Assessment of Petroleum Hydrocarbons in a Remote and Eco-sensitive Environment using Laser Induced Fluorescence (LIF) and a Low Impact Mobile Drill Rig (LIMB DRIG)

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Petroleum Hydrocarbons are a ubiquitous groundwater and soil contaminant across the Canadian Landscape. Assessment and treatment of these compounds is complicated by the diverse, remote and sensitive landscapes and communities found across this vast country. Many contaminated sites are only accessible by helicopter or small payload planes during the relatively calm summer months. This makes performing site duties extremely challenging and costly using traditional assessment approaches such as drilling boreholes or excavating test pits. In addition to the logistical challenges, often these remote contaminated sites are situated in ecologically and culturally sensitive areas where damage to the ecosystem by traditional assessment equipment is unacceptable.

Laser Induced Fluorescence (LIF) spectroscopy, a powerful optical analytical method, has been adapted for in-situ assessment of petroleum hydrocarbons in soil and groundwater. This application involves driving a fluorometric probe into the subsurface while gathering continuous data at the centimetre scale on the spatial distribution, type, and relative concentration of hydrocarbon contaminants. For remote applications, this technology’s speed, real time data processing, and high spatial resolution reduce the need for additional mobilizations by facilitating adaptive assessment strategies and producing a high density of representative data. While the LIF technology offers substantial cost and technical benefits compared to traditional sampling methodologies, remote and eco-sensitive sites can still be a challenge due to the need for a drill rig to deploy the technology.

In order to realize the technological and cost benefits of this technology at a remote and ecologically sensitive site, a low impact mobile drill rig (LIMB DRIG) was developed. This unit enabled LIF technology deployment at a remote island located 175 km offshore of eastern Canada. The unique surficial geology of the assessment location, consisting of well sorted, homogenous sand, supported the development and use of this light weight delivery system. The LIMB DRIG system was constructed to provide a hand-driven push force of 4000 lbs and incorporated a dynamic hammer to facilitate delivery of the probe. This unit was designed to be highly mobile to navigate on site terrain and facilitate transport on a small aircraft. The unit fit into a small crate (and hockey bag) while weighing in at less than 200 lbs.

LIF data was collected from a network of locations over a large area to provide LNAPL confirmation and vertical delineation, resulting in a detailed three dimensional conceptualization of impacts. Data correlations between the LIF and parallel hand dug boreholes showed good agreement. Functional relationships were developed between the fluorescence signals and PAH concentrations to facilitate interpretation and communication of the screening results. Interestingly, organic layers were also identifiable with the LIF system and appeared to be strongly influencing contaminant architecture in the subsurface.

The application of the LIMB DRIG device with the LIF technology in an eco-sensitive and remote site was highly effective, producing a high volume of representative, diverse data in one mobilization. Additional applications with a modified LIMB DRIG are being pursued at other remote and sensitive sites.

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Ben is the technical lead for SCG Industry’s high-resolution site characterization tools and services. Ben is a key member of the SCG team, playing a major role in research & development, remedial action planning, pilot testing, technical design and contaminated site data interpretation.

In these roles he has completed numerous projects across North America, conducting both large and small scale remediation projects and high resolution site characterization investigations. Ben strives to ensure SCG’s clients are equipped with the latest innovative technologies and strategies to help cost-effectively address their environmental liabilities.

Ben has presented at numerous conferences and been involved in technical workshops for both government and private organizations. Ben’s academic background began with a Bachelor of Science in Environmental Science and he is currently pursuing his Masters in Chemical Engineering at the University of New Brunswick.