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Cornplanter Township Installs New Water and Sewer Force Mains Using Combination of Trenchless Methods

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1. ABSTRACT

Born out of a Seneca tribal settlement, Cornplanter Township, PA grew into an early prominent boomtown during the latter half of the nineteenth century. Oil City, in particular, played a central role in the burgeoning petroleum industry, a vital steamboat hub for the oil that moved in and out of Pittsburgh on the Allegheny River. These days, Oil City has begun to revitalize its image, focusing on tourism, nature trails, its Victorian architecture, and aging infrastructure.

In 2012 Cornplanter Twp. began to tackle their aging infrastructure. They hired the engineering services of Hebert Rowland & Grubic, Inc. to design and construct a new 10-inch water main and a new 6-inch sewer force main, totaling over two miles of pipe. The proposed route of these new lines, however, was in close proximity to an existing Pennsylvania Department of Transportation (PennDOT) right-of-way (ROW) north of Oil City congested with existing utilities without available utility record maps, and there were concerns with contaminated soils. In order to address these special nuances, the design team looked at the advantages of utilizing trenchless installation methods, including horizontal directional drilling (HDD) the waterline, and sliplining the new sewer force main into the existing cast iron pipeline.

The design team successfully overcame the difficult and contaminated ground conditions, the various old and unmarked infrastructure in the area and construction permitting impacts within the PennDOT ROW. This paper will review the design and construction considerations as well as lessons learned for the unique constraints overcome as part of this project using trenchless methods.

2. INTRODUCTION

In the northeastern region of Venango County in Pennsylvania lies Cornplanter Township, which was formerly the site of an oil refinery in the mid-1800s. Oil City, in particular, has played a major role in the development of the petroleum industry. After the first oil wells were drilled in the 1850s, Oil City grew to be incredibly prevalent in the petroleum industry while hosting headquarters for numerous major motor oil companies. During World War II, these major oil companies became involved in the construction and operation of Pennzoil Plant #3, a facility which processed high octane gasoline for United States Navy airplanes and PT boats. Although these major oil companies have since relocated and the region's oil industry has diminished, some oil wells continue to produce a steady supply of quality petroleum (Cornplanter Township, 2013). The township's history of oil refineries is currently still a part of the education for the public, contributing to its efforts to revitalize the city's image as a notable tourist attraction (see Figure 1).

Figure 1. Oil City is home to the oldest producing oil well, a nod to the long standing industry associated with the area.

The focus of the Township's economic growth was centered upon improving the existing infrastructure. The population of the County's communities would soar in good economic times and crash as the region's prosperity, measured in barrels of crude oil, dried up. Given the economic impacts affecting population numbers, the township is trying to battle the current population decline driven by economics by enhancing its existing residential and industrial region, starting with the underground utilities.

The original 10-inch waterline along State Route 8 was installed in the 1930s and was failing. There are two residential developments in Oil City that border this corridor. Due to waterline breaks disrupting service, this line could no longer provide reliable water service to its existing customers. One of the largest remaining customers in the Township is one of the last chemical manufacturers in the County. Reliable service was imperative to keep this customer and to encourage new business growth in the area.

A Clean Watersheds Needs Survey was performed to assess the capital needs required to meet water quality goals set in the Clean Water Act. In this survey, it was determined that the area needed a sewer main suitable for residential systems. The area had previously used on-site sewage treatment or "wild cat sewers", neither of which met environmental standards. Adding a sewer system, in addition to rehabilitation of the existing water system, would make the area more attractive for the town's revitalization.

Consequently, in 2012 the Township of Cornplanter began its early stages of design on the Potable Water Distribution Line Replacement & Sanitary Sewer Extension Project. The Township entered a contract with Herbert Rowland & Grubic, Inc. (HRG) to complete the design of the project.

3. PROJECT DESIGN

The entire length of the project took place along the corridor running parallel to Oil Creek. The close proximity of State Route 8 to the creek provided some difficulties with installation space. The distance from State Route 8 to the creek ranged anywhere from 50 feet to 150 feet, which created a significant layout constraint. Also along the road are several industrial buildings, including a large warehouse building located in the middle of the project area. This building stretched from the corridor to the creek, leaving only a few feet of space to lay out and install the pipe. Because there were several businesses that were located alongside the road, setup and laydown operations for the pipe were very limited. On the opposite side of State Route 8, there was also limited space between the road and the bluff (see Figure 2).

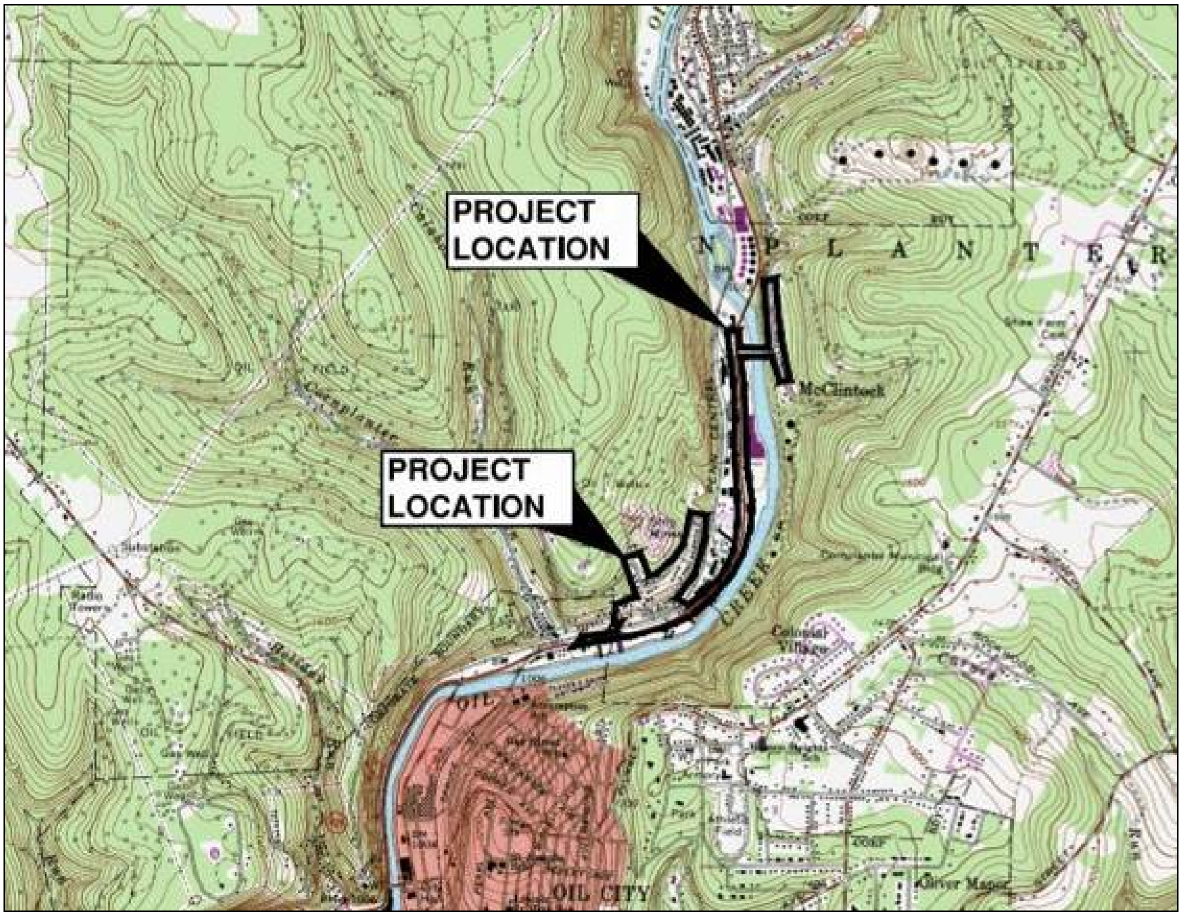

Figure 2. A topography map of the project location showing the project site, proximity to Oil Creek and the steep terrain.

Standard open trench excavation was considered problematic due to the known ground water and hydrocarbon contamination. Standard procedure required that the contaminated soils be taken from the project to be treated and disposed of as a hazardous waste at the local landfill. Existing conditions also had to be taken into account. There were various utilities throughout the project area that had been installed over the last 100+ years (see Figure 3). Of note were the 'process lines' that were used as part of the oil refinery and production processes. These process lines, due to the nature of the fluids they conveyed would greatly increase the cost of the project or at its worst cause a shut-down. The newly installed Pennsylvania Department of Transportation (PennDOT) storm sewer systems also caused concern for open trench installation.

WATERMAIN INSTALLATION

Installing a water line outside of the road corridor was reviewed but due to limited open area was not further considered. The existing buildings spanned from the road right-of-way to the stream bank on the east side and, in some cases, the edge of the paved shoulder to the stream bank. They also extended from the road to the railroad on the west side. As the aforementioned options for installation methods were considered, HRG also explored the benefits of trenchless technology. Horizontal directional drilling (HDD) became the clear installation method because of the limited space for installation and complications that would arise from contaminated soils otherwise associated with open trench construction.

Water service would have to be maintained throughout the construction. To avoid the use of an expensive bypass line with reduced service capacity to its customers, the preferred option would be to keep the existing line in service while a completely new water line was installed. Utilizing HDD for installation of the new line suited this goal well.

The water main was sized to provide sufficient capacity for adequate fire protection service at the furthest reach of the line, which terminates at the end of the corridor. Based on hydraulic evaluation, it was determined that a 10-inch water main would meet this standard. There were approximately eight directional drill sections in the project design, with each installation pit located where the fire hydrants would be installed. The proposed water main would connect to the existing water main on one end, and a gate valve and end cap on the other end. The total number appurtenances included nine gate valves and twenty-three, 2-inch service saddles installed along the water line.

Figure 3. Explorative excavation showing contaminated soils and existing utilities, including a multitude of process lines.

<u>SEWER MAIN INSTALLATION</u>

For the sewer installation, an 8 inch gravity line was initially considered. However, the soil conditions and existing utilities, including a very large existing utility tunnel crossing, posed problems for a gravity system. A new directionally drilled force main was considered but due to the potential interference of existing buried lines within the required easement, HRG was hesitant of this option and looked into other opportunities. The idea of using the existing cast iron waterline as a conduit for the sewer main was promising because it would eliminate interference with existing lines in the required easement and significantly reduce the need for soil disposal. Pipe bursting the force main was evaluated since there were concerns that the 8-inch pipe would be too big to slipline into the existing 10-inch cast iron line. In the end, it was decided that a 6-inch force main would provide adequate service, and that the pipe could be installed via sliplining methods. Per the standard specifications, grouting was required to fill the annulus between the existing pipe and the new sliplined forcemain, with the contractor being responsible for the means and methods for grouting.

HRG also looked into pipe materials that would protect residents from the hydrocarbon contaminants. A 2008 AWWA Research Foundation study found that PVC (without a gasket) provides the best protection against hydrocarbon permeation in a potable water system versus HDPE pipe (Ong, et al, 2008). Because of this, fusible polyvinylchloride pipe (FPVCP) was selected as the preferred material for the water main and sewer force main installations by trenchless methods.

4. PROJECT BIDDING AND CONSTRUCTION

Once the project documents were completed, the project was advertised to prospective bidders. The bid form was fairly basic with one bid item for the HDD installation of 6,135 LF of 10-inch potable water main, and another bid item for the slipline installation of 5,760 linear feet (LF) of 6 inch sanitary force main. The project was awarded to the lowest responsive bidder, Continental Construction of Ridgeway, PA, who was responsible for the entirety of the work. Impact Drilling and Tru-tek Drilling were hired as subcontractors to perform the directional drilling of the waterline.

Construction began in August, 2012 and the water line was installed first. The pipe laydown and staging areas were strategically placed along the road in order to minimize disruption for passing cars as well as the businesses in the vicinity. Figure 4 shows one of the pipe fusion and staging areas along State Route 8. In order to reduce the size of the HDD entry/exit pits, the contractor elevated the pipe using raised rollers. Known in the field as “abbreviated aerial entry”, this method allowed a steeper entry of the pipe which also reduced the amount of spoils to be disposed of when constructing the insertion pit (see Figure 5).

Figure 4. Fusion staging and assembly layout for the waterline to be installed using HDD methods.

During the HDD installation, there was one area of concern. Just south of the Merisol Refinery there is a large concrete tunnel which contained high voltage wiring and cable. The contractor had to schedule a shutdown of the tunnel to proceed with the installation, and installing the pipe underneath this tunnel was a challenge. Although the pilot bore made it underneath the tunnel without trouble, the unexpected soil conditions in this area made pullback difficult. During installation, the contractor discovered that the soil in this area was composed of cobble. Because of these unforeseen conditions, approximately 200 feet of the drill had to be open trenched beyond the tunnel.

The entire 6,135 feet of the 10-inch FPVCP potable water main was installed with a total of nine drill sections of various lengths. A 12-inch reamer was used for the first drill section. The contractor first bore a pilot hole, then reamed with the 12-inch reamer size, and finally pulled the pipe back on the third pass. Although there were no major issues during the drill, the engineer required that the contractor use an 18-inch reamer for the remainder of the project. The contractor bored the pilot hole, then pulled back with the reamer and the pipe in a two-pass installation. Once the drill segments were installed, connections were completed in the installation pits. Figure 6 illustrates a tie-in of two HDD pipe sections along with a gate valve and fire hydrant, which was typical of these connection locations.

Figure 5. Typical insertion location for the HDD entry pit, illustrating the “abbreviated aerial entry” method.

Figure 6. Typical fire hydrant installation and HDD pipe section tie in inside entry/exit pit location.

Once the waterline was completely installed, service saddles were installed along the main. A total of twenty-three 2-inch service taps were installed while the water main was under a static pressure of 135 psi. Figure 7 shows a completed service saddle installation. For this size of waterline, a 2-inch service for FPVCP requires some means to reduce or eliminate the axial stress that is imparted on the pipe during installation. To do this, the design called for bell restraint harnesses to distribute axial stress across the tapping saddle and the location of the tap.

Figure 7. Service saddle installation showing the use of the bell restraint harnesses for axial stress management at the tap location.

Construction of the sewer portion of the project started in December, 2012. Due to the onset of winter, cold weather fusion procedures were followed to ensure quality fusion joints for the FPVCP. A portable tent was utilized to protect the fusion machine and pipe during the fusion process, and the pipe was preheated to 40°F prior to being fed into the temperature controlled fusion machine enclosure.

The existing line was cleaned and televised prior to the installation of the 6-inch force main. The slipline installation was completed in six different segments. Installation pits were placed in areas where there were changes in direction or at manholes, especially those locations where pits would already be excavated for pipe connections.

Figure 8. Typical service saddle connection on 6-inch force main and grout venting lines on exsisting cast iron line.

After the pipe was pulled into place, sections of the existing cast iron line were removed and lateral service saddle connections were installed. Taps and saddles were installed on the 10-inch cast iron line for the purpose of venting during the grout installation. Flowable grout was then pumped through the annular space, and the vent lines were removed prior to closing the pits. Figure 8 shows the installation of the lateral service saddle and grout venting lines.

Cornplanter Township was assisted by the Pennzoil/Quaker State Company and the Pennsylvania Department of Environmental Protection to mitigate issues with contaminated soil and groundwater during the construction phase of the project. Rather than disposing of the soil at a landfill, soils were remediated onsite and distributed throughout the project right of way.

Project funding was provided for the project through the USDA, the Pennsylvania Venango County CDBG, and the Pennsylvania CFA-H2O. Finally, due to their innovative use of trenchless construction techniques on this project, Cornplanter Township won an $800,000 grant from the Commonwealth of Pennsylvania, which was applied to offset a portion of the cost of the project.

5. CONCLUSION

Despite a small number of minor hurdles during design and construction including the management of contaminated soils and the presence of unmarked existing utilities, both the potable water main and sanitary force main were successfully installed by January, 2013. The assistance of Pennzoil/Quaker State Company and the Pennsylvania Department of Environmental Protection relieved the concern of contaminated soil and groundwater. Weather conditions did not pose any major issues and the crews successfully overcame all of the existing ground conditions that were encountered. Explorative excavation surveys provided actual locations of the existing utilities prior to any construction activity.

Overall, construction of the water and sewer lines utilizing HDD and slip-lining methodologies, respectively, proved to be the best options. Open trench construction would have been cost prohibitive for both pipelines due to construction conflicts with abandoned refinery lines and other utilities as well as the contaminated soils issue. Through HRG's careful evaluation and planning, water service remained active during the course of construction for the community and minimal overall excavation was achieved.

6. REFERENCES

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