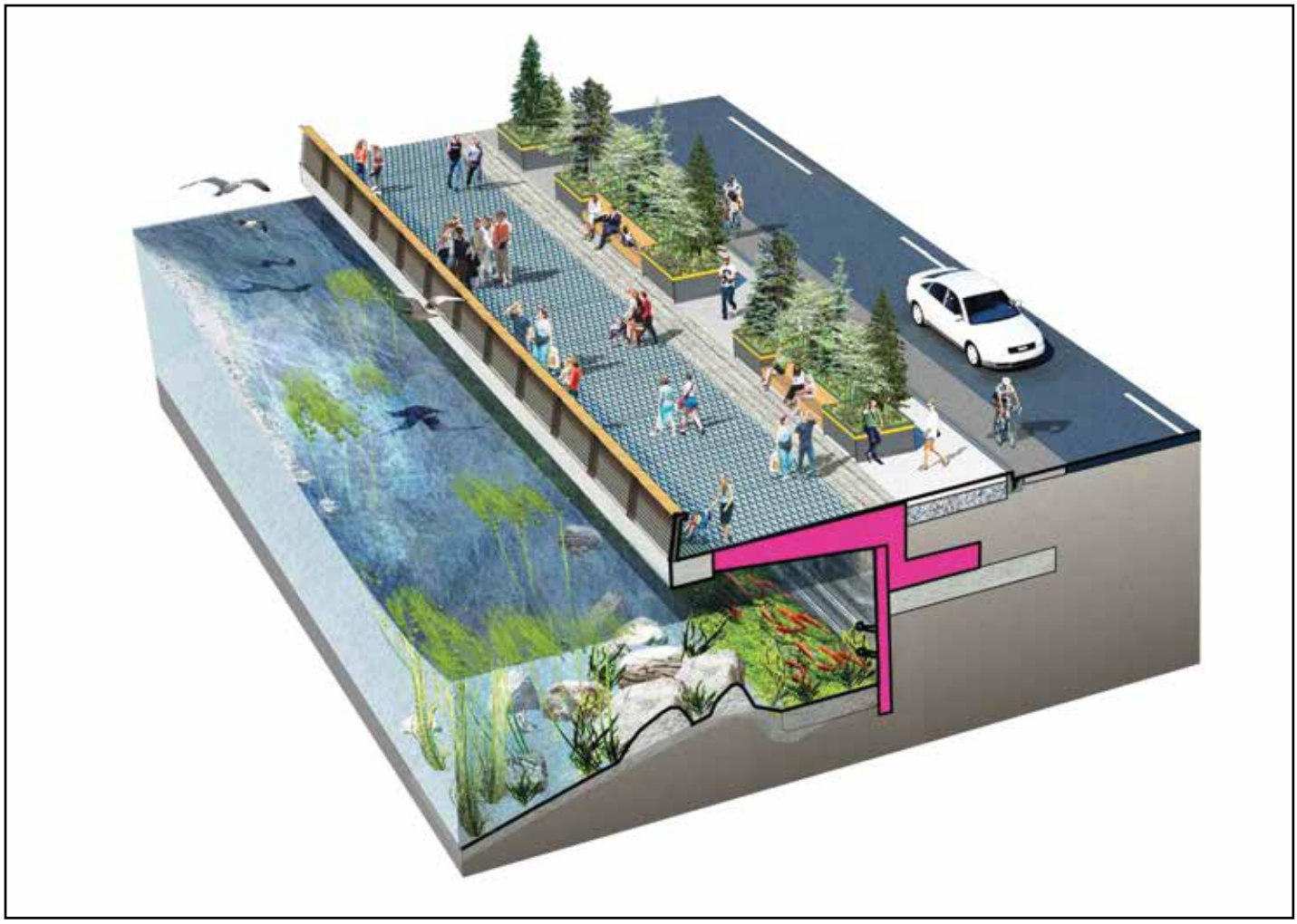
Water Quality Monitoring on the Elliott Bay Seawall Project



New design for Seattle's Elliott Bay Seawall will include habitat for salmon and a sidewalk with glass panels that allow light to reach the shallow water habitat below. Courtesy Seattle DOT

This article will describe how the mechanisms of a design/build contract are being used to manage a wide array of water resource challenges on an inherently dynamic and unique construction project. Through the themes of regulatory protocols, water conveyance, contamination variability, chemical treatment, inert and reactive media filtration, and systems

automation, we will explore how a robust and evolving water management plan was essential to the success of this municipal keystone project.

Summary of Project

Clear Water Services' role on the Elliott Bay Seawall (Seawall) construction project, located in Seattle, Washington, started in 2014 and is scheduled for completion 2017. The Seattle Department of Transportation is the contracting agency for the project. Mortenson-Manson, a joint venture, was awarded the project as the General Contractor/Construction Manager (GC/CM). The project was mostly funded by a voter-approved municipal bond measure. The existing seawall protected Seattle for more than 70 years; however, the marine environment caused cracks within the wall, allowing salt water to infiltrate and eat away at the timber piles that support the wall itself.

Arial rendering of the project area. Photo Credit: Seattle Daily Journal of Commerce

The project is linear and consists of an eight acre area in and amongst an active commercial waterfront in one of the most heavily visited tourist areas in the city. The project logistics are further complicated by concurrent construction projects and the general demands of adjacent transportation corridors.

Major work zone preparation tasks included installation of the sheet pile cofferdam, establishment of a freeze wall, demolition of surface features, dewatering systems installation, treatment systems installation, retaining wall installation, excavation, and demolition of the existing seawall. Major construction activities include establishment of the jet grout slab (30+ feet below shoreline elevation), poured concrete slabs,

and installation of cantilevered zee-panels, face panels, light penetrating surface panels, and a marine habitat bench.

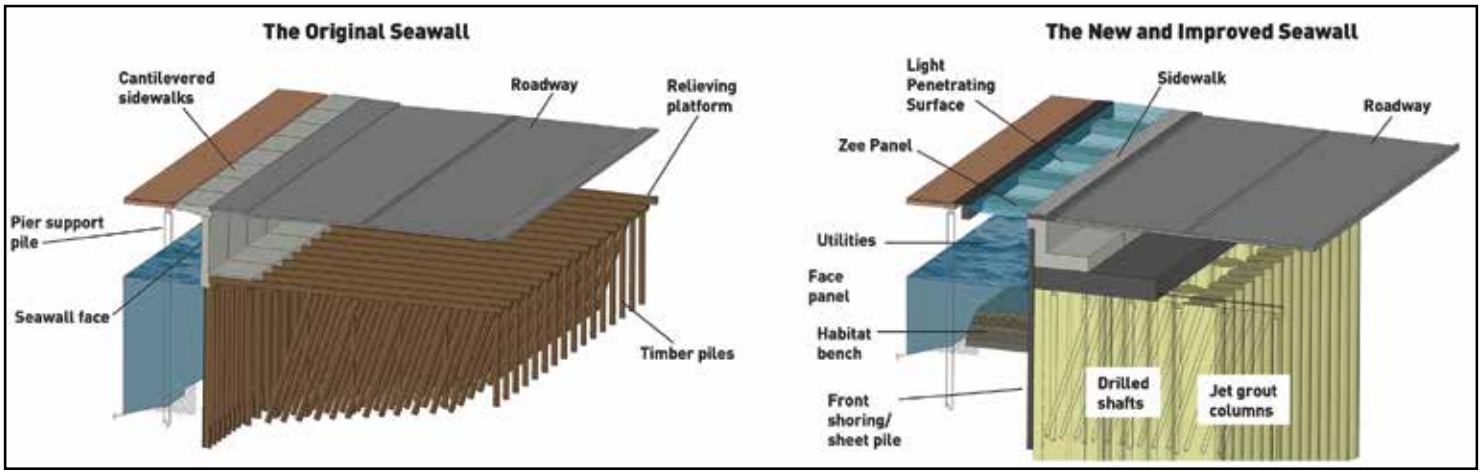
Clear Water was awarded the contract to install and operate the project dewatering and treatment systems. A bid was solicited for a third waste stream source, fed by upland dewatering wells pulling from a suspected contaminated zone. An alternative solution was ultimately employed for this source in the form of a sub-surface freeze wall extending 30+ feet below ground level. The freeze wall was deemed to have multiple benefits over dewatering and treatment including maintaining structural stability for the aging viaduct highway located adjacent to the worksite.

Goals and Water Quality Objectives

The Seawall Project falls under the Washington State Department of Ecology's (Ecology) National Pollutant Discharge Elimination System (NPDES) General Construction permit. The project site contained known contaminated groundwater and soil which has the potential to impact dewatering efforts due to planned construction approaches. An administrative order was attached to the NPDES permit by the state in an effort to further protect the waters of Elliott Bay by placing stricter regulations on the project's construction methods. The project is also permitted to discharge to the local publicly operated treatment works (POTW) facility by a major discharge authorization which is regulated by the King County Industrial Waste Program.

The major challenge of this project was to maintain the two distinct water conveyance and treatment systems under the varying flow scenarios, while simultaneously supporting dynamic and often competing construction activities.

Clear Water Services, an environmental services sub-contractor, was tasked with segregating two distinct sources of water, conveying water from these distinct sources to separate temporary nearby off-site treatment plants, and treating the water to discharge standards under the two separate permitting authorities. The primary water source was landward of the cofferdam, which intercepted marine seep water at rates up to 3,500 gallons per minute (gpm) before it entered the active construction area. This water was conveyed to one of two project-specific treatment plants adjacent to the project and treated to state water quality standards before being discharged back to Elliott Bay. The secondary water source was dewatering of various sources of water that intruded into the active construction areas including stormwater, groundwater and construction related process water. This nuisance water was impacted with known and unknown contaminants, and was treated at one of two secondary treatment plants permitted under the local sanitary sewer authority (King County Industrial Waste). The subcontractor was expected to maintain a dewatered construction environment under a design build contract throughout the various stages of construction.



Seattle Seawall Replacement Design. Credit: Seattle Department of Transportation

What Was Done and What Was Found

The major challenge of this project was to maintain the two distinct water conveyance and treatment systems under the varying flow scenarios, while simultaneously supporting dynamic and often competing construction activities. Each conveyance system was up to 2,000 lineal feet from the furthest collection point to the nearest treatment system.

The tidally influenced cofferdam water management system would have to accommodate drawdown rates, ranging between a few hundred gpm to rates sometimes exceeding the design criteria of 3,500 gpm, within a time frame of 5 to 10 hours. Respectively, the temporary treatment plants' operations needed to accommodate these varying flow rates coupled with unexpected swings in influent turbidity (0-4000 NTU) and pH (5-12 s.u.) values. The two treatment plants utilized to handle the marine cofferdam water source included chemically enhanced sand filtration (CESF) and pH adjustment systems with designed flow capacities of 3,500-gpm and 1,800-gpm. The effluent from these treatment systems were discharged directly to Elliott Bay, one of the locations was in close proximity to the Seattle Aquarium's intake.

The secondary (or nuisance) dewatering system and associated treatment plants also utilized CESF with the addition of reactive granular activated carbon (GAC) media to address the contaminants of concern. These systems were designed with a treatment capacity of up to 500-gpm. These nuisance water treatment systems also had to handle similar swings in flows and water quality although these swings were generally less predictable because they were associated with unintended consequences of construction activities and civil infrastructure damage. For instance, the project utilized soil freeze technology to limit the upland groundwater transport into the work zone. While this added significant benefit to the project, the only available location to install the soil freeze system was directly adjacent to the nuisance water conveyance line. This resulted in several events where the conveyance lines became frozen and inoperable, which also resulted in the emergency deployment of long stretches of temporary hose and pipe.

Tidal Conveyance to Main 3500-gpm Treatment System.

The variability challenges were managed through a series of automation upgrades, increased up-gradient monitoring capabilities, changes in treatment chemistries, changes in treatment plant design, and operation and maintenance flexibility. One of the most significant value engineering impacts to the project was to manage the variability of the tidal dewatering water quality. During periods of intense construction activity, the turbidity of the system influent exceeded 4000 NTU on a regular basis. During jet grouting operations, the pH would often reach up to 12 standard units. However, the influent water quality would also be improved to match the receiving water quality levels on a daily basis, requiring unnecessary treatment of dewatering volumes at the treatment systems. A water quality monitoring and control system was installed on the marine cofferdam conveyance system to directly discharge water that met surface water quality criteria (less than 10 NTU and pH between 6.5-8.5 s.u.). If conditions changed due to onsite activity, the system would automatically close the pneumatic discharge valve and redirect the dewatering volumes to the treatment system for further processing to meet discharge values. Both the water quality

monitoring system and the treatment systems recorded flow, turbidity and pH values in real-time, aggregating the data into 5-minute time weighted averages.

Since the installation of the water quality monitoring and control system in July of 2015, approximately 75% of the tidally influenced water volume has been directly discharged to Elliott Bay within permitted water quality parameters. This has allowed the project to maintain the necessary water levels within the construction site and remain in compliance by allowing the treatment system to focus on water that is truly required to be treated as opposed to commingling large volumes of clean water with smaller volumes of turbid water and generating large volumes of water requiring treatment prior to discharge, as was evident in the early stages of the project.

To date, the project has managed over 640 million gallons of water. Approximately 402 million gallons (63%) of tidal dewatering was treated and discharged to Elliott Bay with an additional 220 million gallons (35%) that was monitored and directly discharged to Elliott Bay. Approximately 15 million gallons (2%) of nuisance water was treated and discharged to the King County POTW sanitary sewer system.

Conclusion

This complicated project continues to evolve and become a more efficient example of a robust and dynamic water management plan, which has become essential to the success of the project. Dewatering means and methods were truly design/build, at times on a daily basis. Water quality monitoring and treatment methods were enhanced and added significant value to the project through automated systems and a dedicated technical staff. This project required flexible treatment methods and equipment that could adapt to the daily changing conditions. The water management plan included some level of contingency planning to achieve the water quality objectives of this project. However, that was not as significant as the on the fly ingenuity and critical decision making skills of the construction team. **L&W**

This complicated project continues to evolve and become a more efficient example of a robust and dynamic water management plan, which has become essential to the success of the project. Dewatering means and methods were truly design/build, at times on a daily basis.

by Nathan Holloway & Tyrone Clager

For more information, contact Nathan Holloway, Clear Water Services, LLC, at Phone: 206-639-5836, or at his Email: nathan.holloway@clearwaterservices.com. You can also contact Tyrone Clager, Clear Water Services, LLC, at 425-754-4016, or tyrone.clager@clearwaterservices.com.