



**North American Society for Trenchless Technology (NASTT)  
NASTT's 2019 No-Dig Show**



**Chicago, Illinois  
March 17-20, 2019**

**WM-T4-02**

**Do It Yourself Water Main Pipe Bursting**

Russell G. Colbath, PE, City of Monroe, Monroe, North Carolina

**1. ABSTRACT**

The City of Monroe (city), a full-service municipality adjacent to Charlotte, North Carolina, was challenged to address its aging water distribution system infrastructure while maintaining affordable rates to its 35,000 citizens. Monroe's water distribution system had over 1.5 million feet of water main, 16 percent of which was aging cast iron and steel pipe material, some dating to the 1920s.

Water Resources Department staff performed a gap analysis and developed a business plan to accelerate water main replacements, with a goal of doubling annual replacement footage. After evaluating multiple options, self-performed pipe bursting was selected as the preferred alternative to supplement existing program approaches. The program had the lowest cost, minimized the need for additional staffing, and met the city's desire to use a trenchless approach and mitigate neighborhood disruption during construction. The business plan and associated budget requests were presented to the City Council, resulting in approved funding of \$565,000 to purchase the necessary equipment to initiate the program.

The city's water main pipe bursting program is now entering its fourth year and has replaced over 28,000 feet of aging mains. The city is the only municipality in North Carolina to self-perform static water main pipe bursting. The internal design-build process has generated efficient, flexible, and cost-effective results. Having static pipe bursting as an additional resource in the city's toolbox has allowed Monroe to approach a level of sustainability in water distribution asset management. Details of the program's successes and challenges, along with project-specific case studies, will be presented within this paper.

**2. INTRODUCTION**

The City of Monroe Water Resources Department faces challenges similar to many water utilities in the United States and worldwide. These include aging infrastructure, limited resources, maintaining affordability and providing reasonable utility rates to customers. All this while navigating political climates and elected official acceptance. The 2012 American Water Works Report titled "Buried No Longer", Confronting America's Water Infrastructure Challenge, brought home this pressing issue and was a call to action for all water utilities to develop plans for asset management strategies and water distribution system sustainability.

The city began its water main replacement program in 2006. Early efforts involved one to two crews using dig and replace methods to replace problematic water main segments. Crew size was typically three persons for most projects. These crews committed approximately 75% of their time to the water main replacement program. Engineering designs were completed by internal engineering staff with some supplementation by consulting engineers. Figure 1 shows the total annual water main replacement footage for 2006 to 2014.

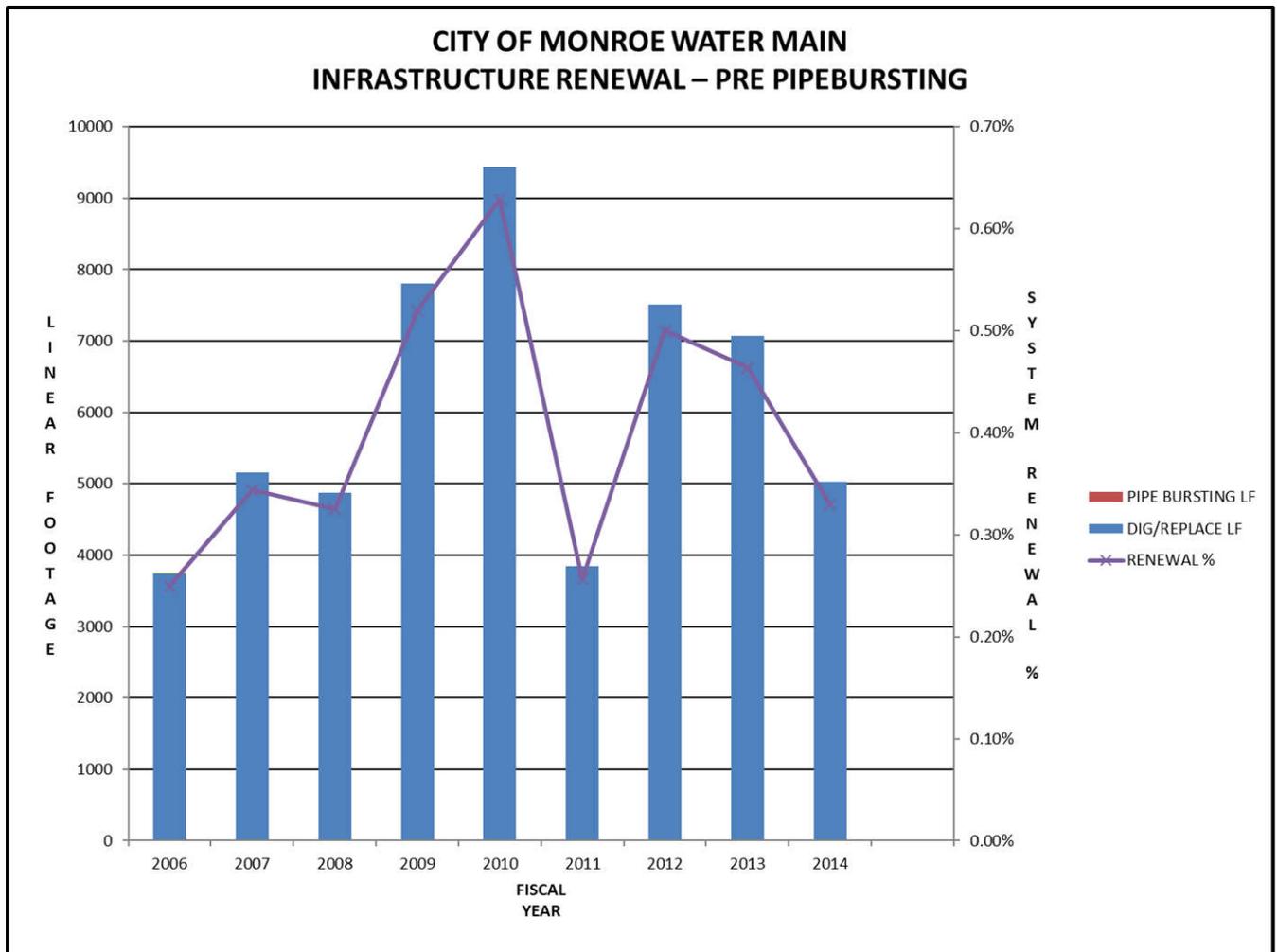


Figure 1. City of Monroe Annual Water Main Replacement Footage, 2006-2014. Pre-Pipe Bursting.

### 3. ACTION PLAN

As part of the Fiscal Year 2014 budget process, Monroe’s Water Resources Department performed a gap analysis of the water main replacement program. Considerable efforts had been made to improve the water distribution GIS, and this provided a useful tool to analyze system age, pipe materials, water main break history and total linear footage of assets. The Gap analysis considered asset useful life, current annual replacement rates, and current funding levels. It was clear from the onset that the city was only replacing 0.5% of its water distribution assets each year, meaning that each pipe segment would need to have a service life of 200 years to maintain a sustainable system. The need for action was clear.

A business proposal was presented to the City Council with the FY2014 budget. Highlights of the proposal are shown below. The plan was unanimously approved.

- 10-Year plan, goal to gradually increase system replacements to 1% annually. Aging cast iron water mains were a priority for replacement based on cold weather water main break history.
- Size on size main replacement via trenchless pipe bursting to supplement dig and replace efforts.
- No new staff were to be hired. The strategy was to re-focus existing construction staff to increase commitment to water main replacements and pipe bursting to greater than 90% of work time. Water main repair crews would be re-purposed to perform new tap installations that had been historically installed by construction crews. This would be possible given anticipated reduction in water main breaks.

- Capital budget of \$565,000 for new pipe bursting and support equipment.
- Increased annual operating budget by \$200,000 for added material purchases and pavement restoration.

#### 4. LEARN FROM THE PROS

As the pipe bursting proposal was rolled out to Water Resources construction division personnel, there was natural apprehension. Staff was accustomed to the dig and replace project methodology for water main replacement and were not sure about leaving this comfort zone. There would be new and unusual equipment, fusing certifications, a faster paced work schedule, and new performance expectations. Engineering staff would also have to change the way construction drawings were prepared, learn new design techniques, and also embrace a faster work pace.

To alleviate these concerns Water Resources Department personnel attended several pipe bursting demonstration projects in the City of Charlotte, NC, and spent time with the City of Greensboro, NC, and their pipe bursting contractor, KRG Inc. Interviews were conducted with contractors from Florida, Michigan, Oklahoma, and Montana to discuss success factors and identify equipment that would make the pipe bursting program successful. Staff began to discover that there was a logical and systematic process to successfully using pipe bursting for water main replacement.

The final step in preparing to initiate the city’s pipe bursting program was a road trip to Lakewood, Colorado to observe the Consolidated Mutual Water Company and their program. Consolidated had an impressive self-performing water main pipe bursting program that was highlighted at the American Water Works Associations ACE 2012 Conference. Learning from Consolidated allowed city staff to finalize their equipment purchasing strategies, refine engineering design standards and approaches, and more fully understand the systematic approach needed to carry out a fast-paced water main pipe bursting program.

#### 5. READY, SET, GO LIVE

There were a number of actions needed to prepare for the first pipe bursting project. Procurement was initiated on the following items, with budget amounts shown.

✓ Pipe Busting System (Formal Bid)	\$420,000
✓ Fusing Equipment	\$ 45,000
✓ Asphalt Milling Attachment	\$ 25,000
✓ Specialty Trailers	\$ 20,000
✓ Above Ground Temporary Water Main System w/ Ramps & Accessories	\$ 20,000
✓ Trench Box/Shoring	\$ 15,000
✓ Traffic Control Equipment	\$ 5,000
✓ Contingency	<u>\$ 15,000</u>
<b>Total</b>	<b>\$565,000</b>

The static pipe bursting system selected was the Grundo-burst 800G by TT Technologies. After discussion with contractors and other municipalities, fusible polyvinyl chloride pipe (FPVCP), SDR-18 was selected as the pipe material for use in the new program. A McElroy 412 fusion machine capable of fusing 6 and 8-inch FPVCP was purchased. Initially, three crew members were sent to fusion certification school as required by the pipe supplier. Underground Solutions (UGS) Inc. also required the City to enter into a contractor agreement to utilize the FPVCP product in the program. The city was the first municipality in North Carolina to become a licensed pipe bursting contractor using FPVCP.

The city’s engineering design staff embraced the concepts learned from other systems to keep the construction drawings simplified. GIS base sheets were used to avoid registered field surveys. Many logistics were purposefully

left to be identified in field such as temporary water main sources, insertion and pull pit locations, etc., rather than being shown on the drawings. Because this was an internal design/build process using city engineers and city crews, conflicts and problems encountered during construction could be addressed by engineering field directives, with no time-consuming contracts or change orders. The city also has delegated permitting authority from the North Carolina Department of Environmental Quality, allowing streamlined issuance of any required pipe bursting permits. Permits were only required if the water main was being upsized (a change in capacity). Size on size pipe bursting of mains was considered “maintenance”, requiring no regulatory permit.

The pipe bursting program went live with an initial trial project in a residential area. The area selected, Benton Street, was served by a 1950s vintage 6-inch cast iron water main with a history of breaks. The city was able to secure a personal services contract with one of the water superintendents from Consolidated Mutual Water Company, who provided a full week of hands-on training to supplement the training provided by equipment suppliers. The success of the pipe bursting approach, and its future potential, was immediately apparent. Table 1 shows the balance of the 2014 projects and their results after completion of the Benton street trial project. The combination of the cost efficiency, the speed of the project schedules, the reduced landscape and pavement restoration requirements, and the general public acceptance, made pipe bursting believers of city personnel.

Table 1. City of Monroe Water Main Pipe Bursting Program Results, FY 2014.

Project #	Project Location/Name	Pipe Diameter	Length	Services	Days	Cost/LF*
14-11	Benton Street (Concord to Old Charlotte)	6	1,080	22	21	\$60.55
14-12	McIntyre Street (Walkup to Steele Street)	6	1,180	19	17	\$49.24
14-13	McIntyre / Polk Street (Steele to Jones)	6	1,080	18	21	\$54.17
14-15	Jones Street (Polk to Steele)	6	940	11	24	\$65.05
14-16	Jones Street (Steele to Walkup)	6	560	7	13	\$75.88
14-17	Steele Street (Jones to Turner)	6	1,200	20	27	\$55.19
14-18	Ashcraft and McIntyre	8	2,300	21	23	\$51.92
<b>Total</b>			<b>8,340</b>	<b>118</b>	<b>146</b>	<b>Weighted Average: \$56.17</b>

\*Cost includes labor with 1.4 overhead factor, materials, equipment, and restoration.

## 6. PROGRAM STATUS AND RESULTS

The City of Monroe Water Resources Department has spent the past four years refining their water main replacement program and the role that pipe bursting plays in managing the water distribution system assets. It was logical to select street segments in the early stages of the program that were less difficult to pipeburst, the “low hanging fruit” so to speak. As the city’s experience grew, more difficult project areas were selected and addressed with pipe bursting technology. Dig and replace strategies continue to play an important role since some water mains are not appropriate pipe bursting candidates based on the city’s equipment and capabilities (2-inch steel water mains for example). Figure 2 shows the updated results for the city’s overall water main replacement program. The average annual footage of water mains replaced for the past four-year period has increased by an impressive 102% compared with 2006-2014.

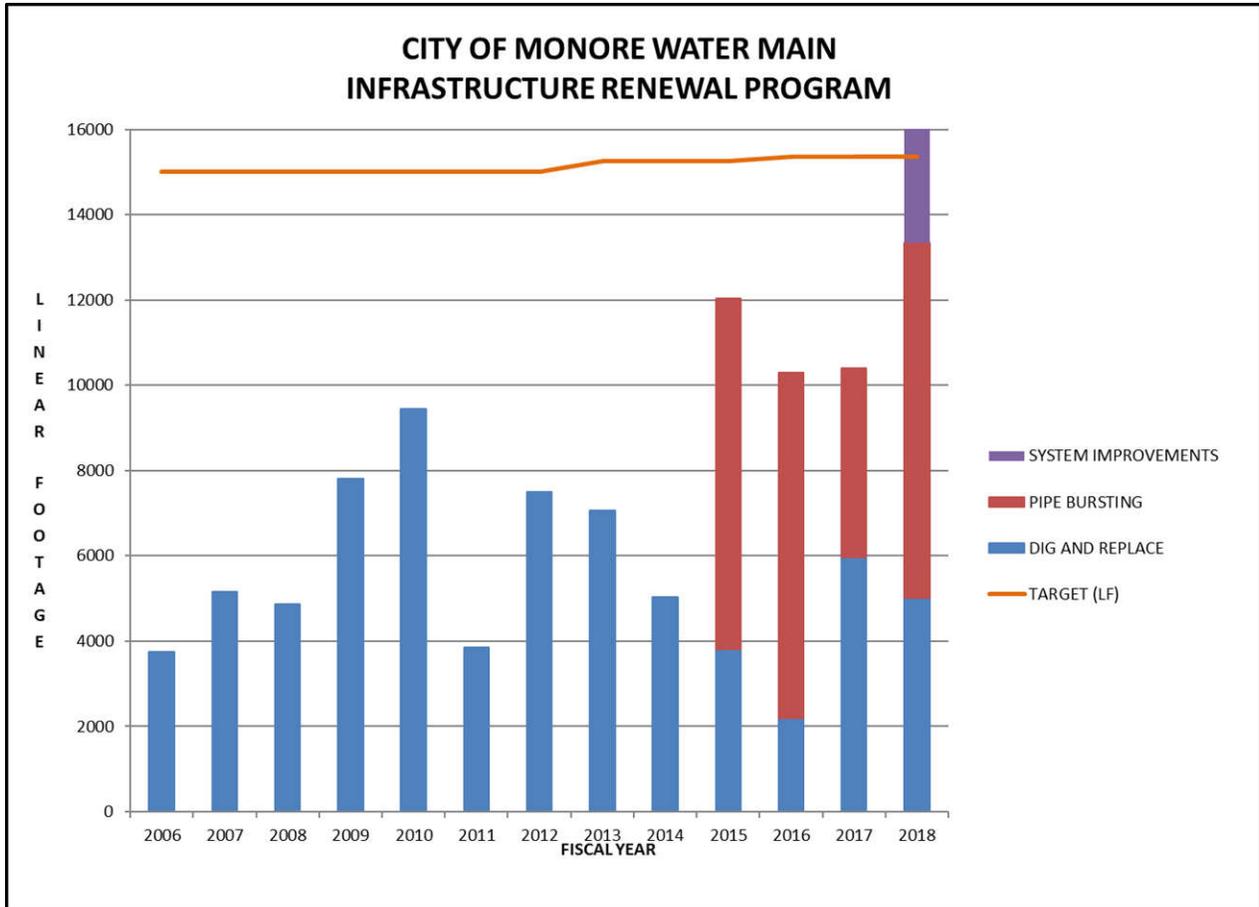


Figure 2. City of Monroe Annual Water Main Replacement Footage, 2006-2018.

For every pipe bursting project the city completes, a detailed cost analysis is performed to examine labor, equipment, materials, and restoration costs. An example project cost summary sheet is shown in Table 2. Results from 2015-2018 pipe bursting projects show installation costs ranging from \$52.48 to \$125.24 per linear feet (LF), with a weighted average of \$76.35 per LF. The primary variable leading to the upper cost range is pavement restoration for water main located under paved surfaces.

Table 2. City of Monroe Water Main Pipe Bursting Program, Example Cost Summary Sheet

Project Summary Sheet			
Project Name: 17-08 Walnut Street			
Crew Leader - Hobbs			
Location: Walnut (Concord to Warren)			
Date Submitted: 1-3-18			
<b>Labor</b>			
Date Project Start	9/7/2017		<b>Total Project Cost</b>
Date Project End	11/2/2017	Labor	\$32,579.32
Total Work Days on Project	35	Materials	\$34,908.30
Total Man Hours on Project	1,314	Equipment	\$23,473.75
Average Labor Cost per Hour (Crew Specific)	\$17.71		
Overhead factor	1.4	Total	\$90,961.37
		Total LF	1183
		LF/Day	33.8
		\$/LF	\$76.89
	Total Labor Cost		\$32,579.32

## 7. LESSONS LEARNED AND KEYS TO SUCCESS

Much has been learned during the past four years by Monroe’s Water Resources Department staff using water main pipe bursting. Perhaps the biggest development is that the uncertainty and reservations originally felt by staff have been replaced with confidence and satisfaction. Up-front planning and research paid off in making the program implementation smooth and efficient. For the city, pipe bursting is here to stay as a tool for meeting long term water main replacement goals. Other items the city would share with municipalities considering starting a pipe bursting program include:

- ✓ Just because pipe bursting is “trenchless”, it still takes hard work and dedication to make it successful. There are buried unknowns in most systems, be flexible and adaptive!
- ✓ Hiring and retaining quality staff is essential. An internal design/build approach is fast, efficient, and cost effective. No more negotiating consultant contracts, issuing construction bids, managing contracts, or hassling with change orders.
- ✓ Spend a little extra budget on specialty equipment to enhance field operations. Your staff will appreciate it.
- ✓ Use a resource allocation matrix to assign and track performance of crews and staff. Set goals and review with staff often.
- ✓ Look for quality shortcuts to improve efficiency. Bacteriological test results can be expedited using laboratory certifications such as Colilert – 18. This method is approved by the United States Environmental Protection Agency (USEPA) and simultaneously detects both total coliforms and *Escherichia coli* in water, giving you results in 18 hours. In many cases a full day can be gained for samples taken by early afternoon that provide results by the next morning to allow service tie-overs to new mains. This compared to 24-hour testing methods.
- ✓ Customers appreciate shorter construction windows and less disruptions and restoration activities. Share your innovations with customers to gain their support.
- ✓ A hybrid approach (pipe bursting and dig and replace) provides many benefits. Non-pipe bursting water main candidates can be done during winter season when above ground (temporary) water mains used for pipe bursting can be problematic.
- ✓ Original concerns for soil and surface heaving have not materialized, particularly given the size on size pipe replacement strategy.
- ✓ Be aware of the “dental floss effect”, where pipe burst mains several hundred feet in length can be moved horizontally underground for hours after installation. This allows pipe to be adjusted in pits, inserted into fittings, and aligned as needed, thereby saving time, money, and sometimes expensive couplings. Soil conditions are a factor in how successful this technique works. Our experience in clay and clay-loam soils in the city has shown this to be feasible in all pipe burst installations.

## **8. CONCLUSION**

The City of Monroe Water Resources Department has effectively integrated water main pipe bursting into their overall water distribution system assets management program. An internal design-build process has been refined to generate efficient, flexible, and cost-effective results. With hard work, effective planning, and quality staff, a self-performing water main pipe bursting program can be a reality for small and mid-sized water utilities that may lack some of the resources enjoyed by larger system as they tackle their long-term infrastructure challenges.

## **9. REFERENCES**

Bennett, D., Ariaratnam, S. and Wallin, K. (2011) – Pipe Bursting Good Practices Guidelines, North American Society for Trenchless Technology (NASTT), Second Edition, 2011, USA

AWWA (2012): Buried No Longer: Confronting America's Water Infrastructure Challenge. American Water Works Association, Denver CO. <https://www.awwa.org>