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Microtunneling at John Hart Lake

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Residents of Campbell River are fortunate to have access to a generous supply of clean fresh water sourced in majority from manmade John Hart Lake through a hydroelectric generation plant owned by BC Hydro.

John Hart Lake, northwest of the Campbell River on Vancouver Island, is within the boundaries of Elk Falls Provincial Park. BC Hydro's John Hart Generating Station has been supplying water for electrical power operation since 1947. To provide safer, efficient and more reliable service, BC Hydro embarked on the construction of a new underground hydro power generation facility slated for completion in 2018. The change required the City of Campbell River to devise an independent means for sourcing its drinking water.

The resulting project, the Campbell River Water Supply Upgrade, required an $18.3-million investment from BC Hydro and $10 million from the City to construct and operate an independent water conveyance system and build a new water treatment facility and pump station alongside John Hart Lake on BC Hydro's property. The design provides better efficiencies to reduce costs, and also reduces park impact by combining operations at one location and eliminating a section of transmission line through the park.

Phase 1 required the open-cut installation of 1.2 kilometres of connecting pipe. Phase 2 involves the construction of 1.4 km of connecting lines, the lake intake structure, pump station and water treatment facility. The City's new system will provide service to residents by the end of 2017.

The Raw Water Intake Project Phase 2/Project 1 calls for a new

Frontier-Kemper Constructors crew members smile in front of their SL60C after completing work at John Hart Lake.

1,524-millimetre (60-inch) microtunneled pipeline connecting a caisson adjacent to John Hart Lake to a submerged intake screening system at 14-metre depths. The intake tunnel comprises 116 m (380 linear feet) of 1,556-mm ID Permalok® microtunnel section joined to the intake screening system with a submerged 147-m, 1,600-mm fused joint HDPE pipeline.

Stantec Consulting Ltd. of Victoria and Highland Engineering and Surveying of Campbell River are responsible for the design and administration of Phase 2/Contract 1 of the Campbell River Water Supply Upgrade Project. Aecon Infrastructure-Frontier-Kemper Constructors JV was awarded Contract 1 on May 10, 2016, with Frontier-Kemper Constructors, Inc. (F/K) of California performing the microtunneling work. Fraser Burrard Diving Limited of Maple Ridge was subcontracted for the MTBM's wet retrieval.

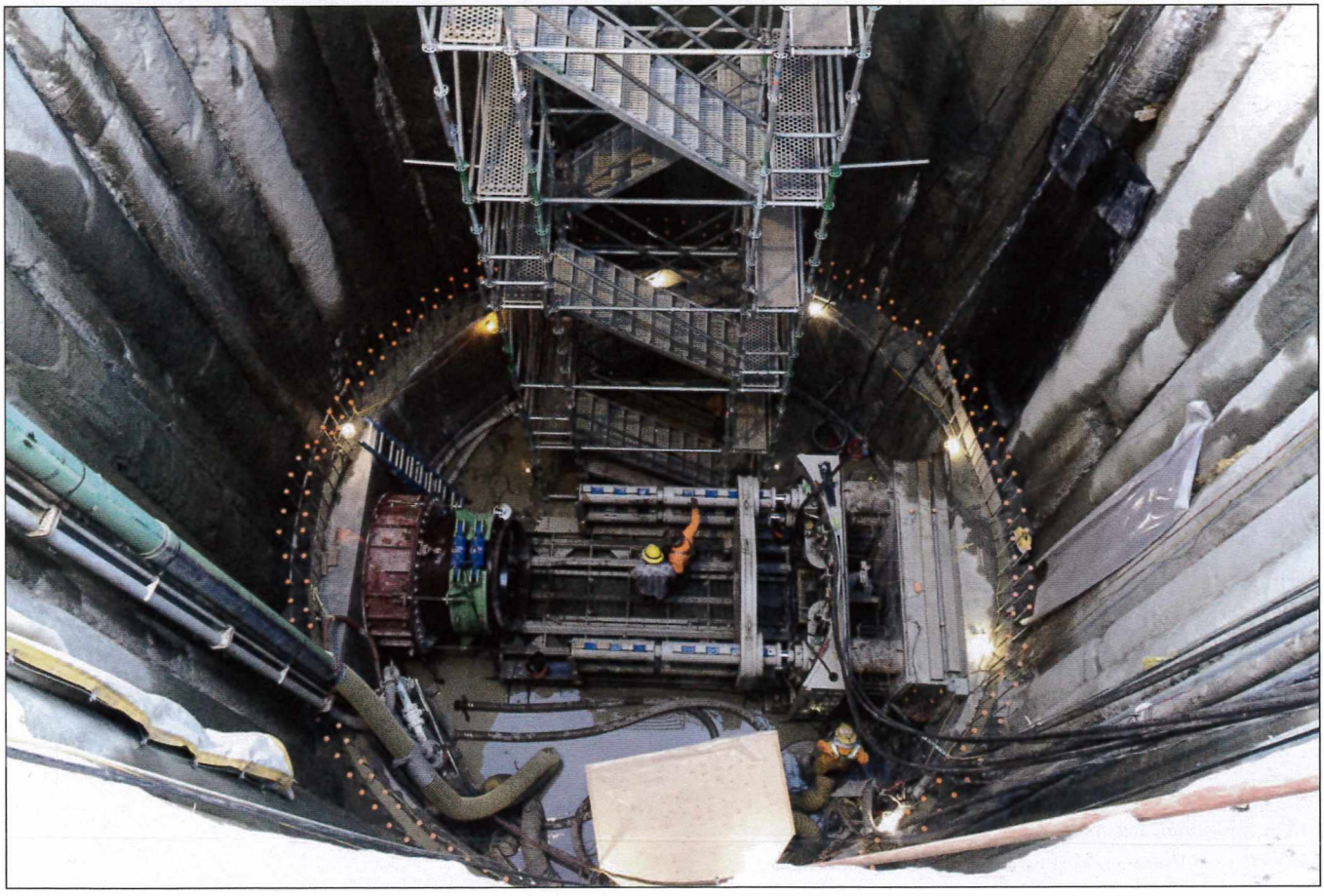
The lakeside geologic conditions for the microtunnel installation consisted of clays and sands with sand primarily present at the interface of the lake. Microtunneling is an ideal means of accurate pipe jacking in low blow count and flowing soil because its closed slurry system offers continuous support to the MTBM face to balance groundwater and soil pressure during excavation. It's also the safest choice in high water levels since the MTBM is remotely controlled by an operator in the control container at the surface level.

Frontier Kemper used their Akkerman SL60C MTBM system with a mixed ground cutter head to contend with the mixed face geology. The system includes an MT875K jacking frame with 800 tons of thrust capacity, a control container with the operator control console, power distribution center and MTBM drive motor, a series of pumps to assist with excavation and slurry circulation and a Derrick® slurry separation plant.

The project's 9-m-diameter, 15.2-m-deep caisson intake structure for the pump station temporarily served as the microtunneling jacking shaft and was modified for microtunneling use with a shaft seal to prevent lake water and ground intrusion, a concrete reaction block to bear jacking thrust loads and scaffolding stairs for crew access.

Microtunneling on projects with high volumes of ground water offers unique challenges and requires a delicate balance of expertise, operator skill and risk mitigation. F/K project manager Nestor Garavelli explained, "F/K viewed the interface with the lake and the disconnection of the MTBM from the jacked pipe as the two points of high risk on the project. We employed Fraser Burrard Diving Limited to survey the interface and remove any foreign material that may create an obstacle for the MTBM. In fact, a tree stump along with a few boulders required removal prior to breakthrough into the lake."

F/K was concerned with the shallow cover



The John Hart Lake project's caisson intake structure for the pump station temporarily served as microtunneling jacking shaft.

The views along John Hart Lake on Vancouver Island are picturesque.

and flowable material present at the lake interface. "The pipe would be subject to uplift when disconnected from the MTBM, thus making the connection with the remaining pipeline an issue," Garavelli stated. To counter this upon MTBM breakthrough, he explained, "the diving crew would add concrete blocks with straps to weigh down the section of pipe behind the MTBM to prevent pipe floatation. A grouting campaign through the pipe would also be undertaken to ensure that no cavity existed between the pipe and the excavated ground surface."

To prevent the tunnel and shaft from flooding, Garavelli said, "a double bulkhead was built into the end pipe section closest to the MTBM. The in-pipe bulkhead was welded in place at 1.2 m in the first pipe joint. Next, small hydraulic jacks were installed between the end of the MTBM and the bulkhead of the last pipe section, which were controlled from the shaft side within the pipe, to allow for the release of the MTBM from the pipe section."

Of great concern for the owner was the preservation of the ecological integrity of the lake, which not only provides drinking water for city residents but also feeds the Campbell River which contains prime salmon habitat. A floating debris boom was installed in John Hart Lake just beyond the construction region to inhibit potential contaminants during construction.

The microtunneling system, ancillary equipment and pipe arrived on the City of Vancouver's car carrier barge to Vancouver Island. Frontier Kemper crew mobilized to the picturesque Vancouver Island

in early September. "The location of the MTBM installation and slurry plant was adjacent to the lake and the job site surroundings were impeccable with an abundance of wildlife," remarked F/K MTBM operator Mike Abbott. "The natural beauty of the site location made the job that much more enjoyable for the crew."

The SL60C MTBM was launched on September 6, 2016. The first seven 1,594-mm-OD Permalok® pipe joints were fully welded to prevent joint separation from the weight of the MTBM when it emerged into the lake bed and subsequent buoyant force when the MTBM was removed. Between each 3-m pipe set, a pipe clamp helped to counter the average 18 psi static ground water pressure and hold the most recently installed pipe in place while the next pipe set was lowered and welded.

Along the 116-m alignment, the MTBM encountered soil variances from soft silts to glacial till seams. Frontier Kemper's seasoned operator precisely navigated the MTBM through the changeable ground.

It's common to find tree stumps in man-made reservoirs, and an extra-large specimen was discovered on the lake bed in the alignment path. While microtunneling was underway, Fraser Burrard's dive crew used underwater chainsaws to dislodge a large stump and massive root system lying in the path of the MTBM's entrance into the lake. On September 21, with the obstruction removed, the MTBM had a clear path to emerge into the lake at 14-m depths on line and grade.

Afterward, F/K entered the tunnel from the caisson side to disconnect the microtunneling utility lines and install the MTBM's bulkhead cover. Next, crew retracted utility lines from the first pipe section, closed the bulkhead hatch door and air-pressurized the chamber between the MTBM and pipe bulkhead. Abbott described, "Prior to releasing the MTBM from the pipe, a pressure test was conducted on the bulkhead to ensure that no leaks were present and the hydraulic jacks were also given a test run to ensure that there were no failures."

MTBM operator Mike Abbott stands next to a section of the 9-metre-diameter tree stump moved from the MTBM alignment path.

The MTBM was successfully released and retrieved from the lake surface without any water breaching the bulkhead. Fraser Burrard's team retrieved the MTBM from the lake on September 30 and hoisted it to land Aecon Infrastructure completed the intake connection with a 147-m fused-joint 1,600-mm HDPE pipeline which was floated and submerged into the lake and attached to the microtunnel, angled downward towards the intake screen.

"The project was deemed a big success for F/K and the project team," Garavelli concluded. "This was the first lake tap that F/K had undertaken, and the crew's knowledge and teamwork were instrumental in the success. The support of the owner and engineer along with AECON formed the perfect team to allow for a very important piece of infrastructure for the Campbell River community to be completed on time and on budget."