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**Long, Large Diameter HDD Provides Critical Link for Forcemain
Project**

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1. ABSTRACT

In an effort to expand wastewater collection and treatment capacity in southern Hillsborough County, FL, near Tampa, a new 30-inch force main, as part of a multi-year investment, was to be installed along U.S. Hwy 301 from state route (S.R.) 674 to Valencia Lakes. When it was determined that the northern end of the line must cross through environmentally sensitive wetlands, traditional open-cut was ruled out as a method of installation. Horizontal Directional Drilling (HDD) methodology was quickly viewed as the easiest and most feasible means of construction for installation of the force main through this region.

The Hillsborough County Public Utilities Department (HCPUD) originally designed the force main using bell-and-spigot PVC and ductile iron to be installed by open cut methods. After it was determined that the force main needed to be directionally drilled through the wetlands, the County completed the design and permitting using 30-inch fusible polyvinylchloride pipe (FPVCP) in a single 2,100 foot installation. The single drill proved to be largest and longest HDD installation for the HCPUD to date.

This paper will review the design and construction highlights of the overall project, as well as focus on this challenging long HDD installation used to complete the critical environmental crossing required.

2. INTRODUCTION

The Hillsborough County Public Utilities Department (HCPUD) is a public utility that provides potable drinking water and sanitary sewer services to unincorporated areas of Hillsborough County outside the cities of Tampa, Temple Terrace, and Plant City, Florida. According to the United States Census in 2010, the HCPUD serves and provides for 1,229,226 people throughout Hillsborough County. The County is located midway along Florida's western coast, and encompasses roughly 1,048 square miles of land, plus an additional 24 square miles of inland water.

The County of Hillsborough was first mapped and explored by the Spanish in the early 16th century. The County takes its name from Wills Hill, British Secretary of State to the Colonies from 1768-1772. Before Florida was granted statehood in 1845, on January 25, 1834, the United States Legislative Council approved an act organizing Hillsborough as the Territory of Florida's 19th county.

The U.S. Hwy 301 Force Main project was designed as part of a multi-year investment to expand wastewater collection and treatment capacity in southern Hillsborough County. It is part of an ongoing effort to increase capacity of the wastewater system in order to meet higher demands due to the recent and projected uptick of growth in the area. Hillsborough County has seen its population increase 23 percent from 2000 to 2010, and continued growth is expected. The 8,000 feet of 30-inch sewage force main will also provide the system with increased reliability and redundancy, connecting the County's Falkenburg and Valrico treatment plants to the South County Wastewater Treatment Plant and acting as a second transmission main along state route (S.R.) 674. The new force main, installed by both conventional open trenching as well as horizontal directional drilling (HDD), will also allow the County to divert wastewater flow from other stations if desired. Figure 1 depicts the location of the new secondary force main along U.S. Hwy 301. Another portion of this job was completed to the south of the shown site location that extended to S.R. 674.

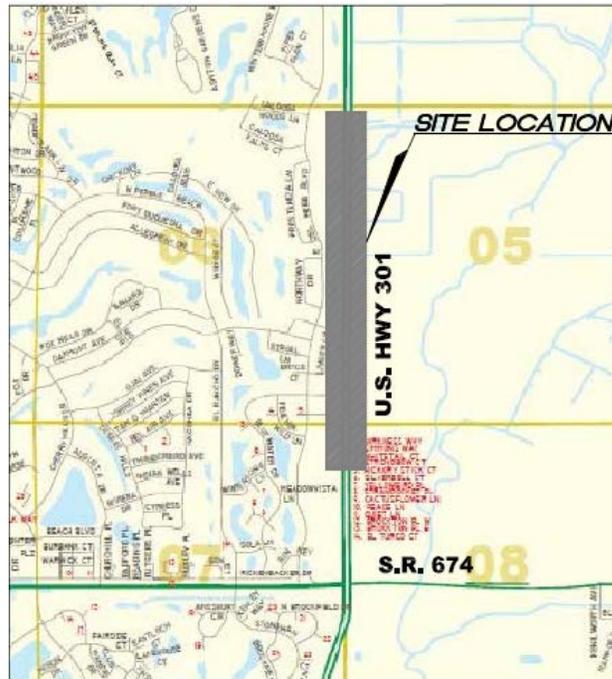


Figure 1: Project location map (Not to Scale).

After identifying the need to upgrade system capacity through this region, the Hillsborough County PUD chose to design the project through their in-house engineering department. Evaluation of several options followed for the new force main through this area, and the initial design consisted of open trench construction along the eastern side of Hwy 301. However, the northern portion of the highway contained a region of environmentally sensitive wetlands. The Wetlands Assessment and Development section of the Environmental Protection Commission (EPC) is responsible for maintaining these areas throughout the County, and would need to issue a permit for construction plans and land development operations on, or adjacent to the wetlands.

Contributions of the wetland areas in Hillsborough County are substantial and irreplaceable for a high quality environment. The general public benefits from the aesthetic and recreational functions served by the wetlands and the multiple practical and economic advantages. Disturbance in these areas may cause everyday functions such as storm buffering, flood control, and water supply – to name a few – to be replaced at public expense. The EPC deemed that it would not be practical to install the new force main by means of open trench construction through this region and that alternate installation methods should be pursued.

Based on previous experience, site parameters, and similar successful projects of this magnitude of pipe size, the County chose to investigate the use of HDD through the wetland region. Without the option to dig up the existing ground, HDD was found to be the most economical choice in this case. The Hillsborough County PUD proceeded with the plan to directionally drill the new 30-inch force main as a means of installation through this area.

3. PIPE DESIGN CONSIDERATIONS

When the initial design was considered, bell-and-spigot PVC and ductile iron were proposed to be installed by means of open trench construction in accordance with the Hillsborough County PUD standard specifications for new force main piping. A majority of the alignment along Hwy 301 could be installed by open-cut just outside the public right-of-way in purchased permanent and temporary construction easements, but a substantial region of environmentally sensitive wetlands was located on the east side of the highway just south of Valencia Grande Avenue. The EPC did not allow for ground disturbance through this area, which eliminated the open trench option. To solve the issue of designing through the environmentally sensitive area, Hillsborough County PUD looked at a trenchless installation.

With open trenching removed as a possibility for the northern portion of the installation along Hwy 301, HDD was presented as an option for this project due to the nature of the installation method. HDD does not have any effect on the existing grade above the installed line, sans for entry and exit pits on either side of the drill (which would be dug outside the wetland area in need of preservation). HDD accomplished this goal while also proving to be an economic solution.

Now that the installation method was chosen, Hillsborough County approached Underground Solutions, Inc. (UGSI) about installing fusible polyvinylchloride pipe (FPVCP) for the directional drill. Based on previous, successful projects with the product in similar applications and pipe sizes, the County felt comfortable specifying 30-inch FPVCP pipe for use on this job. The mechanical properties of polyvinylchloride allowed for optimum hydraulic capacity for a given nominal pipe size, while also providing installation advantages including a reduced pull force requirement and smaller borehole compared to other products. Hillsborough County permitted the use of FPVCP for use on the 2,100 foot proposed drill that would be installed in a single pull.

Based on geotechnical reports and boreholes drilled in the area, depths up to 35 to 40 feet from the ground surface along the proposed alignment contained either poorly-graded fine sand with silt or silty-sand. Groundwater was observed at depths between three and eight feet from the surface at all lengths along the pipeline. The preliminary recommendation from S&ME, Inc. in the geotechnical report was to place the vertical alignment for the drill just at or below the medium dense layer of soil (Kauzlarich and Johnson, 2011). With this in mind, the depth for the drill was optimized in the range of 17 to 22 feet according to blows per foot data recorded at each soil layer using the standard penetration test (SPT) for density measurements. Entry and exit angles were designed to avoid existing utilities in the transverse direction and the bend radius of 30-inch FPVCP was not exceeded. On the north side, the exit angle was influenced by the need to get sufficient clearance under Valencia Grande Avenue leading to the Valencia Lakes Development. Connections would be made to the installed open-cut gasketed PVC to the north and south of the drill by means of ductile iron fittings, per the project specifications.

4. BIDDING AND CONSTRUCTION PHASE OF PROJECT

The Hillsborough County PUD chose to sole-source FPVCP for use on the directional drill. The low bidding contractor on the project was E.T. MacKenzie of Florida, Inc. (Bradenton, FL), who was awarded the project at \$2.75 million. E.T. MacKenzie subcontracted the directional drill portion of the project to Environmental Crossings, Inc. (ECI) for the installation of the 30-inch FPVCP force main along Hwy 301 and through the wetlands.

E.T. MacKenzie began installing the open-cut portion of the job with ductile iron pipe near the intersection of Hwy 301 and S.R. 674 to the south. The new ductile iron force main was laid north along the western side of Hwy 301 in Florida Department of Transportation (DOT) right-of-way. The alignment moved east across Hwy 301, approximately 3,725 feet south of the wetlands and proposed HDD installation, extending into a 20 foot wide easement located just outside of the DOT right-of-way. This easement was purchased by Hillsborough County PUD for the installation of the force main and the possible future installation of a water main. Starting at this location just southeast of Caloosa Golf and Country Club, bell-and-spigot PVC was installed the rest of the way up Hwy 301 to the portion of the project to be directionally drilled. This design and setup allowed for efficient assembly of open-cut gasketed PVC while being able to excavate trenches without disturbing the flow of traffic on the adjacent U.S. Hwy 301.

An additional 15 foot temporary construction easement to the east of the force main easement was obtained for the project to accommodate equipment and pipe stringing for the directional drill installation. Layout for fusion assembly of FPVCP was set up to the south of the HDD installation, east of U.S. Hwy 301 in the 20 foot wide easement. Underground Solutions, Inc. (UGSI) supplied the 30-inch FPVCP for the directional drill portion of the force main and performed fusion services on site. Figure 2 below shows the fusion machine setup with heating plate for fusion of 30-inch FPVC force main pipe. Given the amount of open area in addition to the acquired easements, the space available at the project site allowed for the fusion assembly of 2,100 linear feet of pipe in a single string prior to pull-in. Pipe was fused in 40 foot stick increments until the entirety of the drill section was laid out in one continuous, fused pipe segment.



Figure 2: Fusion setup for 2,100 LF of 30" FPVCP force main pipe to the south.

With the 2,100 feet of 30-inch FPVC pipe completely fused to the south of the wetlands, ECI mobilized to the project site to begin with the directional drill installation. It took two days for setup of the rig on the road shoulder. Drilling operations began on the north side of the wetlands by digging the exit bore pit for the HDD pipe. The drill rig was placed at this location, along the shoulder of Hwy 301, eliminating the need for any lane closures during HDD activities.

Forty-eight hours before the pilot bore was drilled, the Contractor contacted the Sunshine State One Call utilities notification center to advise of the scheduled construction. During the inspection for existing utilities, lines were discovered near the north entry pit that had not previously been accounted for, and were in conflict with the new force main's proposed alignment. The field team adjusted the azimuth and point-of-entry for the drill to avoid these utilities, pending engineering approval. This required adjusting the setup of the drill rig and equipment on the northern side of the directional drill to achieve this newly designed exit angle at the conclusion of the bore.

Given the existing soil conditions in the area and the drill fluid pressures required for maintenance of a borehole of the magnitude the 30-inch line would require, ECI was also worried about the potential for surface frac-outs at the design depth of 15 to 25 feet. At shallow depths there was the possibility of fluid migrating through the soil layers and reaching the surface of the wetlands. Working in conjunction with the engineering design team, the depth of the drill was revised to approximately 40 feet of cover, significantly reducing the chance of potential frac-outs and ensuring that the integrity of the wetlands would be maintained.

With these concerns addressed, ECI then proceeded to drill the pilot bore along the newly proposed vertical alignment with a 1,200,000 pound drill rig from north to south before opening up the bore with the back-ream to the

appropriate size. The 2,080 lineal foot pilot hole took four working days to complete. Although there were a few horizontal grade changes located along the bore to stay within existing right-of-way, the pilot bore went smoothly through the formation.

ECI reports on soil conditions encountered in the field matched the boring logs from the geotechnical report: the crossing entailed fine sand discovered in the field with presence of clay. Some areas containing wood chips and other debris were as noted in the geotechnical investigation. This clogged up the exit pit to the north, and had to be cleared away prior to pipe pull-in. The pilot bore could then be expanded to the required size for insertion by means of back-reaming. ECI decided to make two reaming passes through the drill geometry: first using a 30-inch fly-cutter followed by a final 42-inch fly-cutter to reach the design bore size. Each pass took five working days to complete. After both passes were complete, and the borehole was reamed to 42 inches, ECI spent an additional day preparing for pipe insertion by running a 36-inch swab through the hole for conditioning and two final days for equipment adjustments.



Figure 3: Pipe installation to the south of the wetlands with drill mud recycler setup and telescoping fork lift.

The entry angle for the HDD pull-in at the southern location of the drill was designed at 9.5° , and would connect the FPVCP back to the open-cut gasketed PVC pipe by means of an 11.25° mechanical joint, ductile iron vertical bend. However, the gasketed PVC pipe previously installed by open trench construction extended into portion of the tail ditch area originally designed for the 30-inch HDD pipe. In addition, existing utility crossings in close proximity to the pipe, perpendicular to the alignment, created a problem with the designed plan for insertion.

The pit length needed to be shortened to avoid interfering with the open trench pipe, and the HDD pipe exit angle had to be adjusted accordingly. The 30-inch FPVCP now had to be pulled in at a much steeper angle, but would need to do so without overstressing the pipe by exceeding the recommended bend radius. In order to do this, ECI, E.T. MacKenzie, and UGSI proposed placing a roller support on a dump truck filled with dirt to achieve the necessary aerial insertion required to minimize bending stresses. Figure 3 shows the insertion setup to the south, with pipe resting on the roller placed above the dump truck and insertion at the boundary of the wetlands. Another elevated support by means of a telescoping fork lift was used to aid the installation process. The entire line away from the insertion point was also supported on rollers, as shown in Figure 4, to ease installation and prevent damage to the FPVCP. This setup on the Eastern side of Hwy 301 proved to be an effective field-engineered solution.



Figure 4: Pipe installation to the south of the wetlands with roller system.

As shown in the Figures 3 and 4, drilling fluid recyclers were used on each end of the bore to minimize the disposal of reusable drilling fluid that results from a directional drill. The borehole size required for this large diameter pipe and the overall length of drill drove ECI to utilize such a mud management technique for this installation due to the high volume of corresponding drilling fluid required. ECI used Ellis Williams 446 triplex mud pumps to remove fluid into mud tanks. The mud tanks were designed with 1,000 gallons per minute (gpm) de-silters and de-sanders, and two panel shakers to separate the sand and silt in the surrounding soil from the drilling fluid.

They were able to install the new 30-inch force main during one single pull-in lasting 10 hours through the night. There were no frac-outs recorded due to the revised depth of drill. Tie-in connections were made to open cut portions of the line on each side of the wetlands following pressure testing, and the secondary transmission line was complete. E.T. MacKenzie finished the overall work 36 days before the final completion date set for the project; there were no delays due to weather or on site accidents.

5. CONCLUSION/LESSONS LEARNED

The completed 2,100 LF bore proved to be the largest directional drill to date for the Hillsborough County PUD Department. While it was a milestone project for the County, the previous experience of the Hillsborough County PUD, E.T. MacKenzie, and ECI with FPVCP on past projects installed via HDD and jacking and boring proved to provide a solid foundation for the successful installation with the product on this project. Both E.T. MacKenzie of Florida, Inc. as the general contractor for this project and Environmental Crossings, Inc. as the drilling subcontractor were familiar enough with FPVCP to be comfortable using it for the maxi-drill crossing of the wetlands.

Compared to other products, the smaller borehole and lower pull force allowed for the ease of installation through the environmentally sensitive wetlands. Any problems encountered were resolved early by the resourceful construction team, using successful field engineering techniques. The line proved to provide the necessary additional capacity to the wastewater system while adding redundancy and reliability with the materials chosen.

6. REFERENCE

Kauzlarich, P., and Johnson, S. (2011) – Report of Geotechnical Exploration, US Highway 301 Force Main (Valencia Lakes to SR 674), S&ME, Tampa, FL