CITY OF BILLINGS, MONT. USES PIPE BURSTING TO BROADEN ITS ASSET MANAGEMENT TOOLBOX

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ABSTRACT: The City of Billings became familiar with pipe bursting as a water main replacement method and they were impressed with the viability of the application. They also saw much more work that could be done using the method, so they decided to bring pipe bursting within the technical envelope of their own crews and O&M capability.

They started by purchasing HammerHead® pipe bursting equipment and McElroy™ fusion machines to save money by having City crews perform work normally subcontracted to outside specialty contractors. The original intent of the program was to fuse HDPE pipe and install it via static bursting. After several pipe burst installations, the City decided to try a pilot project with Fusible PVC™ pipe. As part of its on-going asset management plan, the City of Billings recently designated an 8” Cast Iron (CI) water pipe on 3rd Avenue North near North 10th Street for replacement due to extensive deterioration. The City elected to pipe burst the existing line and upsize to 12” with Fusible PVC pipe.

The City decided to give Fusible PVC a try because it already utilizes bell-and-spigot PVC pipe throughout its system, already stocks standard fittings, and has crews familiar with tapping and working with PVC pipe. Among other factors, the difficulty of a pipe burst project relates directly to the increase in size (upsizing) of the new replacement pipe relative to the existing pipe.

The City of Billings believes in trenchless technology and pipe bursting, and believes that it is another tool that they can use to be more cost efficient, less intrusive to their constituents, and provide a greater level of service to their customers. This paper will review the City of Billings’ experiences with their burgeoning pipe bursting program and pipeline materials specific to its use.

1. INTRODUCTION

The City of Billings is located on the Yellowstone River in Montana and serves as the regional center for an approximate 500 mile radius around the area. The City of Billings Public Works provides a full complement of services to the citizens of Billings, including potable water, sanitary sewer, solid waste management, streets, and storm water. The City of Billings maintains approximately 441 miles of water mains, 444 miles of sanitary sewers, and approximately 145 miles of storm drainage piping.
Potable water is sourced from the Yellowstone River, which flows through the community and where waters eventually will end up in the Mississippi River and the Gulf of Mexico. Currently, the City of Billings Public Works is capable of treating about 60 million gallons per day, and provides water to its customers through a major ‘workhorse’ pump station at the treatment facility and a network of booster stations and storage throughout the system.

The City of Billings Public Works, Distribution and Collection Division (BDCD) oversees the repair, maintenance, and limited construction of the city’s water distribution system. The potable water distribution system serves approximately 29,000 service connections and a general schematic of the service area is shown in Figure 1.

![Figure 1. BDCD’s Schematic of the Potable Water Distribution Service Area.](image)

The BDCD also oversees the repair, maintenance, and limited construction of the city’s sanitary sewer collection lines. The sanitary sewer collection system serves approximately 31,900 wastewater customers and a general schematic of the service area is shown in Figure 2.
Figure 2. BDCD’s Schematic of the Sanitary Sewer Collection Service Area.

The City of Billings, like all major utility providers, is challenged with a diverse, aging network of water distribution and sewer collection infrastructure. There is a constant and consistent need for improved and updated piping and appurtenances throughout the two systems, with the most pronounced need present in the water system.

In 1885, a private water company provided water to a portion of the city of Billings and in 1915; the City of Billings purchased that private water company. In 1917, the City of Billings started their first replacement program for defective and undersized water mains in order to bring the new portion of the distribution network into the overall system. In 1979, a formal annual replacement program started for the water and sanitary sewer networks. At that time, the highest number of annual water main breaks was 263 total incidents. Today, water main incidents are down to approximately 50 to 60 breaks a year.

The City and the BDCD is somewhat unique in that it self-performs a very large portion of its routine and maintenance-based utility construction in-house. This includes all emergency repair work, but also includes dig-and-replace programs, rehabilitation programs, and under limited scope, new utility installations. It truly covers all activities short of large scope, new utility installations and larger diameter pipeline installation. As such, the BDCD keeps a keen eye on the impact that it has on the constituency and customers it serves in Billings with its activities. It also monitors the dollars that it spends on such programs and compares them to the amount of work that is able to be completed on the system. It is this fact that actually led the City of Billings and the BDCD to investigate, perform a trial run, and eventually initiate a program using various trenchless technologies, but really focusing on pipe bursting applications for their potable water distribution system. Much of the original piping is cast iron and while it has performed well for the City, it is reaching the end of its useful life. The pipe still performs well as a conduit, but is increasingly recognized as undersized and under capacity for the current needs of the City. One major area of focus in this regard is the ability to provide adequate flow for fire protection in the relatively older sections of the system.
2. THE USE OF TRENCHLESS TECHNOLOGY

The City of Billings Public Works Department has experimented with several forms of trenchless installation over the years. This included the use of horizontal directional drilling (HDD) methodology, sliplining techniques, and bursting. The potential benefits and drawbacks of each method for BDCD became apparent as they experimented with them. Table 1 highlights the chronology of the use of trenchless technology by the BDCD over the years:

Table 1. The City of Billings Historical Use of Trenchless Technologies

<table>
<thead>
<tr>
<th>YEAR</th>
<th>BDCD HISTORICAL TRENCHLESS PROJECTS</th>
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<tbody>
<tr>
<td>1990</td>
<td>• Slipline -Sanitary Sewer rehabilitation project</td>
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<tr>
<td>1995</td>
<td>• Slipline – (fold and form product) – Various replacement projects</td>
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<tr>
<td>2002</td>
<td>• Horizontal Directional Drill - Potable water – Yelomine™ (CertainTeed Certa-Lok™ restrained joint product)</td>
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<tr>
<td>2005</td>
<td>• Pipe Bursting – Sanitary Sewer - Virginia Lane</td>
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</tbody>
</table>
| 2006 | • Pipe Bursting – Potable Water - Pryor Avenue – with HDPE pipe  
• Pipe Bursting – Sanitary Sewer - Daniels Street – with HDPE pipe |
| 2007 | • Slipline – Storm Drain - 20-inch in a 24-inch - with HDPE pipe |
| 2008 | • Pipe Bursting – Sanitary Sewer - 11th Street West – with HDPE pipe  
• Pipe Bursting – Potable Water - Monad Road – with PVC restrained joint – 6” to 8” upsize  
• Pipe Bursting – Potable Water - 1000 Block of 2nd Avenue North – with HDPE pipe – 6” to 8” upsize  
• Pipe Bursting – Potable Water - 1000 Block of 3rd Avenue North – with Fusible PVC™ pipe – 8” to 12” upsize |
| 2009 | • Pipe Bursting – Sanitary Sewer - Burlington Northern Subdivision area – with HDPE pipe  
• Pipe Bursting – Potable Water - South 33rd Street – with Fusible PVC™ pipe – 4” to 8” upsize |

The BDCD had success with HDD methodology and are open to using it again in the future. However, they see it as a new construction benefit, mostly. The big advantage for HDD is the ability to construct infrastructure across obstacles that previously could not be crossed, such as the river crossing that they completed, or that are extremely disadvantageous to cross with conventional means, such as a major highway. Within the activities of the BDCD, HDD does not provide a useful tool for operational or maintenance benefit after the construction of the line is complete.

The BDCD also used sliplining techniques effectively for certain sanitary and storm sewer rehabilitation projects. They like the use of the existing utility alignment and the fact that excavation was kept to a minimum, which limited the amount of negative impact associated with utility conflicts, hits, and disturbance to their customers. The major drawback to sliplining, however, is that the new pipeline by nature needs to be smaller than the existing line, and while the flow characteristics of the new line may make up for some of the hydraulic capacity lost in this tradeoff, downsizing pipelines was not the way that they wanted to rehabilitate their system on a macro level.

Pipe bursting offered the BDCD the best aspects of sliplining and eliminated the largest concern, which was that of downsizing the new pipeline. With pipe bursting, they could offer size on size capability and even upsizing capability with the new pipeline. This was a very critical aspect, as most of the rehabilitation work looking forward for the potable water system would involve upsizing the distribution system in certain areas for adequate capacity and in particular, adequate fire flow. For the existing distribution system, this meant that those sections of town with networks of 4” cast iron mains would need to be upsized to 6” as a minimum.

3. PIPE BURSTING HISTORY

BDCD’s first pipe bursting project in 2005 was a sanitary sewer burst that was 360 feet of 10-inch HDPE pipe replacing a 10-inch clay sewer. This project was completed without anyone having any experience or observation of any other similar pipe bursting projects. Since that time, they have completed about nine projects of varying size using the technology and have embarked on their own pipe bursting program to rehabilitate aging and undersized potable water distribution infrastructure.
The advantages for pipe bursting and the BDCD were quickly apparent – it minimizes the surface disruptions associated with utility line work in urban environments, it allows them to replace an existing line with a new one with the same size or larger, and it utilizes the same utility corridor as the existing alignment limiting problems with surrounding utilities. One additional benefit that they discovered with the technology is the cost savings compared to direct bury replacement. Surface disruption and replacement is a major component of cost for BDCD when they work on utility lines within the City right-of-way. Pipe bursting process drastically reduces these costs. In addition, bringing these operations in-house as opposed to using a specialty contractor saves them even more.

After realizing the benefits available to them with this technology, BDCD’s hands-on approach led them to purchase pipe bursting equipment to take advantage of pipe bursting technology within their yearly operations and maintenance program. The BDCD has highly competent and efficient crews and the addition of a new installation technique and technology, including required pipe joining process, was not viewed as a major hurdle. Looking at all of these items with a long-term vantage point convinced the BDCD to move forward with a pipe bursting program.

The BDCD recognized several manufacturers of pipe bursting and sliplining equipment that could provide the required machinery to forward its pipe bursting program. They decided to purchase and use Hammerhead pipe bursting equipment, as manufactured by Vermeer, for one main reason: there was a local representative and facility in Billings. It was important for the BDCD to have local experience, assistance, and most importantly, parts. When a problem arises on a particular project and particular site, the ability to fix it right away is paramount and Vermeer is the only one currently in Billings to give them that possibility.

Figure 3. BDCD Pipe Bursting Equipment in Operation.
The BDCD purchased a HammerHead® HB100 pipe bursting system as outlined in Table 2, capable of 100 tons of bursting pullback force, which allows them to work with pipe sizes in the 4” to 12” range and at comparable lengths for working in a gridded street system, which is the heart of the work that the City intends to perform.

Table 2. City of Billings Pipe Bursting Specific Equipment List

<table>
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<tr>
<th>Equipment</th>
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<tr>
<td>McElroy Trac Star 412 Fusion Machine</td>
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<tr>
<td>Hammerhead HG 12 Winch – 12 Ton</td>
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<tr>
<td>Hammerhead Hydroburst HB100 – 100 Ton</td>
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<tr>
<td>Hammerhead PP70 Power Pack</td>
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<tr>
<td>Ingersol Rand Air Compressor – 375 CFM</td>
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<tr>
<td>Kiefer Industrial Telescoping Trailer</td>
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<td>- will handle 40-foot lengths of pipe without extending over the end of the trailer</td>
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4. PIPE MATERIALS FOR USE IN PIPE BURSTING

When the BDCD began to experiment with pipe bursting, a major component that they focused on was the pipe material that would be required with the process. As a rehabilitation process, the advantages of the installation methodology are not worthwhile unless the final product, once installed, can be maintained and operated efficiently going forward by the City. The bulk of the City’s water system is cast iron and ductile iron pipe, and the current specification for water pipe is ductile iron. For the last 30 years, the pipe being used for 12 inch size and smaller is C900, DR 14, PVC pressure pipe. The operations and maintenance crews and teams have been trained with and work with ductile iron and PVC pipe. The BDCD stocks fittings, tapping equipment and materials, and has crews trained with installation processes and operational procedures specific to these types of piping.

Table 3. Current Water Distribution System Pipe Materials

- 30” and 42” PCCP
- 14” through 30” Ductile Iron and Cast Iron
- 20” PVC – 3,000 feet
- 12” and smaller
  - Cast Iron
  - Ductile Iron
  - PVC
  - Steel

When the BDCD first experimented with pipe bursting, they used High Density Polyethylene (HDPE) pipe because it was viewed as the predominant pipe material for use with the process. The thermally butt-fused joining procedure for the pipe created a monolithic pipeline, free of mechanical joints, which could be installed via tension, a must for pipe bursting operations. Additionally, the very low profile bead, as part of the fusion joint exterior, meant that there was not a large “effective Outer Diameter (OD)” for the pipe when joined. In other words, the barrel OD was the maximum size space required to install the pipe. This compared favorably to other forms of mechanically-joined pipe, which usually had a much larger coupling or bell OD, and thus required a larger space to install them. For pipe bursting, this meant that the bursting operation had to create a void space capable of passing the overly large coupling or bell OD, complicating the bursting operation with little benefit in the actual size of pipe installed.

The benefits of HDPE were offset with several disadvantages from the perspective of the BDCD. The first disadvantage was the required tie-in to the rest of the existing system. Due to HDPE properties, coupling the pipe required special fused-on adaptors to provide a restrained connection to the typical appurtenances that the City stocked and used on a regular basis. Additionally, the pipe material represented another differing pipe material, which the BDCD crews needed to gain familiarity and training. It also represented another pipe material that required additional and different parts, equipment and knowledge to maintain and repair. While the BDCD was comfortable with having system workers trained on how to join the material and work with the fusion equipment, including tapping and specialty fusion, concerns persisted on what this would mean for emergency repairs and post installation work on the pipelines.
The BDCD then tried a mechanically coupled PVC product from CertainTeed®, called CertaLok®, which utilizes a grooved pipe barrel and a coupler and spline technology to join the pipe into a longer string capable of being installed via tension. The advantages of the product were that they were working with a pipe material that they were very familiar with in PVC. In addition, the segmented installation was good for tightly constrained areas, in that it did not require very much layout room for the pipe, unlike the products that had to be fused together into a string prior to installation. These advantages, however, were outweighed by the problems they found in installing it with pipe bursting methodology. They found that the greater OD of the coupling, compared to the pipe, created problems with the bursting operations in that it required a very large void space to be created and had the tendency to drag substantially more than a pipe product with a uniform OD.

At this time, the BDCD was introduced to Fusible PVC™ pipe, which is a PVC pipe product capable of being thermally butt-fused, much like HDPE. This product has the advantage of a low-profile joint with very high tensile capacity, a critical component required for trenchless installation. Therefore, PVC works very well with the existing equipment, knowledge, and stocked materials that the BDCD currently has. This product still poses the same logistic considerations as other fused or welded pipe systems in layout, insertion, and handling. In fact, the stiffer PVC material has even greater bend radius requirements than the more flexible HDPE. In addition, the BDCD had to have technicians trained on how to fuse the pipe. However, the post installation benefits of a PVC pipe for the City outweigh the temporary inconveniences that may be experienced in the initial installation and handling. Their current knowledge and stock fittings will work with Fusible PVC pipe, just as they do with the rest of the PVC pipe in their system. No need to worry about an ‘emergency fusion’ situation, simply make the repair with couplings and stock pipe that they would use in any other repair situation.

Currently, the BDCD has completed an initial trial and sample project with Fusible PVC™ pipe and has the remainder of an installation schedule with the material in the spring of 2010. At that point, they will evaluate the direction of their pipe bursting program and how they will proceed with the pipe bursting technology and pipe materials. The plans to use pipe bursting technology could be quite expansive going forward. It will depend on how efficient the BDCD crews can be, what will make the most sense for replacement programs, the capabilities of the technology, and how far the City can stretch its budget for the work.
5. FUTURE PROGRAM AND CONCLUSIONS

The BDCD has come a long way from its first pilot program utilizing pipe bursting technology. They are hopeful that the use of such technology will not only continue to save them customer dollars, but also save them valuable public relations credit by minimizing the disruptions and surface destruction common to standard direct bury replacement programs that they have endeavored in the past. Utilizing a methodical process of trialing equipment and pipe materials, the BDCD has settled on a system and a process that is proving effective, and they are looking forward to increased efficiency as well as rehabilitated potable water pipes in 2010. Pipe bursting gives the City of Billings another tool to meet the challenge of providing safe, clean water to their customers for years to come.

6. REFERENCES