CANADIAN CONSULTING engineer

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CCE AWARDS 2020

Construction of the Largest Solid Wall HDPE Outfall in North America

Improving the environment and communities in the Capital Regional District and abroad...

Summary

AECOM and Joint Venture partner Graham Construction (AGJV), designed and facilitated the construction of North America's largest solid wall High Density Polyethylene (HDPE) outfall a 1.92 kilometres long, 2250-millimetre DR26 HDPE pipe associated with the McLoughlin Point Wastewater Treatment Plant.

Unique features include: construction in two distinct segments; a 120-metre-long inshore segment, constructed with steel pipe by "wet exit" microtunnelling; and an 1800-metre-long offshore segment, constructed with HDPE pipe and installed by "float and sink" construction.

Innovation

The McLoughlin Point outfall is the largest solid wall high-density polyethylene (HDPE) outfall installed in North America. The outfall was designed to be constructed in two segments; 1) A 120-metre-long inshore segment, constructed with steel pipe by microtunneling methods; and 2) An 1800-metre-long offshore segment, constructed with 2250 millimetre solid wall HDPE pipe and installed by "float and sink" construction.

The inshore segment included the design of 120-metre-long section of steel pipe, microtunneled through bedrock, using a "wet exit" technique, avoiding the use of very expensive coffer dams, and limited the disruption of the sensitive intertidal marine environment. Construction of this segment was critical, as a failure of this component during construction could result in flooding of the entire shore-based construction site, The tunnel was installed between a shore-based launch shaft, blasted into bedrock to a depth of approximately 8 metres below sea level, and an exit trench blasted offshore approximately 10 metres below sea level. The MTBM was driven offshore into the exit trench. Once the tunnel boring machine (TBM) broke through into the underwater exit trench, TBM utilities i were removed from the TBM and the TBM advanced fully into the ocean. A specially designed bulkhead door was then sealed shut. A blind flange was installed in the launch shaft and the pipe flooded. The TBM was then disconnected from the pipe string and floated to the surface.

To prevent deterioration from corrosive sea water, the pipe material on the inshore segment was treated with an abrasion-resistant epoxy overlay, and the tunnel annulus was filled using a specialty calcium nitrite grout. The interior of the pipe was lined with a high-quality polyurethane pipe coating.

The offshore section consisted of solid wall HDPE pipe designed for a "float and sink" installation. This is the largest HDPE pipe deployed in North America and the largest HDPE outfall in North America. The pipe weighting was designed to resist the effects of ocean currents, wave induced energy and buoyancy. A total of 350 reinforced concrete weights, weighing approximately 11,000 kg each were installed at a spacing 4-6 metres apart. Permanent fastener materials were constructed of corrosive-resistant products such as super duplex stainless steels, silicon bronze and titanium.

To offset environmental impacts as a result of construction, artificial reefs were constructed, using the waste blast rock from the offshore trench an economical re-use of waste that achieves an overall environmental benefit.

Complexity

Every facet from design, procurement and coordination of construction of the outfall proved complex. Design included determination of ocean induced forces using 100 years of wind data, and current velocities at a nearby ocean monitoring mooring. On-bottom stability analysis then determined the mass required to keep the pipe stable on the ocean floor.

Installation force analysis was also completed, as the highest stresses the pipe will see is bending during installation. This analysis determined a safe bend radius during the float and sink operation and determined a required Pipe "end pull" of up to 100 metric tonnes to maintain this safe radius.

Pipe materials were constructed as far away as South Carolina and transited to the outfall marshalling site in Nanoose Bay on Vancouver Island. Pipe was assembled and tested in Nanoose Bay and transported 100 nautical miles to the south by tugboat to Victoria.

A unique method of diffuser installation was designed to allow the diffuser to be installed by "float and sink" methods as part of the main outfall. Traditionally, diffuser sections of outfalls are installed separately from the main "float and sink" parts of the outfall, which is very expensive. Temporary diffuser closures were designed to be pressure tight allowing for pressurization of the pipeline during sinking. The internal sealing system for the 36 diffuser ports was designed to withstand pressures up to approximately 3 bar. Once on the bottom, these seals were removed using a Remotely Operated Vehicle (ROV).

Social and/or Economic Benefits

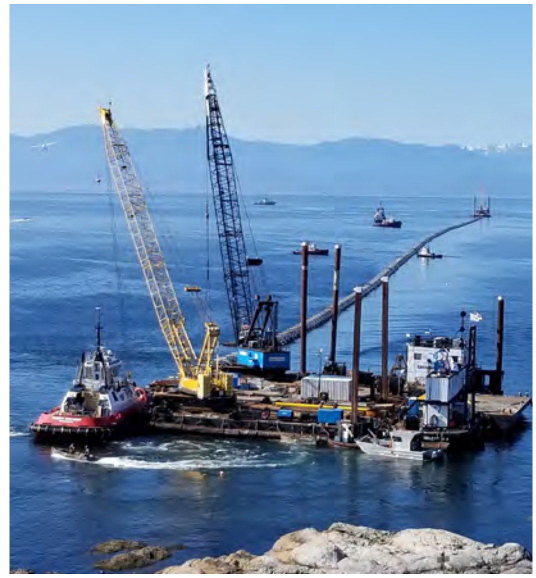
The CRD up until completion of the new plant, discharged raw sewage into ocean from two existing outfalls. Construction of the new outfall facilitates discharge of treated effluent from the new McLoughlin Point WWTP, an end to decades of debate and public embarrassment related to unsustainable waste management.

The new outfall is part of the puzzle that will end decades and decades of debate and public embarrassment related to unsustainable waste management for the CRD.

Preliminary concepts for the project included reusing the existing outfalls to discharge treated sewage from the treatment plant. This would have required the twinning of conveyance pipelines to one or both pump stations, an additional 1.2 to 4.2 km of underground infrastructure, and the installation of lift station pumps to overcome the limiting hydraulics. By installing a new outfall at the treatment plant site this additional infrastructure was not needed, reducing the initial conveyance system cost and the ongoing operating cost to the taxpayer.

The location of the project, including Victoria Harbour and the surrounding waters of Juan de Fuca Strait, supports a diverse community of fish, marine mammals and invertebrates considered to be culturally and economically important. The waters are frequented by many harvestable species important for commercial, recreational and Aboriginal fishing as well as environmental tourism. The deep ocean outfall has been designed to minimize the impact of discharging treated effluent into this sensitive ecosystem with the goal of supporting robust and sustainable tourism and fishing industries.

The construction timeline was developed to leverage funding from both the federal and provincial governments reducing the tax burden to the public. The completed project will also exceed federal and provincial environmental targets reducing discharge fees payed and preventing costs associated with regulatory penalties.



Environmental Benefits

The new marine outfall will protect the environment by transporting treated effluent from the McLoughlin Point WWTP into the marine environment.

To comply with stringent environmental regulations, near field and far field modelling of the treated effluent plume was completed to make certain the adequate dispersion of treated effluent plume into the environment. The use of wide “duckbill valves” on the 36 port diffuser was selected to meet dilution criteria throughout the entire 75-year flow development of the treatment system.

Three potential design alternatives were initially compared, two options included laying the outfall pipe across the foreshore through the intertidal and subtidal zones. The chosen option utilized a tunnel beneath the intertidal and subtidal zones to avoid disturbance of fish and migratory bird habitat. Additionally, microtunneling was chosen, over horizontal directional drilling, as the preferred construction method due to the lower environmental risk from drilling fluid losses.

While on-bottom disturbance was minimal, compensatory restoration of an equivalent footprint of the outfall was required in accordance with the federal Department of Fisheries and Oceans (DFO) regulation. This was achieved by salvaging blast rock from the outfall exit trench to create habitat reefs adjacent to the construction site.

The DFO was concerned over the effect construction may have on movement of crab species. It was uncertain whether the outfall would permanently embed in the soft sea bottom – potentially creating a barrier on the sea floor. Safe passage was integrated and maintained through the addition of fibre reinforced plastic bridges along the pipe.

Meeting Client's Needs

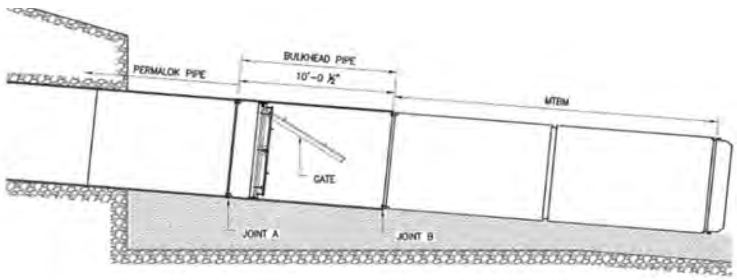
The Capital Regional District is building a complete wastewater treatment system to meet the provincial and federal regulations for treatment by December 31, 2020. This system includes raw sewage pump stations with preliminary treatment, a liquid stream wastewater treatment plant complete with an ocean outfall (the subject 'McLoughlin Point outfall'), conveyance lines and a residuals treatment plant, The McLoughlin Point outfall is a critical piece of the overall integrated wastewater treatment program and good communication with the CRD through the design and construction of the outfall was key to meeting all of the client's requirements.

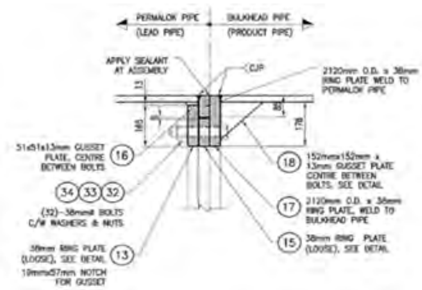
The CRD's needs are multi-facetted, including the following: the provision of increased infrastructure capacity with long-term resilience, adherence to project budget and schedule, overall benefit to the environment, and minimal impact to the community during construction. The new outfall needs to provide capacity today and for the flows projected over the next 75 years, this was achieved through detailed analysis and careful detailing of the outfall components to minimize friction head loss within the pipe and ensure minimum scour velocities were achievable during low flow periods. To meet the CRD's long-term infrastructure resilience needs materials were selected to withstand the harsh marine environment reducing future maintenance and replacement needs. The CRDs budget and schedule needs were met by the Design Builder (AGJV) prioritizing the outfall earlier in the overall program construction, acknowledging that the outfall was a high risk schedule risk and complex construction that could only be completed under specification conditions with specialty equipment.

The McLoughlin Point Outfall is a critical piece of the Capital Reigonal District's overall integrated wastewater treatment program.

Technical Achievement

Inshore Construction





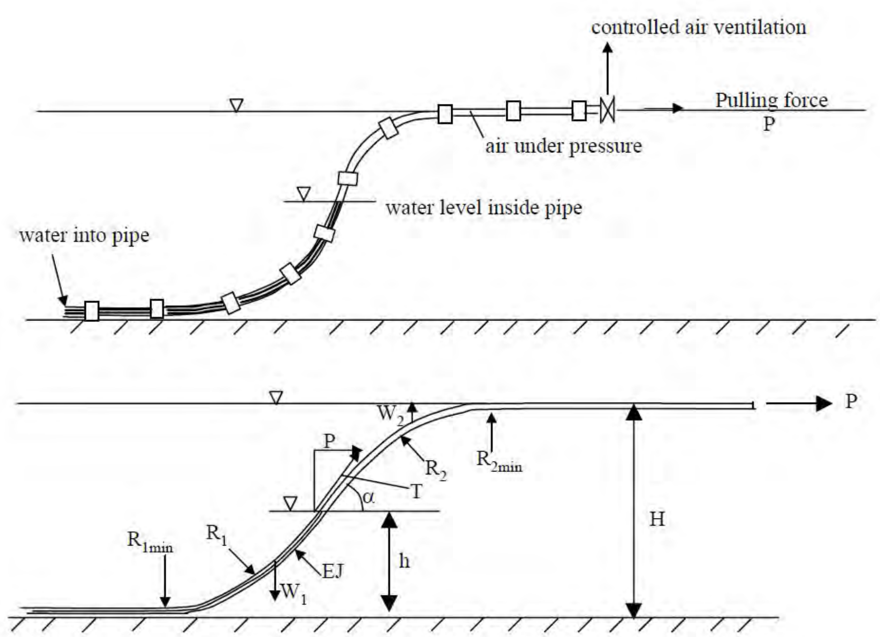
The inshore section from the new treatment plant to the ocean consisted of a 120-metre long, "wet-exit" microtunnelling drive which was constructed with a 2120-millimetre steel pipe section with a 25-millimetre pipe wall thickness to safely resist installation jacking forces. The pipe was driven through highly abrasive granodiorite bedrock.

The drive started from an inshore blasted jacking shaft at a depth of approximately 12 metres below ground (top left photo), to a blasted offshore marine trench at a water depth of approximately 12 metres (top right photo). This section of pipe was installed by a Herrenknecht AVN Microtunnel Boring Machine (MTBM). Production was in the order of 3 metres per day, with one shift.

The pipe used in the drive included a custom designed bulkhead door behind the MTBM (bottom graphics), which allowed for the MTBM to be removed in the wet, and floated to surface. The connection of this system required a specialized 3-ring internal flange for connection of the bulkhead pipe to the product pipe to minimize intrusion of the internal flange to approximately 60 millimetres, to reduce head loss. The inshore end on the pipe featured a blind flange which protected the treatment plant site from flooding during constriction. On completion of the plant construction, the outfall chamber was flooded and the blind removed by divers.

Offshore Segment

The offshore section of the outfall was comprised of concrete weight ballasted 2250-millimetre HDPE pipe. The pipe was installed by "float and sink" methods, as illustrated below, in water depths up to 62 metres deep. The float and sink installation was approximately 1800 metres long and included a 210-metre long, 36 port diffuser. The HDPE pipe consisted of a short inshore section of DR 21 pipe (107 millimetre wall), and the balance used DR 26 pipe (87 millimetre wall thickness).



MCLOUGHLIN POINT OUTFALL —
the largest deployment of solid wall HDPE and the largest solid wall HDPE outfall in North America.

About AECOM

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