**TerraStryke® TPHENHANCED™ Residual Source Mass Remediation**

**Fire Training Center: Petroleum Hydrocarbons, Naphthalene, BTEX Former Chanute Air Force Base, Illinois USA**

TerraStryke® Remediation Products LLC (TerraStryke®) develop biostimulation additives proven to cost-effectively enhance the destruction of dissolved phase, sorbed and/or residual source mass contaminants by native microbial populations.

TerraStryke® TPHENHANCED™ enriches site geochemistry and native heterotrophic microbials to stimulate PHC degradation with minimal support equipment and site impact.

This case document summarizes product efficacy under full-scale application. The Site, a fire training ground, is located within a former US Air Force (USAF) facility. Smear zone soils and groundwater were adversely impacted by Volatile Organic Compound (VOC) and Petroleum Hydrocarbon (PHC) contaminants. Baseline total organic carbon (TOC) was initially reported at approximately 25 milligrams per kilogram (mg/kg) in soil, and 7-10 micrograms per liter (µg/L) in groundwater, with additive loading established accordingly.

**RESULTS:** 12-months post TPHENHANCED™ deployment, native microbials enhanced the solubilization of residual source mass contaminants: a >23-fold increase in total VOC dissolved phase concentrations (from 23.3 µg/L to 556 µg/L at MW-6116). Five months later total VOCs realized ≈ 75% REDUCTION in bioavailable contaminants and >95% REDUCTION additive assimilation. Specifically, VOCs within the TPHENHANCED™ amended groundwater realized:

- A near 30-fold increase in Benzene followed by >71.8% REDUCTION
- A secondary 6-fold increase in Benzene followed by >74.2% REDUCTION
- A near 10-fold increase in total VOCs followed by >71.9% REDUCTION
- A secondary 9-fold increase in total VOCs followed by >74.7% REDUCTION

TPHENHANCED™ nourishes native microbials, enhances the production of biosurfactants thereby increasing contaminant bioavailability, and helps to achieve long-term remediation goals.

TPHENHANCED™ is a cost-effective, long-term source mass remediation strategy eliminating typical above ground, energy-consuming, emissions-generating equipment. It is ideal for fixed, remote, and legacy site locations. TPHENHANCED™ provides a low-cost, low-impact process to address soil and/or groundwater environmental management concerns efficiently and sustainably.
“Make Something Good Happen Today”

BACKGROUND: Prior to treatment, soils adjacent to the proposed treatment zones had been excavated to remove smear zone soils contaminated with residual (sorbed and stringer) contaminant source mass. Excavated soils were reportedly removed to immediately below the groundwater/soil interface. Three distinct treatment areas resulted; each with an assumed 10-ft thick groundwater impact zone, and surface areas of approximately 3,000 square feet (s.f.), 5,600 s.f. and 17,400 s.f., respectively. The treatment areas had within them one groundwater monitoring well each, for the two smaller areas, and three monitoring wells located within the larger area. Monitoring well MW-6116, located within the larger treatment area, is generally downgradient from the majority of the treated areas.

OPERATIONS:
Additive deployment was performed using Direct Push Technology (DPT) with site costs approximating $10-$15 per ton. It was later reported that smear zone TOC concentrations were 4-8 times that reported as baseline; this increase in source mass contaminants subsequently increased the additive load demand and extended compliance timelines; however, without complete residual source mass contaminant removal, compliance goals would be forfeited over time. The TPHENHANCED™ process proved a cost-effective strategy to aggressively enhance contaminant solubilization, bioavailability and degradation.

TerraStryke® TPHENHANCED™ provides native microbials an analog to Oxygen (O₂), allowing for the cost-effective aggressive destruction of VOC/PHC contaminants, with less surface impact. The TPHENHANCED™ process eliminates costly, long-term above-ground, energy-consuming and emissions-generating support equipment. TPHENHANCED™ is proven effective in terms of cost and performance, allowing the realization of long-term compliance goals by working with Mother Nature, not against.

To determine if our additive is appropriate for an environmental management concern at your site please consider our low-cost, low-risk pilot evaluation process described below

PRODUCT EVALUATION PROCESS:
TerraStryke® has established a low-cost, low-risk Pilot Study program to determine additive efficacy under actual site biogeochemical conditions, eliminating the ‘jar effect’ inherent to bench-scale tests, and providing potential end-users a representative, yet conservative, ‘Go-No-Go’ evaluation. The Pilot Study confirms amendment efficacy and facilitates more accurate additive loading requirements. TerraStryke’s on-site evaluation provides insight into full-scale remedial expectations allowing all Stakeholders a level of assurance with full-scale implementation while avoiding costly mistakes.

DEPLOYMENT PROCEDURES
TerraStryke® evaluations are performed in-situ, under actual site biogeochemical conditions, using Passive Release Sock (PRS) deployment units. Additive filled PRS units fit within 2-inch diameter groundwater monitoring well(s) and remain suspended, undisturbed, within the test well screened interval for a prescribed period of time. Ideally the test well is proximate to source zone contaminants. At scheduled intervals, PRS units are replaced and performance groundwater monitoring-sampling is performed. Average evaluations require up to 4-5 deployment/replacement events including the monitoring and sampling of groundwater as described in the TerraStryke® Pilot Study Guidance Document.

LENGTH OF EVALUATION
TerraStryke® evaluations at petroleum hydrocarbon (PHC) sites require up to 6-9 weeks to complete; whereas, chlorinated volatile organic compound (cVOC) sites require 6-9 months for completion. A minimum 50% Performance Goal is established for the evaluation to be considered a success and justify future discussions regarding full-scale additive deployment strategies. Upon the completion of each evaluation, TerraStryke® provides a Technical Memorandum discussing pertinent results relative to established Performance Goal(s), estimated costs, and remediation time-lines. Please note, PRS deployment units are for efficacy evaluation only and are not designed for use for full-scale remediation.

PILOT STUDY COSTS
TerraStryke® provides at no cost (other than shipping) additive filled PRS deployment units to complete an approved evaluation. The evaluation represents a low-cost/low-risk treatability study, under actual biogeochemical conditions, providing stakeholders proof of amendment efficacy prior to full-scale commitment, and without any long-term impact to treatment zone geochemistry.