Construction Dewatering Risk Mitigation: Protecting Estuary Baseflow and Groundwater Quality in Coastal British Columbia

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An environmental investigation at a Western Stevedoring (Western) shipping terminal in North Vancouver, BC (the Site) identified soil contaminated with petroleum hydrocarbons (PHCs). A remedial excavation was completed and the soil contamination was removed, however PHCs remained elevated in groundwater above the Federal Groundwater Quality Guidelines. A human health and ecological risk assessment and post-remedial investigation concluded the residual groundwater contamination was delineated on the Site, did not pose a threat to any receptor and would naturally attenuate on the Site over time.

Re-development of the Site by G3 Terminal Vancouver (G3TV) to a grain export terminal included construction of a road underpass adjacent, and cross-gradient, to the known groundwater contamination (Figure 1). While the risk assessment determined the groundwater contamination could remain in place, road underpass construction required dewatering to facilitate deep excavation below the water table. It was unknown if the dewatering would induce a sufficient hydraulic gradient to pull the groundwater contamination into the excavation. Further complicating the planning and construction of the road underpass was the presence of the Lynn Creek estuary located to the east of the road underpass excavation. Strict provincial regulations required the groundwater contribution to baseflow in the estuary be protected.

The challenge was to design a dewatering system for the road underpass excavation that:

- Minimized cross-gradient movement of PHC contamination towards the underpass excavation; and
- Prevented baseflow reduction in the estuary.

Further it needed to be determined if extracted groundwater would exceed the British Columbia Water Quality Guidelines (WQGs) and require treatment prior to discharge to the Burrard Inlet. To address this challenge, several data gaps had to be filled. A pumping test was designed to determine:

- Aquifer properties to help design a construction dewatering system to minimize movement of the known groundwater contamination;
- The potential effect of dewatering on baseflow of Lynn Creek estuary; and
- Water quality under pumping conditions during construction dewatering.

The extraction well was placed at the east edge of the groundwater contamination to ensure worst case conditions of extracted water quality were documented. The bottom of the well screen was set at the expected depth of well points required to dewater the proposed underpass excavation. The top of the well screen was above the water table. Monitoring wells were installed between the extraction well and the proposed excavation.

A step test was conducted to determine the optimal pumping rate for the pumping test. A 24-hour pumping test was then initiated. A short pumping test was necessary to prevent interference with on-going construction at the Site and to minimize the amount of water requiring treatment and disposal in Site infiltration galleries. Water quality, groundwater levels in monitoring wells and groundwater contamination migration were monitored throughout the test.

Interpretation of the pumping test data and design of the dewatering system was a multi-step process. The drawdown response in the monitoring wells was masked by tidal fluctuations. The USGS open code SeriesSEE was used to model tidal influence and extract the drawdown response from water level data during the pumping test. The resultant drawdown time series was imported to Aqtesolv and aquifer parameters were determined using curve matching techniques. The geology of the Site was coarse sand and the assumption of groundwater flow in porous media was judged to be satisfactory. Water quality results from the extraction well and the monitoring wells indicated groundwater pumped for construction dewatering of the road underpass would not exceed the WQGs for PHCs in the short term.

The dewatering system was then designed using the estimated hydraulic conductivity and the analytical models for unconfined aquifers with the simplifying assumptions of Dupuit. The system geometry limited the area required for deep dewatering. A design pumping rate of 1200 gallons per minute (gpm), for both the shallow and deep dewatering, was proposed to minimize the hydraulic gradient between the groundwater contamination and the underpass excavation, as well as the hydraulic gradient between the underpass excavation and the estuary. Plume movement was predicted to be minimal under the designed dewatering system. Drawdown at Lynn Creek estuary under the proposed pumping scheme was also predicted to be negligible.

As a further precautionary risk management measure, the dewatering system was also segmented into three zones (east, northwest and southwest). The east segment was discharged directly to Lynn Creek estuary to supplement baseflow. The west segments, adjacent to the groundwater contamination, were routed through storage tanks and sampled prior to discharge to Burrard Inlet to ensure the PHC contaminated groundwater wasn't discharged to the environment. A water treatment system was also mobilized to the Site as a contingency in case contaminated groundwater was encountered.

The dewatering system was commissioned in October 2017 and operated until January 2018. Monitoring wells were installed adjacent to the estuary to validate the drawdown predictions at the estuary during construction dewatering. Discharge water quality, plume movement and groundwater gradients adjacent to both the groundwater contamination and the estuary were monitored throughout construction. As predicted, groundwater met the WQGs throughout construction and clean groundwater was discharged to the environment. PHC contamination moved eight metres cross-gradient during pumping and was not intercepted by the dewatering system. There was no measurable change to the groundwater gradient at the estuary.

The complexity involved in designing this dewatering system to protect baseflow and to minimize plume migration was successful due to cooperation between Western, G3TV and the constructor Peter Kiewit Sons ULC. While this did present contractual challenges, they were out-weighed by the strong commitment of all parties to environmental protection.

Figure 1: Site schematic showing key Site features. Scale and locations are approximate.