CONSTRUCTION OF A CONTAINED AQUATIC DISPOSAL FACILITY END DIKE CONTRACTOR'S PERSPECTIVE

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ABSTRACT

There is a contaminated sediment site on the St. Louis River, which flows into Lake Superior, forming the Duluth, Minnesota/Superior, Wisconsin Harbor. The site was used for heavy industry since the turn of 20th century. The primary pollutant is coal tar (PAH's).

As the selected contractor, our task was to construct a Contained Aquatic Disposal Facility (CAD), a stone dike with a fabric/clay liner, across an existing deep-water slip that was adjacent to the primary Area of Concern (AOC). This would create a disposal facility large enough to hold the dredged contaminated material from the primary AOC.

The project was completed ahead of schedule and within budget. This was primarily due to amiable relationships between the Contractor, Design Engineers and Construction Managers. A "Partnering " relationship was created between the three firms, heading off potential problems and design changes and avoiding costly delays.

Keywords: Turbidity curtain, pile driving, stone placement, fabric/clay liner, partnering, contaminated sediment.

INTRODUCTION

This project is located in Duluth, Minnesota on the St. Louis River Estuary, which creates the Duluth, Minnesota / Superior, Wisconsin Harbor. This is a natural harbor that was utilized in the mid 1800's to accommodate the booming lumber business for export of lumber back to major cities. Returning vessels carried the supplies that were needed by settlers as they moved westward. In the late 1800's, iron ore was discovered in northern Minnesota and was mined to supply iron ore to the steel mills of the Midwestern USA. As this industry grew, steel mills and foundries were built on the St. Louis River, creating the AOC that this project is associated with.

Multiple means were needed to construct the dike including:

- A durable water control structure (turbidity curtain) was required to contain suspended particles (contaminates are present at the dike location);
- The design required driven pile;
- Approximately 50 percent of the rock required "placing " and could not be bulk dumped from the shore;
- Soft sediment in the slip bottom would not allow over loading of material in one location for concerns of bottom failure; and
- The project required divers to install the Geotextile Clay Liner (GCL) and verify quality control (QC).

Pre Construction

This project is a Superfund site, and required that all crewmembers complete the OSHA 40-hour Hazardous Material Training (Hazmat) prior to construction. Our next step was to update the soundings of the area where the dike was to be constructed. The slip had received numerous deep draft vessels recently and, with the soft sediment common to the area, it was important to verify quantities of stone fill prior to construction. Single-beam hydrographic surveys indicated that some scouring had taken place from the vessel traffic. The contract did have a unit price for additional stone not covered in the plan quantity. The Construction Managers and Design Engineers were notified and the owner acknowledged the condition.

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Figure 1. Location of dike prior to construction.

Water Control Structure (WCS)

Design specifications required either a flow thru or double / offset turbidity curtain. Our choice was the flow thru method, which would enable us to open and close the structure with less effort. See Figure 2. The WCS needed to be well secured to avoid wind and “seiche” influence on the structure. We secured the structure with 10” pipe pile on 50’ spacing, as past experience proved this to be an effective method.

Figure 2. Water control structure at site.

Driven Pile

Design required 27-10”x 40’ pipe pile driven in two parallel rows across the slip entrance to handle lateral loads created by the disposed material. Because of the large area required to drive the pile, we decided to use a sub-centimeter GPS positioning system and appropriate software rather than a driving template on our crane barge. We also had to decide whether to drive the pile to final elevation (-12’ below surface) or leave the pile long (exposed at the surface) and cut it off after the tremie fill with concrete was completed. We chose to leave the pile long for two reasons: (1) by leaving the pile long, we had the visual means to show inspectors the pile was in the correct location, and (2) this simplified the task of locating pile to use for tremie fill. After the pile was filled with concrete, we used divers to cut the pile to length. See Figures 3 and 4.

Figure 3. Driven pile.

Figure 4. Tremie pumping.

Placed Stone

Due to the risk of creating high levels of suspended contaminated sediment in the water column, design specifications required the first 8' lift to be placed by clam shell bucket rather than surface dumped. Our approach was to use Cable Arm's Clam Vision software to show and track each bucket placed. We were able to track thickness with pressure sensors on our bucket (we used a rock skip for improved production) that relayed prior and post placement water depth as we worked across the footprint of the dike. See Figure 5.

Figure 5. Rock skip monitor from crane seat.

After placing the initial 8' layer, we removed the crane barge from the dike area as shown in Figure 6. This required opening the WCS, which was determined to be a feasible option after monitoring proved there was no suspended sediment in the water column.

Figure 6. Crane barge leaving.

Dumped Stone

The remaining stone was dumped via end loader from stock piles of material located adjacent to the dike.

Due to the water depth being deeper than expected, which was verified by pre-work soundings, and some reach limitations by the equipment, a long-reach excavator was utilized to shape the final grades. We had a dilemma because stone being bulk dumped has a natural angle of repose of 1.5:1 slope. However, if we centerline dumped we would not have stone reaching out to the toe area (design slope is 2.5:1).

Prior to placement, we discovered that placement of the equipment on the centerline would not reach the toe and would prevent dike shaping to the required shape. We came up with a feasible solution of dumping the materials offset of centerline so the material offset would reach the toe. We presented the new method to the design engineers prior to placement, providing them with ample time to analyze our approach and approve the method. This approach was approved and completed as shown in Figures 7 and 8.

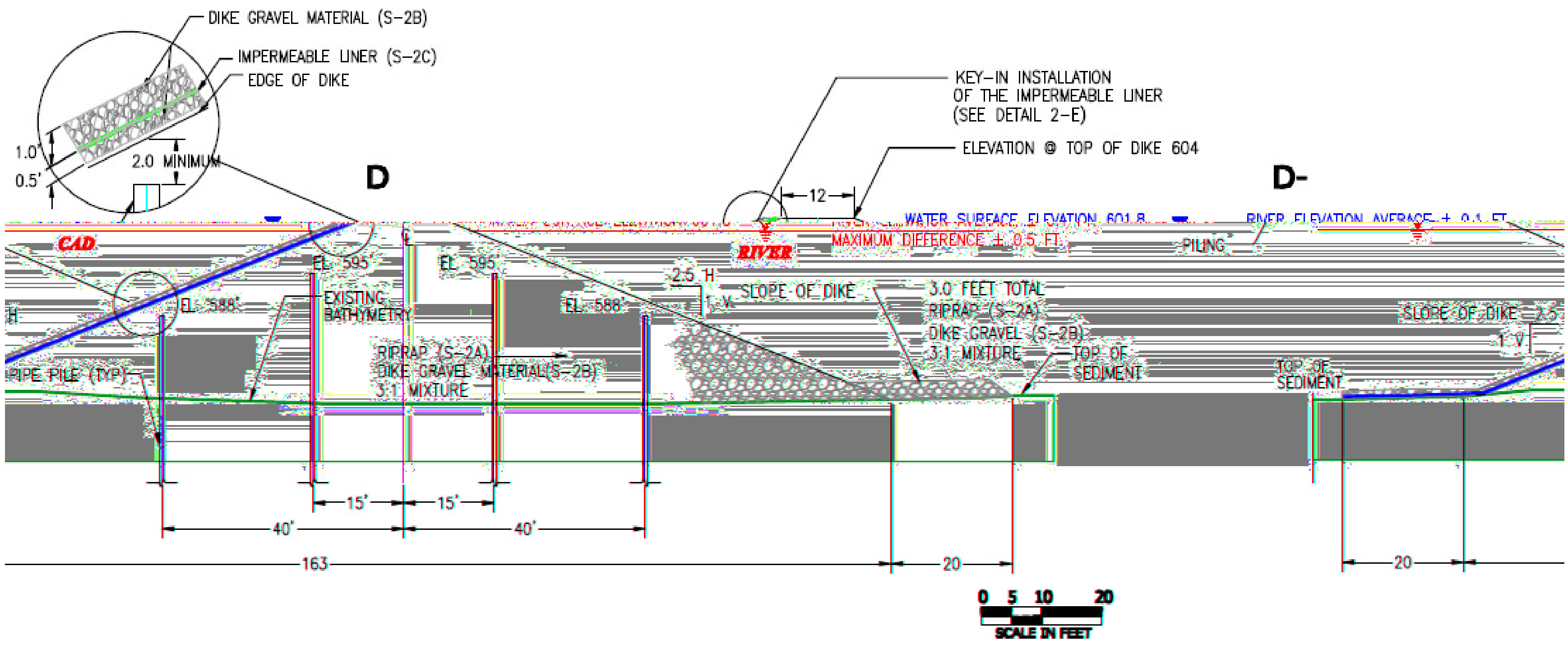

Figure 7. Cross section.

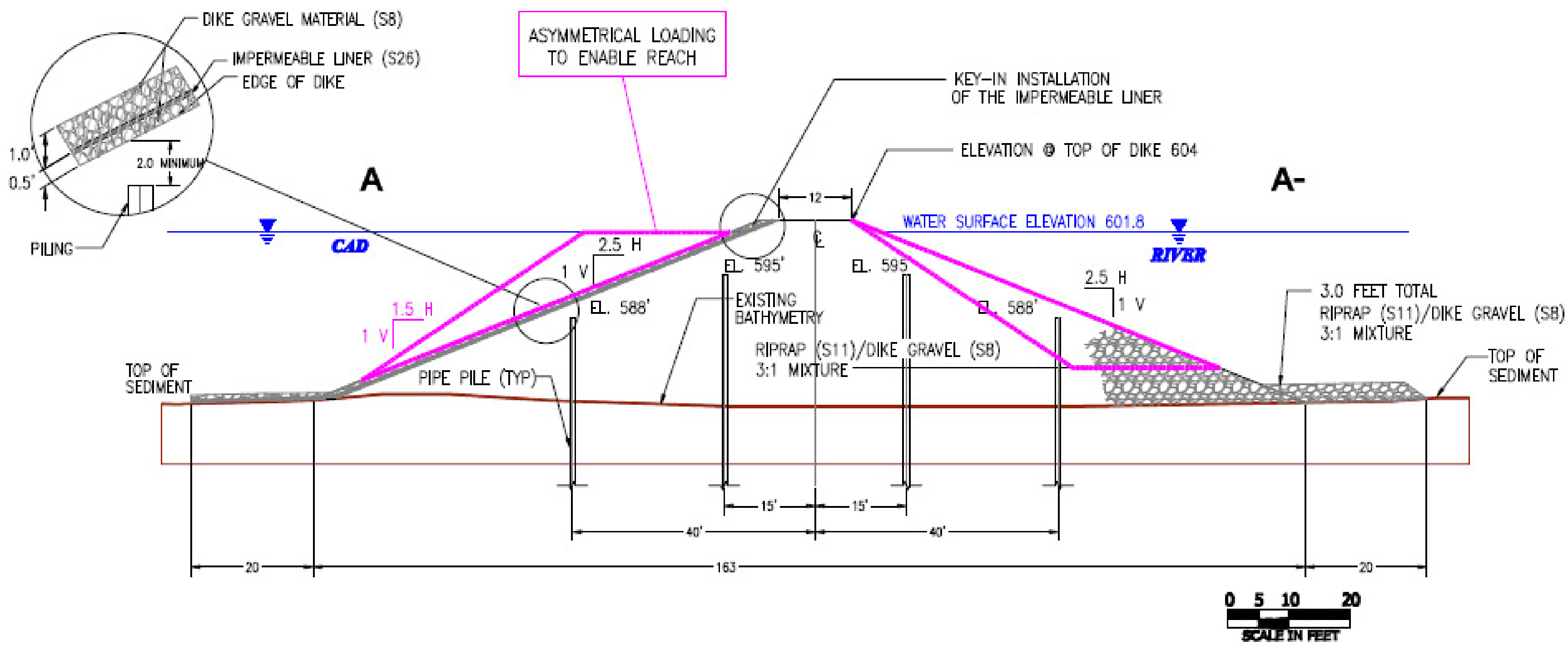

Figure 8. Asymmetrical load.

The new 1.5:1 slope allowed us to reac h the toe with our equipment and shape the slope beginning at the toe and working up the slope. This method allowed us to side cast the excess material behind us, to the side of the dike that needed stone. A concern about whether or not the base mat of stone (8' stone layer) wouldsupport the asymmetrical load was favorably resolved, after a review and some adjustments of load location determined the mat would support the load.

Figure 9. Slope shaping.

Geotextile Clay Liner

Following completion of the shaping of the dike, we installed a 6" layer of 1" diameter stone (per specification) to give the GCL a smooth base to lay on. The GCL was installed from the top of the dike to the toe, with 2' overlaps per manufacturers instruction. See Figure 10. We used a small work skiff to pull and unroll the GCL perpendicular to the dike. This was coordinated with a dive crew to verify overlaps and video the installation for QC. After installation of the GCL, we installed a 1' layer of 1" diameter stone to protect the GCL. See Figure 11.

Figure 10. GCL installation.

Figure 11. One inch stone installation.

CONCLUSION

“Partnering” was the key to keeping this project moving forward without costly delays, which can sometimes create short tempers and result in lack of trust. A relationship of trust needed to be formed between the Project Managers, Design Engineers and Contractor to successful completion of the project. This trust would have been difficult to achieve if the Design Engineers were inflexible on design and constructabity approach or if the Contractor was focused on getting as many change orders as possible. The final key to success was the willingness of the Construction Manager to form a bond with the group and create a “Construction Team”.