

Project Overview

Site: First Nation site in east-central Alberta

Contaminants: MTBE and PHCs

Subsurface Material: Clay with sand seams

Contaminant Location: Groundwater at three defined treatment areas (Areas A, B, C)

Remediation Criteria: CCME (Canadian Council of Ministers of the Environment),
 CWS (Canada-Wide Standards), and CDWQ (Canadian Drinking Water Quality)

- Objectives**
- Bioremediate contaminants in-situ
 - Multiple treatment events
 - Area A and C fracture inject bioremediation amendments
 - Area B:
 - Fracture inject sand to create a network of permeable pathways
 - Permeation inject bioremediation solution through sand pathways

- Challenges**
- Area B heavily contaminated with free phase PHCs
 - Many utilities across the site

- Amendments**
- PTS: micro- and macro- nutrients mixture
 - PTBac: petroleum treatment bacteria mixture
 - iPAC: highly reactive activated carbon

Field Summary The following was injected in two treatment events:

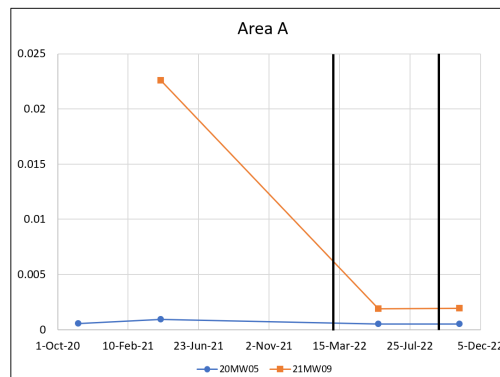
Treatment Area	Treatment Depths (mbgs)	PTS (kg)	PTBac (kg)	iPAC (kg)	Sand (kg)
Area A	2.5 to 10	3,060	75	2,910	0
Area B	6.5 to 13.5	8,185	32	5,980	59,575
Area C	2.5 to 10.5	4,780	45	2,925	0

- Technical Overview**
- iPAC provides initial removal of contaminants from groundwater
 - Long term decreased levels seen from bioremediation
 - PTBac is more critical for MTBE degradation

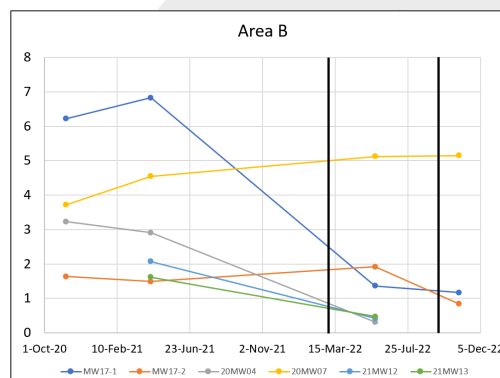
- Summary**
- Project in progress, client is happy and planning a third treatment event
 - Details of MTBE and PHC treatment are attached

MTBE Groundwater Analysis Summary

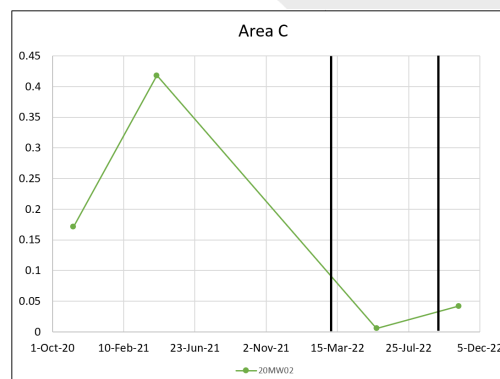
- Area A**
- MTBE concentrations below CCME criteria after First Event (~90% reduction)
 - Original concentrations were close to criteria particularly at one of the wells
 - No treatment required for Second Event



- Area B** Variable results at six wells:
- Three wells only sampled after First Event and showed ~70 to 90% reduction in MTBE levels
 - One well showed an ~80% decrease in MTBE levels after the Second Event
 - Two wells showed no change or no significant change in MTBE concentration



- Area C**
- The one monitoring well in this area showed a reduction of at least 75% in MTBE concentrations



Note: Soil analytical results were unavailable for MTBE

— Bioremediation event
All MTBE concentrations are in mg/L

PHC Groundwater Analysis Summary

- Area A** Two wells sampled:
- All PHCs were below detection limits at all sampling events at one well.
 - At the other well, only benzene and ethylbenzene above CDWQ prior to remediation. All PHCs below detection post remediation.
- Area B** Variable results at six wells:
- BTEX concentrations decreased 90% to 99% at two wells, 60% to 95% at one well, and 40% to 95% at one well.
 - F2 contamination generally did not change, except at one well with ~85% reduction.
 - Two wells showed no change or no significant change in PHC concentrations.
- Area C**
- The monitoring well in this area showed only benzene above guidelines prior to remediation.
 - Benzene lowered 99% and below guidelines.
 - All other PHC constituents lowered to below detection.

Summary – No treatment was required for Area A after the first event

PHC Soil Analysis Summary

- Benzene and ethylbenzene were only PHCs detected.
 - Benzene decreased 55 to 75% to non-detect, but started below criteria.
 - Ethylbenzene lowered to non-detect from exceeding CCME (98% decrease).
 - No comparative soil analysis has been completed.
- Two boreholes sampled:
1. At 3.0 m, ~40 to 90% decrease in PHCs (only benzene and ethylbenzene started above CCME) and at 4.5 m, ~89 to 99% decrease in PHCs to below CCME (all PHCs also below detection limits, besides benzene).
 2. No marked changes shown at other borehole location. BTEX and F1 above CCME / CWS standards.