

**MINIMIZE YOUR FOOTPRINT AND YOUR MAINTENANCE HEADACHES –  
50 MGD SELF-CLEANING TRENCH TYPE WET WELL DESIGN**

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## 1. INTRODUCTION

### 1.1 TRENCH TYPE WET WELLS

#### 1.1.1 HISTORY

Trench type wet wells were invented by D.H. Caldwell in 1964. Subsequently, twenty-seven wet wells of this configuration were constructed for Seattle Metro (present-day King County Department of Environmental Services) based on the prototypical Kirkland Pump Station (Figure 1). The Seattle Metro and Kirkland pump stations were observed to be more efficient to other station designs of the era; especially in regard to storage requirements and dewatering processes.

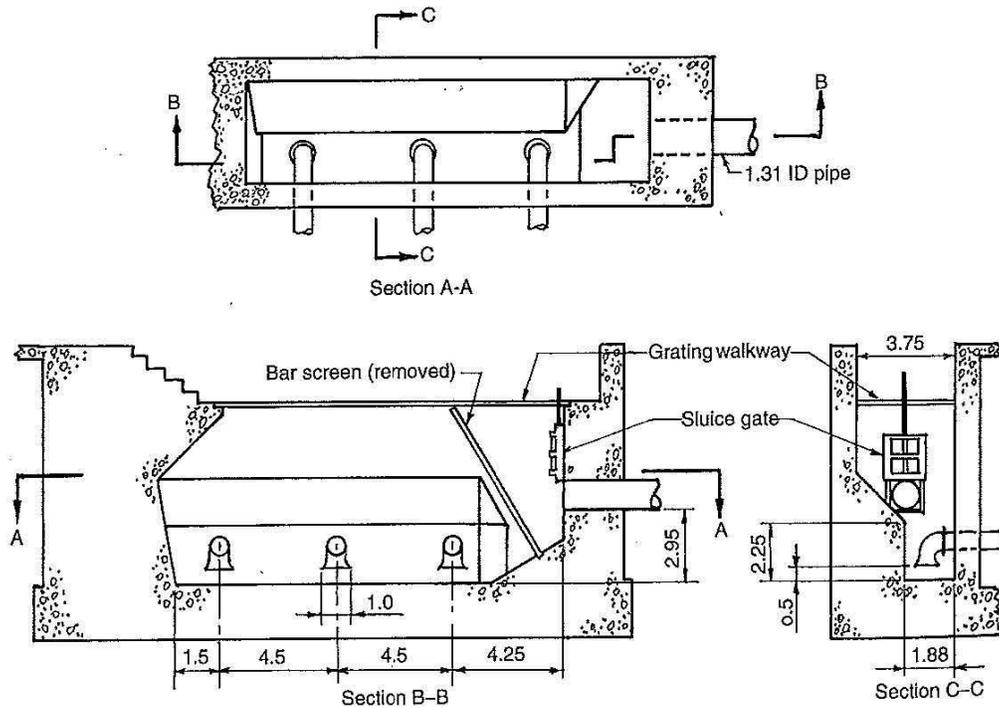


FIGURE 1. ILLUSTRATIVE VIEW OF KIRKLAND PUMP STATION (1).

The original designs were further improved by Dr. Robert Sanks, Ph. D. in the early 1990s, where he discovered that flow during pump-down were much too slow (0.9 ft/s on average) for complete cleaning. As a result, the cleaning process only removed the majority of the recently deposited sludge layer and left a hardened 2-inch sludge layer. Dr. Sanks began to test the effect of fluid velocity on the rate of grit movement with river sand to find the minimum velocity for effective sludge removal. He discovered that a minimum velocity of 5 ft/s were required to move sand at a practical rate. In addition, a 1:3.3 scale model of the Kirkland Pump Station demonstrated that at its current flow rate, only a fraction of the sand was ejected at pump down equilibrium. Sanks, Jones and Sweeney added a curved ramp from the inlet pipe invert to the trench floor, adjusted the last pump to a lower floor clearance at a quarter of its diameter, and inserted a baffle between the last pump and the wall. A resulting high velocity produced a hydraulic jump that homogenized the sludge, which increased cleaning efficiency to 45 to 100 times the efficiency of the Kirkland model (1).

However, even with the improvements, trench type wet wells did not gain popularity until its publication in the 2<sup>nd</sup> Edition of Pumping Station Design and the ANSI/HI 9.8 standard in 1998 (Figure 2).

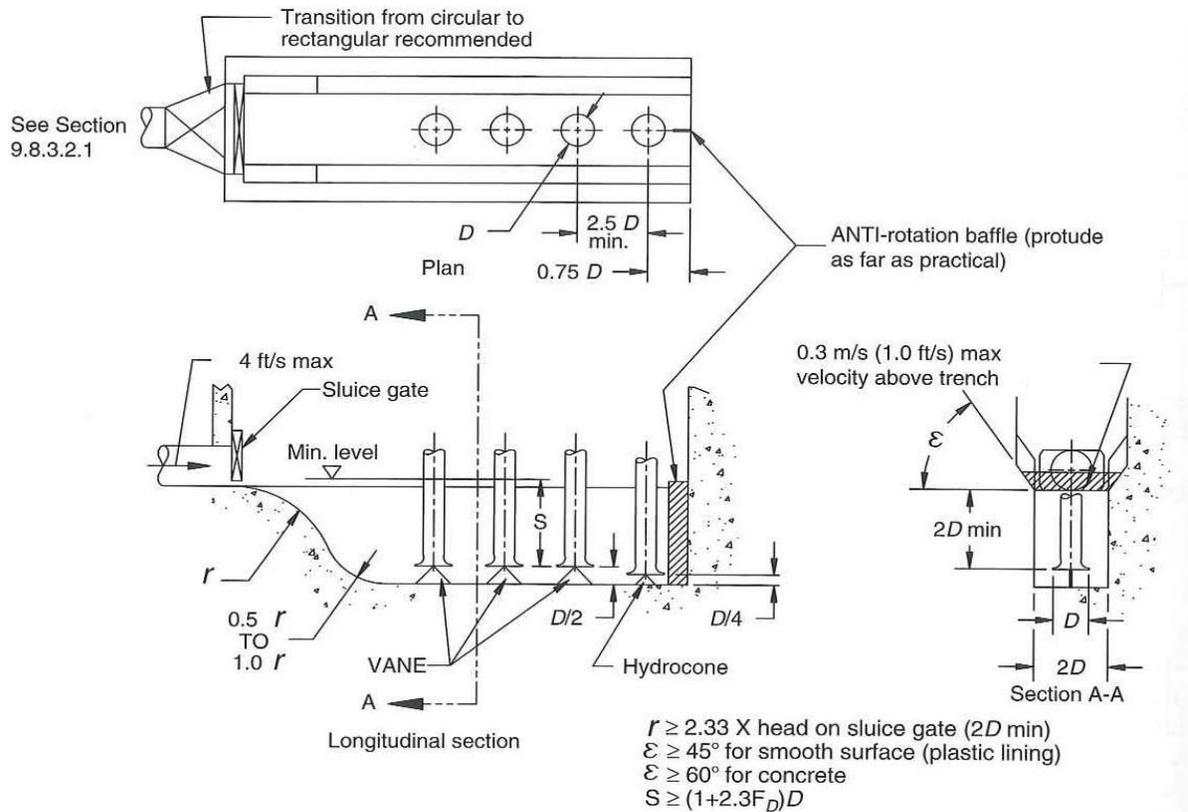


FIGURE 2. ANSI/HI 9.8 PUMP INTAKE DESIGN (1).

### 1.1.2 APPLICATION

Trench type wet wells have been found to be suitable for various design parameters as shown in the case studies discussed later. Wet pit and dry pit/wet pit with vertical turbine solids-handling (VTSH), submersible and/or non-clog centrifugal pumps are compatible with trench type wet wells. It can also be applied to potable water, activated sludge, and raw wastewater operations. Potential problems could arise due to its minimal storage capacity, increased depth, and clogging issues without the use of pumps. However, these wells are exceptional in creating a superb hydraulic environment for pump intakes, minimizing footprint size and floor area (which in turn reduces sludge accumulation), and reducing maintenance costs.

### 1.1.3 SELF CLEANING OPERATION

The self-cleaning cycle occurs at pump down. The cleaning system employs an upstream isolation gate (in most designs), which reduces influent flow. An Ogee ramp provides a hydraulic jump that assists in moving massed sludge and scum to the pump farthest from the influent side. As the water level decreases, the far pump runs at full speed, increasing the scouring velocity, and forcefully ejecting the solids.

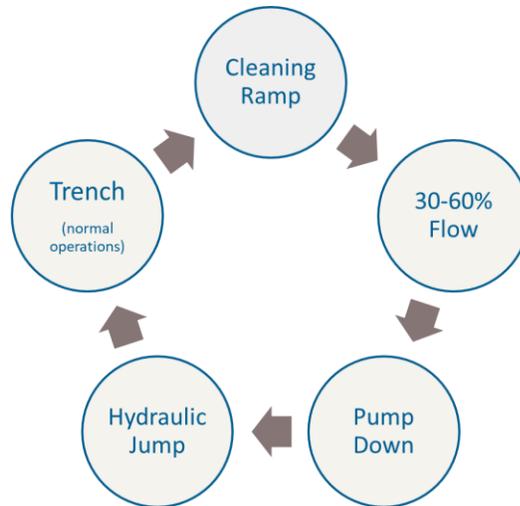


FIGURE 3. SELF-CLEANING PHASES OF A TRENCH TYPE WET WELL.

## 2. CASE STUDIES

### 2.1 PUMP STATION 13B TRINITY WATER AUTHORITY PLANT

#### 2.1.1 SUMMARY

Design and construction of a self-cleaning, trench-type wetwell at the Central Regional Wastewater System Treatment Plant of the Trinity River Authority (TRA) reduced the Authority's initial investment, reduced environmental impact and, through its self-cleaning features, achieved significant operational efficiencies and long-term savings in maintenance costs. TRA anticipated increased return activated sludge (RAS) flows at the plant, and a feasibility report recommended a horizontal, non-clog centrifugal pump station (wet-pit/dry-pit) for the site. However, analysis of the proposed site in the preliminary design phase indicated a variety of conflicts between the recommended pump station and surrounding structures, pipelines and utilities. The design team studied alternatives and determined that the horizontal configurations required resolution of significant conflicts. Opinions of probable construction costs were as high as \$11.4 million. A wet-pit configuration yielded probable construction costs of \$9.5 million, but the design team saw an opportunity to reduce costs further and, after research, recommended a trench-type wetwell design, which was bid and awarded for construction for \$8.5 million.

#### 2.1.2 COMPLEXITY OF THE PROJECT

Complexity in this project lay in fitting a 50-MGD RAS pump station into a site shared by the following:

- 84-inch primary clarifier effluent pipe
- 60-inch final clarifier effluent pipe
- Caustic soda storage facility
- 2- to 12-inch utility pipes, including non-potable water, drain pipes, etc.
- Electrical duct banks
- 12-foot-wide concrete roadway

The team performed a site analysis and examined three pump station arrangements to determine their overall footprints. The wet pit yielded a smaller footprint and lower probable





maximizing the hydraulic jump for more mixing of settled solids in the incoming RAS flows. The flow splitter extends from the wetwell entrance to beyond the second of three pumps to minimize flow vortices developed during the cleaning cycle. This design provided high velocity to the influent RAS, thereby conserving energy and creating a powerful hydraulic jump. Specifications called for 316 stainless steel for the flow splitter. The design team also designed a hydrocone and vane for the third pump in the trench to eliminate surface vortices usually carried to the last pump (Figure 8). Two anti-rotational baffle plates — one attached to the wall and the other attached to the pump — resist circulation of RAS behind the last pump.

#### 2.1.4 EXCEEDING CLIENT NEEDS

The original opinion of probable construction costs as recommended by the previous feasibility study was \$11.4 million for the vertical non-clog centrifugal pump station. However, with the application of the trench type wet well, this construction cost was decreased to \$8.5 million, with the savings of \$2.9 million. This saved the client more than the consultant's fee, which totaled to \$1.6 million.

#### 2.1.5 FUTURE VALUE TO THE ENGINEERING PROFESSION

This project has introduced many wastewater plant designers to a concept that can reduce construction costs for constricted sites and will continue to yield savings through its self-cleaning features. The design helped TRA avoid costly relocation of pipelines and structures, including concomitant permitting requirements and materials-disposal activities. Many plants across the state face similar challenges. Presentations by the design team have familiarized other members of the profession with the concepts introduced here and there are other such pump stations in design now, including a pump station at a nearby plant owned by the City of Dallas. The savings to TRA exceeded the engineering fee for this project, exemplifying the value of good engineering design.

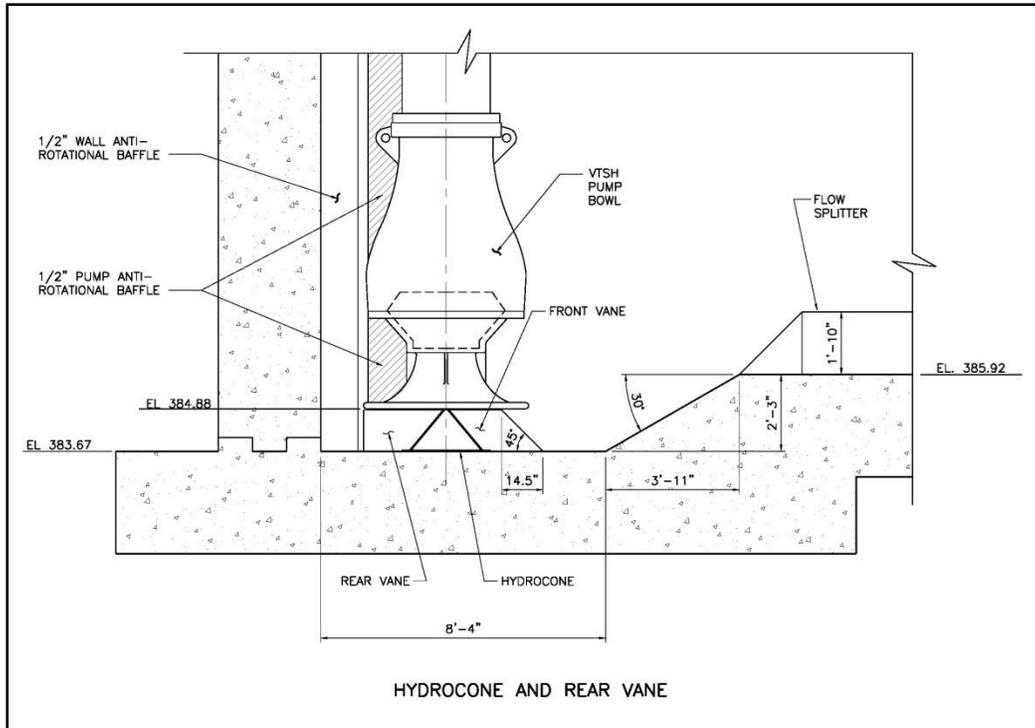


FIGURE 8. HYDROCONE AND REAR VANE DESIGN IN PUMP STATION 13B

## 2.2 DALLAS WATER UTILITIES CENTRAL WASTEWATER TREATMENT PLANT

Trench type wet wells were also utilized in the expansion of an existing 335 MGD wastewater treatment plant to a 425 MGD system in Dallas, Texas. The project involved the construction on an influent pump station, with the sewage coming from an upstream coarse screen. The pump station included 6 pumps (2-1000 HP, 4-800 HP), with 42-inch diameter columns, 62-foot shaft, with a total of up to 20-80 MGD per pump. The preliminary design of a trench type dry pump pit was considered, but the footprint savings of the trench type VTSH pump station proved to be far superior.

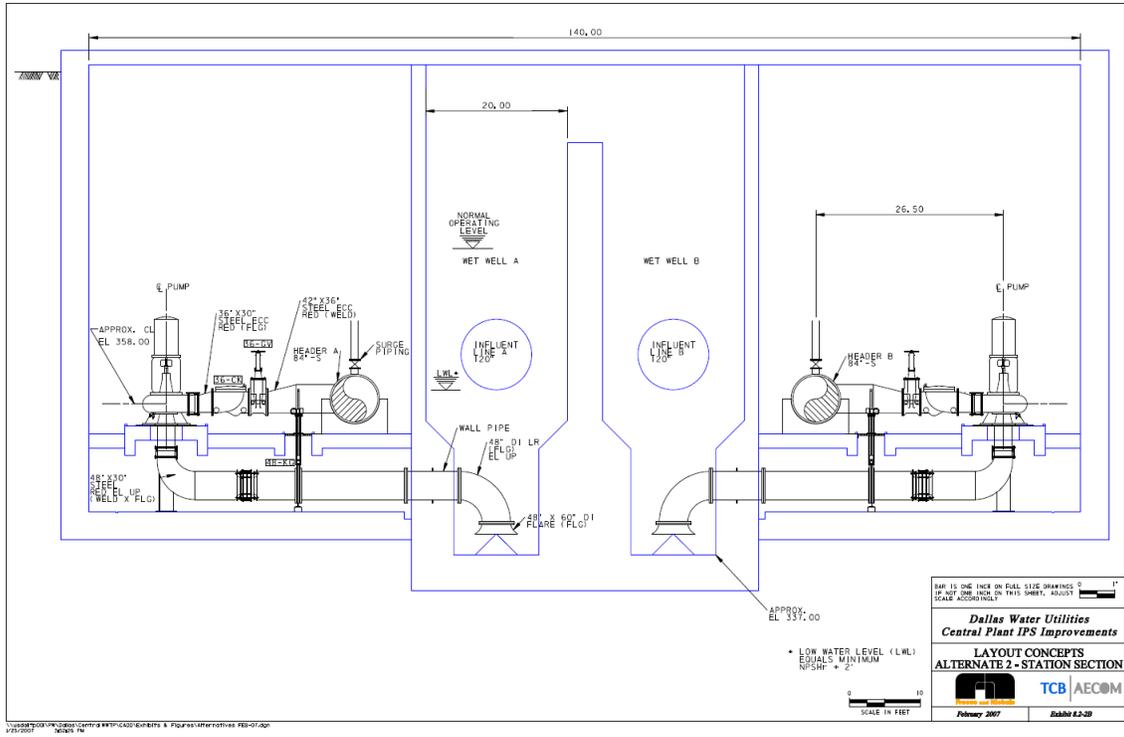


FIGURE 9. LAYOUT FOR A TRENCH TYPE WET WELL DRY PIT/WET PIT PUMP STATION

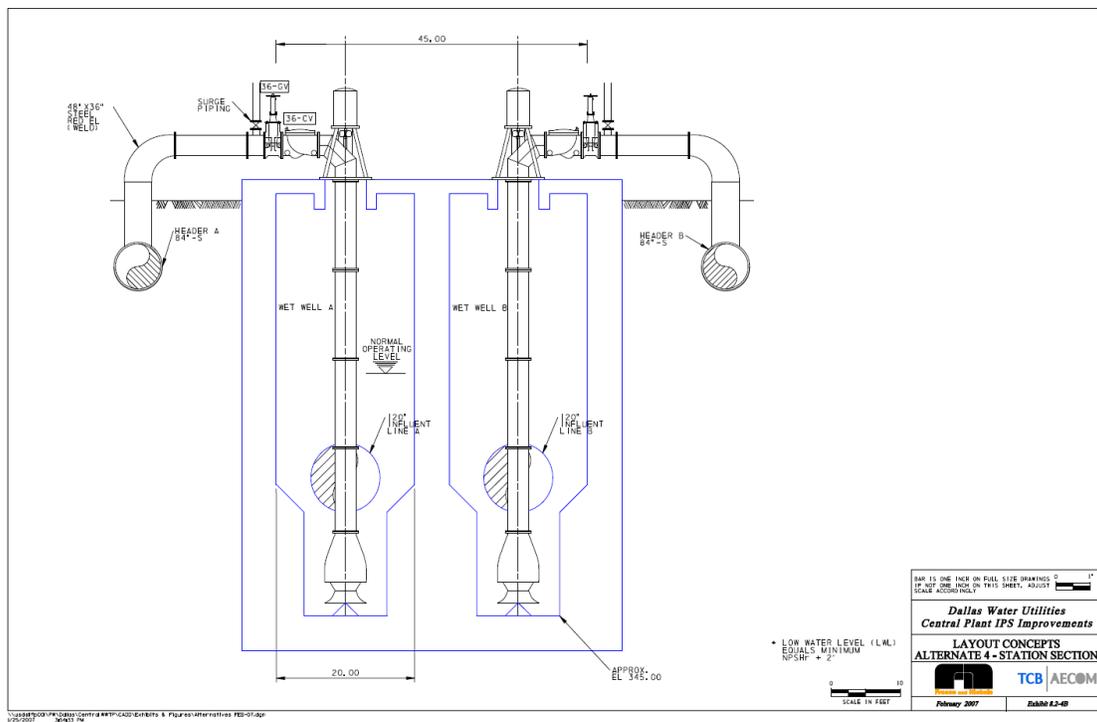


FIGURE 10. LAYOUT FOR A TRENCH TYPE WET WELL VTSH PUMP WET PIT PUMP STATION

## 2.3 CITY OF MIDLOTHIAN WATER TREATMENT PLANT

Trench type wet wells are also very effective in potable water treatment applications. To illustrate, the City of Midlothian utilized the trench type wet well in the construction of a new water treatment plant. With a firm capacity of 9 MGD with 3 pumps, and an ultimate capacity for 18 MGD with 5 pumps, the City of Midlothian was able to expand its water system with minimum costs and foot print.

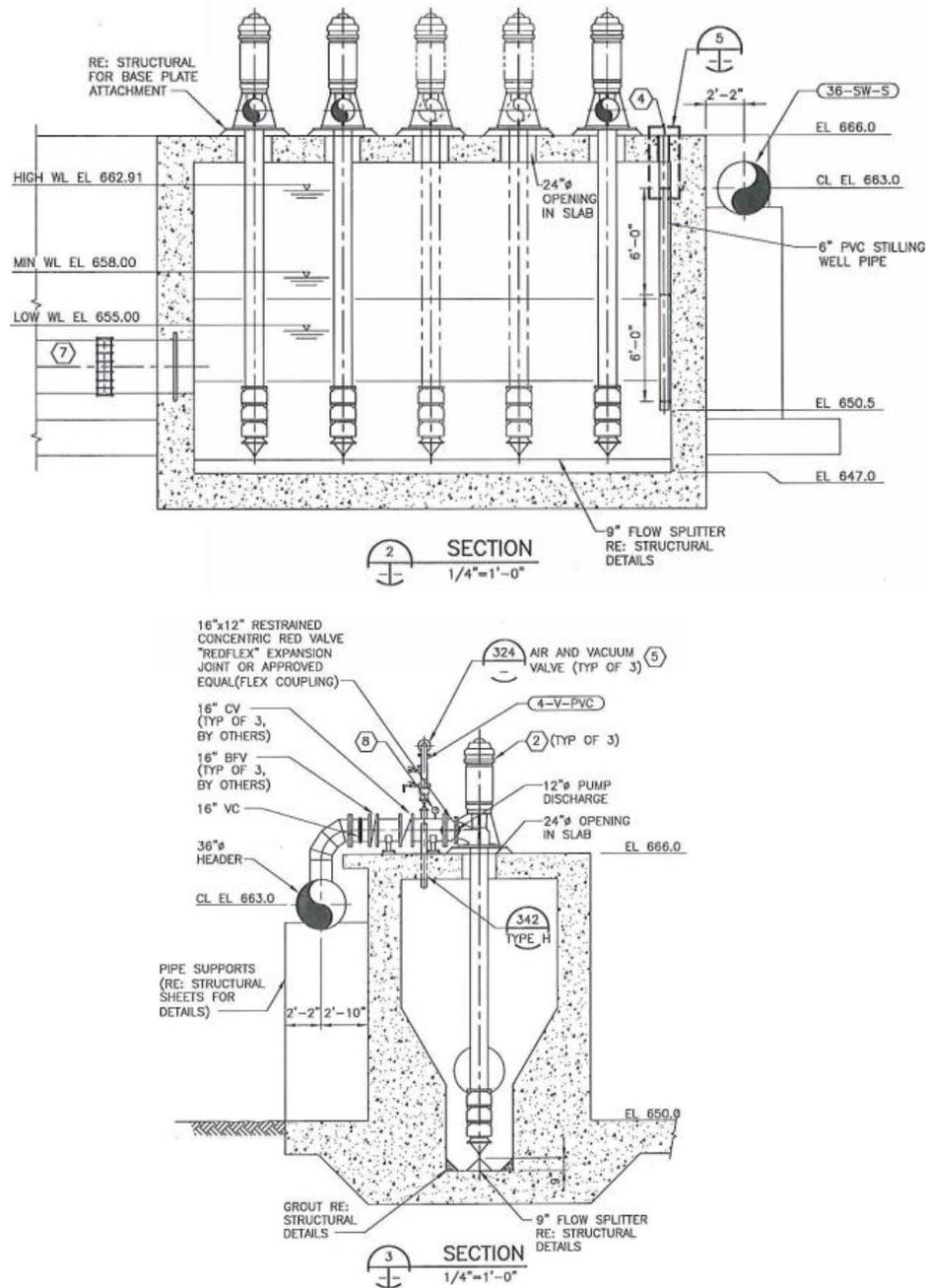


FIGURE 11. SECTION VIEWS OF MIDLOTHIAN WTP TRENCH TYPE WET WELL PUMP STATION

## 2.4 FORT WORTH LAKE ARLINGTON LIFT STATION

Although yet to be constructed, a lift station for raw sewage will be utilizing a trench type wet well in the expansion of Lake Arlington's collection system. Portions of the existing wastewater collection system serving the Village Creek Wastewater basin are at capacity, with some areas experiencing wet weather overflows. Increased conveyance capacity is necessary to handle projected growth within the Village Creek Wastewater Basin which also includes the wholesale customer cities of Burleson and Crowley. With the installation of a trench type wet well and the use of VFDs, there is a reduction in the size of the site and maintenance costs, and an overall increase in efficiency is the range of required flows. Lift Station will have ability to add peak-shaving storage and parallel structure to increase capacity to from 44 MGD to 80 MGD in the future. Construction is anticipated to commence in November 2019 and be completed by March 2022.

## 3. OPTIMAL CONDITIONS FOR APPLICATION

Trench type wet wells are optimal for projects with limited space, a solids or grit problem, maintenance issues. Before considering this design, it is recommended to perform a cost-benefit analysis, a life cycle analysis, as well as reference and site visits to ease client and engineer concerns.

In the TRA and Dallas Water Utilities plants, the clients were unfamiliar with the equipment and uneasy about lacking comparable size installations in their area. The project engineers provided an extended warranty, witness performance testing, first contracted maintenance vibration monitoring, and a pump seminar to ensure their clients of their design considerations. While this new design was a risk for the client, the biggest driver tipping the risk versus benefit scale was the significant capital cost savings (example of up to \$16 million for Dallas Water Utilities).

## 4. REFERENCES

(1) Jones, G. M.; Sanks, R.L.; Tchobanoglous, G.; Bosserman, B. E., Eds. *Pumping Station Design*. 3<sup>rd</sup>, ed.; Elsevier: Oxford, 2008.