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**Clay County Utility Authority Utilization of Trenchless Water &
Wastewater Pipeline Installation**

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1. ABSTRACT

Clay County Utility Authority (CCUA), located outside of Jacksonville, FL has utilized trenchless methods of pipeline installation since the 1990's. This includes the use of HDD, jacking and boring, slip-lining, pipe pushing and pipe bursting within their potable and reclaim water distribution systems and wastewater force main pipelines. CCUA has gained significant experience with the trenchless technology since its introduction in the county and currently has over fifteen miles installed with no operational issues. Learning gained during some early installation challenges has been applied to establishing best practices for HDD installation that have led to an outstanding installation track record. CCUA continues to experience a growing need for trenchless pipe installation to cross roads, wetlands, waterways, and existing utilities and in some instances avoid expensive restoration associated with traditional open cut. Specific projects illustrate these experiences and cover pipe sizes from 4-inch to 20-inch and HDD bores up to 3,000 LF in length to cross a variety of ground conditions. CCUA design criteria for utilizing trenchless methods and materials illustrate the way in which CCUA has adapted trenchless technologies into their system, including future maintenance and long term material compatibility with specific service applications.

This paper will review a variety of projects where CCUA has leveraged the installed cost advantages associated with trenchless technologies. It will also review the lessons learned by CCUA in terms of designing, bidding, applying and installing trenchless methods and materials with their infrastructure projects.

2. INTRODUCTION

Clay County Utility Authority (CCUA) was established by a special act of the Florida Legislature on Oct 1, 1994. As of September 30, 2013, CCUA serves approximately 47,500 water accounts, 43,600 wastewater accounts and 11,900 reclaimed water accounts in the unincorporated areas of Clay County, Florida. CCUA's primary goal is to provide the highest quality service at the best value for its customers.

CCUA has employed a number of different trenchless technologies including the following since 2004:

1. Horizontal Directional Drilling
2. Conventional Jack and Bore
3. Pipe bursting
4. Cured in Place piping (Insituform®)
5. Pipe push method

Because of the amount of work CCUA contracts yearly, 5-year continuing contracts have been entered into for the horizontal directional drilling, jacking and boring and slip-lining work. CCUA recently piggy-backed an existing pipe-bursting continuing services agreement to obtain these services. Piggy-backing is a commonly used practice by municipalities and government agencies that involves entering into an inter-local agreement to allow the requesting government body to use a construction or procurement contract that was publically bid by the other governmental body. There are laws governing the correct procedures and limitations for piggy-backing contracts which must be followed to prevent protests from competing vendors and contractors.

3. TRENCHLESS METHODS UTILIZED

Horizontal Directional Drilling (HDD)

CCUA entered its first continuing contract for horizontal directional drilling in 2004. This was a 5-year continuing contract for equipment and labor only. Selecting the Contractor was based on evaluating a number of factors. These factors are listed below:

1. Cost - Cost is always an important factor, however it is not the only consideration.
2. Emergency Service - Contractor must respond to an emergency situation within 24 hours and be mobilized and ready to make repairs as required and in accordance with the specifications.
3. Experience of the Firm - Years of experience providing these types of services along with customer references are important factors that will be considered. Contractor shall have successfully installed in last 24 months, a minimum amount of 10,000 linear feet (LF) of pipe for the referenced type of work.
4. Logistics - The location of the firm in relation to the service area and the logistical effort required to transport equipment are factors that will be taken into consideration.
5. Prior experience - The CCUA reserves the right to reject a bid based on unsatisfactory prior experience with a firm.
6. Equipment Availability - Contractor must own or have a long-term lease for all equipment and be capable of performing all of the work listed in the bid form with this equipment.
7. Safety: The Authority reserves the right to reject a bid based on unsatisfactory safety record or a lack of documented safety procedures.
8. License Required - Contractor must have valid Florida Underground Utility Contractor's License.

All work under the agreement must be covered by a 1-year, 100 percent performance and payment bond with an additional 1-year, 100 percent warranty bond for the second year of the warranty period. Purchase orders are issued for all work. For planned projects, the bond is delivered along with the signed copy of the purchase order for the amount of the purchase order. For emergency work, CCUA requires the contractor to maintain at all times, a \$100,000 performance and payment bond that is renewable on an annual basis. The additional 1-year warranty bond is required for all emergency work. The most common example of emergency work CCUA experiences is replacing a damaged above ground stream crossing with a directionally drilled pipeline.

CCUA pays the premium of the annual bond up to a maximum of 2.5 percent of the project cost to cover both emergency and planned work. The bond costs for planned work are based on the bid price for the bond provided in the bid form. Once a project design is complete and CCUA is ready to move forward with implementation, a separate procurement only bid is prepared for the directional drill pipe and materials. Generally this is a two part bid with separate parts for bidding either high density polyethylene pipe (HDPE) or fusible polyvinylchloride pipe (FPVCP). Bidders which include material supply houses are permitted to bid either or both parts. Because of the differences between the two types of pipe with regard to inside diameter, the sizes may differ for the pipe type on the bid form. For example, a 16-inch nominal diameter FPVCP C-905, DR 25 pipeline has an inside diameter of 16.01 inches; whereas, to achieve the same inside diameter from an HDPE DR 11 requires a 20-inch nominal diameter pipeline with a 16.15 inch inside diameter. The DR rating is also critical for the design engineer to review in selecting the proper pipe type. Most often this is selected based on two factors; the maximum working pressure

of the pipeline and the overall anticipated loading for the pipeline to be installed when compared to the safe recommended pull force for the given pipe section.

As previously stated, the 5-year continuing contract covers equipment and labor. This includes fusing of the pipe in most instances; however, the FPVCP supplier in most cases does not certify directional drill contractors to fuse pipe material over 12-inches in diameter. Therefore, the procurement bid must include these services. Another item that may need to be included with procurement bid is any special equipment such as pull heads that the pipe supplier will provide to the driller during the installation.

Lastly, for large diameter directional drilling projects (over 16-inches in diameter) CCUA requires the pipe supplier to provide instruction and supervision when necessary ensure the proper handling and installation of the pipeline. The following is an excerpt from the CCUA standard specifications that covers this requirement.

The Seller shall provide detailed written instructions for the handling, joint fusion, installation and testing of the pipe material and shall warrant the materials providing the following:

- a. The installation is performed by a Contractor whose personnel are certified by the Seller;*
- b. All personnel of the Contractor who fuse pipe joints shall be certified by the Seller;*
- c. The bore plan for each directional drill shall be reviewed and approved by the Seller;*
- d. The filling and pressure testing of the pipeline upon successful completion of each installation shall strictly follow the Seller's written instructions; and*
- e. All written logs and field inspections support that the Seller's written instructions were strictly followed.*

If there are costs associated with the services identified above, the bidders need to include these in their bid pricing. The intent of CCUA is to obtain all of the missing, outstanding, or additional pricing during the procurement bid so it can evaluate its least total cost for the pipeline installation. This least total cost is based on competing suppliers which is required by CCUA's purchasing policy.

Lastly, CCUA has some concerns with utilizing HDPE pipelines with its reclaimed water distribution system due to elevated chlorine residual levels in the reclaimed water. To alleviate these concerns CCUA worked with the HDPE pipe manufacturer's technical experts to develop a special specification that provides the cell classifications that are the most resistant to chlorine. This specification is provided below:

Materials used for the manufacturer of polyethylene pipe and fittings shall be PE3408 high density polyethylene meeting cell classification 445574C or 445574E per ASTM D3350; and shall be listed in the name of the pipe and fitting Manufacturer in PPI TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds, with a standard grade rating of 1600 PSI at 73°F. The manufacturer shall certify that the materials used to manufacture pipe and fittings meet these requirements.

Conventional Jack and Bore

The State of Florida allows local governments to enter into inter-local agreements for the purpose of "piggy backing" procurement contracts for goods and special services. Since CCUA is a special district, it can piggy back contracts and this was the source of CCUA's original continuing services contract with its jack and bore contractor. Unfortunately, this contract only had a short-term duration and CCUA has since bid and awarded a separate 5-year continuing contract for these services. CCUA used most of the same factors as were previously discussed under horizontal directional drilling to select the successful bidder.

Except for Florida Department of Transportation (FDOT) highway and Chessie Seaboard Express (CSX) railroad crossings, CCUA has developed its own standard details for jack and bore installations. The differences are in the sizes of the various steel casing pipe for a particular size carrier pipe and the fact that CCUA does not require each joint of the carrier pipe to be restrained. Casing spacers are required but only the carrier pipe sections at the ends of the casing pipe must be restrained to its respective end of the steel casing pipe. This is accomplished with all thread

rods that attach to an all-grip restrainer gland on the carrier pipe and to an eye bolt that is welded to the end of the steel casing pipe. CCUA's standard detail which illustrates this design is provided in Figure 1.

CCUA is presently considering allowing FPVCP carrier pipe in an effort to further reduce the size of the steel casing pipe. No casing spacers are needed for this method, therefore, the casing size can be reduced for most applications.

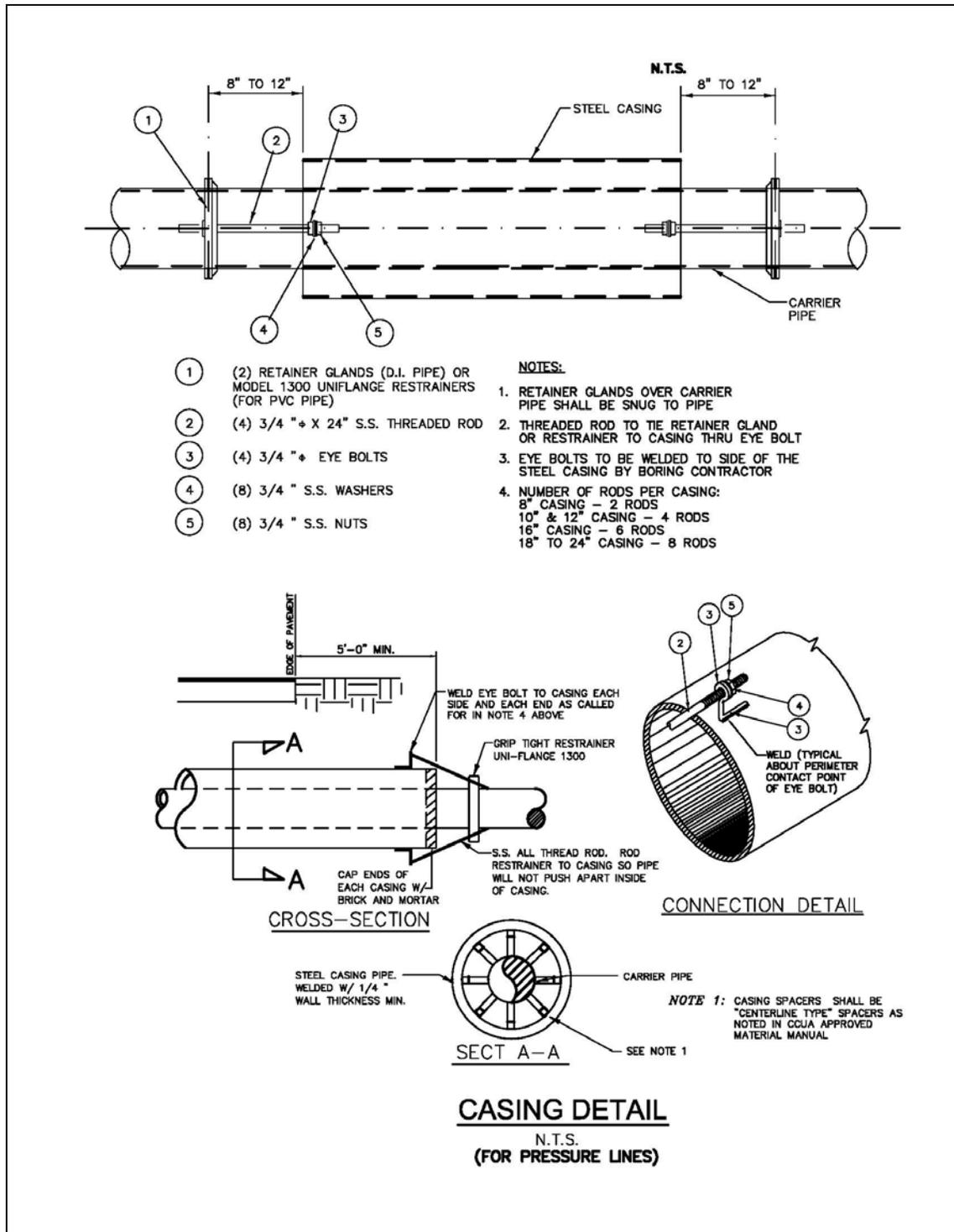


Figure 1. CCUA jack & bore standard detail for restraining the carrier pipe to the casing pipe at the ends.

Pipe Bursting

CCUA had a continuing contract for pipe bursting services at the end of the 1990's but no projects were ever completed under this agreement. Since then, CCUA has bid and performed one pipe bursting project within a somewhat inaccessible area to convert a 12-inch sewage force main into a 12-inch reclaimed water main. The project was successful although the lengths of the pulls were less than what was originally portrayed to CCUA by the pipe suppliers. This resulted in having to access the pipeline corridor in more locations to set-up the pipe bursting equipment.

Since the completion of this project, CCUA has started planning and implementing a capacity, management, operation and maintenance (CMOM) program with the goal of cleaning and televising all of CCUA's gravity sewer collection system every 5 to 10 years. Given that they anticipate finding sewer lines that may require two or more point repairs, CCUA piggy-backed a continuing services contract in 2012 for pipe busting services to repair and replace these pipelines.

Cured-in-Place Pipe (CIPP)

CCUA has had a continuing contract for cured-in-place pipe (CIPP) since the 1990's and has lined many miles of gravity sewers. CCUA has its own cleaning and televising equipment and performs routine inspection and maintenance on its gravity sewer system. This program has been very successful in eliminating infiltration and inflow into the gravity sewer system over the years and the plan is to continue this method of trenchless technology. In 2012, CCUA employed CIPP technology to rehabilitate a pressure pipeline underneath a major thoroughfare. The project was a success and a second project in the 2013-14 fiscal year is being planned.

Pipe-Push

Lastly, CCUA has installed numerous pipe-pushes beneath roads and driveways for many years. This saves customers money in restoration costs and is a very proven method for small diameter service pipelines and mains. Pipe-pushing is generally limited to pipe sizes of 4-inch diameter and smaller. Generally, 4-inch diameter pipelines are limited to approximately 60 feet in length; whereas, 2-inch and smaller pipelines can be as long as 120 feet. The process involves pushing a steel rod with a hydraulic ram beneath a road or driveway and then setting up on the opposite side of the hydraulic ram and pulling the pipeline in behind the rods.

4. FIELD EXPERIENCE AND IMPLEMENTATION

Spencer Road Pipe Bursting Project

CCUA rehabilitated approximately 7,150 linear feet of an existing 12-inch PVC reclaimed water main. The existing pipeline is located in a highly urban area in Orange Park, Florida. Access to the easement area where the pipeline is installed is difficult and trenching for the pipeline rehabilitation was seen as highly intrusive and expensive. The existing pipeline was a pressure class 100 PVC pipe. The existing pipe was approximately 25 years old. The highly urban nature of the area around the existing pipeline also included numerous other existing underground utilities in close proximity.

CCUA decided to replace the 12-inch PVC pipe line using the pipe bursting method (see Figure 2). The pipe bursting method allowed for significant portions of the pipeline to be rehabilitated with minimal impact to the existing properties where the pipeline is placed.

CCUA's contractor had set-up pits between 130 to 1,000 linear feet apart depending on obstacles or changes in direction along the installation route. The contract for the installation of the 12-inch PVC allocated 90 calendar days to reach a substantial completion progress level. The 7,150 linear feet of rehabilitated pipeline was installed, pressure tested, and placed into service in 66 calendar days.

CCUA's contractor worked with CCUA's staff to field-locate the existing utility infrastructure which crossed the pipe bursting operation route. There were two locations where the existing utilities were found to be too close in proximity to pull the pipe bursting head past safely. These two areas were open cut and the new reclaimed water main was installed by the traditional trenching, placement, backfill, and restoration methods.



Figure 2. The picture on the left shows an elevated alignment of the replacement pipe being installed with pipe bursting methodology, and the picture on the right is a close up of the pipe bursting head, expansion head and replacement pipe as it is entering the existing pipeline.

Issues with the pipeline installation during construction involved two adjacent gravity sanitary sewer laterals which were struck by the cutting edge of the pulling head. These service laterals were inactive and capped after a TV inspection was made. Other construction issues included pavement cracking due to soil displacement. There was one area where the pipe burst operation clearly caused the upheaval and then cracking of an existing concrete pavement. There was one additional area where cracking of the existing pavement was claimed by the property owner, but this area was in question. Considering the length of the pipe bursting project, the small areas of pavement cracking were very small in comparison to the potential disturbance which could have been caused by open trenching to rehabilitate the reclaimed water pipeline.

Ridaught to Mid-Clay Wastewater Treatment Plant's Utility Main Extensions

The Ridaught to Mid-Clay WWTP Utility Main Extensions project connected CCUA's Ridaught Waste Water Treatment Plant (WWTP) to the Mid-Clay WWTP through a series of reclaimed water main and sanitary sewer force main extensions. The utility main extensions were installed by direct bury, horizontal directional drilling, and jacking and boring.

The construction of the utility main extensions was completed in three parts. The horizontal directional drilling portions of the project, with one exception, was completed under the CCUA continuing contract for horizontal directional drilling services. The upland trenching and restoration portion of the project was placed out to bid and awarded to the lowest bidding contractor. The utility main on the County Road 209 bridge was handled as a completely separate project and bid out separately.

CCUA installed over 2,900 LF of 18-inch FPVCP for reclaimed water mains, 2,900 LF of 18-inch FPVCP for sanitary sewer force mains, 700 LF of 24-inch FPVCP for a reclaimed water main, and 1,800 LF of 16-inch FPVCP for a sanitary sewer force main by horizontal directional drilling methodology. CCUA elected to use the horizontal directional drill method of installation because the 16-inch sanitary sewer force main was installed through an existing residential neighborhood. The 18-inch pipelines were installed under existing wetlands. The 24-inch reclaimed water main was installed within an easement which crossed an active public school site. CCUA wanted to minimize surface impacts along all of these pipeline routes. Horizontal directional drilling allowed for the installation of long segments of pipeline and minimal impacts to existing residential driveways, wetlands, and a school parking lot.

The horizontal directional drilling commenced in February, 2012. There was a considerable amount of coordination with all of the property owners during the course of the drilling operations. The horizontal directional drills were completed in June, 2012.

The trenching portion of the project involved the installation of approximately 10,300 LF of 18-inch PVC reclaimed water main, 10,000 LF of 18-inch PVC sanitary sewer force main, and nearly 6,300 LF of 24-inch PVC reclaimed water main. The trenching portion of the project also included three jack and bores under two existing county roads with heavy volumes of traffic. Two of the jack and bores were 36-inch steel casings totaling a length of 193 LF. The remaining jack and bore was for a 30-inch steel casing with a total length of 155 LF.

The jack and bore method for the installation under the existing county roads was chosen because of the limited area to land on one side of the road, the need for precise elevations and a protective steel casing because of future storm water infrastructure which was going to be installed in close proximity to the new utility mains. The trenching portion of the project was given the notice to proceed on July 30, 2012. The substantial completion of the trenching portion of the project was held on April 11, 2013. This resulted in a 256 calendar day construction period.

During installation of the horizontal directional drills, one handling break of a FPVCP pipe string occurred. The failure occurred at a fusion joint and was attributed to inadequate fusion during the joining process. The drilling contractor cut the FPVCP just beyond the pipe failure and joined the pipe to the next pipe segment with another fusion joint to complete the installation (see Figure 3).



Figure 3. An intermediate butt-fusion joint is performed at the location of a break that was realized during installation of the pipe string.

One inadvertent drilling fluid return to surface (frac-out) was experienced during the horizontal directional drilling operations along County Road 209. The event displaced and broke a 2-inch water main serving a local veterinary clinic. The contractor quickly isolated the water main break and began clean-up and restoration operations. Considering the length of the horizontal directional drills on this project, the frac-out event was a relatively minor issue. However it occurred on a property where the owner had been very clear that he did not want his property impacted in any way.

In having the horizontal directional drills completed by one contractor and the trenching portion of the project completed by another, CCUA had to coordinate the connections where these pipelines met. The trenching contractor had bid the project based upon the design presented on the drawings included in the bid package. Field conditions differed somewhat from the design drawings due to location of the entry and exit points, exit angles, depth of pipeline, etc. These differences between the design and the field conditions resulted in several change orders to CCUA.

16-inch Potable Water Main Extension from NE Commercial Circle to the Postmasters Water Treatment Plant

The 16-inch potable water main extension from NE Commercial Circle to the Postmaster Water Treatment Plant (WTP) was a project that involved over 17,000 LF of 16-inch PVC and FPVCP. Within the scope of this project 550 LF of the potable water main was installed with a horizontal directional drill and nearly 400 LF of 24-inch steel casing was installed under State Road 100 and other local county roads.

This project was unique in the fact that CCUA assigned the authority's horizontal directional drilling and jack and bore contracts to the project's low bidder, the primary contractor. CCUA had provided itemized allowances for CCUA's horizontal directional drilling and the jack and bore contractors in the bid documents. The contractor awarded the project was to utilize CCUA's assigned contractor's as if they were their sub-contractors.

During installation of the 550 LF horizontal directional drill, the 16-inch FPVCP pipeline filled with a substantial amount of mud. This was caused by the horizontal directional drilling contractor not securing the end of the pipeline after the successful installation and a significant amount of rain causing soil to flow into the newly installed pipeline. The mud in the pipeline was a significant issue for CCUA because the expansion of the nearby Postmasters WTP was under construction. The CCUA did not have a water supply with sufficient pumping capability to adequately flush the mud out of the horizontally directionally drilled pipeline.

CCUA elected to purchase a new piece of Vac-Con® equipment and vacuum out the newly installed pipeline. This procedure removed the majority of the mud from the pipeline. The contractor was then able to sufficiently flush the pipeline with the water supply CCUA had available.

The other issues on the 16-inch water main extension from NE Commercial Circle to the Postmasters WTP involved coordination between the primary contractor and the two sub-contractors CCUA had assigned to the primary contractor. The issues included sub-contractors arriving on-site and finding the area of work had not been prepared, pits were not dug, pits were not prepared per the project specifications, etc. The contract documents were clear regarding the delineation of responsibilities. CCUA staff had to provide a relatively heavy hand in guiding the coordination efforts.

Spencer's Lake / Glenn Utility Protection

The Spencer's Lake / Glenn has an existing storm water management system spillway that is failing (see Figure 4). The failing spillway has an existing potable water main and an existing gravity sanitary sewer main under the spillway which has become exposed. The final failure of the spillway and the storm water lake embankment will likely sever the existing exposed utility mains.

CCUA developed a utility protection plan which involved horizontal directional drills of a new potable water main and sanitary sewer force main under the failing spillway. CCUA designed the horizontal directional drills to be deep enough so when the final failure of the spillway happens, the new pipelines will not be affected. The project area

was relatively small with set landing areas on each side of the control structure. The horizontal directional drills were approximately 220 LF of a sanitary sewer force main and 240 LF of potable water main, both completed with FPVCP (see Figure 5).

The horizontal directional drill contractor used one day for the delivery of materials, one day for set-up and preparation, one day to drill the sanitary sewer force main and one day to drill the potable water main. The horizontal directional drilling of the pipelines was completed inside of one week. There were no issues or complications during construction.



Figure 4. The existing spillway at Spencer's Lake / Glenn that is failing over time.



Figure 5. The pipe for the HDD was fused and staged in a tight landing area on one side of the spillway.

5. CONCLUSIONS AND LESSONS LEARNED

Underground trenchless technology, such as pipe bursting, horizontal directional drilling, and jacking and boring offer excellent rehabilitation or installation methods for underground utilities. Pipe bursting has demonstrated itself as a cost effective and less invasive method of rehabilitating existing underground utility mains. Horizontal directional drilling and jacking and boring have proven to be dependable methods of installing underground utility mains in difficult areas such as wetlands, under hazards, and under roadways with heavy volumes of traffic. The following items detail some specific lessons learned regarding CCUA's experiences, looking forward to more trenchless work in the future:

1. The first lesson learned deals with having two separate contractors working on two aspects of the same project. Language describing some form of contingency in connecting the pipeline installed by the horizontal directional drilling contractor and the contractor installing the pipeline by the traditional trenching methods is recommended. There are always some variations from the design drawings and the installed pipelines. Having language in the contract with which every contractor is following in the installation schedule to include contingencies for such items as cutting back the pipes or the addition of fitting, etc., is recommended to avoid change orders.
2. The second lesson learned involves the assignment of CCUA's continuing contracts to the design-bid-build primary contract. Clear and concise listing of responsibilities is recommended. The listing of clear responsibilities helps reduce potential work trading and potential change order. It is also recommended that the owners field representative be well versed in the listing of responsibilities to prevent work trading in the field.
3. The third lesson learned involves monitoring the care taken by the contractor in the installation of the pipelines with the horizontal direction drill method. Poorly fused joints and unprotected ends of drills are items which can be easily avoided. Having well trained utility inspectors can minimize these types of issues.