1. ABSTRACT

Located along the southeast coast of South Carolina, Beaufort County’s population is rapidly expanding and that expansion brings new challenges to the county’s wastewater systems. To remain ahead of demand, the Beaufort-Jasper Water and Sewer Authority (BJWSA) completed a pair of piping projects, including a new force main and reclaimed effluent line, relying on horizontal directional drilling (HDD) methodology and a focused procurement method commensurate with the installation risk. BJWSA worked with the same drilling contractor, engineering consultant, and pipe supplier for these installations as were involved in the first high-risk HDD project BJWSA completed in 2007.

First, a new, 5,300-foot, 16-inch force main was installed, using HDD, parallel to a similarly installed 10-inch pipe ten years earlier below the Beaufort River. This new force main was designed to augment flows to the Port Royal Island Water Reclamation Plant and additional wastewater collection capacity for residents.

Second, a new, 4,200-foot, 24-inch reclaimed effluent pipeline was installed using HDD for the Great Swamp Expansion project. This new pipeline would allow even disbursement of effluent throughout the Great Swamp wetland area, returning cleaned effluent water to the local ecosystem for natural filtration and reintegration.

Ten years after the first long, historical Beaufort River HDD crossing, the success and efficiency of a procurement method that couples quality partnerships with material and performance capability prove repeatability of successive, higher risk HDD installations.

2. INTRODUCTION

Beaufort County, South Carolina has a long and important history in the colonization of North America, as well as the development of the post-Civil War South. Cited as the location of the second landing of Europeans on the North American continent by Spanish Captain Pedro de Salaza in 1514, Beaufort County was instrumental in the exploration of the modern South. After a series of failed attempts, the British finally established the City of Beaufort in 1711, which is now the modern seat of Beaufort County. Named after Henry Somerset, Duke of Beaufort, who was one of the Lord Proprietors of Carolina, the city faced violent confrontations with the local Native American tribes and did not truly begin to grow until after the founding of Georgia in 1733. The county itself was formed in 1769 from nearby parishes Prince William, St. Luke, St. Helena, and St. Peter. After famously being occupied by the British during the American Revolution after the Battle of Beaufort in 1779, the county was fully evacuated of...
British troops in the summer of 1782. The official state line between South Carolina and Georgia was established along the southern edge of Beaufort County in 1787 through the Treaty of Beaufort.

After a Category 3 hurricane hit the Lowcountry in 1893, Beaufort County entered a state of decline that lasted over 50 years. It was not until post-World War II that the area began to see serious economic improvement and a return to earlier population numbers. The establishment of Marine Corps Recruit Depot Parris Island beginning in 1917 and the addition of a naval air station in WWII brought in significant military funding and residents. An expansion of resort development on Hilton Head and Fripp Islands in the 1960s also began to attract increasing amounts of tourism.

As the population began to increase and the economy picked back up, the State established the Beaufort Jasper Water and Sewer Authority (BJWSA) in 1954 through a legislative act to serve Beaufort County as a nonprofit organization. The Authority was intended to maintain local water and sewer utilities already present in the area and to oversee the expansion of such utilities as needed. In 1969, BJWSA’s powers themselves were expanded to include wastewater facility construction and services. As the population continued to grow, BJWSA merged with Jasper County Water and Sewer Authority into a single entity, that still exists today, to serve both Beaufort and Jasper Counties. BJWSA is governed by a board made up of eleven individuals – seven from Beaufort County, four from Jasper County – who are recommended to and appointed by the governor.

Today, BJWSA services more than 55,000 retail customers with approximately 20 million gallons of potable water each day. Additionally, they supply potable water wholesale to customers for resale or redistribution. The majority of this water is obtained from the Savannah River.

In terms of non-potable water, more than nine million gallons of wastewater is collected, treated, recycled and returned to the environment each day. Currently, BJWSA operates the Chelsea and Purrysburg Water Treatment Plants, the Cherry Point and Port Royal Water Reclamation Facilities, and the Palmetto Bluff and St. Helena Wastewater Treatment Plants, as well as hundreds of pump stations throughout both counties. The majority of this reclaimed water is used to water local golf courses and a sod farm. When there is a surplus, the reuse from the Port Royal Island Water Reclamation Facility is emptied into the Beaufort River. Surplus from the Cherry Point Water Reclamation Facility is now recycled into the Great Swamp.

The Great Swamp was chosen as the Jasper County recycled water deposit point after water quality and biological baseline studies were conducted by BJWSA in 1993-94 and 1998. The land was purchased in 1998 and construction of the new system began. The project was named the Great Swamp Effluent Management System (EMS); it was made up of a 500-acre natural wetland. Operations began in January of 1999 and have been steadily running since. Routine water quality monitoring ensures that the wetland remains a safe environment for local flora and fauna. Since the Great Swamp EMS is a natural wetland system, it contains a number of plants that are able to absorb reclaimed water without harm and continue doing so even during rainy seasons.

A series of boardwalks cross the length of the wetland, providing the support structure for the water distribution pipelines. There are two separate systems in place which are alternately used on a rotating yearly schedule so as to not overwhelm the natural balance within the swamp. Once the reclaim had been added to the swamp, the flora of the area further filtered the water, allowing it to fully enter into the water cycle once again.

As the population of Jasper County continues to increase at nearly the same pace as Beaufort County, the amount of wastewater collected on a daily basis is consistently increasing. This resulted in a greater flux of water being directed towards the swamp, requiring an improved distribution system. In 2017, BJWSA undertook a new EMS expansion project in order to better account for the increasing flow of water to the swamp.

Earlier that same year, BJWSA also began the process of expanding its force main system within Beaufort County to better account for the similarly increasing burden being placed on the wastewater collection system due to population growth. This extension would augment flows to the Port Royal Island Water Reclamation Plant and allow for higher collection capacity.
3. DESIGN

This was not the first time that BJWSA had reason to expand their wastewater capabilities. One decade prior, in 2007, a 10-inch fusible polyvinylchloride pipe (FPVC) was successfully installed as a force main below the Beaufort River via horizontal directional drilling (HDD) to deliver water to the Secession Golf Course. At that time, the project was designed by Hussey Gay Bell of Savannah, GA. BJWSA made the decision to work with the same engineering group to design the new line, as they were already familiar with the area in which the project was to take place.

It was decided that the line would be placed parallel, and in close proximity, to the existing line in order to remain within the previously granted right of way. The new force main was to be upsized to 16-inches to meet the current need and prepare for further growth of the serviced community. It would also allow for continued expansion of the existing system in areas where further development may occur.

In total, 5,300 linear feet of DR14 force main was to be installed below the river. It was to be drilled to the north of the existing pipe, along the same alignment, though at a deeper depth (see Figure 1). Since the project was to take place within a previously tested area, no geotechnical report was required. One aspect of the project that would need to be carefully monitored, however, was the tight horizontal ‘S’ curves that the pipe would have to follow to remain within the existing alignment. Though the new pipe would be installed at a greater depth, the proximity to the existing pipe could prove difficult as the non-metallic nature of FPVC meant that it would not appear on the HDD steering tools. The contractor would have to rely on the detailed plans of the original alignment in order to stay an appropriate distance away from the existing pipe without exiting the alignment.

![Figure 1. Approximate alignment of 16-inch DR14 FPVC force main crossing the Beaufort River.](image)

In a similar but separate project, BJWSA continued its work with Hussey Gay Bell to design the expansion for the Great Swamp EMS. As this would expand the existing infrastructure considerably, careful attention had to be paid to the natural life surrounding the boardwalks.

The first phase of this project required 4,200 linear feet of 24-inch DR18 FPVC to be installed from the center of the swamp extension to the north end of the existing swamp in order to connect new system into the existing one. To ensure there would be adequate clearance below the standing water level, the pipe would have to be installed at least 25 feet below the surface. An additional 2,700 linear feet of 24-inch FPVC was to be installed using a standard open cut method to connect the new pipe to the existing effluent main, extending from Highway 278 once the HDD portion was completed. In order for the pipe to be appropriately transported, the logging road connecting the swamp land to the highway was upgraded in order to account for the increased traffic the work would bring to the area.

A geotechnical report was ordered from Terracon Consultants, Inc. to ensure that the planned area was amenable to boring. The testing consisted of two boring points to a depth of 60 feet. Both bores revealed that the first 17 feet of soil was a very loose to medium density sand. Bore 1 revealed that from 17 to 32 feet, the ground was made up of a layer of clay followed by more of the sand variation found above. Beneath that, however, there was a consistent presence of stiff to hard lean clay through until the 60-foot mark. Bore 2 had a similar layer of clay followed by more very loose to medium dense sand as Bore 1 from 17 feet to 60 feet. Overall, the grounds were determined to be an acceptable location for a boring installation method. It was noted, however, that due to the fact that the level of
groundwater would change depending on weather and seasons, the presence of water should be carefully minded during the design.

Due to the tight constraints of the installation area, it was proposed by BJWSA to hand-remove approximately 20 trees along an existing access road to the south point of the swamp in order to create a lay down area for the new pipe as it was fused. Once the pipe was fused, a series of wood mats would be used to transport the pipe from the staging area to the installation point – located in the center of the 600-acre expansion.

The decision to once again use FPVCP for the crossing was made by both owner and engineer; it would allow for continuity within the system and it was a proven choice for the installation method. As the pipe is intrinsically restrained and the outer beading caused by the fusion process can be removed, it is an ideal material for long, subaquatic installations because it reduces the chance of a snag or separation during the actual installation. The comfort felt by both owner and engineer with the material and its durability was also a factor, as the length of both bores would require pull-strengths that gasketed materials would have difficulty matching.

During the planning process of both projects, the US Army Corps of Engineers, the South Carolina Department of Health and Environmental Control, and the Office of Ocean and Coastal Resource Management were heavily involved to ensure that the areas surrounding the projects would remain protected and that the appropriate construction permits were acquired.

4. CONSTRUCTION

Both the Lady’s Island and Great Swamp projects were designed with a specific contractor in mind; the same one who had installed the 10-inch force main in 2007 – Mears Group, Inc. They were not bid out to the general public and instead were put immediately into action once all appropriate permitting had been acquired.

Lady’s Island was installed first. The drill rig, an American Augers 140, was set up at the exit point of the project on the eastern edge of the Beaufort River. An additional American Augers 440 drill rig was set up at the entry point in order to assist with the initial clearing of the bore hole. The set up for the pipe and pull in took place on the western edge on Shipwright Circle in the town of Port Royal in a salt water marsh. To protect the march, temporary platforms were made from construction mats (see Figure 2). It was on these mats that all of the construction machinery and installation work took place.

Figure 2. Construction equipment was kept on construction mats to protect the marsh.
Since the total length of the bore was greater than the available staging area, the FPVCP was fused into six separate strings of pipe that were laid out along the access road (See Figure 3). In total, it consisted of 118 joints using a McElroy T-630 fusion machines. During the installation, a public road did have to be closed to residents to allow for the pipe strings to be appropriately laid out, but there was little to no actual impact to residents as there were additional routes of access to either side of the blocked location. At the time of pullback, five intermediary fusions were made to connect the pipe segments into a single string.

The initial pass for the pipe was made using a 10 5/8-inch bore. Additional passes were made to enlarge the hole to 24-inches and finally to 30-inches. In order to ensure that the hole was clear and stable enough to withstand installation, a final swab was done to 26-inches, clearing any loose debris and ensuring there were no sharp rocks in the path that could gouge the pipe during pull-back.

Pull in began on March 8th, 2018 at approximately 11:30 AM. In order to ensure a proper angle of entry for the pipe into the bore pit, two cranes were utilized to elevate the pipe above the road. From start to completion, pullback took 16 hours, ending at 3:30 AM the next morning. Overall, the installation went smoothly and without any delays. Once the pipe was settled in place, it was pressure tested on March 12, 2018 to 100 psi for a duration of two hours.

A few weeks after the completion of Lady’s Island, Great Swamp was prepared for installation (See Figure 4, right). In this case, however, only three strings were required. Two intermediaries were needed during the pull-back process. In total, 92 joints were fused using a McElroy T-900. The same drilling equipment was used as in the Lady’s Island project, first to open a hole to 10 5/8-inches, then to expand to 24- and 38-inches. Great Swamp was swabbed at 34-inches to ensure the hole had been sufficiently cleared to allow for a smooth pull in.

In view of the actual soil conditions encountered during the drilling process, the pre-installation work took place over a longer period of time than initially anticipated. This had the unfortunate side effect of delaying final completion, bringing the project outside the projected schedule and budget.

Pull in began on April 21st, 2018 at 9:00 AM and took a total of 23 hours to complete. Installation went smoothly, though slowly. It was pressure tested on April 26, 2018 to 100 psi for a duration of two hours.
5. CONCLUSION

The completion of both the Lady’s Island and Great Swamp projects has allowed BJWSA to continue to provide the highest quality of service to their customers without interruption and to maintain their high standard of environmental ethics. It has created a degree of preparedness within the wastewater management system that was previously not held, as well as allowed for a greener footprint as more water is able to enter the natural cycle once more.

Within the Great Swamp, there is still work to be completed before the project can be fully closed out. Approximately 12,300 linear feet of boardwalk is to be installed on sunken piling to cross the new swamp areas. Along the edge of this boardwalk, distribution headers will be attached. It is to these that the new force main will deliver the recycled water, allowing for even dispersing throughout the new area. The very last portion of the project will occur once all the construction has been completed – new indigenous bareroot hardwood seedlings will be planted along the access road impacted by the initial pipe staging and throughout the wetland acreage that was disturbed by the pipe installation. This vegetative repopulation will assist in bringing the swamp back to its full potential as a natural water restoration site.

The success of both projects was in large part due to the open communication of expectations and abilities between owner, engineer, supplier, and contractor. The track record of these four entities working together has proven itself effective and may set an example for future projects of how a proven methodology in combination with the continued cooperation of each group can bear impressively longer and more difficult installations.

REFERENCES

Hussey Gay Bell (2017) – Lady’s Island Force Main Diversion Beaufort River HDD – Plan Set
Hussey Gay Bell (2017) – Great Swamp EMS Expansion – Plan Set
Terracon – Geotechnical Engineering Investigation Great Swamp Expansion Directional Drilling