

Tidal Implications for Contaminant Delineation in a Foreshore Environment

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An historic plume of light non-aqueous phase (LNAPL) diesel that was released to the subsurface more than 30 years ago has resulted in a residual pool of LNAPL that persists in the foreshore of a coastal site in British Columbia. Since the mid-1990's, several environmental investigations have occurred at the site. After soil and groundwater contamination was identified, subsequent investigations were conducted to determine the nature and extent of this contamination and to develop a strategy for the remediation and/or risk management of the site. Free-phase diesel contamination in the subsurface currently extends into the intertidal zone down gradient from the site.

The cyclic reversal in hydraulic gradient and salt water intrusion induced by tides plays an important role in the migration, distribution and release of contaminants to the foreshore environment. The magnitude of contaminant fluxes associated with groundwater discharge to the foreshore is difficult to evaluate due to the dispersed nature of the discharge and the complexity of processes controlling the flux. Tidally induced mixing of seawater results in variable concentrations within seeps that discharge to the intertidal zone. Although the peak groundwater discharge rate may occur at low tide when the hydraulic gradient is at a maximum, the peak contaminant loading rate to the environment does not coincide with the low tide and is more closely correlated to the instantaneous position of the transient seepage face relative to the location of residual LNAPL in the subsurface.

In 2009, detailed hydrogeological investigations were undertaken to evaluate and predict the evolution of groundwater chemistry under varying tidal conditions and to characterize the spatial and temporal variations in diesel contaminant loadings to the foreshore. The investigations included an assessment of permeability to characterize contaminant transport pathways, spatial and temporal correlation of seepage chemistry to tidal cycles, sediment pore water profiling within the intertidal zone and a theoretical analysis of light non-aqueous phase liquid mobility. The results from this program have been essential to validate exposure concentrations used in the risk assessment, to design a more meaningful strategy for long term monitoring and to more effectively quantify and manage the associated risks in order to move the site forward to closure.

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Mr. Mitchell is a hydrogeologist with over 22 years of experience managing surface and subsurface investigations. He is a Contaminated Sites Approved Professional in BC and specializes in the assessment and modelling of groundwater flow and contaminant transport in saturated and unsaturated systems.

Mr. Mitchell has undertaken numerous challenging and complex projects for Government and industry, providing expertise in support of groundwater management, risk assessment and remediation. He has presented at public hearings, as an expert witness for sites under litigation and is an invited expert to various committees including the Science Advisory Board of BC and on behalf of the Ministry of Environment to review technical guidance documents under development for hydrogeology practitioners. He has worked throughout Canada including permafrost environments, in Europe, Australia and the United States. Mr. Mitchell is the Director of Hydrogeology services at SLR Consulting (Canada) Ltd.

Erin Robson, M.Eng., P.Eng.

Ms. Robson is a hydrogeologist and professional engineer with ten years of experience in environmental consulting. Currently based on Vancouver Island, Ms. Robson's work in the consulting industry has taken her to commercial and industrial sites across British Columbia, Alberta and Alaska. Additionally, she is a member of SLR's hydrogeological services department and is responsible for conducting and reviewing hydrogeological investigations across SLR's Canadian operations. She has extensive experience with contaminated site assessment, remediation data gap analysis, and provides technical and management expertise for a variety of commercial and industrial projects. Erin has actively participated in developing remedial action plans, involving in situ, ex situ and risk assessment approaches and has developed numerous groundwater models, addressing fate and transport of contaminants. Her experience includes both federal and provincial regulatory frameworks. In addition to being a licensed Professional Engineer in British Columbia, Erin is also on the Yukon Environment External Review Roster for Hydrogeological Assessments.