

SUCCESSFUL PHYTOREMEDIATION OF SALT AND HYDROCARBON IMPACTED SOIL IN NORTHERN ALBERTA USING PEPSYSTEMS™

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Petroleum hydrocarbons (PHC), arising from oil and gas exploration and production, are one of the most widespread persistent soil contaminants in Canada (CCME, 2001). Earthmaster Environmental Strategies Inc. , in collaboration with the University of Waterloo, has developed a PGPR (plant growth promoting rhizobacteria) - Enhanced Phytoremediation System(s) (PEPSystems™) which has been successfully deployed across Canada for treatment of soil contaminated with PHCs and salt.

PEPSYSTEMS™ TECHNOLOGY

PEPSystems is based on multiple complementary techniques that target different aspects of PHC and salt impacted soil remediation. PEPSystems remediates PHC to non-toxic compounds via plant-supported microbial metabolism (Gerhardt, 2015). PEPSystems also increase plant tolerance to elevated plant stressors, such as high salt levels, allowing improved plant growth with commensurate salt uptake into aboveground plant tissue (Gerhardt, 2017). PEPSystems lower stress ethylene concentrations in plants which improves plant root and shoot growth on impacted soils. This results in efficient and timely re-vegetation of impacted sites. Soil can be treated in situ or ex situ using PEPSystems.

SITE DETAILS AND REMEDIATION OBJECTIVES

The project sites operated by Baytex Energy Ltd. were located in north central Alberta, approximately 400 km north of Edmonton. Stockpiled soil (9,200 m³) from historical emulsion spills (i.e. salt (sodium and chloride) and PHC impacted water) had previously undergone numerous unsuccessful treatment attempts using different remediation methods. Baytex requested Earthmaster evaluate then deploy PEPSystems for treatment of the impacted soil. Laboratory soil analyses completed in 2011 showed elevated levels of salt (ECe 7.00 dS/m), benzene (0.880 mg/kg), ethylbenzene (1.200 mg/kg), and PHC fractions F1 (1100 mg/kg), F2 (3000 mg/kg), and F3 (7500 mg/kg). The remediation objectives were to reduce PHC levels in the soil to comply with



Figure 1. Construction of treatment facility (top), phytoremediation showing grasses in active treatment area (middle), and the decommissioned treatment facility following phytoremediation (bottom).

Alberta Tier 1 Soil and Groundwater Remediation Guideline values for natural area fine grain surface soil or subsoil, and to comply with the salinity remediation endpoints agreed to with the Alberta regulator.

PHYTOREMEDIATION RESULTS

Following Alberta regulatory approval, Earthmaster and Baytex designed and constructed three one-time biopile soil treatment facilities on which the impacted soil would be treated. The treatment facilities consisted of engineered compacted clay treatment liners and surface water run-off collection systems. Impacted soil was spread to a depth of 0.45 m across each of the treatment areas. Permanent assessment points were established on each treatment area to allow for regular soil and vegetation sampling and analyses to monitor remedial progress.

PEPSystems was deployed in the fall of 2011 using a combination of *Pseudomonas* bacteria and perennial and annual grass species. The treatment facilities were operated over four growing seasons. Following the first season, the soil salt levels had been reduced to comply with guideline values. Using PEPSystems over three full growing seasons, PHC levels in 8,100 m³ of soil were reduced to comply with either surface soil or subsoil guidelines. In the fourth field season the remaining 1,100 m³ of PHC impacted soil underwent additional treatment and, at the end of the field season, the entire volume complied with surface soil guideline values. For the more recalcitrant PHC compounds, their degradation was at a rate of approximately 35% per annum. Remediation of all impacted soil was completed within a period of four growing seasons at a cost that was significantly less than offsite landfill disposal.

CONCLUSIONS

Earthmaster, in collaboration with Baytex, successfully treated 9200 m³ of PHC and salt impacted soil using PEPSystems. Within four growing seasons, all of the treated soil complied with surface soil and/or subsoil remediation guideline values and was suitable for re-use in the area.

REFERENCES

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