Understanding Complex Hydrogeological Conditions to Protect a River from a Gasoline Release

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In December 2021, 22 rail cars derailed from a Canadian National Railway Company (CN) rail line in Alberta, Canada (Site), which resulted in a release of approximately 26,447 gallons (100,113 liters) of gasoline (Incident). The rail line is approximately 100 meters from the shoreline of the Athabasca River, and the ground surface between the rail line and the shoreline is steeply sloped towards the east. The aquifer at the Site is shallow and unconfined, and seasonal river elevations and flow rates influenced groundwater elevations and flow directions, creating a dynamic hydrogeological system that influenced the behaviour of the gasoline impacts in the subsurface. No impacts have been observed or detected in the River to date, which is attributed to the agile and technical response of CN, GHD, and other contractors.

Initial response activities, including soil excavation and LNAPL recovery, were completed to the extent practicable during the period immediately after the release when these activities have the greatest potential benefit. The soil excavation and LNAPL recovery were completed to the extent practicable based on geotechnical constraints associated with the rail infrastructure and steep embankment. Given the Site constraints, LNAPL, soil impacts,and groundwater impacts remained below and adjacent to the rail line after the excavation was completed. A series of soil and groundwater investigations were conducted to understand the complex hydrogeological system at the Site, characterize and delineate the remaining impacts, design and install a soil vapor extraction system (SVE) and a biosparge system on a rapid timeline, and generate an LNAPL conceptual Site model (CSM). Modelling and a three-dimensional visualization (3DV) were also utilized to help understand the complex hydrogeological conditions and protect the River.

This presentation will focus on challenges and successes during the response and remediation, key learnings from the work completed, and path forward, such as those outlined below:

Challenges at the Site and how they were addressed:

- Extreme temperature fluctuations, extreme winds, and steep topography.
- Limited access due to Site conditions and presence of a fibre optic cable, and work time restrictions due to rail traffic.
- Seasonal groundwater fluctuations and a river that is significantly influenced by the substantial spring/summer freshet in the Rocky Mountains create a dynamic groundwater flow system that influences the behaviour of subsurface impacts, including the direction of migration of the dissolved phase groundwater plume.

Successes and key learnings, including how the river was protected under the challenging conditions:

- The rapid design and implementation of a well-performing SVE system.
- The rapid design, implementation, and operation of the biosparge system, including the performance of the system and ongoing system optimizations.
- Development of the LNAPL CSM including natural source zone depletion (NSZD) testing (biogenic heat testing, CO_2 efflux (Traps) monitoring, and soil gas gradient method).

Path forward and Site management objectives.

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Arden is a project manager responsible for providing environmental consulting and spill response services across Western Canada for Class I railroad clients, oil and gas clients,insurance clients, and many others. She has managed, coordinated, and responded to numerous environmental emergencies including train derailments, pipeline spills, port and marine incidents, highway trucking incidents, chemical fires, and residential heating in Western Canada and across North America.

Arden has a strong technical background in environmental remediation projects, including managing sites with light non-aqueous phase liquid management (LNAPL) using natural source zone depletion (NSZD). She also has significant experience with designing and managing environmental sampling programs, environmental site assessments, unmanned aerial vehicle (UAV) surveys, containing/confinement of spills, stream rehabilitation, maintaining field equipment, air monitoring programs, risk assessment and toxicology, hydrogeology, and contaminant fate and transport.