Greensboro’s Pilot Program for Water Pipe Bursting Leads to Expanded City Wide Program

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Abstract

The City of Greensboro Water Resources Department, Greensboro, NC, had been contracting with a local contractor for several years to pipe burst deteriorated gravity sewer lines with pneumatic equipment. During this same period, the utility had been upgrading miles of old 4-inch cast iron water distribution lines by traditional open cut replacement. The ability of static pipe bursting machines to install multiple product pipe options presented the utility with an opportunity to move into water main pipe bursting in lieu of open cut replacement. This case study highlights the pilot program project that includes 1200 feet of 4-inch cast iron, burst and replaced with 6-inch Fusible PVC™ in the Allendale neighborhood.

In addition, the project called for the installation of 4-inch fusible PVC pipe through directional drilling along Wendover Avenue to enable the transfer of services from the existing location under the roadway and allow for the pipe bursting of a 12-inch cast iron water transmission line. The 12-inch line was replaced with restrained joint ductile iron pipe. As a result of this pilot project, the Greensboro City Council approved the Water Resources Department budget for FY 2009/10, which included a major expansion of the City’s rehabilitation program to include pipe bursting of substandard waterlines. Additional water pipe materials and diameters are also being considered for bursting.

This project demonstrates a high level of cooperation between the water utility, pipe manufacturer and trenchless equipment manufacturer to develop a municipal pipe bursting program. It serves as a model for other utilities in terms of an approach to developing achievable solutions to rehabilitation and replacement projects.

Background

The City of Greensboro is located in central North Carolina and is the third largest city in the state. The City operates and maintains a water distribution system of over 1,200 miles with lines ranging in size from 2-inch to 36-inch pipe. Historically, the City standard has been to use ductile iron pipe or cast iron pipe. There is very little PVC pipe in the City’s water distribution system.

As with most water systems, much of the City of Greensboro’s water system is more than 80 years old, having been constructed from the early 1900's and forward. Additionally, much of the older water system is located in congested, high traffic areas such as downtown and major thoroughfares. Because the majority of the system is ductile and cast iron, the City has relied on traditional methods of water line replacement, which in these congested areas becomes problematic and inconvenient.

With this in mind, the Greensboro Water Resources Department decided to explore other options for water line replacement/rehabilitation. Slip lining and cured in-place pipe (CIPP) were considered, but pipe bursting rose as the most viable and cost effective alternative to traditional dig and replace construction.
Characteristics of hydraulic (static) system pipe bursting include:

- Static Pull System, No pneumatics
- Hydraulically Operated
- Brute Force Pulling
- Roller Cutters for non-fracturable pipe
- Quick Lock Bursting Rods
- Requires two excavations
- No vibration
- Ability to split both fracturable and non-fracturable
- Ability to replace with HDPE, fusible PVC (FPVC), or other restrained joint pipe.

Case Study #1

The first demonstration of pipe bursting was a small water line replacement project in an affluent residential area. A 1,200-foot 4-inch cast iron water main was to be replaced with 6-inch fusible PVC pipe. Several factors made this location the ideal pilot project to demonstrate the comparison of traditional dig and replacement to pipe bursting. These include:

- Low Traffic
- Minimal Number of Service Connections
- A Nearby Park to Stage Construction
- Smaller Diameter Pipe
- Relatively Short Length to Replacement.

Prior to beginning the project, a temporary lock joint potable water line was installed to provide uninterrupted water service free of charge to the customers for the duration of the project. Water for this temporary line was provided from a nearby hydrant that was connected to a different source point.

The City chose to replace the existing cast iron pipe with fusible PVC pipe as an alternative to HDPE pipe.

The fusible PVC pipe offers more control in the heating, fusing and cooling cycles of prepping the pipe for installation and, giving a greater degree of confidence in the product.

Other advantages of fusible PVC pipe include:

- Provides a monolithic, fully restrained, gasket free, leak-free piping system
- High tensile strength (ASTM D638) of the fused joint (up to 7000 psi) allows for higher safe pulling stresses and consequently longer trenchless pull-in lengths
- Reduced wall thickness for given pressure requirement translates into highest flow per outer diameter dimension
- Superior stiffness compared to other plastic pipe which limits long term deformation under soil load
- PVC material properties have low time dependencies - the properties do not change over time - i.e. no pull-in relaxation period
- Standard waterworks fittings are used to tap, connect and change direction, eliminating the use of expensive transition fittings or fused-on fittings
- Resistance to hydrocarbon permeation is better than other thermoplastic pipe systems
- More resistant to water disinfectant induced oxidation than other thermoplastic pipe systems.
Figure 1 is a sample of fusible PVC pipe.

Figure 1. Sample of FPVC Pipe

The pipe manufacturer generally provides fusing services as a part of supplying their product and for this installation, they were subcontracted to perform the work. However, as an additional part of the project, the company trained and certified the City’s contractor on the project, KRG Utility, Inc. KRG Utility, Inc. is now one of four utility contractors in the southeast certified to fuse PVC pipe.

For this small project, the equipment used was the GrundoBurst 800G which provides over 160,000 pounds of pull.

Figure 2 shows the exit trench wall. Without the reinforcement shown, the force during bursting would pull the cage into the bank of the trench.

Figure 2. Receiving Pit Wall
To prepare for pipe installation, quick-lock bursting rods are inserted into the existing pipe by running the machine in reverse (See Figure 3).

![Figure 3. Rod Installation in Receiving Pit](image)

At the entrance pit, the new pipe is fitted with a pulling head which is then attached to the rod system with a swivel and splitter.

Figure 4 also shows the pipe resting on rollers to keep from abrading the pipe during installation.

![Figure 4. Pipe Rollers @ Splitter](image)

As the machine pulls the new pipe into the existing pipe, the cutter slices the existing pipe and it is pushed out of the path of the new pipe. Even though the GrundoBurst 800G has the capability of pulling though existing valves, for this installation it was decided that all the 1920-era valves would be replaced so they were removed prior to installation.
Figure 5 shows a demonstration section of ductile iron that has been cut. In reality, the pipe is cut on the bottom so that the old pipe is pushed up and away and not under the new pipe where it could abrade the pipe over time.

![Figure 5. Cutter Assembly](image)

Figure 5. Cutter Assembly

Figure 6 shows the new PVC pipe emerging into the exit pit.

![Figure 6. New Pipe in Receiving Pit](image)

Figure 6. New Pipe in Receiving Pit

From this point, the new pipe installation becomes “routine”. The line is chlorinated, services are installed and the line is prepped for potable use.

This pilot project demonstrated many benefits to the City in favor of pipe bursting including a shorter construction time and less disturbance to the existing conditions. In this case, the existing waterline was located underneath the street.

With conventional dig and replacement, there would have been considerable asphalt removal and replacement, adding cost and time to the overall construction.

All of these factors would soon be put to the test in what could have been a catastrophic event for the City.
Hole Swallows Car: Film at 11

Every city has at least one road “bad traffic area”, where the slightest hiccup brings everything to a screeching halt. Utility departments dread the thought of routine maintenance, much less emergency repairs, in these areas because of high traffic, difficult surroundings, safety concerns, and the inevitable citizen complaints. Wendover Avenue is such an area for the City of Greensboro.

When the call came from the police department that there was a giant hole in Wendover Avenue, the Department of Water Resources was quickly on the scene. Luckily, the person who drove into the hole was not injured.

Figure 7 shows the magnitude of the failure. What this image does not show is how quickly the failure occurred. To give an idea of how quickly the hole manifested, a police officer had just driven over this spot and felt a “bump”. Before he could turn around and investigate, the roadway had collapsed and “eaten a Honda”.

![Figure 7. Sink Hole Containing Car](image)

Figure 8 shows the culprit. The 12-inch cast iron pipe installed in 1929 fractured, causing the dramatic failure. After dealing with the immediate emergency of the failed section, the Department of Water Resources chose to investigate using pipe bursting to replace the pipe. The success of the project was extremely important with all eyes, from City elected officials to news crews, reporting constantly of progress and inconveniences. What would have been a high-profile project based solely on location became even more sensitive.

The initial capital improvement project included replacing approximately 3,000 feet of 12-inch water line. For the dig and replacement project, the cost was estimated to be over $1.3 million dollars. This included 3,000 feet of 3-lane overlay on Wendover Avenue required by NC Department of Transportation because of the number of cuts required for the installation.
To avoid the cost and disruption of the asphalt overlay, the City chose to install 1,400 feet of 4-inch fusible PVC via directional drill as a by-pass water line to serve the houses and businesses along the route (See Figure 9). This was the first water main line installed using directional drilling by the City of Greensboro.

Many benefits were apparent from installing this service line; not only during construction, but also long-term including:

- Ability to avoid all utilities during drilling
- Minimal interruption in service to homes and businesses
- No temporary water line needed to serve customers during construction
- All services moved out of pavement and heavy traffic.
The Main Event

With the new 4-inch service line in place, the replacement of the 1920's-era water line could begin. The project included replacing 3,000-feet of 12-inch cast iron pipe with 12-inch ductile iron pipe. As stated before, the initial estimate for dig and replacement of the water line was $1.3 million with an estimated construction time of six months.

The equipment used for this larger project was a GrundoBurst 1250G which provides over 250,000 pounds of pull (See Figure 10).

![Installing Pulling Rods in Receiving Pit](image)

Figure 10. Installing Pulling Rods in Receiving Pit

Construction crews worked 12 hour day and night shifts from Friday evening through Tuesday morning to avoid heavy traffic congestion (See Figure 11).

![Traffic Congestion](image)

Figure 11. Traffic Congestion

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For this application TR Flex Ductile Iron pipe was used. This particular ductile iron pipe is ideal for trenchless technologies because of its joint strength and the fact that no special pulling head is needed. The bell of the pipe fits into the pipe bursting machine's expander head and is secured inside the bell by the pulling rod cone. The joints of the pipe are locked together by metal retainer clips which lock the bell against the bead on the mate pipe (See Figure 12).

All tees and crosses were excavated in order to cut all side connections to insure the intersected 6-inch lines were not damaged during construction (See Figure 13).

Figure 14 shows one of the tees after the new pipe has passed through. After the pipe bursting was complete, the
new pipe was cut and new tees and crosses were connected. Additionally, main line valves were installed throughout the project. Once the installation was complete, pressure testing and disinfection was completed as with standard water line construction.

NC Department of Transportation required that the installation pits were filled with flowable concrete. The initial material estimate was 75 cubic yards of concrete for the entire project. However, when backfilling the first pit, the crew used 75 cubic yards for the one pit. From that point, crews filled the remaining pits half with stone, then with flowable concrete.

Construction crews worked 24 hours a day in 12-hour shifts from Friday evening until Tuesday morning to complete the work.

Conclusion

The pilot project and the Wendover Avenue pipe bursting project both proved that pipe bursting is not only a viable alternative for water line replacement for the City of Greensboro, it is also highly beneficial.

1. Traditional dig and replace construction was estimated to cost at least $1.3 million for the Wendover project. In reality, the pipe bursting project cost was $770,000, a savings of approximately $500,000.
2. Traditional dig and replace construction had an estimated construction schedule of 6 months. The pipe bursting project was completed over three 4-day weekends, working 24 hours each day in 12-hour shifts.
3. Construction was completed without causing massive delays on Greensboro's busiest thoroughfare and without a single public complaint.
4. The use of fusible PVC and ductile iron for pipe bursting was highly effective.

References
