Case History of the York Energy Center Intake/Blowdown

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ABSTRACT

The York Energy Center project in Delta, PA consists of 565 megawatt generating facility that recovers heat from hot gas exhaust leaving gas turbines. The combustion turbines burn either natural gas or low sulfur diesel fuel oil. Combined, these two power cycles consume 70-80 percent of the fuel needed by a traditional fossil-fired boiler/steam turbine generator plant. A microtunnel solution to installing the cooling water intake and return was developed by the owner, contractor & tunnel subcontractor. A 460 m x 1500 mm (1500 ft x 59 in) steel casing was jacked through rock and zero blow count river deposits that served as the intake. A 406 mm (16 in) HPDE line was installed inside the casing to serve as a return. Financial and environmental considerations for the microtunneling solution led to replacing the original twin pipeline trenched design. The TBM was recovered from under Conowingo Lake along the Susquehanna River.

INTRODUCTION

With a continuous growing need for energy throughout the world, it was not a difficult decision for Conectiv Energy (later acquired by Calpine) to decide on building a new power plant in Delta, Pennsylvania, located just 72 km (45 miles) North of Baltimore, MD. Calpine owns and operates power plants, which provides electricity to communities in 21 states. The new power plant will use state of the art technology by using two types of turbines. Energy will be created by using either a combustion or steam turbine. The combustion turbine is capable of being fueled by either natural gas or ultra-low sulfur diesel. The steam turbine uses steam generated from hot gas exhaust from Combustion Turbine. By using both of these power cycles, The York Energy Center will be highly fuel efficient and have an eco-friendly footprint. This energy center will be able to produce 565 MW, using four units.

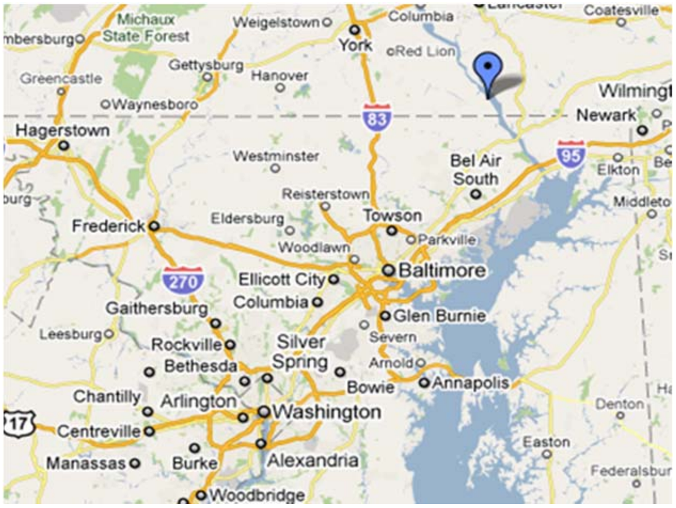

Figure 1. Job Location

Figure 2. York Energy Center

PROJECT

The design-build Intake/Blowdown Project was one phase of the $110 Million York Energy Center Project. This portion was headed by C.H. Schwertner & Sons (General Contractor) of Bala-Cynwyd, PA. With the Energy Center being able to produce such a large amount of energy, it will also produce a great amount of heat on the turbines. The Energy Center was constructed near Lake Conowingo, so this was the optimal source to use for cooling the turbines. The intake/blowdown line was designed to begin in the lake, where water would be withdrawn, pumped to the Energy Center, cool down the turbines, and returned back into the lake. The majority of the 8 km (5 mile) intake/blowdown pipeline was open-cut, from the York Energy Center to where the pump station was designed to be constructed, nearly 91 m (300 ft) from the shore of lake.

SUBSURFACE CONDITIONS

The area of the Peach Bottom Township is underlain by the Peters Creek Tectonite, which is described as phyllonite composed primarily of muscovite, chlorite and quartz. The Peters Creek Tectonite is also interbedded with diabase and serpentinite rock. This area also contains a less tectonized zone called the Peters Creek Schist, consisting primarily of quartz, muscovite, plagioclase and chlorite.

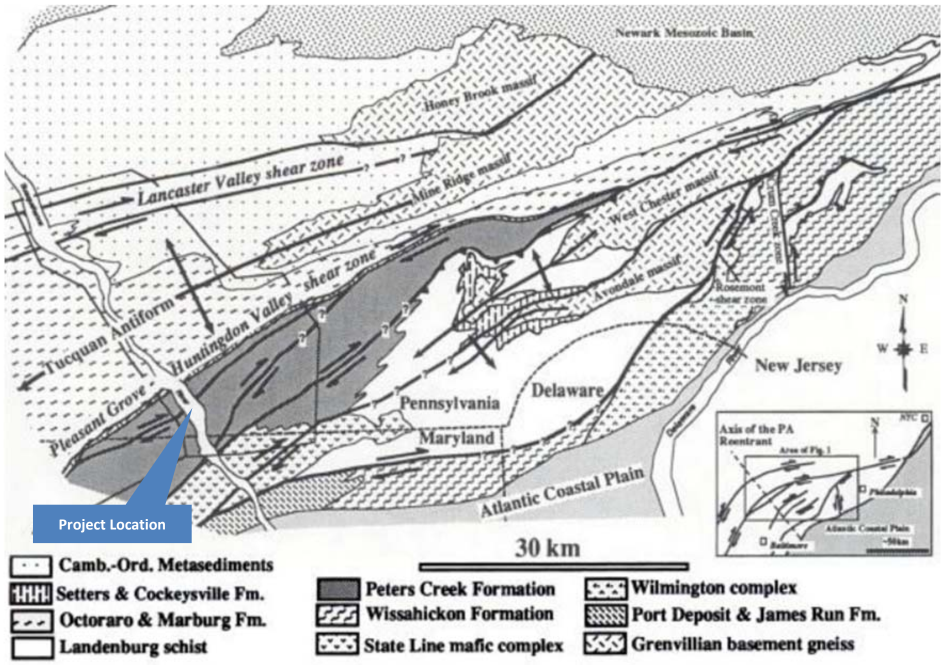

Figure 3. Peters Creek Formation

At the project location, the intake/blowdown pipe alignment encountered several variations in subsurface conditions, from bedrock to silt. Soil borings indicated that the bedrock along the pipeline alignment varied from 16,000 KPa to nearly 48,000 KPa (2,300 psi to 7,000 psi). The subsurface conditions on shore, above the bedrock, consisted of decomposed rock and residual soil, along with occasional boulders. As the intake/blowdown pipe alignment moved under the lake, subsurface conditions above the bedrock transitioned to sand, rock fragments and silt. Geotechnical information indicated that once the silt layer was disturbed, it would have liquid like properties. Standard Penetration Tests showed the silt being the weight of rod.

DESIGN

The original design envisioned a trench through Conowingo Lake in the middle of the silt deposit for two (intake & outfall) water pipelines and 7 air pipelines (to intake screens). The outfall and intake structures were separated by 61m (200 ft). The construction would have required extensive underwater disturbance of the silt deposit, subgrade stabilization, anti-floatation devices and extensive usage of turbidity curtains and pumps to control sediment releases into the lake.

Bradshaw Construction Corporation (tunnel subcontractor) was contacted by the general contractor to propose possible trenchless construction methods. Several concepts were developed by the tunnel subcontractor and evaluated by the owner and general contractor. The most important change was to place the outfall pipe and intake airlines inside a lined and coated permanent casing that would serve as the intake pipeline, thus facilitating a single tunnel solution. Several tunnel alignments were considered including lowering the tunnel into the rock below the silt deposit under the lake. Ultimately, a solution was selected that included microtunneling through rock, from the on-shore pump station, into the silt deposit under the lake at an elevation such that the casing was jacked at the boundary between rock and silt, thus allowing the structures to be built without blasting as per the contract requirements.

The casing/intake pipeline used was a 1500 mm (59 in) OD steel pipe, manufactured by Permalok, lined with an epoxy compound and coated with a coal-tar product both manufactured by Tnemec. The casing was rolled to its maximum wall thickness of 41 mm (1.625 in), for the diameter, and half-moon shaped counter weights were added to the invert to bring the unit weight of the casing to approximately 2870 kg/m (1925 lb/ft) under the silt deposit to reduce the buoyancy of the pipeline during microtunneling.

Figure 4, Permalok Steel Casing

The 1500 mm (59 in) OD casing fit a Herrenknecht AVN-1200, Microtunneling Boring Machine (MTBM). Bradshaw has successfully used this machine in previous lake tap Projects. During tunneling, transitioning from hard rock, to decomposed rock, then into sand and silt, proposed to be a challenge. Equipping the MTBM with a rock cutter head was able to break the nearly 48,000 KPa (7,000 psi) rock, while also excavating the residual soils, weathered materials and alluvial deposits. The AVN-1200 has an articulating head, which allows the operator to adjust line and grade at any given moment. The machine is also able to be separated into two pieces, in order to retrieve the machine in a smaller shaft.

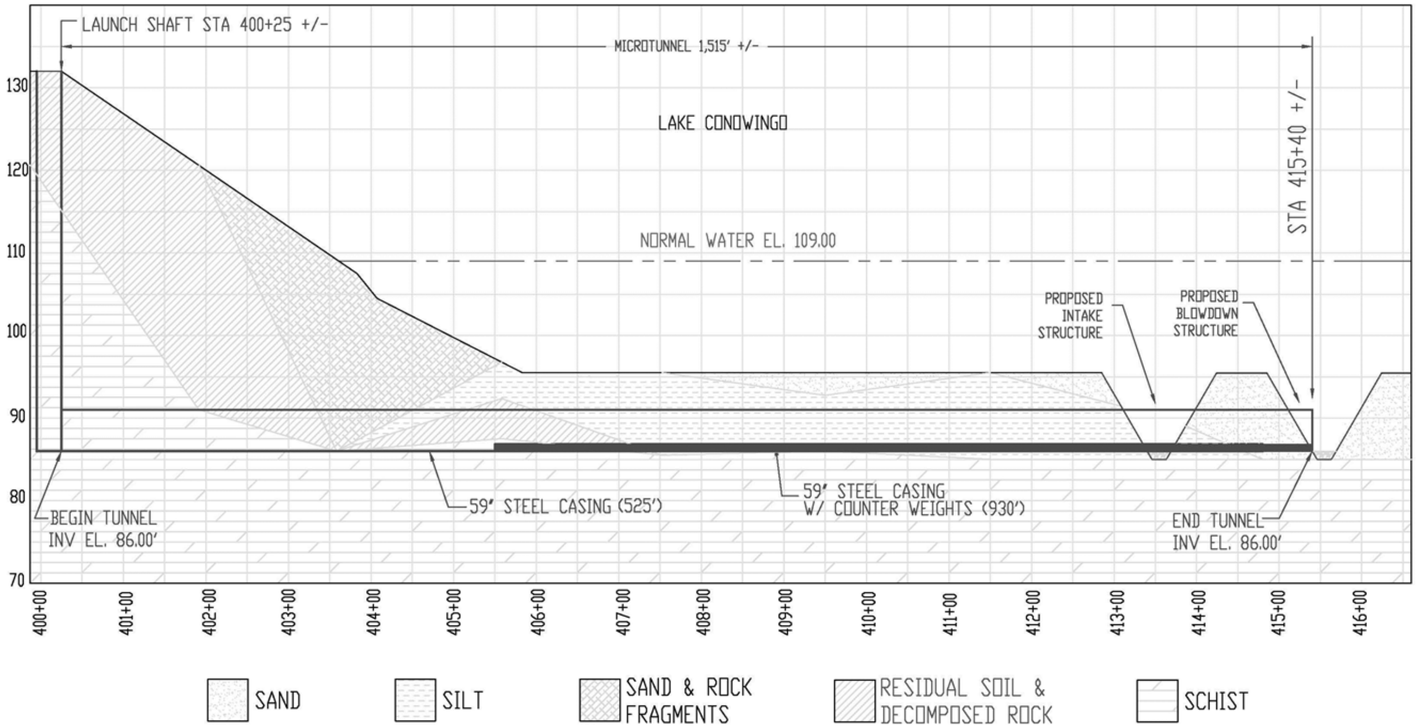

Figure 5, Final Design – Profile View

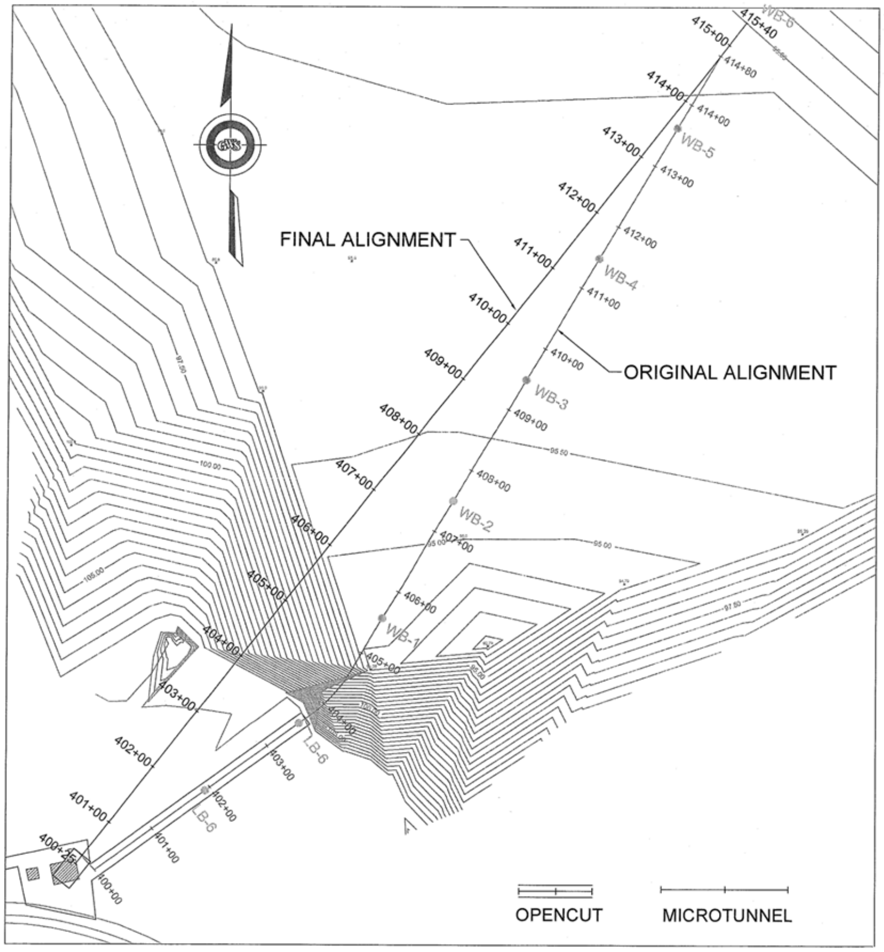

Figure 6, Final Design – Plan View

The AVN-1200 is recommended for drive lengths of up to 200 m (656 ft), without an intermediate jacking station (IJS). The designed tunnel length was 457 m (1500 ft), which is more than double the recommended length. This posed as a challenge in designing the intake/blowdown pipeline. A bentonite mix is commonly used for microtunneling to fill the overcut void, and provide a slick lubricant to reduce friction, along with jacking pressures. Bradshaw worked with Liquid Earth Support in finding a lubricant to help reach the final station. The polymer lubricant that was incorporated into the design was Liquid Earth Support's Pushlube. Grout ports were installed in the Permalok steel casing to pump the Pushlube into the overcut void.

CONSTRUCTION

The intake/blowdown pipeline from the York Energy Center to the designed location of the pump station was installed by open-cut methods prior to shaft work and tunneling. Excavation for the pump station/jacking shaft took place in from November 2009 to March 2010.

The 15 m x 9 m x 15 m deep (48 ft x 30 ft x 50 ft) shaft was excavated though rock without blasting using pre-drilled reliever holes and track-mounted hydraulic breakers.

Bradshaw was able to mobilize to the jobsite on March 15, 2010. Bradshaw designed and installed the push block, which the jacking frame would push against, along with the entrance wall and seal. Mining began on March 26, 2010. When tunneling commenced, Bradshaw worked 2 shifts per day. Bradshaw used Thackray Crane operators, union operating engineers and union laborers to assist during the tunnel construction.

The initial 34 m (110 ft) of microtunneling was in located in the bedrock. Just before the MTBM reached the transition zone, the disk cutters were checked to make sure they would not need to be changed, since the cutters would not be able to be checked after this point. Operators had to be cautious in the transition zone, because too much jacking pressure would cause the machine's grade to rise since the bedrock was harder to mine.

Figure 7, Setting First Pipe

Production continued to increase when it reached the second transition zone, where subsurface conditions were composed of decomposed rock and silt. In this area, production reached the highest of the entire drive at 43 m (141 ft) in a shift. The Pushlube demonstrated to be working immensely by providing low jacking pressures to this point. Maintaining line and grade were no problem, however the laser guidance system began to become less accurate the farther the drive reached. Already aware of this, Bradshaw talked to VMT, guidance systems specialists, based out of Bruchsal, Germany. VMT provides different types of guidance systems for all types of tunneling projects, and recommended the SLS LT Microtunneling Navigation

System. This system uses a theodolite along with surveying techniques to calculate the exact location, along with line and grade. This system was installed at 236 m (773 ft) out, and was used until the MTBM reached the final station.

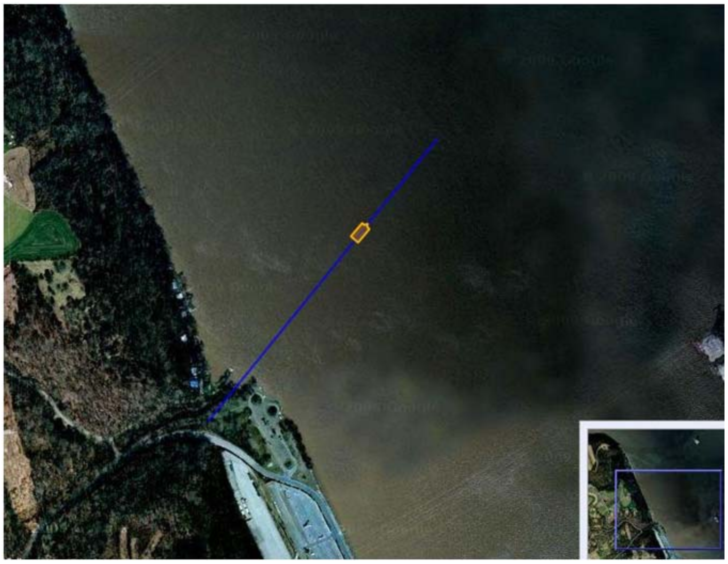

Figure 7, VMT Guidance Screen

When the MTBM reached the silt layer, operators noticed that it was more difficult to control the line and grade of the machine. Operators also observed that the machine became more likely to rolling, likely due to the lack of lateral resistance in the very soft alluvial sediments. Around 264 m (865 ft) of the drive, Bradshaw's MTBM operators found it difficult to maintain grade because of the subsurface conditions. The machine was mining through rock on the bottom of the alignment and silt on the top. The silt layer did not have enough resistance on the machine to keep it from rising at the current speed. The jacking pressures were reduced to keep to MBTM from rising. This resulted in lower production rates for the rest of the drive. Bradshaw worked around the clock to complete the drive.

When the MTBM reached 456 m (1,496 ft), it started to mine upwards and could not be steered down. This left the intake/blowdown line 40 ft from the final station, at 450 m (1,476 ft) out.   The Owner and General Contractor decided that the intake and outfall structures could be built to accommodate the achieved tunnel length. All electronic and hydraulic equipment were removed from the machine to prepare for the wet retrieval of the machine. A plug was installed on the casing in the shaft, then filled with water to prevent a surge of water enter in the casing when the MTBM was retrieved.

Figure 8, Job Site Overview

Figure 9, Steel Casing Plug

Walker Diving, based out of Hammonton, NJ, assisted Bradshaw in the wet retrieval of the MTBM. Walker Diving built a cofferdam, around the MTBM, where the outfall structure was to be built. Excavation spoils recovered in-front of the MTBM indicated the MTBM had probably bull-dozed a pile of cobbles and debris and maybe a boulder or two that was not able to be digested through the cutter face and led to the uncontrollable grade lift. The machine was retrieved in two pieces using a crane, and transported on barges, to the shore. Once the machine was retrieved Walker Diving was able to build the intake and outfall structure, as well as install the HDPE pipe for the discharge line. After Bradshaw demobilized, Schwertner completed construction of the pump station.

Figure 10, Wet Retrieval of MTBM

CONCLUSION

The completion of the design-build York Energy Center Intake/Blowdown project was a unique accomplishment. Mining 450 m (1476 ft) by direct jacking behind a microtunnel boring machine, in a single run, through such variable conditions proves that trenchless technologies are viable for installing pipelines that may have been previously unconceivable. Reaching out to tunneling contractors during the design phase may result in ideas that could radically change design assumptions on what is possible. Improvements in lining and coating materials may also change the way we think about one-pass pipejacking with steel casing.