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**HDD Enables Florida Utility to Serve Popular Tourist
Location Without Interruption**

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1. ABSTRACT

In the early to mid-2000s, Bay County Utility Services of Florida (Bay County) installed a series of potable water transmission mains to better serve its municipal end users. A key segment of the new system included a 2,400-foot 36-inch sub-aqueous crossing, installed by trench, below North Bay and adjacent to Deer Point Dam. In the fall of 2015, a severe, visible leak was detected in the crossing. After evaluation, replacement was selected as the most cost-effective means of repair.

Due to a burst within the North Bay main during a bypass installation, Bay County decided to replace an additional segment of main of a similar age. This 1,100-linear foot length was a subaqueous crossing of the West Bay Intracoastal Waterway. These mains provide the only two delivery points of potable water to the city of Panama City Beach. The leak occurred just two months prior to Spring Break, during which time the City typically experiences a 50-60% increase in peak water demand.

In the face of an extremely limited timeline, all design and permitting was completed within three and a half weeks and completed construction within two months. For both replacements, 30-inch fusible polyvinyl chloride pipelines were installed parallel to the existing main, using a subaqueous horizontal directional drilling (HDD) installation methodology. The focus of this paper will be on the successful use of HDD as a fast and cost-effective construction method for subaqueous water crossings adjacent to existing utilities.

2. INTRODUCTION

In 1913, state officials in Florida began considerations for introducing a new county to the state to allow for a better division of resources amongst the existing population. On February 12th of that year, representatives from five towns surrounding the four bays of the mid-panhandle area met to discuss the formation of this new county, pulling from the existing counties of Washington, Calhoun, and Walton. The new county was incorporated into the state on July 1, 1913 and named Bay County (see Fig. 1). Today, it is home to seven incorporated towns and cities, as well as ten unincorporated cities, five census designated populated areas, and the Tyndall Air Force Base (Tyndall AFB). As of the 2010 census, 168,852 people permanently resided in Bay County.

As part of its duties, the county government formed the Bay County Utility Services (Bay County). Bay County is responsible for the upkeep of water and wastewater systems within the county, including potable water. Its service area includes ten towns and cities, including Tyndall AFB. Bay County obtains its water reserves from the Deer Point Reservoir, which is then distributed out to the various service locations. This allows the county to use surface

water as its main supply rather than ground water, which in turn allows natural reserves to continue to build over time. One of the largest issues Bay County must mitigate as a highly desirable vacation and summer destination is the drastically variable water consumption peaks between winter and summer months.

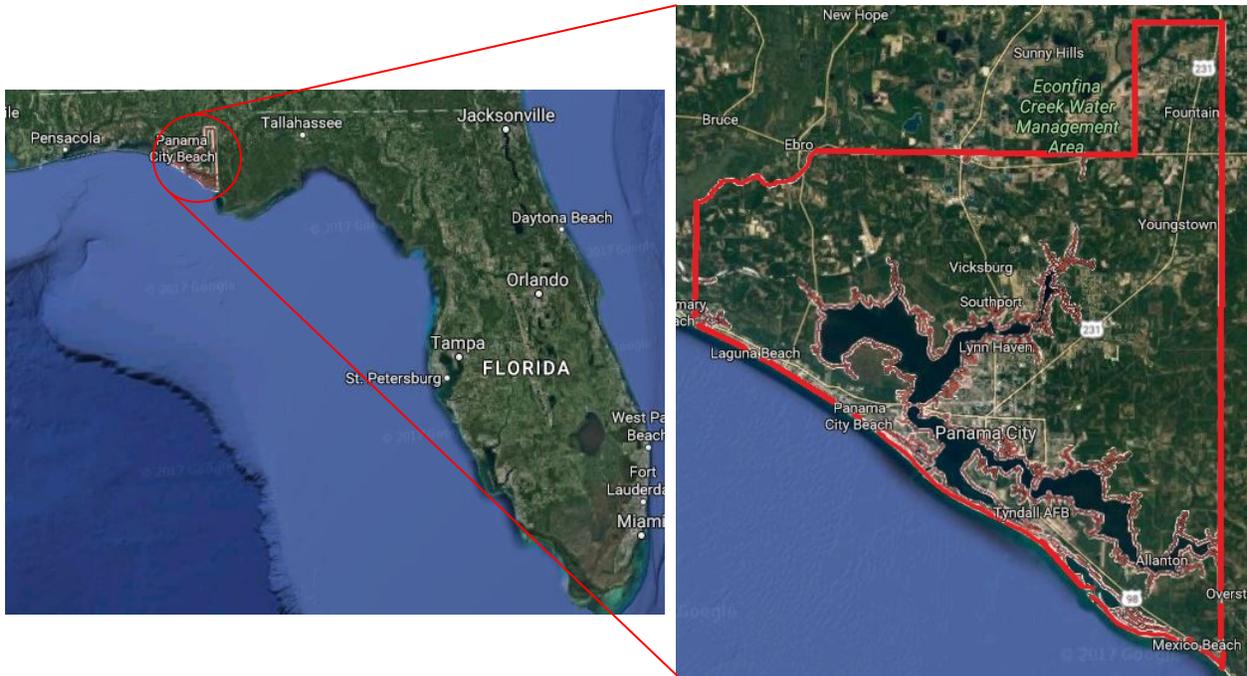


Figure 1. Location of Bay County and Bay County bay system

One of the clearest examples of this is the City of Panama City Beach (City). Incorporated into the county in 1977, the City had an estimated permanent population of 12,191 individuals as of 2014. During the summer months, however, the population swells significantly, reaching approximately 100,000 residents by July each year. The City purchases water from Bay County to supply its residents, an estimated 17 million gallons per day (mgd) during these peak months. Water is supplied from the Bay County water treatment plant, located across the bay from the City. The water is delivered through two access points located below the North and West Bays. The City does maintain reservoir tanks within its limits, however they are not extensive enough to maintain service for more than a 24-hour period during peak season demand.

In order to better serve both its permanent and seasonal residents, Bay County installed new potable water transmission mains from its water treatment facility to the City in the mid-2000s. These were located beneath the North and West Bays and consisted of 36-inch high density polyethylene (HDPE) collared pipe. The pipe had initially been designed to be installed by horizontal directional drilling (HDD), however, once on site, the contractor received permission to use a trenching method in the shallower North Bay crossing and to sink the pipe in the West Bay crossing, leaving much of the pipe exposed. Over the following years, small leaks were detected and repairs made at both locations.

3. PROJECT BACKGROUND

In December 2015, the potable water transmission main crossing the North Bay (Line 1) (Fig. 2, left), located along the Highway 77 Bridge to Southport to the McElvey Plant, began leaking in a place that could not be detected from the surface (see Fig. 2, left). Stretching 2,400 linear feet from the eastern shore to the west, Line 1 was integral to supplying water to the City. As the existing pipe used in the initial installation was not a fused product, the most likely scenario is that a leak had sprung at one of the collared joints due to deterioration with age.

Bay County quickly converted a 24-inch raw water main, parallel to Deer Point Dam to serve as a bypass line and temporarily restored water to the service area. However, before repairs could begin on the leaking subaqueous crossing, Line 1 suffered a complete failure attributed to the internal pressure of the pipeline at the leaking joint location. The damage was severe enough that the water surface looked as though it was boiling as the fresh potable water was pumped into the bay. As a result, the line was no longer repairable; it would need a full replacement

Though the City's reservoir tanks would allow for normal household activity during off-peak season, residents were advised to reduce their water consumption and halt landscaping use to ensure basic needs would be met.

Facing both the City and Bay County was a larger problem – the upcoming tourist seasons. As of March 1st each year, the Spring Break season begins for college students, soon followed by seasonal vacationers beginning in late June. During these periods, the City experiences a 50 to 60 percent increase in water consumption. As these periods are also very important economically for the area, the water line issue needed to be resolved prior to March 1st in order to avoid impacts on tourism activities.

Within the same timeframe that Line 1 had initially been installed, a similar sub-aqueous crossing had been installed consisting of approximately 1,100 linear feet of pipe beneath West Bay (Line 2), connecting the West Bay Plant to the main system (Fig 2, right). In an effort to lessen the chance of a similar failure, Bay County moved forward with replacing Line 2 with the same design approach to avoid another failure previously experienced at the North Bay crossing. No testing was completed on Line 2 prior to the decision to replace it, but by pre-emptively completing the work, Bay County hoped to avoid repeating the same potential pipe failure.



Figure 2. (left) North Bay and (right) West Bay pipe line placement (Existing lines demarked in pink)

Once Bay County had determined that both lines would be replaced, it was decided that an alternative material would be used. Fusible polyvinyl chloride pipe (FPVCP) was chosen as the new pipe material by Bay County, in large part due to its thermally butt-fused joint. Bay County hoped to reduce the propensity of leaks and the risk of sudden failure by eliminating the collared joints, as well as using a different pipe material.

4. DESIGN

Dewberry | Preble-Rish was retained by Bay County to design the emergency project on December 8, 2015. The design timeline was exceedingly tight; from the start of design to permitting, there were only three and a half weeks available in order to begin construction in time for the required project completion date. Additionally, the new pipelines would need to be installed in close proximity to both the existing lines to be replaced as well as other existing infrastructure. To keep things moving quickly, Bay County determined what work was to be accomplished; the City was informed of developments and coordinated schedules.

At the outset of planning, a geotechnical report was ordered by Dewberry | Preble-Rish for Line 1 from Southern Earth Sciences, Inc. (SES) On January 12, 2016, the report was issued. SES used a barge mounted drill rig to acquire the two water borings and a standard drill for two land borings. The borings were located at the site of the anticipated pits and approximately 500 feet offshore at either side of the bay. All samples were split barreled and drilled to 60-feet below the surface before being extracted, placed in airtight containers, and sent to the laboratory for testing and analysis. Along Line 1, the results were mostly variations in sand at various depths.

After the determination that work would also be occurring along Line 2, another geotechnical report was ordered from Magnum Engineering, Inc. (Magnum). This report was delivered on March 8, 2016. In total, six bores were completed for this report; four within the alignment and two farther up State Highway 79. The four bores applicable to the alignment were again located at the anticipated entrance and exit pits and two were accomplished by barge mounted rig along the alignment in the bay itself. The bores were each approximately 60-feet deep and each indicated that the soil composition was primarily sand.

During the cost assessment phase of the project design, it was determined that a full replacement would be the most efficient and cost-effective way for the work to be completed on both lines. However, since Line 2 was not in any proven danger of complete failure, Bay County decided to treat it a little differently. Instead of installing the new line as an immediate replacement, the new FPVCP line would be installed in place but not connected into the existing system right away. Instead, it would be isolated with the use of a valve at either end so that it was functional but it would not be connected into the system until after the peak season passed. This would allow a greater degree of leeway on the installation timeline of Line 2 and would minimize risk of additional service disruptions during construction. Once the FPVCP line was fully integrated, the existing HDPE line would be valved off, providing both Bay County and the City with a redundant line that could be turned on in case of emergency.

The means of replacing Line 1 was limited due to the nature of its failure after the initial leak. The gash in the pipe wall created by the continued passage of pressurized water meant that sliplining was no longer an option. Instead, HDD was chosen to install both new lines as it would allow for deeper placement below each of the bays with minimal disruption to the surrounding area.

Since the pipe material had been chosen by Bay County prior to contacting Dewberry | Preble-Rish, there was no need to walk through a material selection. Due to its smaller outer diameter, 30-inch FPVCP was used, reducing the size of the borehole needed and providing a comparable inner diameter to the existing pipe. This allowed Bay County to save on installation while providing the same hydraulic capacity, and thus quality of service, to the residents of the City while also minimizing the outer diameter and required thickness of the pipe (see Fig. 3).

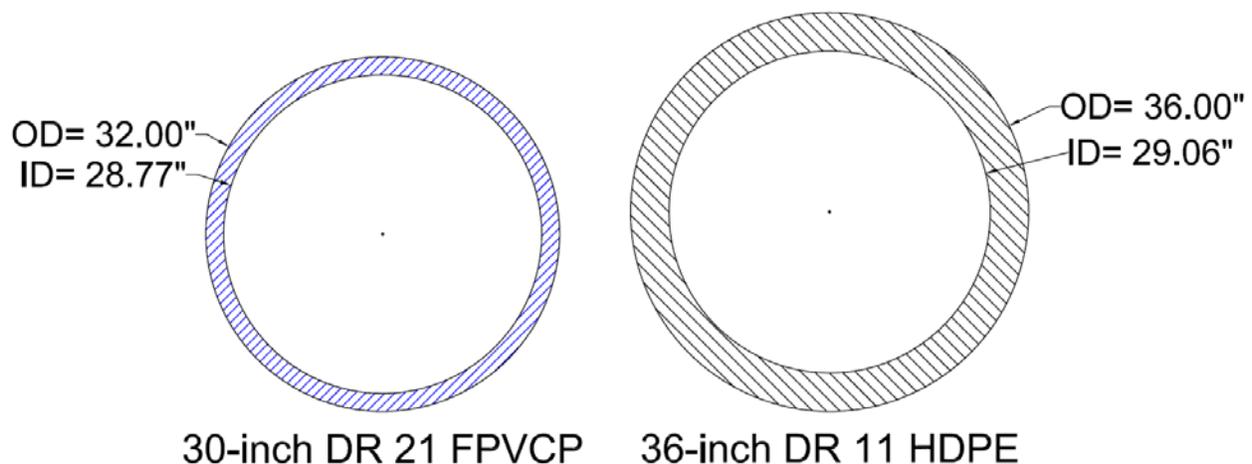


Figure 3. Pipe comparison of 30-inch FPVCP and 36-inch HDPE.

Line 1 was located in such close proximity to Deer Point Dam and its spillway that designing around it would require more time and permitting than the design team had available. Bay County was unable to purchase additional land to the east of Line 1, which was privately owned, to allow space for fusion. This meant the new line had to be installed within the existing right of way.

It also meant Bay County was not required to secure additional state lands authorization from the State of Florida's Department of Environmental Protection (FDEP), which holds the title for the submerged sovereign land beneath both bays. According to the Environmental Resource Permitting and Sovereign Submerged Lands Rules, "Authorization is required for any construction or use on, over or under submerged lands owned by the State."¹ By side stepping this requirement with the reuse of land parcels they already had permission to work on, Bay County was able shorten the schedule by several months. There were, however, emergency permits issued by both the Florida Department of Environmental Protection and the United States Army Corps of Civil Engineers, which allowed the work to occur in public water ways.

To further complicate matters, as-built plans were not available for the dam or spillway, which were constructed in the 1950s, so there was no definitive way to determine how deep either piece of infrastructure was sunk into the bay bed or the exact location of the dam's concrete bulkhead crossing. No members of the Bay County staff had been present at the time of its construction. In a choice made to compensate for this lack of information, the new pipe was to be positioned in a much deeper alignment than the initial pipe. As Line 1 had become partially uncovered from its initial position in North Bay prior to its failure, it was determined that both new lines would be located at least 20 feet below the surface of each bay. This would provide an additional layer of protection for the pipe, which would no longer be exposed to elemental dangers such as weather events. In addition, the surrounding areas would also be less immediately impacted should a new leak occur.

Line 2 also faced design challenges. Line 2 had to cross under the intracoastal waterway at the Highway 79 bridge. At this location, there were deep concrete fenders which protect the bridge from barge traffic within the channel. Similar to the dam at North Bay, the County did not have as-built drawings for these structures which were more than 30 years old. These walls were in place for the protection of the barges making deliveries within the bay. No as-built plans were available for this infrastructure at the time of design. The plan was to have the pipe pass approximately 15 feet below the walls, but without knowledge of the exact location of the sinks made for the fenders' foundation, Dewberry was forced to be conservative with the design and depth of the new line. Please see Figure 4 for Profile views of Line 1 (top) and Line 2 (bottom).

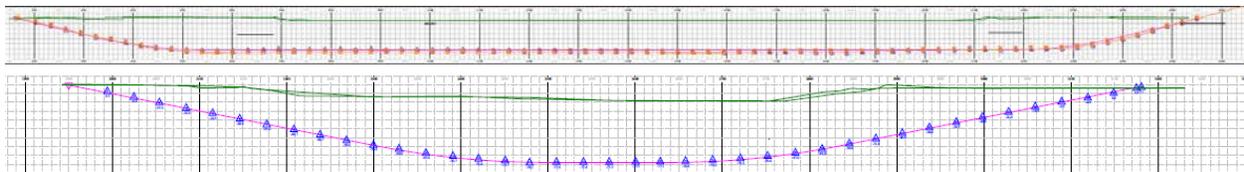


Figure 4. Profile views of Line 1 (top) and Line 2 (bottom).

Since the Line 1 project was so close to the Deer Point Dam and reservoir, the State required the project design to include a contingency plan in case a catastrophic failure occurred during installation. Additionally, because the pipe would be passing through the State's sovereign lands, a frac-out plan had to be developed and implemented in case of release of the bentonite slurry in order to minimize the risk of impacts to environmentally sensitive areas. After installation was completed, the line had to be fully flushed clean with potable water. All traces of this water had to be cleared from the premise to ensure that no sediment remained on site from the construction.

Another aspect of the design that was carefully considered was the bend radius of the FPVC. Due to PVC's naturally more crystalline structure, it is not as pliable as HDPE and is unable to accomplish the same angles of insertion or exit. To compensate for those bend radii limitations, Dewberry | Preble-Rish worked directly with the FPVCP supplier to develop an installation design that would accomplish all of the project goals while also meeting the installation requirements of the pipe itself. Most significantly, the lengths of both bores were increased to reduce the angles of insertion and exit. This increased length also meant the pipe located at a greater depth for a longer distance, which would increase the required pull forces.

At the completion of the design process, Dewberry estimated the cost of the project to be approximately \$2 million for the North Bay portion and approximately \$2.4 million for West Bay.

5. CONSTRUCTION

Given the extremely tight timeline during which the work on Line 1 was to occur, the project was classified as an emergency and not brought to public bid. It was determined that Marshall Brothers Construction & Engineering, Inc. (Marshall Brothers), a local contractor that had performed previous repairs and that had put the temporary bypass line into operation would be best qualified to perform the work. Their previously garnered knowledge of the pipeline, as well as their expertise in the field, would make them the most qualified to take on the task of replacing the damaged lines. The HDD work was completed by TB Landmark Construction Inc. (TB Landmark), a statewide subcontractor well known for its skill with difficult and lengthy drills.

In order to properly accommodate the spring break tourists, who were expected to arrive in a matter of weeks, the work on Line 1 needed to be completed by March 1st, 2016. To meet this timeline, work at North Bay began in the last week of December. The construction of Line 2 began shortly before Line 1's installation was completed. In total, the length of Line 1 was approximately 2,420* feet and Line 2 was approximately 1,250* feet.

During construction on both sites, traffic maintenance was required by the Florida Department of Transportation. The initial layout for Line 1's pre-installation had to be rethought. In order to follow the two-lane road that ran parallel to the right of way, the pipe string would need to traverse a curve that would test its bend radius. (See Figure 5) In an effort to ensure a successful layout, a solution was found through obtaining permission from the adjacent land owner to allow the laydown of the pipe across the privately-owned pasture, located along the right of way.



Figure 5. Pipe layout along road at North Bay right of way.

Line 2 was less complicated in its layout. The road alongside which the pipe would be laid was four lanes wide, including a median, with a split to two freestanding bridges as it crossed the water. This allowed for more right of way space in which to stage the pipe and operate the drill rig. There was a temporary closure of a utility access road during the construction, but the general public was not impacted.

Since both pipes could be laid out to their full length in a single string, no intermediate fusion joints were required during the installation process. The set up that TB Landmark was able to use for the drill and pull equipment was

equally as convenient. During the drill for Line 1, the drill rig was set up near a public use boat ramp in a local park. This was also the site of the exit pit. Due to the boat ramp's proximity to the active work site, it was required to be closed for a short period of time. With clear communication between the City and Bay County, residents were given notice of the activities and expected timelines in order to safely work around the inconvenience.

The drill and pull equipment for Line 2 was located in a spot that had even less of an impact on area residents than Line 1 (see Figure 6). Since the pipeline would be located directly under the bridge, TB Landmark was able to set up their equipment in an overflow parking lot used by local restaurants during busy times. As the work was completed during the off season, this lot was seldom being used and allowed the construction workers to arrive and depart as needed with minimal interruption to local businesses.



Figure 6. Pipe layout below bridge at West Bay.

Two different drill rigs were used during the construction. On Line 1, an HRE 500 rig was used for both pilot drilling and pull back of the pipe while Line 2 utilized a Vermeer 330 x 500. Line 1 was drilled to a max depth of approximately 45-feet while Line 2 was required to go deeper to approximately 64-feet. Both drills began rather smoothly. Ground conditions for the first 600 feet were soft, consisting mainly of sandy soil. Beyond that point, however, conditions quickly changed to a much harder material.

Beneath both bays were limestone rock deposits directly in the path of the drill. Due to the nature of limestone rock, it appears in large pieces rather than being one continuous presence. This means that during geotechnical surveys, it can be easy to miss rock deposits, especially in areas like Florida where limestone is particularly prevalent. In adapting to the changed conditions, TB Landmark switched from the jetting assembly used in soft ground conditions to a mud motor drill using a tricone bit. This bit, which is designed to grind through solid rock in a more controlled manner than a traditional drill bit, had six individual grind points on its outer edge, which allowed a large amount of rock to be ground away at once. In Line 2, there was significantly less limestone to drill through than in Line 1.

The entrance pits used for each drill measured 12- by 20-feet and the exit pits were 6- by 20-feet. The initial pilot bores were 10 ⁵/₈-inches in diameter. Once those had been successfully completed, additional reaming passes were completed at 24-inch, 36-inch, and finally 48-inch cuts successively (see Figure 7 for the custom made tricone bit used by TB Landmark). Once the bore holes were completed and found to be stable with a final swab of 44-inches, the pipe was pulled into each alignment using a 30-inch pull head. There were no issues during pull ins with Line 1

completed in a total of 24 days. With its shorter length and comparative dearth of limestone, the installation of Line 2 took only 7 days.



Figure 7. Custom 48-inch tricone drill bit ordered by TB Landmark for the Bay County project.

Line 1 was successfully installed in mid-February (see Figure 8). The pipe of Line 2 remained in place during the start of the summer season, and was successfully put into operation in by the beginning of August. After the pipes had been pulled into place, they were required to pass a sustained pressure test. Each pipe had to maintain a consistent pressure of 150 pounds per square inch (psi) for 2 hours. Both Lines passed, Line 1 on February 24, 2016 and Line 2 on August 8th later that year.



Figure 8. Pipe connection made at North Bay.

6. CONCLUSION

Due to the coordinated efforts of all involved parties, replacement of both Lines 1 and 2 were completed successfully, on time, and within budget. By using HDD as the installation method for both lines, an estimated four to six months of construction time was saved, significantly decreasing the impact on the local communities as well as the overall cost for Bay County.

By staying near the existing alignment of the original transmission lines and utilizing the existing right of way, Bay County avoided the application process for sovereign land use with the Florida Department of Environmental Protection as well as additional regulatory permitting requirements. Since the area had already been approved for work, no additional environmental areas were affected by the design and installation method. Additionally, working within the existing right of way also allowed Bay County to mostly avoid time consuming negotiations with private land owners in an attempt to expand the available work area to the east of Line 1.

With the successful installation of both lines, Bay County provided continued quality service to a popular tourist destination during one of its peak water usage periods. By providing a fast, thorough repair, residents were offered peace of mind that quality service would continue for a long time into the future.

7. REFERENCES

¹Sovereign Submerged Lands Authorizations (June 30, 2015),
<http://www.dep.state.fl.us/water/wetlands/erp/ssla.htm>