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**Camp Ravenna Joint Military Training Center Design-Build
Ten Miles of Sanitary Sewer and Water Main
Via Horizontal Directional Drilling**

David Parkinson, CT Consultants, Columbus, OH
Gary Seelbinder, Rock Industries, Pontiac, MI
June Baterina, Underground Solutions, Inc., Poway, CA

1. ABSTRACT

Camp Ravenna Joint Military Training Center is an Ohio Army National Guard military base located between Ravenna and Newton Falls and adjacent to the village of Windham. Before its present status as a training facility for the Ohio National Guard, Camp Ravenna was a military ammunition production facility for the United States Army, serving as an ammunition factory for World War II.

In 2014, the Ohio Army National Guard let a project in support of enhancing capabilities for the training center. Rock Industries, Inc., the prime contractor, hired CT Consultants and crafted a collaborative design-build approach which provided both design and construction services for 26,750 feet of 8-inch sanitary force main and 26,100 feet of 12-inch water line at Camp Ravenna. Environmental conditions were taken into account during the design process - including existing soils, potential groundwater contaminants, and wetland areas. One key factor for pipe material selection was the requirement that the pipe could be installed both in open-cut, trenched installations as well as horizontal directional drill (HDD) installations. In order to provide a leak-free pipe system, guard against potential permeation of ground contaminants, and minimize disturbance the best option was to install the entire length of both the water and sewer mains using HDD installation methodology. The design-build approach by the construction team will be described as well as the management plan, design challenges, and trenchless specific construction.

2. INTRODUCTION AND BACKGROUND

Camp Ravenna Joint Military Training Center, formerly known as the Ravenna Training and Logistics Site and the Ravenna Army Ammunition Plant, and commonly known as the Ravenna Arsenal, is an Ohio Army National Guard military base located between Ravenna and Newton Falls and adjacent to the village of Windham in the U.S. state of Ohio (see Figure 1). It currently occupies portions of Freedom, Windham, Charlestown, and Paris townships in Portage County, along with part of Braceville Township in Trumbull County. Formerly utilized as a military ammunition production facility for the United States Department of the Army, the facility employed over 14,000 people during World War II, when the facility was at peak operation (See Figure 2). At the end of World War II, the facility was placed on a temporary halt. Control of the facility was reassigned to the U.S. Army, and from there operation continued on a limited basis.



Figure 1. Entrance to Camp Ravenna in Windham, Ohio



Figure 2. Manufacturing plant where laborers made ammunition during World War II [outside view (left); workers using stenciling machine to show correct zone and lot numbers on shells (right)].

After World War II, during the Korean and Vietnam Wars, the Ravenna Arsenal was again in full operation. When not in full operation, the facility was used for aeronautical experiments for the National Advisory Committee for Aeronautics. In 1971, the facility was again placed on standby and ammunition located there was demilitarized, a process which continued until 1984. The facility also took part in ammunition refurbishment and minor research and development projects until 1992.

The Ravenna Training and Logistics Site (RTL) of the Ohio National Guard began as a tenant unit of the Army facility in 1993, which at that time was officially designated the Ravenna Army Ammunition Plant (RVAAP) (see Figure 3). 16,164 acres of the facility were included in the RTL tenancy by 1999. The site is now known as Camp Ravenna Joint Military Training Center (Camp Ravenna) and currently occupies approximately 93 percent of the land originally covered by the RVAAP.

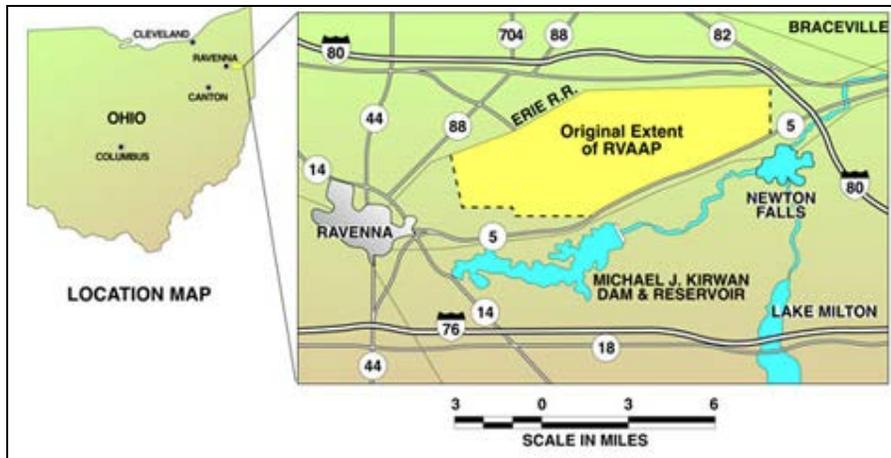


Figure 3. Location map and extents of RVAAP

Looking to expand usefulness and restore existing facilities, Camp Ravenna designated a Maneuver Training Center-Light (MTC-L) in early 2013, which is a training installation that supports individual and collective training for multiple battalions. Existing storage buildings were converted to transient barracks, dining, and recreational facilities. New facilities were built to support mobilization and Army Warrior Task Training. Due to these developments, the infrastructure for sewer and water were in urgent need of expansion at the MTC-L.

In the fiscal 2014 Government Spending Bill, the Camp Ravenna Joint Military Training Center received money to expand the water and sewer service at the facility. The Ohio National Guard's plan included installing a sewage lift station, a sewage force main, a water booster station, and a potable waterline within Camp Ravenna. The new water booster station and waterline will convey potable water from the Tactical Training Center (TTC) area, where the local utility provides public water service into Camp Ravenna, to the Post 1 Cantonment Area (CA) near the intersection of SR 5 and George Road, approximately 5 miles in length. With the recent improvements that took place, the sewer and water systems would allow for expansion of temporary housing on the base for soldiers while they are in training. Sewage generated at the CA is expected to be entirely domestic in nature and will be conveyed through a collection system to the new sewage lift station located at the CA. The new sewage lift station will convey wastewater through the new force main back to an existing 8-inch diameter gravity sanitary sewer at the TTC that is tributary to the public sanitary sewer extended into Camp Ravenna.

3. PROJECT DESIGN AND EXISTING CONDITIONS

The primary mission of the Ohio Army National Guard (OHARNG) is to maintain combat readiness. The primary method to maintain combat readiness is through training. Training activities, such as troop and vehicle movements, have various impacts on watersheds and the environment. These activities, numerous types of soil conditions, as well as possible existing underground infrastructure and groundwater contamination had to be considered during the design. Under the design build approach, several teams consisting of contractors and designers submit their project proposals to the OHARNG. After review of proposals, Rock Industries of Pontiac, Michigan was selected to design and construct both the water and sanitary sewer lines. CT Consultants, of Columbus, Ohio, was Rock's design engineer for the project. According to a Watershed Inventory study by hydrologist Chad J. Ostheimer and biologist John S. Tertuliani, 87 percent of the facility is classified as forest, with existing grasslands, which are likely remains of agriculture. Numerous streams drain Camp Ravenna, but there are four major streams that drain approximately 65 percent of the facility - South Fork Eagle Creek, Sand Creek, Ordnance Creek, and Hinkley Creek. Sand Creek was the only stream that crossed the path of the proposed water and sewer pipe (see Figure 4).

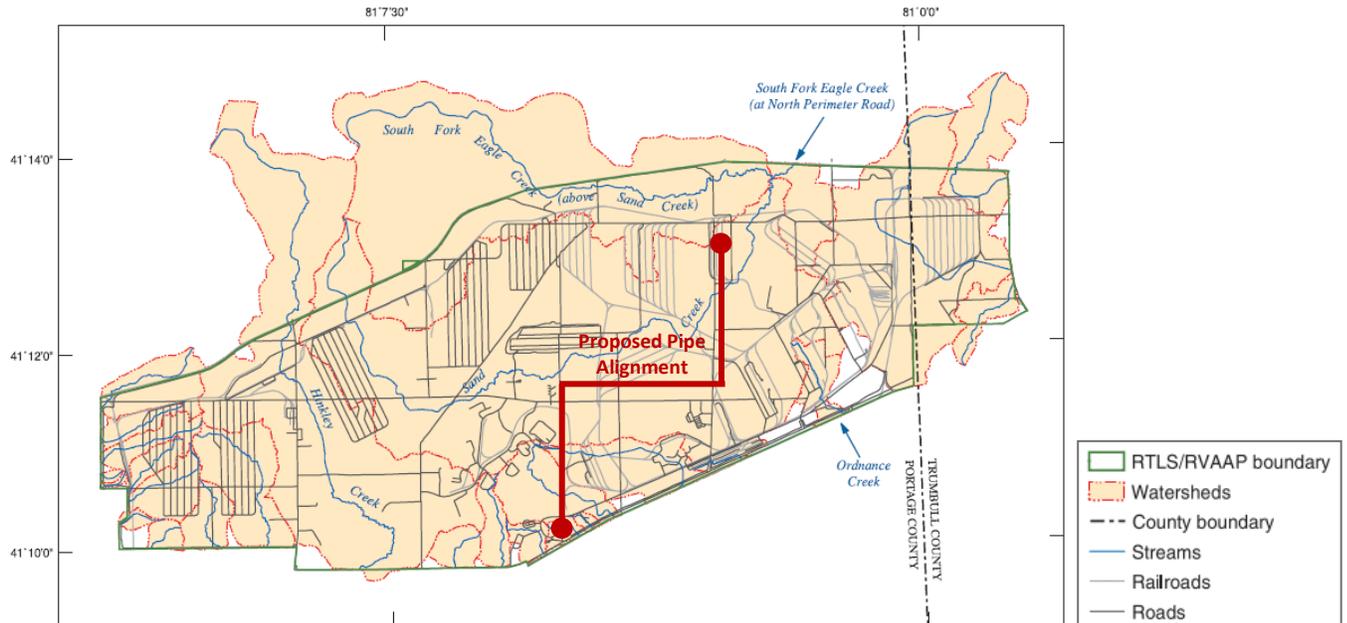


Figure 4. Site Map of the Ravenna Training and Logistics Site / Ravenna Army Ammunition Plant

CT Consultants explored options for installing the sanitary force main and potable water main, performing a series of calculations and analyses given the existing site conditions. Due to the topography of the project corridor and the considerable amount of pipe being installed, CT needed to design a water booster station for the water main, as well as a sewage pump station for the sanitary sewer force main. Both the water booster station and sewage lift station would serve as connection sites to join the existing water and sewer main to the proposed mains. After completing their design calculations, CT Consultants determined that 26,750 linear feet of 8-inch sanitary sewer force main and 26,100 linear feet of 12-inch potable water main would be sufficient sizes to meet the anticipated demands at ultimate development as defined by the OHARNG.

4. PIPE MATERIAL AND INSTALLATION METHOD SELECTION

Due to the substantial number of trees and the concern for the Northern Long Eared Bat, an endangered species, environmental contamination “Areas of Concern” (AOC), abandoned-in-place utilities, wetlands, other jurisdictional waters or streams, and other existing ground conditions that occupied the Camp Ravenna Joint Military Training Center, CT Consultants knew that pipe installation via open trench for 52,000 feet of pipe would present many obstacles. The alignment selected would require many trees to be removed and cleared in order to pave the way for an open cut option as well as pipe staging and layout before installation. Given the limitations on the time of year that trees may be removed, this could have potentially delayed the project upwards of six months. Additionally, groundwater is considered an AOC. Groundwater removed from excavations must be stored, tested, and disposed of properly in accordance with the testing results. Disturbance of wetlands and jurisdictional waters would require Army Corp of Engineers permits, which could also significantly delay construction. Areas of Concern could not be disturbed or encroached upon. CT Consultants examined alternate methods to install the proposed water and sewer mains, based on these constraints. They explored the benefits of trenchless technology, which included minimal disturbance to the environment, along with significant cost savings from excavated soil and groundwater mitigation and disposal. The real savings was in the reduction of risk by not having excavation and spoils and the associated potential for environmental issues to arise. It was decided that the new water and sewer mains would be installed primarily by horizontal directional drill (HDD) method, which would substantially mitigate these potential environmental issues.

PVC was the favored pipe material for both the potable water line and the sewer force main. Since HDD was the method favored for this project, bell-and-spigot PVC was eliminated as an option for the joint type required. For

trenchless installations, a fully-restrained joint pipe system would be required. The options for pipe material came down to two pipe systems; a restrained-joint PVC pipe with a spline-and-groove restraining mechanism (S&GRP) and thermal butt-fused pipe, or fusible polyvinylchloride pipe (FPVCP). With both pipes being viable options, CT Consultants needed to look further into their advantages in order to select the best material for the new water and sewer mains. S&GRP pipe is manufactured in 20-foot lengths and is assembled using a gasket, with spline-locked couplings providing the restraint mechanism. The couplings would require the bore holes used during HDD installation to be larger than the bore holes of FPVCP (see Figure 5). A smaller bore-hole diameter requires less back reaming, resulting in a higher production rate and lower cost, drilling mud, and spoil disposal which significantly reduces potential environmental issues as a result. In addition, FPVCP has a higher pull force capability than the equivalent S&GRP pipe systems. This larger pull force capability allows FPVCP to be pulled in longer lengths, minimizing overall excavation, as well as the number of gasketed joints by a factor of almost 50. A 2008 AWWA Research Foundation study found that PVC pipe material provides the best protection against hydrocarbon permeation in a potable water system, however a gasket, if used, does not. Additionally, a gasket-free pipe system would also eliminate potential leak points in the sewer force main. Because of these benefits, FPVCP was selected as the preferred material for the water main and sewer force main installations by HDD.

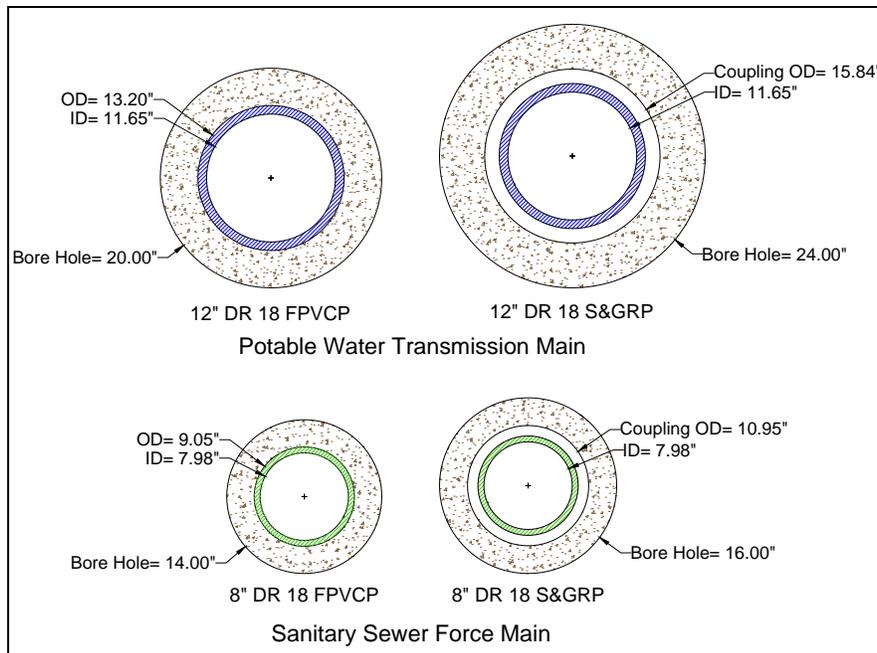


Figure 5. Bore hole comparison between FPVCP and S&GRP pipe

5. CONSTRUCTION

Construction began in August 2015 and both the potable water main and sanitary sewer main were installed simultaneously, on opposite ends of the Paris-Windham Road. The water booster station was installed first on the east side of the road. This took place next to several abandoned buildings and open areas, including roadway and grassy land. From the booster station, installation of the potable water main using HDD began. On the other side of the booster station, approximately 200 feet of water main was installed up to the existing water main. From there, the proposed and existing main were connected using a ductile iron mechanical joint sleeve. Installation of the sewer force main began on the west side of Paris-Windham Road, where it was also connected to the existing main using the same type of ductile iron sleeve. Once connected, Rock proceeded to set up and lay down pipe south along Paris Windham Road. From there, the pipeline continued west along Newton Falls Road, then south along George Road (see Figure 6).

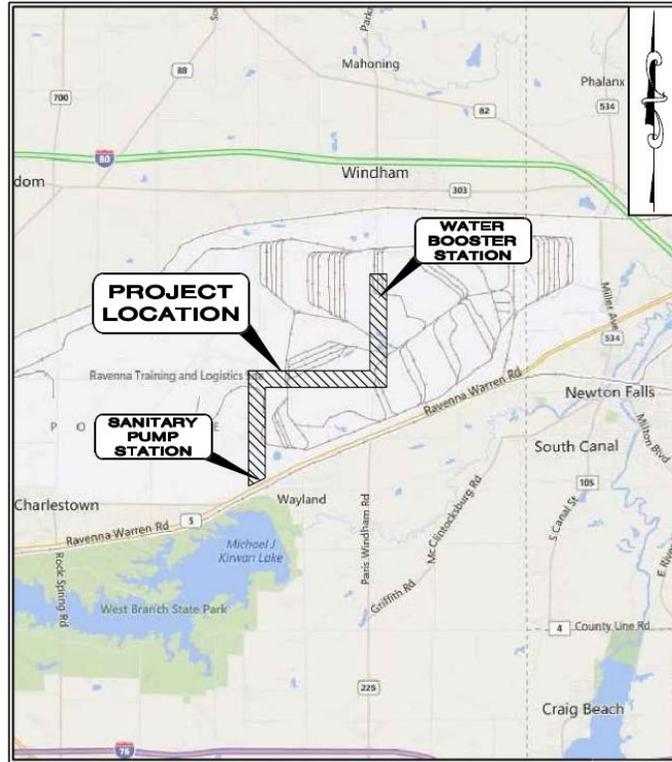


Figure 6. Map of project location

Both proposed pipe alignments maintained a consistent 5 to 8-foot distance from the edge of the road. The pipe laydown and staging areas were strategically placed along the road in order to minimize disruption for passing cars in the vicinity. During construction, the potable water main was staged on the east side of the road for installation and the sanitary sewer main on the west side (see Figure 7).



Figure 7. Pipe fusion and layout alongside roadway

Rock hired Speer Brothers, Inc. as a subcontractor to perform the HDD work on the project. Speer Brothers, Inc. is a general contractor who specializes in excavating, rock trenching, horizontal directional drilling, and pipe fusion.

Due to the significant amount of pipe involved, technicians from both Speer Brothers and the FPVCP supplier took part in a dual-company fusion approach. Each team set up the project area with all necessary equipment and fused pipe side by side. This dual-company fusion setup allowed both fusion teams to work concurrently which increased daily production rates, sometimes exceeding 1,200 linear feet in one day (see Figure 8). Pipe staging and layout were achieved without difficulty since the majority of both the water and sewer main pipe were installed alongside the roadway. There were enough tree clearings along the project alignment to allow staging to be completed as needed. Selected pipe bundle positioning and pipe handling equipment took advantage of existing open areas which allowed for easy installation of the pipe using HDD and optimum efficiencies through the staging process (see Figure 9).



Figure 8. Dual-company fusion setup with Speer Brothers Inc. and Underground Solutions, Inc.



Figure 9. FPVCP staged along the side of the road ready for installation

Early on during the construction process, after approximately 2,000 feet into the pipe installation, contractors reached the bridge across Sand Creek. Here they discovered a sudden shift in soil conditions during the HDD

installation of the pipe. They came across unknown rock in the existing ground and found that it extended roughly 1,200 feet in length. Because construction was taking place on government property, OHARNG was required to obtain the appropriate permits from the Department of the Army (DA) in order to allow the contractors to drill through the rock. OHARNG began the process to obtain the permit. However, acquiring the permits was going to be a time consuming process, so the contractors decided to continue with the water and sewer pipe installation via HDD just past the rock.

Since the new water and sewer mains were part of future plans to expand the training facility and the existing pipe was not disturbed by the new installations, there was no need for bypass lines. The remainder of both the potable water main and sanitary sewer force main were installed via HDD in sections of up to 7,000 to 8,000 linear feet, with HDD pits located in between each lengthy pipe section. All HDD pits were installed just outside of the road, in mostly grassy areas.

In December of 2015, as the crew completed the HDD installation of both the water and sewer mains, OHARNG was still waiting for environmental permits from the government to excavate through the rock. Once they received final approval, the contractor resumed the pipe installation in March of 2016. Approximately 2,400 linear feet of pipe remained for installation through rock (1,200 feet of potable water main and 1,200 feet of sanitary sewer force main). Since HDD through rock can be time consuming and expensive, Rock Construction decided that it would be best to install the pipe using direct bury methods in order to prevent any further delays and additional costs.

6. CONCLUSION

The project was completed successfully in May 2016 and both the potable water main and sanitary sewer force main were immediately put into service. On the south end of the project on George Road, the sanitary sewer pump station was installed, which is where the proposed sewer main ended. The water main was capped off in order to allow for possible addition to the water system in the future. Despite the unexpected delay in construction due to rock in the existing ground, OHARNG was able to manage a successful installation. Using the design build process, both CT Consultants and Rock Industries were able to accurately conceptualize the completed project at an early stage and begin construction shortly thereafter. Recommendations and changes to the project were addressed in a unified manner, which minimized any conflicts or delays during construction. Streamlining project delivery through a single contract between the owner and the design-build team transforms the relationship between designers and builders into an alliance, which fosters collaboration and teamwork.

Rock Industries' selection of Speer Brothers as the HDD subcontractor was critical to the overall success of the project. Their HDD expertise as well as Speer Bros' collaboration with Underground Solutions technicians on fusion layout and process facilitated the timely project completion. The only delay in the project involved obtaining permits, but the installation of pipe using HDD methods allowed the construction to be completed in a timely and cost effective manner.

7. REFERENCES

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