

ERDENHANCED™ Pilot Study Evaluation Project Highlights

- PRS Based 6-month Pilot Study Evaluation, under actual Site biogeochemistry.
- **>96%** Decrease of Chlorinated Alkane Compounds.
- ERDENHANCED™ proven **Green** and **sustainable**, minimizing environmental impact - costs.
- ERDENHANCED™ **cost-effective** site compliance **eliminating** long-term Site operations and maintenance needs - costs.
- **>99%** Reduction in 6-months Vinyl Chloride.
- ERDENHANCED™ **minimizes** environmental impacts of off-site transportation and disposal; ideal for remote site locations with limited access and energy.
- **>80%** Reduction in 6-months total cVOCs in site conditions with pH > 13 s.u.



BioStryke® ERDENHANCED™ Pilot Study Saudi Arabian Refinery cVOC Source Area Bioremediation On-Site Evaluation – Additive Evaluation

BioStryke® Remediation Products, LLC, provide innovative and cost-effective additive formulations designed to biostimulate treatment zone conditions and enhance the in-situ and complete biotransformation of chlorinated volatile organic compounds (cVOC). ERDENHANCED™ leverages existing site conditions to cost-effectively enhance native microbial populations and the dehalorespiration of dissolved, sorbed, and residual source mass cVOCs. ERDENHANCED™ is proven effective in terms of cost and performance, providing years of sustainability after full-scale deployment event; attaining Site compliance with less environmental impact, working with Mother Nature, not against.

The Pilot Study was performed by a consulting group from the Kingdom, under oversight by a major US firm retained by the refinery, and charged to evaluate potential in-situ remediation strategies to address source zone and downgradient cVOC contaminants. Source zone contaminants exceed 4,000 milligrams per liter (mg/L) with chlorinated alkanes, alkenes, and other organohalides which also exceed regulatory thresholds. Primary source zone Contaminants-of-Concern (COC) include 1,2-dichloroethane (DCA) and vinyl chloride (VC), with baseline pH levels recorded at 13.1 s.u. (MW B).

The refinery was under order by the Saudi Royal Commission, the governing environmental regulatory agency, to remediate the impacted groundwater contaminants. The performance goals required the additive be effective at providing source control of residual dense, non-aqueous phase liquid under challenging biogeochemical conditions. BioStryke® ERDENHANCED™ was identified as the additive of choice due to its proven effectiveness at enhancing the biotransformation of residual source mass contaminants cost-effectively by leveraging native microbial populations.

A Remedial Action Plan (RAP) was prepared and submitted which included the implementation of a Passive release Sock (PRS) based Pilot Study to determine additive efficacy prior to committing to full-scale additive use. The results of the Pilot Study realized >90% reduction in Vinyl Chloride concentrations, upwards of a 96% reduction in DCA, and upwards of a 96% reduction in total cVOCs within the limited treatment zone. Baseline and performance groundwater testing results data are presented below:

COCs (ug/L)	Baseline		Month 6		% Change	
	MW A	MW B	MW A	MW B	MW A	MW B
DCA	199,770	4,072,000	6,500	808,000	96.7%	80.2%
VC	4,650	649,750	25	63,695	99.5%	90.2%
Total cVOC	233,300	4,093,400	7,250	811,200	96.9%	80.2%

The data indicate that Dichloroethane (DCA) destruction was as great as 96.7% during the evaluation period; and, upwards of 80% destruction rates of the same in groundwater measured with a pH >13 s.u. Vinyl chloride concentrations [VC] were reduced greater than 90%; and most importantly, total cVOC concentrations were reduced by 96% in 'normal' groundwater and >80% in groundwater with excessive pH values. The Pilot Study clearly demonstrated BioStryke® ERDENHANCED™ a cost-effective additive for the complete in-situ biotransformation of recalcitrant chlorinated alkene and alkane source zone contaminants. BioStryke® products are proven to simplify site remediation activities and performance because:

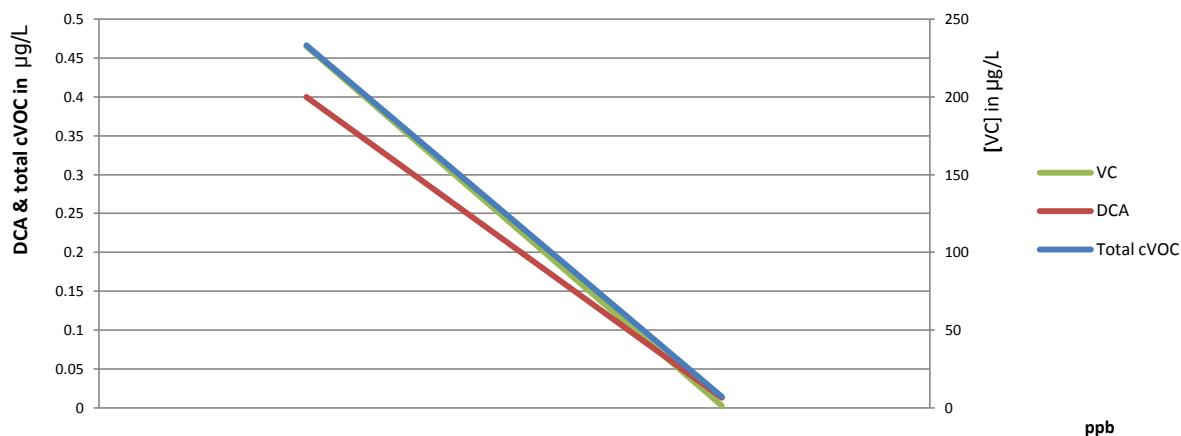
BioStryke® additives demonstrate enhanced solubility making them amendable to multiple deployment strategies to include Direct Push Technology (DPT), infiltration gallery, permanent/temporary injection wells, direct solution application, etc.

BioStryke® amendments provide ease of handling, requiring less water and minimal pore space displacement rates minimizing site time and overall remedial costs.

BioStryke® amendments maximize performance while minimizing project costs and environmental impacts to the Site; all the while maximizing project operating margins.

Chart One below diagrams the results obtained from MW-A during the 6-month PRS based Pilot Study evaluation.

CHART ONE



BioStryke® Remediation Products LLC estimates full-scale amendment costs to address both saturated soil and groundwater adversely impacted with DCA, VC and chlorinated alkenes to approximate less than \$15.00 per treated ton; eliminating the need for long-term operational and maintenance costs, and minimizing the environmental impacts and costs associated with off-site transportation and disposal.

Contact your BioStryke® Remediation technical sales representative now, to discuss Pilot Study and full-scale additive deployment opportunities, and establish a cost-estimate for an additive strategy designed to meet your environmental remediation needs.