

A COMPARISON OF TRENCHLESS PIPE BURSTING VS. CONVENTIONAL OPEN CUT METHODS FOR WATER AND WASTEWATER TRANSMISSION MAINS

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ABSTRACT

Over the last 15 years, new advances in trenchless technologies have emerged across Europe and are finding their way into the United States. One of the fastest growing methods involves pipe bursting of existing pipe and replacement with new larger diameter pipe. The existing pipe is shattered into small pieces and pushed into the surrounding soil. A new pipe of like or larger size is then towed into the borehole. Pipe bursting can be used for water transmission mains, wastewater force mains, and gravity sewer lines with excellent results. However, there are some instances where conventional open cut and replacement of the existing pipe is necessary. Before any design is undergone using trenchless pipe bursting technology or conventional open cut replacement, an analysis should be performed which provides an investigation of the following areas:

1. The design requirements for pit size, trench requirements, pipe depth, pipe materials, and disinfection for the different types of line replacement.
2. The pros and cons associated with each method, including but not limited to handling and disposal of existing pipe, pipe material limitations for new pipe, system operational requirements, and excavation limits.
3. Permitting requirements for the different methods.
4. A cost comparison of the different methods.

Following a location specific engineering analysis of the different methods, a determination can be made as to what type of method should be employed for a specific system. This paper will discuss each of those four elements and provide results of an analysis performed in Kissimmee, Florida.

KEY WORDS

Trenchless, pipe bursting, transmission, main, open cut.

INTRODUCTION

Over the last 15 years, new advances in trenchless technologies have emerged across Europe and are finding their way into the United States. One of the fastest growing methods involves pipe bursting of existing pipe and replacement with new larger diameter pipe. The existing pipe is shattered into small pieces and pushed into the surrounding soil. A new pipe of like or larger size is then towed into the borehole. Pipe bursting can be used for water transmission mains, wastewater force mains, and gravity sewer lines. According to the July 2004 article in *Civil*

Infrastructure by April Goodwin and B.C. Macauley, pipe bursting is “ideal for urban applications where an existing pipeline has exceeded its useful life.” The article also discusses the applications of pipe bursting beneath existing buildings, roads, and waterways. However, there are some instances where conventional open cut and replacement of the existing pipe is necessary. Before any design is proposed using trenchless pipe bursting technology or conventional open cut replacement, a site specific engineering analysis should be performed on the following criteria:

1. The design requirements for pit size, trench requirements, pipe depth, pipe materials, and disinfection for the different types of line replacement. Included in this portion of the analysis should be an evaluation of the advantages and disadvantages associated with each method, including but not limited to handling and disposal of existing pipe, pipe material limitations for new pipe, system operational requirements, and excavation limits.
2. Permitting requirements for the different methods.
3. A cost comparison of the different methods.

Following a location specific engineering analysis of the different methods, a determination can be made as to what type of method should be employed for a specific system. This paper will discuss each of those elements and provide results of an analysis performed in Kissimmee, Florida.

1.0 DESIGN REQUIREMENTS

The first part of the analysis to determine if pipe bursting or conventional open cut and replacement of the existing pipe is to be used; the design considerations for each method should be reviewed to determine the applicability of each method. Key design considerations include the following:

- Available area for construction.
- Operational use of the existing system, i.e., can the system be isolated during construction or must it remain in service the entire time.
- Location of other utilities, i.e., minimum separation distances between water, storm and sewer mains, and the location of other key utilities such as gas lines and buried telephone lines.
- Traffic considerations such as maintenance of traffic concerns, driveway access, and or street access.
- The depth of the pipe to be replaced.
- Location of fittings such as valves, tees and bends.
- The material of the existing pipe and associated disposal requirements.

The design requirements for open cut replacement of the existing pipe are fairly common and include the following general guidelines:

- Provide side slopes and bench per OSHA requirements (typical 2:1 slopes).

- Excavate and remove the existing pipe with special attention applied to asbestos cement pipe, including but not limited to special handling procedures, and federally regulated disposal requirements.
- Provide proper pipe bedding and compaction for minimal settling and pipe support.
- Install warning tape and or identification wire if applicable.
- Provide a minimum of 36-inches of cover for most applications.
- Resurface the area with proper sod, concrete or pavement as applicable.
- Perform the required disinfection and bacteriological testing per FDEP requirements and achieve clearance prior to use.

The type of pipe usually used in open cut applications for water and sewer mains include cement lined ductile iron pipe and PVC pipe. As provided earlier, the most limiting aspects of open cut replacement of existing pipe are the space available for construction, which is directly proportional to the depth of the existing pipe, and the type of material being replaced. However, the advantage of using open cut replacement is that conditions of the existing pipe, locations of isolation valves and fittings, and potential “problem areas” are identifiable and therefore can be adjusted to during construction. In addition, cement lined ductile iron pipe or PVC pipe can be used for the new pipe.

The design requirements for pipe bursting of the existing pipe include the following general guidelines:

- Available area needed for drill pit can be approximated to be 2-1/2 times the depth of the existing pipe to be replaced if HDPE pipe and 3-1/2 times the depth if using fusible PVC pipe.
- When bursting water or sewer force mains, it is recommended that the bursting is performed valve to valve or valve to hydrant if applicable.
- When bursting water or sewer force mains, it is essential that an accurate survey and utility location is performed so that the contractor has the best available knowledge of the existing utilities, including but not limited to fittings such as valves, tees, bends, and any deflection of the existing pipe.
- Perform a site specific analysis to determine the potential for surface heave. For water mains, it is recommended that the existing pipe have a minimum cover of 36-inches for size on size and increasing one pipe size for no surface heave using the static pipe bursting method. For gravity sewer, it is recommended that a minimum of 36-inches of cover is available for the existing pipe if upsizing up to two (2) pipe sizes to minimize heaving using the pneumatic pipe bursting method. If performing a size on size replacement of the gravity sewer, then no heaving is expected using the pneumatic pipe burst method.
- Resurface the pit area with proper sod, concrete or pavement as applicable.
- Perform the required disinfection and bacteriological testing per FDEP requirements and achieve clearance prior to use.

The type of pipe usually used in pipe bursting applications for water and sewer mains include HDPE for water and sewer and Fusible PVC pipe for water. As provided earlier, the most limiting aspects of pipe bursting of the existing pipe are the depth of the existing pipe for the

prevention of heaving, the knowledge required of the existing system, and limitations on what type of pipe can be used for the pipe bursting process. If the locations of the fittings and valves is known before hand, the pipe bursting operator can layout the pits to perform the work on a valve to valve basis. The advantages of pipe bursting include the following: the path of the new pipe follows an established path of the existing pipe, the existing pipe does not require any special handling or disposal procedures as it is pushed into the surrounding soil, slope of the existing pipe (gravity sewer) is maintained during construction, and the disturbance of surrounding utilities is minimized.

2.0 PERMITTING REQUIREMENTS

In general, the permitting requirements for both water and sewer main replacement utilizing either conventional open cut replacement and pipe bursting are the same. The requirements for permitting, construction, operation and maintenance of potable water systems including water mains are listed in Chapter 62-555 of the FAC. According to Section 62-555.520 – Applying for Public Water System Construction Permits, Paragraph (c), no construction permit is required for replacement of any existing water main with a new main in the **same** location as the existing main, provided the new main will either be the same size as the existing main, no more than two sizes larger than the existing main, or no larger than the minimum size required or recommended in *Recommended Standards for Water Works*. However, this does not relieve the permitting engineer or supplier of water of submitting written notification to the FDEP prior to beginning the work. The written notification must include a description of the scope, purpose, and location of work or alterations, and assurance that the work or alterations will comply with all applicable requirements of Chapter 62-555 FAC. If there are no objections from the FDEP following notification of the proposed work or alterations, the supplier can begin the work 14 days after providing the notification.

The requirements for permitting, construction, operation and maintenance of wastewater collection and transmission facilities are listed in Chapter 62-604 of the FAC. Section 62-604.600, paragraph 2 (a), a collection system permit is not required if the existing facilities are replaced with new facilities of the same capacity at the same location as the facilities being replaced.

From a permitting aspect, these two rules provide an advantage to the pipe bursting method because pipe bursting uses the existing whole, and if the depth of cover is sufficient, i.e. greater than 36-inches, then minimal heaving, if any, will occur.

3.0 COST COMPARISON

The Toho Water Authority (TWA) contracted with Tetra Tech to perform an analysis of a section of existing gravity sewer along US 192 in Kissimmee, FL. The analysis included an estimation of wastewater flows entering the system along this corridor to determine recommended pipe size for modifications to the system along with a cost analysis comparing open cut and replacement of the existing pipe to pipe bursting. Record drawings provided by TWA showed that the existing 10-inch gravity sewer was constructed with vitrified clay pipe (VCP) installed at a slope of 0.22%. Any replacement technology would be required to result in

a similar slope, therefore, hydraulic evaluations were based on the existing slope of 0.22%. For the section of gravity sewer west of Vista Del Lago, it was determined that the existing 10-inch VCP would need to be replaced with a 15-inch gravity line to convey the projected flows. Similarly, it was determined that the gravity sewer east of Vista Del Lago would need will need to be replaced with an 18-inch pipeline. The two (2) alternatives for pipe replacement considered for this study included conventional removal and replacement and pipe bursting.

The first option, conventional removal and replacement, would involve bypass pumping, excavation of the existing pipelines, removal and replacement of the existing pipe, backfilling, and restoration of areas disturbed by the construction activities. The second option would involve pipe bursting the existing pipe and pushing it into the surrounding soil to make room for new pipe that is pulled through the larger opening.

The line section west of Vista Del Lago is about 10 feet deep and bursting operations should not cause any surficial heaving. The section east of Vista Del Lago is very shallow and it is likely that surficial heaving would occur during bursting. Accordingly, driveway restoration and some repair to unimproved areas would be necessary if pipe bursting were completed for this section, however, it should be noted that driveway repair will probably be necessary regardless of the replacement method due to the locations of the existing service lines.

In general, pipe bursting is found to be most cost effective when the existing piping is deep and in areas where conventional excavation results in high restoration costs. The depths and condition associated with the line sections under consideration are not such that the most advisable alternative is obvious. Accordingly, costs for each replacement option have been developed and presented in Table 1.

**TABLE 1
COST COMPARISON FOR TOHO LIFT STATION 79 GRAVITY SEWER
REPLACEMENT**

LINE SECTION WEST OF VISTA DEL LAGO

Item	Quantity	Unit	Conventional Replacement		Pipe Bursting	
			Unit Cost	Extension	Unit Cost	Extension
Replace Existing 10" VCP with 15" PVC or HDPE	2,773	L.F.	\$150.00	\$415,950	\$100.00	\$277,300
Connect Services to New Pipe	7	Each	\$500.00	\$3,500	\$1,500.00	\$10,500
Pavement Restoration for Conventional Replacement	995	S.Y.	\$40.00	\$39,800	N/A	N/A
Pavement Restoration for Pipe Bursting	995	S.Y.	N/A	N/A	\$40.00	\$39,800
Totals				\$459,250		\$327,600

LINE SECTION EAST OF VISTA DEL LAGO

Item	Quantity	Unit	Conventional Replacement		Pipe Bursting	
			Unit Cost	Extension	Unit Cost	Extension
Replace Existing 10" VCP with 18" PVC or HDPE	1,867	L.F.	\$150.00	\$280,050	\$100.00	\$186,700
Connect Services to New Pipe	2	Each	\$500.00	\$1,000	\$1,500.00	\$3,000
Pavement Restoration for Conventional Replacement	450	S.Y.	\$40.00	\$18,000	N/A	N/A
Pavement Restoration for Pipe Bursting	450	S.Y.	N/A	N/A	\$40.00	\$18,000
Totals				\$299,050		\$207,700

As shown in Table 1, pipe bursting is very cost effective for the section west of Vista Del Lago and considerably more expensive for the section east of the Vista Del Lago. In view of these costs, it was concluded that pipe bursting would be used for the section west of Vista Del Lago and conventional replacement would be used for the remainder of the pipeline under consideration.

CONCLUSIONS AND RECOMMENDATIONS

As was discussed earlier and is shown in the cost analysis, a site specific analysis should be performed on the project prior to the final design to determine if pipe bursting is a feasible option over conventional open cut and replacement. In conclusion, this report shows that when compared to conventional open cut replacement of water and wastewater transmission mains, pipe bursting can be a viable alternative in certain situations.

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