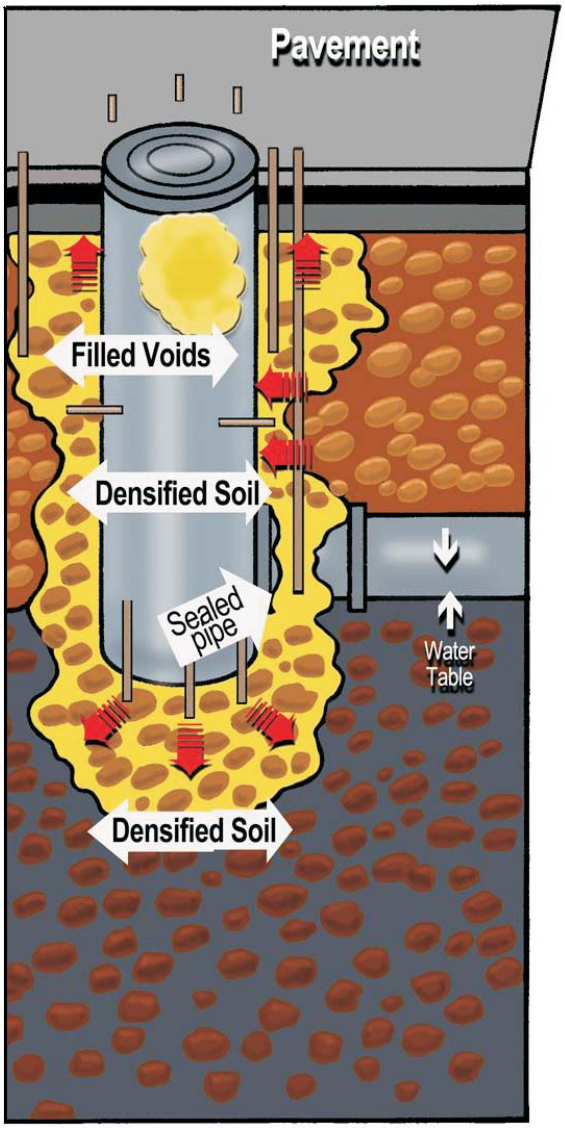
The URETEK process facilitates the stabilization of manhole structures that have these types of structural challenges. The patented 486 polymer material can be injected from the surface, the floor or through the manhole wall itself to fill the voids and spaces wherever cracks may exist (see diagram). The injections can continue all the way around the manhole structure as necessary, creating a unified and solid mass of polymer material.

The injected polymer will reinforce the brick walls and retard the penetration of both water and base soils. Since the weight of the material is a fraction of the comparable weight of cementitious grouts, it does not add any additional overburden to the wall or the surrounding soils that could contribute to

further structural movement.

The pattern of injections described in the previous section to address sealing, can also be applied for stabilizing soils near a leaking sewer, storm or drain pipes. For this type of stabilization, an additional round of polymer is injected above and below the leak location.

When the polymer expands, it fills any existing voids and encapsulates the pipe. The process is complete when the polymer cures in place, taking less than 15 minutes. The stabilizing properties of the 486 polymer material provide similar benefits for other types of sub-surface facilities such as:



- *Road, Highway, Bridge and Tunnel Applications*
- *Industrial, Commercial and Residential Applications*
- *Military, Commercial and General Aviation Runways and Taxiways.*

Lifting

The expansive properties inherent with the URETEK 486 polymer material provides a non-disruptive, cost-effective, and long lasting solution for lifting sunken highways, roads and runways, and misaligned bridge approaches or departure slabs. These situations are often associated with infrastructue problems. With URETEK, equipment, labor, and material costs are significantly reduced because there is no need to take the transportation or infrastructure elements out of service during peak use periods.

Insulating

The patented URETEK 486 polymer material has excellent insulation qualities and its inherent tensile strength protects the material from freeze damage. Since the polymer can also be sprayed onto infrastructure surfaces, it has a greater potential use in applications with smaller pipes and conduits where alternative insulation materials such as foam wrap would be difficult to install.

Vibration Protection

When vibration occurs as the result of equipment operation or the flow of material (in the case of oil pipelines), foundation slabs that support these assets are often compromised as their base soils consolidate. The resulting void conditions can be easily filled with URETEK's material which also provides flexural and tensile strength to dampen further damage from the inherent system vibration.

Summary

Within large metropolitan areas, the number of functional infrastructures is closely tied to population growth. As population size increases, municipalities become increasingly dependent on long lasting, cost effective infrastructure repair methods.

The combination of the patented URETEK Deep Injection Process and URETEK 486 polymer material provides states, municipalities, and commercial enterprises with superior lifting, sealing, and stabilizing benefits.

As a summary of benefits, the URETEK patented application process for Infrastructures:

Seals - The hydro-insensitive nature of the patented URETEK 486 polymer material drives out standing water, effectively retarding further water penetration.

Stabilizes - The expansive nature of the URETEK 486 polymer material aggressively fills any ground fissures or voids. When the material cures, it provides a strong and secure level of support for the infrastructure.

Lifts - The patented URETEK 486 polymer material provides exceptional lifting capabilities for restoring sunken or damaged infrastructures, reducing both the time and cost of repair as compared to conventional methods.

Protects - With the URETEK process, your infrastructures are protected from the potential damage caused by execessive vibration.

Minimizes Overburden - The lightweight nature of the URETEK 486 polymer material minimizes additional overburden on soils strata.

Provides Longevity - URETEK USA guarantees the 486 polymer material against shrinkage or deterioration in underground service for a minimum of 10 years.

Is Environmentally Friendly - The URETEK polymer is inert and environmentally neutral.

Case Study #1: The URETEK Deep Injection Process on a Public Sewer System

Customer Profile: A Utility Board in a Major Tennessee Metropolitan Area

Customer Environment: A pavement settlement problem around a sanitary sewer manhole at a busy river front section of the city.

Customer Situation: An abandoned sewer pipe weakened the area presenting a potentially significant traffic problem.

Background: A case involving asphalt settlement in a major metropolitan area of Tennessee was brought to the attention of URETEK USA during June 2001.

The city had overlaid the pavement around a manhole twice before notifying the Utility Board that there may be a problem with the site. Upon investigation by the Utility Board, a broken 8-inch sanitary sewer line entering the manhole at approximately 25-feet from the surface was identified. A miniature camera revealed the pipe was blocked and broken 3-feet outside of the manhole wall. While the brick manhole was structurally sound, it was also quite susceptible to water and soil infiltration through the gaps in the deteriorated mortar joints at random locations along the barrel of the manhole.

The Metropolitan Utility Board contracted with URETEK in July of 2001 to accomplish three tasks that were deemed necessary to solve the manhole problem. First, the soils surrounding the manhole needed to be stabilized. Secondly, the entry of the 8-inch broken pipe into the manhole was to be sealed. Third, the base soils under the pavement were to be void filled and stabilized.

Methodology: The URETEK Deep Injection Process uses a series of injections forming a grid pattern design that provides a precise, uniform, and sequential layout of injection probe placements. In this case, the pattern was determined by the results of penetrometer testing as well as soil information that the Utility Board supplied. The initial penetrometer test was taken approximately 3-feet south of the edge of the manhole. The test revealed a 33-inch void directly under the asphalt pavement. The soils were so weak that the penetrometer rods dropped under their own weight to a depth of 22-feet. This penetrometer test revealed just how extensive and weak the soils strata had become. A potential collapse of the manhole, the possibility of subsequent backup and possible flow of sewage into the adjacent river, the loss of sewer services, as well as delays and interruptions needed for a massive excavation could have cost the Utility Board many times the cost of the URETEK repair.

The soil and structural problems dictated the spacing and depth of the injection pattern. The relative weakness of the soils determined the volume of the resin consumption. As a general rule the weaker the soil, the greater the amount of material that is necessary to achieve an adequate soil densification.

URETEK designed an injection pattern around the manhole starting with the deepest points first, then radiated outward and upward in a shallower pattern to achieve the needed total repair of this pipe and manhole. A diagram of this injection pattern is illustrated in Figure 1, on the next page.

Based on the an analysis of the original area covering both the slow and passing lanes of traffic, a pattern made up of 20 injection points, covering an area of 18-feet by 15-feet was used. This injection plan called for four depths of injections, at 17, 13, 9, and 5 feet respectively.

Various large voids were found up to 5 feet in depth beneath the pavement and were initially filled to support and lift the street to near original profile. The three deeper levels were then injected to fill and densify the weak, unconsolidated, and wet strata encountered around the manhole down to the broken pipe. In addition to the soil densification, URETEK 486 material was also used to seal off and isolate the abandoned 8 inch pipe as well as to penetrate and replace missing mortar in the brick manhole, thereby restoring structural strength to the weakened walls (see Figures 3 and 4 on page 9).

Figure 1 - Injection Grid Diagram Surrounding the Manhole (Top View)

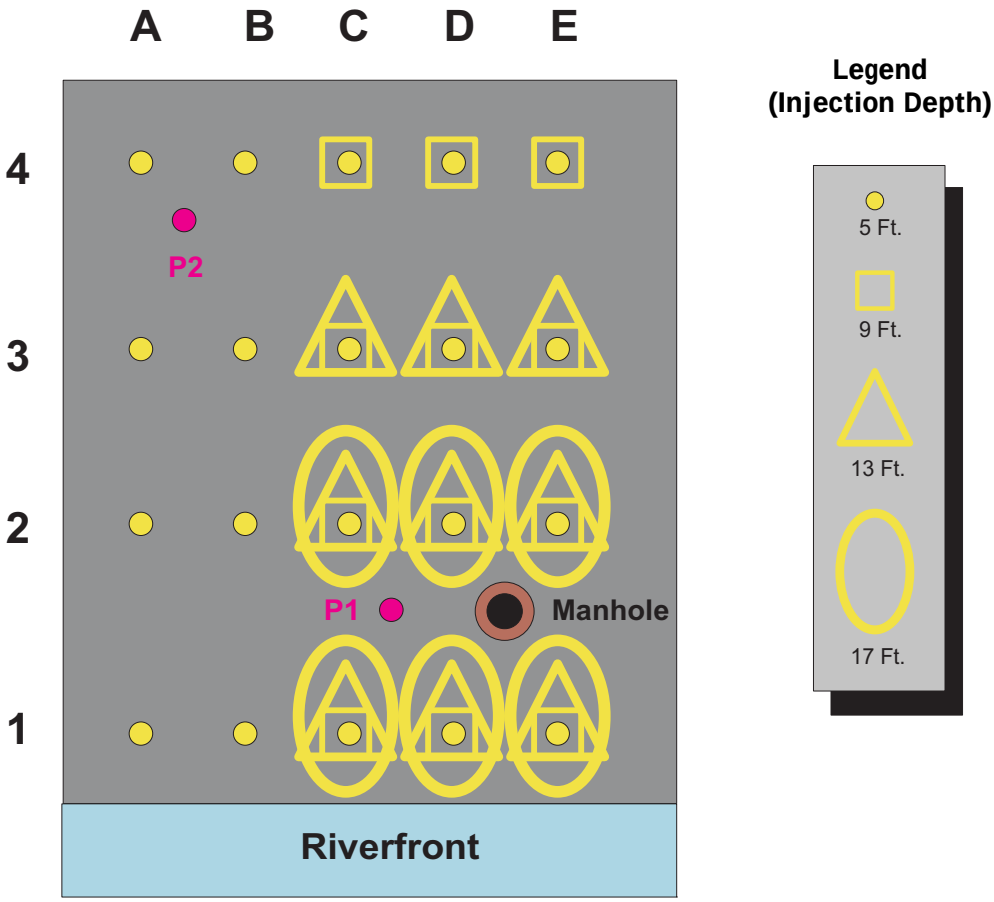
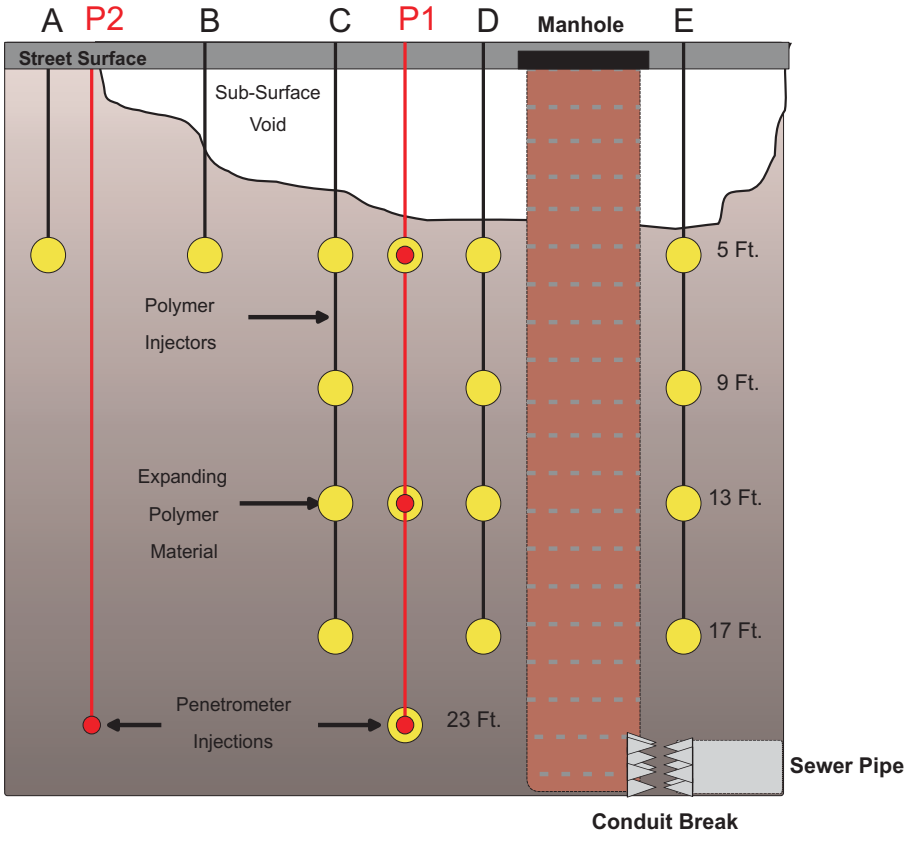


Figure 2 - Depth Diagram of Injections (Side View)



All work performed by URETEK was completed during evening and early morning hours over the course of five nights, allowing the roadway to be used each day during peak traffic periods. As a result, there was little or no traffic flow disruption.

Validation: A post application penetrometer test was completed within 2-feet of the original test location (P1). This test showed a marked improvement in the densification of the soil. In addition, the manhole was sealed against further deterioration, evidenced by polymer penetration throughout the interior mortar joints. Figures 3 and 4 below shows illustrations of the brick wall of the manhole and the inside of the sanitary sewer line after they had been sealed with the URETEK 486 polymer material.

Figure 3 - View Down Manhole after URETEK 486 Injection

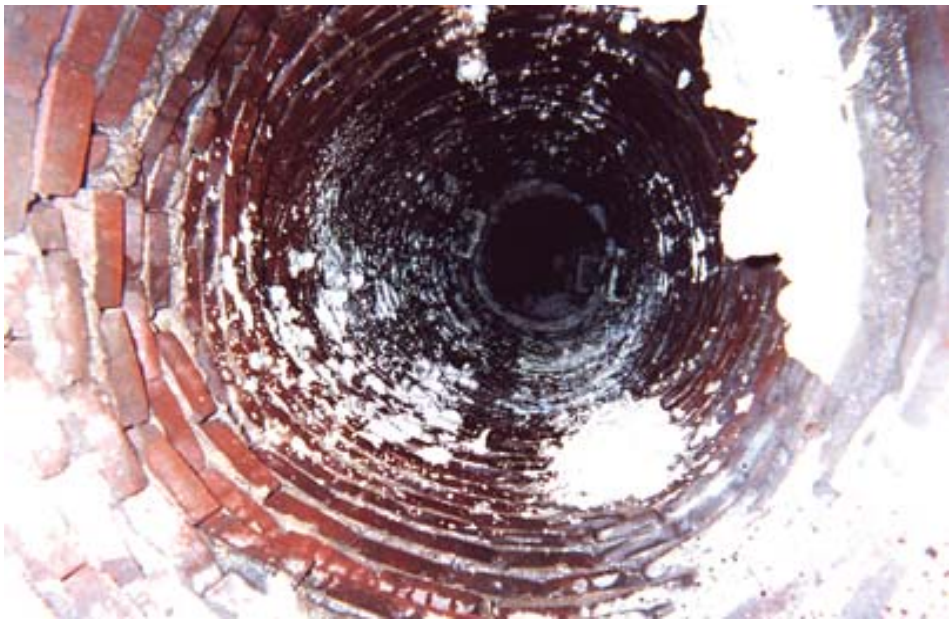


Figure 4 - Sealed 8-inch Sanitary Sewer Line, 25 Feet Below Ground

Case Study #2: The URETEK Deep Injection Process on a Public Culvert

Customer Profile: The Alabama State Department of Transportation (AL DOT).

Customer Environment: A large underground void forms beneath a public culvert under a busy public roadway.

Customer Situation: Soils below the culvert were eroded; Water flowed beneath the culvert compromising the structure and roadway above.

Background: A case involving a ground soil problem with a public 3-barrel culvert underneath a busy divided highway in Alabama was brought to the attention of URETEK USA during August 2002.

After many years, the soil beneath a 3 barrel culvert had washed away to the point where the stream water no longer flowed through the culvert but into a large void. Figure 4 below, illustrates this problem showing the entrance and the exit of this culvert, with water flowing beneath the infrastructure.

Since the two lane roadway above the culvert was heavily traveled, there was growing concern that the culvert and the road above might collapse. The potential for serious traffic danger and disruption as a result of such an event prompted the DOT to take action to resolve the problem.

Total replacement of the culvert was considered. This solution would both exceed the AL DOT budget for the project as well as necessitate a fifty mile traffic detour, creating long term and extensive travel problems for the rural community nearby.

Figure 4 - Water Flowing Underneath a Public Culvert

Culvert Entrance

Culvert Exit

After careful review of possible repair options AL DOT chose URETEK USA to fill the existing voids, and stabilize the existing culvert structure.

Methodology: URETEK applied a uniform injection pattern for the polymer material, ensuring an even disbursement of the material throughout the void area. With the three barrel design of the culvert, URETEK used a multi-point pattern injection spread evenly across each of the three culvert barrels. The two barrels located directly above the deepest section of the void received the most injections, while the third, outer barrel received the remaining injections.

Validation: The injection process began at 8am in the morning and was concluded by 3pm that afternoon. Continuous injection of polymer along the base of the culvert gave visual assurance of filling. The rapid curing time of URETEK's material allowed both traffic lanes of traffic above the culvert to be fully opened to traffic by 4pm. URETEK's rapid resolution to the problem saved AL DOT from having to manage several weeks of detours and disruptions, as well as the additional expenses associated with lane and traffic closure.

Figure 5 - Injecting Polymer Material into one of the 3-Barrels

Figure 6 below shows the repaired infrastructure, with water re-directed and correctly exiting through the culvert.

Figure 6 - Water Correctly Exiting Through the Repaired Culvert

URETEK USA puts customers in control of their infrastructure revitalization, pavement lifting and soil stabilization problems by reducing the repair cost, time, and disruption through proprietary, safe, predictable products, people, and methods. Since 1989, with over 75,000 successful worldwide jobs, URETEK focuses on resolving complex concrete lifting and soil stabilization projects.

For more information about URETEK and the URETEK Deep Injection Method for Infrastructures, please visit our website at **www.worldofuretek.com** or call 1-888-287-3835.

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