EARTHMASTER
environmental strategies

Technical Case Study

Phytoremediation of Petroleum Hydrocarbon Impacted Soil in North Central Alberta using PEPSystems®

Abstract

Earthmaster successfully treated petroleum hydrocarbon (PHC) and salt impacted soil using a PGPR (plant growth promoting rhizobacteria) enhanced phytoremediation system (PEPSystems®). Approximately 9,200 m³ of impacted soil was spread across three treatment facilities and PEPSystems, utilizing perennial and annual grasses, was deployed. Within 4 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.

PEPSystems® Technologies

PEPSystems is based on multiple complementary techniques that target different aspects of PHC and salt impacted soil remediation. PEPSystems not only removes PHCs from soil, but results in their metabolism to non-toxic molecules. PEPSystems also increases plant tolerance to elevated salt levels allowing improved plant growth with commensurate salt uptake into aboveground plant tissue. PEPSystems lowers stress ethylene in plants which allows for improved plant root and shoot growth on impacted soils and results in efficient and timely re-vegetation of impacted sites. Soil can be treated using PEPSystems both *in situ* and *ex situ*.

Project Background

The site was located in north central Alberta, approximately 400 km north of Edmonton, in the Central Mixedwood Subregion. Stockpiled soil (~9,200 m³) from historical emulsion spills had undergone numerous unsuccessful treatment methods previously. Laboratory analyses of the soil completed in 2008 showed elevated salt, BTEX, and PHC fractions F1 to F4 levels. The client identified phytoremediation as a potential means of remediating the salt and hydrocarbon impacts. This would avoid having to dispose of the soil to an off-site landfill facility.

Remediation Objectives

The remediation objectives were to reduce PHC and salt levels in the soil to comply with Alberta Tier 1 Soil and Groundwater Remediation Guideline values for natural area fine grain surface soil or subsoil, and to comply with the salinity/sodicity remediation endpoints agreed to by the Alberta regulator. The regulators approved the use of subsoil remediation guideline values for treated soil being placed deeper than 1.50 m below ground level.

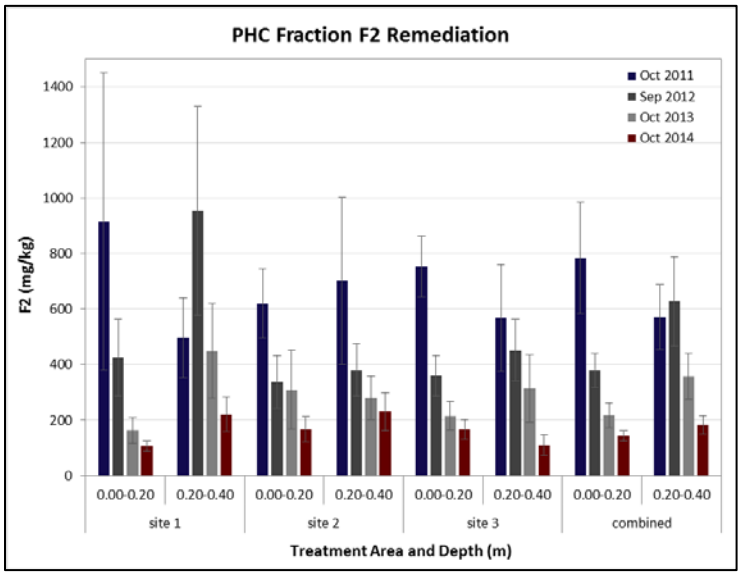
Solution

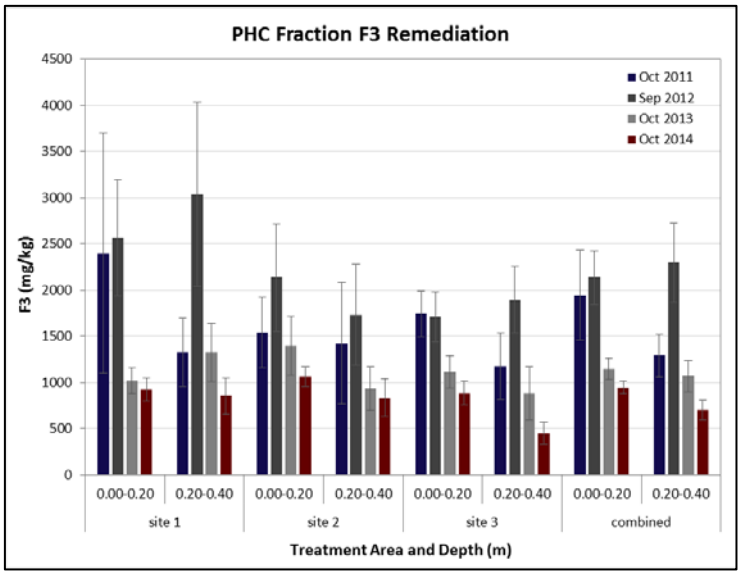
Following Alberta regulator approval, Earthmaster designed, constructed, and operated three one-time biopile soil treatment facilities at three active client lease locations. The treatment facilities consisted of compacted clay treatment pads and surface water run-off collection systems and sumps. Impacted soil was spread across the treatment pads within each of the treatment facilities. Permanent assessment points were established across the

treatment areas for use in conducting regular soil sampling and vegetation analyses to monitor remediation progress. PEPSystems was deployed in the fall of 2011 using a combination of *Pseudomonas* bacteria with perennial and annual grasses. The treatment area soils were managed over several growing seasons to remediate the salt and hydrocarbons in the soil.

Results

From PEPSystems deployment in the fall of 2011 through the 2014 growing season, ~8,100 m³ of soil was successfully treated. As of the end of the 2014 growing season, laboratory soil test results for PHC fraction F4, BTEX, ECe, and SAR met remediation objectives. A total of 2,000 m³ complied with surface soil remediation guideline values for PHC fractions F1, F2, and F3 concentrations and ~6,100 m³ complied with subsoil remediation





guideline values. Remediated soil was stripped and placed into stockpiles for future use. The remaining ~1,100 m³ of impacted soil (i.e. material that was in treatment zone 'hot spots') was spread across portions of the treatment areas for additional phytoremediation. As of the summer of 2016, more than 900 m³ of the additionally treated soil complied with surface soil guideline values for hydrocarbons and the remaining (<200 m³) complied with subsoil guideline values. Remediation of the site was completed within a combined total of 4 full growing seasons.

Conclusion

Phytoremediation successfully removed salt and PHC impacts from the soil allowing the soil to be conserved and reused in the area. While PEPSystems technologies are more time consuming than traditional disposal based remediation methods, PEPSystems offers innovative and effective low cost green solutions to remediating and conserving contaminated soil. This technology is especially suited to remote and northern areas where traditional remediation techniques are not cost effective or sometimes practical.

References

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