

Project Highlights

- **TPHENHANCED™** proven to expedite biodegradation of saturated soil/groundwater PHC contaminants, *anaerobically*
- **TPHENHANCED™** facilitated **>96%** reduction in Naphthalene over 13-week evaluation period.
- **TPHENHANCED™** proven **Green** and **sustainable** strategy, minimizing environmental impact and remedial costs.
- **TPHENHANCED™** **cost-effective** site compliance reducing long term monitoring, operations, and maintenance.
- **TPHENHANCED™** leverages existing Site conditions to realize enhanced in-situ contaminant biodegradation.
- **TPHENHANCED™** eliminates above-ground support equipment costs/needs; ideal for remote site locations with limited access and energy.



TPHENHANCED™ Pilot Study - Residual Petroleum Remediation Former Fire Training Center: Naphthalene, BTEX Contaminants Former Chanute Air Force Base, Illinois USA

BioStryke® Remediation Products, LLC, provide innovative and cost-effective amendment formulations designed to biostimulate treatment zone conditions and enhance in-situ anaerobic destruction of Site contaminants. **BioStryke® TPHENHANCED™** leverages existing site conditions, passive-aggressively destroys dissolved, sorbed, and residual source mass eliminating above-ground, energy-consuming emissions-generating equipment. **TPHENHANCED™** is proven effective in terms of cost and performance, allowing Site compliance with less environmental impact, working with Mother Nature, not against.

A National environmental consulting group implemented a Pilot Study to evaluate the efficacy of **TPHENHANCED™** under actual Site conditions. The Site is a former Air Force Base Fire Training Center with smear zone and dissolved phase PHC contaminants. The 13-week evaluation realized a > 96% decrease in the Contaminant of Concern (COC) Naphthalene without the use of costly aboveground, fuel consuming, emissions generating equipment. The study demonstrated **BioStryke®** amendment **TPHENHANCED™** a cost-effective in-situ strategy for the destruction of source zone PHC contaminants.

Pilot Study groundwater was amended using Passive Release Sock (PRS) deployment units. Each amendment filled PRS unit fits in an existing 2-inch groundwater monitoring well. PRS units remain suspended, undisturbed, within the screened interval of the test well, passive-aggressively amending a vertical column with an area-of-influence (AOI) of < 3-ft. Groundwater sample/analytical testing events are performed at the start, and at regular intervals throughout the evaluation, to include replacement of PRS deployment units. PRS Pilot Study's provide a low-cost, low-risk process for Owner(s), Regulators, and Practitioners to evaluate the amendments ability prior to full-scale remedial commitment.

BioStryke® amendments, due to enhanced solubility, are suitable for multiple deployment strategies including Direct Push Technology (DPT), infiltration gallery, or direct application.

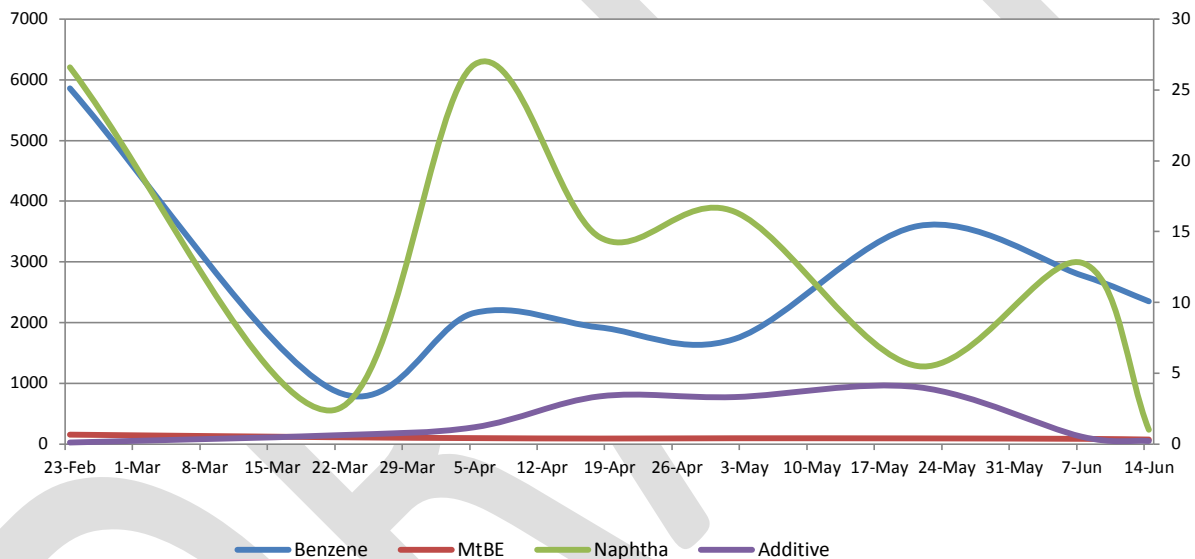
BioStryke® amendments provide ease of handling, requiring less water, less pore space displacement, less site time, less overall remedial costs.

BioStryke® amendments maximize project margins while minimizing project impacts.

The former Chanute Air Force Base is located in central Illinois, a sparsely populated rural area. The contaminant zone is within the former US Air Force base where fire training exercises were performed for several decades resulting in surface and subsurface concerns to include smear zone residual source mass. **BioStryke®** additives *eliminate* long-term, energy-consuming, emissions-generating on-site support equipment – gone; and estimates, full-scale amendment costs to be less than **< \$7.00 per treated ton**; with no off-site transportation, no off-site disposal.

Over the 17-week Pilot Study evaluation, results shown in Chart One below indicate, the biostimulation of treatment zone groundwater with **TPHENHANCED™** provided native microbial populations a metabolic analog to Oxygen (O₂) resulting in the passive-aggressive biodegradation of dissolved phase and residual source mass petroleum hydrocarbon contaminants (PHCs). Specifically, additive introduction demonstrated an impressive ability to destroy dissolved phase contaminants and secondarily increase contaminant bioavailability, followed by a cyclical pattern of enhanced PHC contaminant biodegradation. In 17-weeks concentrations of the COC Naphthalene decreased by over 90%; while, the volatile organic compounds Benzene and Methyl-tert butyle ether (MtBE) decreased 60% (5,860ug/L to 2,350ug/L) and 53% (153 ug/L to 72 ug/L), respectively. All contaminant concentrations are trending downward, as was the presence of additive constituents, after an initial increase in additive due to deployment, and contaminant bioavailability due to natural concentration gradient based flux and microbial related enhanced contaminant desorption. Concentrations on the left axis to Chart One are µg/L (Naphthalene, Benzene, MtBE); whereas, the right axis values represent additive constituents in milligrams per liter (mg/L)

Chart One
17-week Pilot Study Results



In a second evaluation performed at the base, saturated soils were placed and amended in a 55-gallon drum using Pilot Study dosing rates. Over the 64 day evaluation period, groundwater concentrations of Benzene in the drum amended with **TPHENHANCED™** realized an initial 12 fold increase in Benzene bioavailability, followed by a dramatic decrease of >98.8% from a maximum concentration of 8,360 µg/L to < 93 µg/L in the first 36 days. Similar patterns were observed for the COCs Naphthalene and Toluene; with a 153% increase in [Naphthalene], followed by an approximate 93.5% decrease to 19.7 µg/L. Toluene, increased by over 350% then similarly decreased by > 99.8% to 8.40 µg/L. Impressive totals to be sure.

In summary, **TPHENHANCED™** is a patent pending blend of alternative electron accepting salts providing a metabolic analog to dissolve O₂. The additive is combined with a proprietary macro-micro nutrient formulation to provide growth support to native microbes. Together, by leveraging existing site conditions **TPHENHANCED™** realizes non-assimilatory biodegradation of PHC contaminants cost-effectively, passive-aggressively, with less environmental impact and minimizing secondary contaminant concerns. **TPHENHANCED™** amendment should always be performed in sensitive receptor zones in conjunction with a prudent groundwater monitoring and testing program including treatment zone and downgradient locations.