Design and Installation of a Large Force Main

The Conway Easterly Force Main Project in Orange County

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The Conway Easterly Force Main project in east Orlando was undertaken by the Orange County Utilities Division (OCUD) to upgrade existing wastewater transmission systems and to provide sewer service capacity for future development in the study area, which included large, undeveloped parcels of land in eastern Orange County.

There are more than 20 lift stations that manifold and pump into the old force main that carries flow from the Conway Master Pump Station to the Eastern Service Area WWTF. Because many of the existing smaller pump stations were having to pump against heads that exceeded design heads, the county needed a new force main so that flows from the Conway Master Pump Station could be diverted from the existing system, allowing the existing pump stations to operate within their design conditions.

The OCUD was faced with the alternatives of upsizing existing force mains and upgrading dozens of existing pump stations, which were operating near shut-off head, or constructing a new, large-diameter wastewater transmission main into which existing wastewater flows could be diverted. After careful review, the OCUD decided to implement a new wastewater transmission main with the help of Glace & Radcliffe of Maitland. The project included the construction of approximately 8.4 miles of PVC force main and improvements to the existing Conway Area Master Pump Station. A portion of the force main was constructed using 36-inch PVC pipe, which is the largest PVC pressure pipe installed in the United States.

Preliminary Design Phase

Preliminary design involved the following tasks:

- Definition of service/study area boundary
- Estimation of existing wastewater flows
- Estimation of additional wastewater flows from urban development
- Prediction of total future wastewater flows for the service/study area
- Definition of alternative force main routes between the pump station and WWTF
- Completion of field investigation of each alternative route
- Performance of hydraulic analysis and select force main size for each alignment alternative
- Estimation of the cost of each force main alignment alternative
- Ranking of each alternative relative to cost and other non-economic factors
- Recommendations of the preferred alternative based on ranking

After the alternative force main alignments were evaluated and ranked, the preferred force main alignment alternative utilized an existing Orlando Utilities Commission (OUC) power right-of-way/easement. OUC agreed to grant OCUD an easement for construction and operation of the force main with the stipulation that in the vicinity of its high voltage transmission cable towers, the force main needed to be constructed with restrained joints, regardless of whether there were fittings or valves that needed to be restrained.

Final Design

During this phase of the project, the detailed project design was completed, the construction plans and specifications were prepared, permitting was completed, and necessary utility easements were defined and acquired. The project team consisted of the county staff and a consulting engineering team consisting of Glace and Radcliffe and a number of specialty firms to provide specific design services. The specialty services included land surveying, aerial photography, environmental assessment and permitting, and electrical engineering.

Numerous issues related to the pipe class, hydraulic requirements, transient analysis, and thrust restraint were addressed. The required peak pumping capacity of the Conway Master Pump Station was 2,800 gpm (4.0 MGD) for the design period (through 2005). Using measurements from the preliminary design report, a computer model, and computer flow simulations, the hydraulic

conditions for the station were estimated. Based on the results, it was determined that the hydraulic design condition for the Conway Master Pump Station was 2,800 gpm at 122 feet of total dynamic head. Because the pump station was a triplex station, the peak flow condition had to be met with two pumps operating and the third pump designated as a standby.

After a review of the existing wetwell, it was determined that it had sufficient capacity to meet the design flow condition and that the wetwell was still in excellent condition. Therefore, it was decided to reuse the existing wetwell and replace the three existing 47 hp pumps with 88 hp pumps, that were capable of pumping 1,400 gpm at 122 feet of head.

Another issue addressed during the final design was the concern of pressure transients in the force main transmission system. To address these concerns, a computer transient flow analysis was utilized to predict pressure transients in the force main system. Under a worst case scenario (instantaneous valve closure), the predicted pressure surge in the system exceeded 100 psi. As a means to minimize the effects of any potentially harmful surges, it was decided to include a surge relief valve in the piping configuration near the Conway Master Pump Station. The valve was tied back into the wetwell where pressure and liquid could be bled off if the system experienced a surge exceeding the setting of the surge relief valve.

During final design, consideration was also given to the class of PVC pipe to be installed. The peak system pressure which could be experienced under an abnormal event was estimated to be 125 to 150 psi. Thus, it was decided that PVC pipe having a DR 25 wall thickness and meeting the requirements of AWWA C905 would be suitable.

There were several areas where the pipe would be subjected to exceptional deep burial (in excess of 20 feet). For these areas an analysis of pipe wall failure was conducted, and it was concluded that PVC pipe with a DR 18 wall thickness would be suitable. IPEX was the manufacturer who would be supplying all of the PVC pipe for the project.

Proper restraint of the force main at fittings and other points where unbalanced thrusts occur was also considered. Typical means of restraint for pipe systems include both thrust blocking and restrained pipe joints. Due to the large PVC pipe sizes being used, the project team decided to use a pipe restrainer that is bolted around the outside of the pipe in a way which allows a full 360 degree contact with the pipe wall.

Permitting for the project included preparation and submittal of a DEP permit to construct a wastewater collection/transmission system, a DEP environmental resources permit, and an FDOT utility permit for a major expressway bore and jack crossing. The environmental resource permit was necessary for permitting the construction of the force main through several existing wetlands. This permit required that the county mitigated the construction of the force main in the existing wetlands by creating new wetlands at a remote location. Thus, the specified project work in the contract documents included the creation of approximately 11.3 acres of wetland on property owned by Orange County.

Once the final design of the force main project was completed to a point where the specific location of the force main was established, the required permanent utility easements and temporary construction easements across private property were identified. The entire force main would be constructed on property that was either owned by the county (or the county already had an existing easement), owned by the OUC, or owned by private property owners who had already granted a power easement to OUC.

Construction

The contractor started the work by first surveying and staking the entire pipe alignment, so that the areas could be cleared, grubbed, and prepared for the pipe installation. In areas where the contractor anticipated high groundwater, dewatering was initiated prior to excavation and installation of the pipe. Dewatering was accomplished by use of an underdrain system consisting of 5-inch perforated pipe installed along the alignment of the force main. The perforated pipe was connected to dewatering pumps so that areas could be dewatered several days in advance of the excavation of the pipe trench. The contractor had five dewatering pumps which could be moved to different locations during the course of pipe installation.

Pipe was delivered from the factory by trucks and by railcar. Once pipe installation was started, the contractor installed pipe at an average of over 500 feet per day. IPEX fabricated and delivered all of the pipe within a 4-month period and did not cause any delays for the contractor. The total pipe installed on the project included 18,960 feet of 36-inch PVC pipe, 4,280 feet of 30-inch PVC pipe, 9,380 feet of 24-inch PVC pipe, and 2,280 feet of 20-inch PVC pipe.

Excavation of the pipe trench and installation of the pipe was completed using a Komatsu PC-400 backhoe. Where restrained joints were required, the contractor mounted the clamping ring on the pipe above ground. After the pipe was installed in the trench, the pipe crews installed the steel rods between the rings or rings and fittings. To facilitate field installation of the threaded rods and nuts, the contractor utilized an engine powered air compressor and air impact wrenches to tighten the nuts onto the threaded rods.

Minimal problems were encountered during construction, and none was related to the pipe or its installation. The most significant problem involved a 320-foot long jack and bore crossing of an expressway. It required installation of a 48-inch steel casing with a 30-inch PVC carrier pipe. While installation of the 48-inch casing was progressing, the ending 10 feet of the casing separated from the remaining trailing portion of the casing and could not be advanced. Several options were considered, and the decision was made to insert a 42-inch casing inside the 48-inch casing and complete the jack and bore using the 42-inch casing. The 42-inch casing was successfully pushed through the 48-inch casing and advanced across the expressway. Because the casing spacers were set up to be used with a 48-inch casing, the spacers had to be specially modified.

On-site Testing

After installation of all the force main pipe, the installed pipe was subjected to pressure and leakage tests conducted between in-line valves along the length of the force main. The tests consisted of maintaining a 100-psi gage pressure for two hours. There was no reported leakage over the entire 35,000 feet of PVC pipe. We believe that this is testimony to the overall high quality of IPEX PVC pipe.

Commissioning

Activities required for making the force main operational included certifying the completed construction to permitting agencies and opening and shutting valves at various connection points in the system to flow diversion from the existing force main system into the new force main system. The flow diversion was completed as soon as the permitting agencies provided a clearance for operation letter.

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