Surfactant Flushing and Enhanced Remediation at a Remote Site in Northern BC

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Site Location
Site Plan – AEC 1

AEC 1 - Maintenance Garage and Generator Shed
Site History

Alaska Highway Construction Camp 1942
• One of the main camps in the construction effort
• Support camp for the Liard River Bridge construction work

Highway Maintenance Camp
• Site has been used as a Construction and Maintenance area since the Alaska Highway was built in 1942.
Previous Investigations

2001: Phase I ESA, PWGSC
2002: Phase II ESA, PWGSC
2003: Phase III ESA, PWGSC
2005: Environmental Audit, PGL
2005/6: Stage II PSI and DSI, Franz
2007/8: Remedial Excavation, Franz
2008: Groundwater Modeling and In-situ Treatment System Design, Franz
2008: Site Specific Risk Assessment for AEC 1 and AEC 4, Franz
2009+: Remedial System installation and operation, groundwater sampling
Site Stratigraphy / Groundwater Flow

• Stratigraphy:
  – Surface to 22m - unconsolidated sand and gravel, with layers of cobbles and traces of silt. Silt and sand lenses.
  – No wells have encountered bedrock.

• Groundwater Flow:
  – Groundwater levels:
    • Spring ~ 16.5 mbgs (meters below ground surface)
    • Winter ~ 18.5 mbgs
  – Inferred flow direction: Varies from north to north-east, towards the Liard River
Background #5 – Site Stratigraphy / Groundwater Flow
Remedial Excavation

• 2007 / 2008: Excavation of 4,600 m$^3$ hydrocarbon contaminated soil from areas adjacent to the new and old maintenance garages (AEC* 1) and at discrete areas (AEC 2 and 4)

• On-site treatment in an LTF

• Approximately 50 m$^3$ hazardous waste soil and 25 m$^3$ of soil contaminated with Molybdenum and Zinc was transported offsite

* Area of Environmental Concern
Conditions Prior to Start of Remedial System Activation

- Shallow impacted soil remained under the old maintenance shed
- Deep impacted soil - 18-21 mbgs
- Free phase hydrocarbon at 7 of 8 locations inside the Target Zone.
  - Observed in 6 of the 7 remediation pumping wells
    - 14cm, sheen, 0.5cm, 16cm, 7cm, 10cm
  - Observed in the one MW located in the Target Zone (10cm)
Remedial Objective

Eliminate Risk caused by hydrocarbon contaminated soils

• Onsite Receptors
• Down Gradient Receptors
Challenges in Remediating the Site

• Very Deep – 18 to 21 mbgs.
• Partly under a building, including a significant shallow impacted zone.
• Power – not available.
• Active maintenance yard.
• Large target area – 50m x 30m.
• Extremely cold in the winter (lowest reported temp approx -50C, 2007 by the Onsite Operator).
• Logistic and Personnel Support.
Challenges in Remediating the Site
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Bison, Bison and More Bison
Remedial Strategy

- Capture free phase
- Immobilize the dissolved phase plume
- Mobilize the soil contamination
- Capture the mobilized hydrocarbons
- Degrade the mobilized hydrocarbons thru enhanced biodegradation
System Design – 7 Components

- Mechanical System (Pump and Treat)
- Outside Water Holding Tanks (4 x 16,000L)
- 7 Remediation Pumping Wells
- Shallow Infiltration Bed (under old Main Shed)
- Deep Infiltration Bed (over the remainder of site)
- Side Gradient Treated Water Discharge Gallery
System Design – Mechanical System

System Components inside of 2 shipping containers
• Manufactured by Ground Effects Environmental (Regina)
• Water Treatment Unit (Pump and Treat)
  – Oil Water Separator
  – MCM Vessels (modified clay media)
  – Primary GAC Vessels (granular activated carbon)
  – Secondary GAC Vessels
  – Pump Manifold
• Power and Control Unit
  – Control Room (Main Power Panel, Control, Communications, Datalogging, Telemetry)
  – Generator Room (30 KVA, Diesel Primary Power Generator)
  – Fuel Tank Room (10,000L)
Infiltration Beds

• Purpose – trickle surfactant and water through the subsurface in order to mobilize the hydrocarbon contamination.

• Design:
  – 1 inch Perforated Polyethylene lines spaced 2m apart
  – Shallow lines under the old maintenance shed
  – Deep Lines across the remainder of the site.
Tanks

• Purpose:
  – Capture Emulsion if Present, Sediment, Floc and Precipitate.
  – Maximize dispersion of infiltrated water to the target zone.

• Design:
  – 4 x 16,000L Polyethylene Stock Tanks.
  – Tank 1 – Capture Tank
  – Tanks 2 to 4:
    • Surfactant Addition and Flushing
  • Connected in Parallel
System Description and Features
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Operations and Lessons learned

• Soil Washing Using IveySol
  – Batch injections at 4.3% and 2.5%
  – Continuous addition at 0.07%

• Pneumatic Pumps
  – QED Hammerhead Pro, Top and Bottom Loaders
  – DGSI SRX Top Loading Pump
  – Problems with icing were overcome using 3-way solenoid valves
Operations and Lessons learned

• Effectively Flooding the Subsurface
  – Flood the entire bed with 48,000L of water and surfactant using a high capacity pump.
  – Connect Tanks in Parallel to achieve a sufficient volume

• Water Level Data Loggers
  – Solinst Levelogger
  – Provides information to support the GW Model and demonstrate capture
Trends in Free Phase

• Start – Observed in 7 of 8 wells located in the target zone.
  – Max 16cm

• Fall 2013 – Observed in 2 of 8 wells located in the target zone.
  – Max 1.5 and 3.4cm (centre of the zone).
Trends in Contaminant Loading

• Significant Free Phase Reductions (only 2 wells now).
• Contaminant Loading in Pumping wells has reduced in the pumping wells by approximately 70% in 3 operating seasons.
• Concentrations have almost reached non-detect levels in all but the immediate area of the old maintenance shed.
• Concentrations in down gradient sentinel wells (all non-detect) indicate that the system is capturing the dissolved phase plume.
Trends in Bio-Remediation

- Initially no evidence of significant biological activity was observed. Clear water no bacterial build-up.
- Once IveySol injections were initiated (year 2), significant biological activity became evident (at the beginning of year 3) with significant iron reducing bacterial growth on all wetted components.
- Water is injected with approximately 5 ppm Oxygen and is being extracted at approximately 0.5 ppm.
Next Stages in the Remedial Plan

- Add smaller targeted injection galleries and injection points to focus on the remaining hot zones.
- Enhance the biological remediation mechanisms through nutrient addition.
Questions

Questions and Comments