TerraStryke® **Products LLC**
519 Main Street
P.O. Box 254
Andover, NH 03216
603.735-5312

www.terrastryke.com

SUMMARY DESCRIPTION DOCUMENT

TerraStryke® Biostimulation Additive **TPH*ENHANCED***™
In-Situ Non-Assimilatory Destruction of Petroleum Hydrocarbon and Volatile Organic Compounds

TerraStryke® Products LLC (***TerraStryke***®) is pleased to provide the following information summarizing the composition and benefits associated with the use of the biostimulation additive **TPH*ENHANCED***™. This summary was developed to assist your evaluation and includes discussions as to appropriate application, formulation components, and performance history; to include, field and microcosm case studies.

TPH*ENHANCED*™ is a biostimulation additive designed to enhance native heterotrophic bacterial populations and the non-assimilatory destruction of petroleum hydrocarbons (PHC), volatile organic (VOC) and semi-volatile organic (sVOC) contaminants by providing inorganic analogues to Oxygen (O_2) and our proprietary blend of macro-micro nutrients to enhance:

1) Respiration of indigenous heterotrophic bacteria under anaerobic conditions.
2) Microbial growth and communication between the additive enhanced microbial populations.
3) Collective development of biofilm by the enhanced indigenous microbials.
4) Solubilization (mass transfer) of residual source mass contaminants to the dissolved phase.
5) Bioavailability of the contaminant mass; and
6) Sustainable, low-impact, PHC utilization/destruction by additive enhanced microbials.

What is an appropriate application for **TPH*ENHANCED***™? principally, the additive is used in association with in-situ applications to contaminated vadose and/or saturated soils/groundwater. The additive may also be utilized in ex-situ BioPile applications and/or analogous applications where anaerobic conditions and moisture levels may be maintained.

TPH*ENHANCED*™ is designed for the treatment of PHC/VOC/sVOC (or analogous) contaminants; be they present in the dissolved *or* sorbed-phase (residual source/smear zone). The additive is proven effective against residual/smear source mass, both light and non-aqueous phase liquids (LNAPL), in groundwater and saturated soils. The additive is ***not*** for use against free product; nor is it likely to be effective against separate-phase NAPL. **TPH*ENHANCED***™ is highly effective against residual LNAPL. Please refer to the attached case studies for examples of additive performance.

TPH*ENHANCED*™ is most effective against straight chained gasoline and diesel range organics (GRO/DRO) in addition to aromatic hydrocarbons such the BTEX components Benzene, Toluene, Ethyl-Benzene and Xylenes. In addition, the additive has been proven effective against Methyl-tert Butyl Ether (MtBE), Trimethylbenzene and Dichlorobenzene; 1,3,5-TMB and 1,4-DCB, respectively. It is believed to be effective against additional contaminants including, but not limited to, Pentachlorophenol (PCP), Carbon-tetrachloride, and other petroleum-based contaminants.

With regards to geologic conditions, the application of **TPH*ENHANCED***™ has been proven most optimal under homogenous, isotropic hydrogeologic overburden conditions; yet, prudent engineering design can be applied to achieve desired performance results under more heterogeneous, anisotropic conditions to include fractured bedrock and fine silty clays. Bedrock applications are feasible depending on the connectivity of the fracture network in the desired treatment zone and/or whether the bedrock can be considered as porous media at the scale of interest.

TPH*ENHANCED*™ also enhances treatment zone geochemistry, raising the system out from contaminant induced methanogenic conditions while maintaining anaerobic, reducing conditions; lowering methane concentrations [Methane], increasing Oxygen Reduction Potentials (ORP), and enhancing the utilization of naturally occurring respiratory sources such as; Iron (Fe), Manganese (Mn) and Sulphates (SO_4). The additive formulation is proprietary and Patent Pending. The ability to maintain anaerobic yet non-reducing conditions allows for the elimination of aboveground support equipment, fuel usage and associated vapor, noise and/or emissions. This simplicity in performance leveraging Mother Nature allows every Shareholder to lower the overall carbon footprint, minimize site impacts, and cost-effectively achieve your remediation objectives.

TPH*ENHANCED*™ has been preliminarily awarded Patents in both Canada and by association the United States. The additive itself is the same as many competing oxidation-based additives; however, being non-Oxygen (O_2) based and purposely maintaining anaerobic conditions is what demonstrate the products uniqueness and superior performance in terms of residual mass solubilization, dissolve phase destruction, and overall sustainability. Addition factors for consideration include:

Geochemical:

TPH*ENHANCED*™ is most effective under anaerobic (dissolved oxygen, DO <0.5 milligrams per liter, mg/L), chemically reducing (oxidation-reduction potential, ORP <50 millivolts, mV) conditions; however, the additive is proven to rapidly 'pre-condition' the hydrostratigraphic formation of a desired treatment zone to achieve the necessary conditions required for cost-effective PHC/VOC/sVOC contaminant destruction.

Physical:

TPH*ENHANCED*™ is a dry, granular additive typically blended on-site using Site water. Applications are most easily carried out in accessible, uncongested areas devoid of surficial structures or underground utilities; however, prudent engineering design can achieve effective remediation, even under such less optimal conditions. The additive typically blends using an approximate 4:1 ratio, making the viscosity of the additive 'slurry' incredibly conducive to subsurface distribution. Furthermore, slurry viscosity is not temperature dependent, maintaining its viscosity regardless of out-site temperatures. The additive is also compatible with any number of deployment technologies including, but not limited to, permanent well, fracturing, direct push, infiltration galleries and recirculation systems.

For example, Direct Push Technology (DPT) can be used in more accessible, uncongested areas, to inject **TPH*ENHANCED*™** passively and/or under pressure to induce fracking in a desired treatment zone via a grid-like injection (node) pattern. In other more congested or inaccessible areas, the additive is amendable to a system of injection/extraction wells which can be operated independently to provide hydraulic control and manage additive propagation throughout the desired treatment zone; subslab infiltration galleries, and even direct application in powder form to open excavations during source removal activities can be implemented.

Please note the desired geologic, chemical, and/or physical conditions for robust non-assimilatory contaminant destruction are presented above; however, prudent engineering design can more than overcome adverse conditions when observed on a case-by-case basis. For example, recirculation systems, injection galleries and/or trenches can be used as an alternative to DPT injections so that additive deployment may be accomplished via Inject & Drift or Recirculation, depending on specific Site conditions.

In certain instances (e.g., presence of residual LNAPL) **TPH*ENHANCED*™** may be combined with nano-Carbon to increase its aggressiveness for source control; and/or, where Site conditions include very low contaminant concentrations typically below minimal thresholds necessary to support biological utilization.

The *underlying scientific principles* on which the additive process or 'equipment' operates is the understanding that, under anaerobic and chemically reducing conditions, petroleum hydrocarbons can serve as electron donors which scavenge naturally occurring terminal electron acceptors (TEAs) necessary to support the respiration of certain heterotrophic (petrophylic) soil bacteria. In the absence of their preferred TEAs (oxygen, nitrate, ferric iron, oxidized manganese, sulfate) scavenged by the amorphous introduction of petroleum based contaminant source(s), the additive provides specific TEAs to enhance respiration.

As previously noted, the introduction of petroleum contaminants into subsurface soils and groundwater provides an excess of electron donors which scavenges naturally occurring TEAs and renders impacted groundwater methanogenic. **TPH*ENHANCED***™ replaces specific TEAs to facilitate microbial-mediated respiration under anaerobic conditions while increasing ORP values within the treatment zone, raising the system out of methanogenic conditions, allowing naturally occurring TEAs to also be utilized for respiration. The additive also includes a proprietary blend of macro-micro nutrients which further enhances the 'fitness' of native microbial populations, increasing their populations and contaminant degradation efficiencies.

Under methanogenic conditions microbial respiration is very limited and contaminant degradation slow and non-assimilatory PHC degradation cannot proceed at a rate sufficient enough to satisfy property Owner, Consultant and Regulatory remediation objectives. By increasing heterotrophic microbial respiration while maintaining anaerobic conditions we allow, secondarily, microbial enhanced consumption of the naturally occurring and amorphously (human) introduced carbon (electron donors) available within the assigned treatment zone. Please note, as with any additive-based in-situ remedy there must be direct contact between the microbes, the additive, and contaminant for effective contaminant destruction and the realization of Site compliance objectives.

There are many remedial additives on the market that enhance petroleum-based contaminant destruction; however, none are designed to maintain anaerobic conditions while specifically targeting residual LNAPL. Time and time again **TPH*ENHANCED***™ has successfully demonstrated an ability to enhance the degradation of dissolve phase contaminants, expedite the production of biosurfactants naturally produced by the additive enhanced microbial populations, to realize expedited residual mass solubilization. The ability of **TPH*ENHANCED***™ to enhance residual LNAPL solubilization gets rebound out front. The biosurfactants lower the sorption coefficients of site contaminants allowing for their flux to the dissolved and/or vapor phase at rates far superior to that observed in un-treated areas. This enhanced desorption of residual source mass increases contaminant bioavailability and dissolved-phase destruction, effectively enhancing the realization of long-term compliance objectives.

Technical

Please find attached a current Material Safety Data Sheet (MSDS) and Product Specification Sheet which provides additional information on the remedial additive **TPH*ENHANCED***™.

The following is a list of design parameters (permeability, radius of influence, etc.) which are important towards the effective use of the additive: the range of each, and the optimum. Generally, suitable design parameters include:

- Hydraulic conductivity of $\geq 10^{-4}$ centimeters per second (cm/sec) for optimal distribution.
- Radius of influence for DPT injections ranging from:
    - $\leq$~2.5 feet for $\leq 10^{-4}$ cm/sec[1], hydraulic conductivity (problematic and highly influenced by anisotrophic conditions).
    - $\leq$~25 feet for $>10^{-4}$ cm/sec, hydraulic conductivity (optimal)

- A reasonably representative conceptual site model of contaminant fate & transport.
- A list of operating parameters (flow rates, pressures, temperatures, pH, dissolved oxygen levels, residence times, concentrations, etc.): the range of each, and the optimum.

Operational

The primary operating parameter of **TPH*ENHANCED***™ is the availability of Nitrate (NO_3) and groundwater pH within the desired treatment zone. When implemented, effective microbial respiration will continue at Nitrate concentrations as low 0.5 mg/L; however, for effective remediation deployment [NO_3] of 15,000 mg/L to 30,000 mg/L are typically required to initiate cost-effective contaminant degradation. What is also typical, is the relative immediate utilization of introduced additive components, including [NO_3] to below baseline concentrations, within weeks of deployment. The process is basically stochiometric. Due to regulatory concerns, additive loading rates are established below theoretical volumes required for stochiometric balance to ensure complete additive utilization so that, **TPH*ENHANCED***™ works to enhance natural monitored attenuation (MNA) while maintaining anaerobic conditions. At sites where no source mass remains, the remediation timeframe for dissolve phase contaminants typically ranges from 8-24 weeks; whereas, sites with residual LNAPL in saturated soils require longer timeframes. Regardless, multiple deployments are typically required to ensure safe, consistent and conservative additive deployment. As with any in-situ project, until all residual source mass is removed, long-term compliance cannot be achieved.

Generally, pH values below 5.5 standard units (s.u.) or above 10.0 s.u. can be inhibitory to native soil bacteria and adversely impact efficient biotic derived contaminant degradation. Experience has demonstrated pH values in the range of 6.0 to 8.0 standard units as optimal. Treatment zones with pH values outside the above stated range may require injection of either weak acids or bases to adjust pH values toward neutrality. Unlike typical oxidants **TPH*ENHANCED***™ does not increase pH values, maintaining neutral pH values during remediation, to allow maximum degradation rates to be achieved anaerobically.

With regards to additive components, **TPH*ENHANCED***™ is formulated using Ammonium Nitrate, Potassium Nitrate (NO_3) and a proprietary blend of macro-micro nutrients. The [NO_3] in the formulation are maintained below United States Department of Transportation (DOT) restrictions allowing the material to be shipped throughout North America and the World as a non-regulated specialty biostimulation additive. The proprietary blend of macro- and micro-nutrients; which, when combined with the NO_3 containing compounds, enhances the fitness of naturally occurring microbial populations, enhances their ability to reproduce, increasing the natural secretion of microbial produced biosurfactants. In summary, the additive enhances microbial respiration, facilitates the expeditious solubilization (flux) of residual source mass (LNAPL), and maximizes the non-assimilatory microbial degradation of bioavailable dissolve-phase PHC contaminants. The components *and* process of **TPH*ENHANCED***™ is the basis of the current Patent application.

Application rates of **TPH*ENHANCED***™ are highly dependent on site specific conditions which may influence the assimilative capacity of a given treatment zone formation. The primary approach to monitor the need for re-application is by monitoring [NO_3] and ORP values of treatment zone groundwater. Noted previously, additive dosing typically involves 'under-dosing' the system to initiate enhanced MNA and ensure complete

additive utilization. As additive is consumed rates of microbial respiration increase. As respiration increases microbial activity increases; including, reproduction and biosurfactant production. Subsequently, enhanced dissolved-phase contaminant assimilation and LNAPL solubilization increase. LNAPL solubilization contributes to dissolve-phase contaminant concentrations, i.e. increases contaminant bioavailability; therefore, as dissolve-phase contaminants are consumed and dissolve-phase levels drop, expedited LNAPL flux replaces and/or contributes to dissolve-phase levels generating asymptotic data until such time all residual mass is removed/fluxed to the groundwater and/or vadose zone-atmosphere.

As noted previously, additive is typically under-dosed requiring multiple dosing to polish dissolve-phase contaminants or address remaining residual source mass. Additive will be depleted by enhanced microbial respiration and/or re-occurring contaminant (oxidant) loading; at which time treatment zone groundwater reverts towards methanogenic conditions, with lower ORP values, the lack of alternative TEAs, and slowed contaminant assimilation. Under these conditions, re-application(s) is required to address continuing fluxed contaminants, unless remediation goals have already been achieved.

About 'side-streams', wastes, spent catalysts, effluents, air emissions, or other residues remaining in the treated groundwater or soil, and the nature, volume and fate or disposition of these materials is described next. At sites where **TPH*ENHANCED***™ has been applied, the only known and/or expected 'residue' from the process is increased population densities of heterotrophic soil bacteria after treatment. However, once treatment has been completed, population densities typically slowly return to baseline levels within months, if not weeks. A list of sampling parameters to include in the analysis of groundwater, soil, and/or air during an active remediation program and post remediation monitoring periods is provided in the table below. These metrics are intended to track both the progress of the cleanup and the fate of any chemicals, nutrients and/or catalysts that are unique to the product or process.

Media	Analytes
Soil	Contaminants of concern and TOC
GW	Contaminants of concern, TOC, pH, temperature, DO, and ORP; and a subset of samples for nitrate, dissolved iron and manganese, sulfate, methane, ethene, ethane, and inorganic chloride
Air	Contaminants of concern, methane, carbon dioxide, and possibly hydrogen sulfide depending on baseline sulfate concentrations

Performance

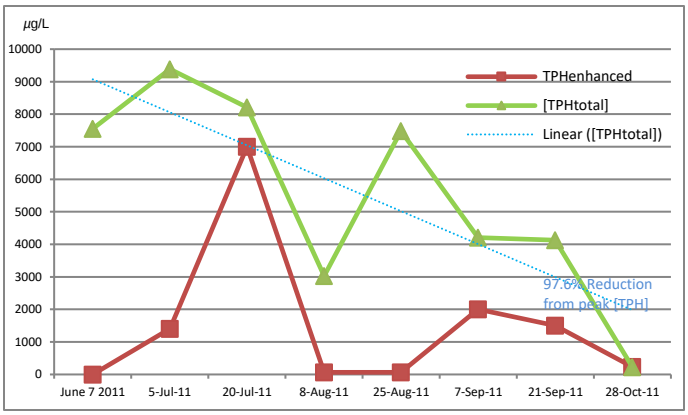
TPH*ENHANCED*™ biostimulates native heterotrophic, petrophylic microbial populations and enhances treatment zone geochemistry to realize passive-aggressive PHC/sVOC/VOC contaminant destruction; the additive is not suitable for use at sites contaminated with chlorinated hydrocarbons. Examples of percent reductions ($\%_{Reductions}$) realized using **TPH*ENHANCED***™ under field and laboratory conditions may be found in the attached documents. The following data was generated during an on-site pilot evaluation sponsored by the Maine Department of Environmental Protection (MEDEP). Purpose, to determine additive efficacy to polish groundwater contaminants at existing sparge treatment system with asymptotic, non-recovery data over the past several years. Proximate to the source zone is monitoring well AMRW01R; it was amended with **TPH*ENHANCED***™ filled Passive Release Sock (PRS) deployment units suspended in the saturated well column.

PRS units are 5-feet long, contain ≈2-lbs additive, have grommets to allow extension, and passively generates ≈3-5foot area-of-influence (AOI). Baseline groundwater conditions were determined prior to initial deployment. Multiple deployments area performed throughout the evaluation period to maintain amended conditions within the AOI against the advection of upgradient contaminants into the limited treatment zone. PRS replacement events are performed every 10-14 days with groundwater monitored, sampled and tested concurrently each event (performance). By comparing performance data to baseline conditions additive efficacy is determined. The attached Pilot Study Guidance Document summarizes the complete evaluation.

GRAPH ONE

Graph One demonstrates additive utilization and contaminant degradation.

- Initial 7-order magnitude increase in additive availability
- 96.7% additive utilization in ≈2-weeks
- [PHCs] decrease >67% same period
- Additive depletion (>99% reduction)
- Microbial respiration slows
- [PHCs] increase 147%
- Increased additive availability allows for increased microbial respiration
- Total [PHCs] decrease 97.6% from peak

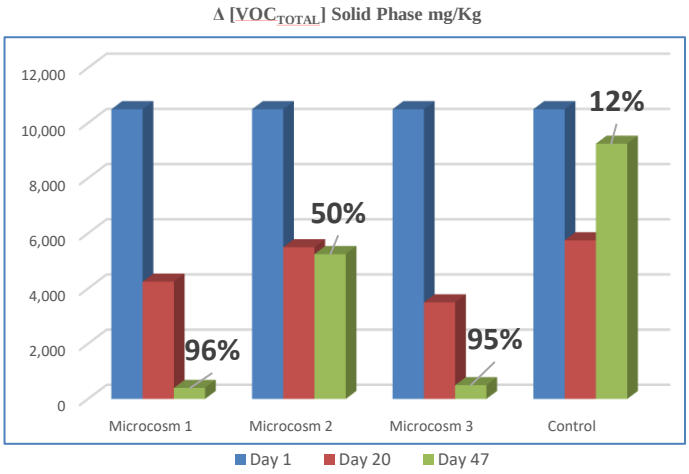


The above graph demonstrates ability of **TPH*ENHANCED***™ to passive-aggressively enhance the destruction of PHC contaminants by increasing native heterotrophic petrophylic bacteria respiration while maintaining *contaminant generated* anaerobic conditions. The evaluation also demonstrated the effectiveness of the additive as a residual source mass remediation strategy; and, how we can eliminate long-term above ground support equipment, associated fuel costs, nuisance emissions, and vapors. Summarizing the MADEP evaluation above; ARMRW01R groundwater was amended with approximately 25-30 pounds of **TPH*ENHANCED***™ over an 18-month period; at 4-pound increments, every 10-14 days. The first PRS was deployed June 7, 2011, the last September 21, 2011 with no additive deployed thereafter. Observations include increases and subsequent decreases (utilization) of [additive], increases in ORP values, increased utilization of naturally occurring alternative electron acceptors (diss. Mn/Fe, SO_4), decreases in [Methane] and periods of contaminant solubilization and subsequent reductions in dissolve phase [PHCs].

Specifically, after the first two deployments additive availability increased 4-orders of magnitude, resulting from PRS deployments to struggling microbial community. Three weeks later, additive availability had decreased ***>99%*** due to enhanced petrophyllic microbial activity, all while maintaining anaerobic conditions. During this same period; as additive became available [PHCs] initially increased 24% (solubilization) the decreased ≈68%. When additive availability was depleted (see August 25th) [PHCs] increased 147%, again due to additive enhanced solubilization and/or natural flux. However, by week-11 as additive availability steadily climbed, heterotrophic microbial respiration increased, resulting in ≈97% reduction in [PHCs] over final 5-weeks of the evaluation. Overall, [PHCs] decreased 97.6% from early peak bioavailability. The evaluation demonstrated effective in-situ PHC degradation can be realized in the presence of residual mass while maintaining anaerobic conditions, cost-effectively, safely, and with minimal impacts; realizing aerobic rates of PHC reduction anaerobically.

Graph Two summarizes results of an independent microcosm evaluation, performed by Spectrum Analytical of Agawam, Massachusetts, in 2012. The evaluation extended 47-days and compared the reduction in VOCs in saturated soils amended with various in-situ additives. At the end of the 47-day evaluation [VOC] reductions under anaerobic conditions (amended with **TPH*ENHANCED***™) were statistically identical to those observed under traditional aerobic conditions; 95.24% to 96.19% respectively, a difference of 0.95%.

GRAPH TWO



Evaluation of VOC degradation in saturated soils amended by various additives.

- Three amended microcosms
  - Microcosm 1 - ORC
  - Microcosm 2 – NH_4
  - Microcosm 3 - TPH*ENHANCED*™
  - Control – non-amended
- Anaerobic contaminant degradation rate statistically identical to aerobic
- [Groundwater] not recorded
- 47-day independent microcosm study
- Difference in rates of reduction <1%
- Realize performance with less costs, less emissions/vapors, less impacts.

The next set of data was generated in 2013 during an on-site comparison evaluation, implemented by CB&I on behalf of the US Air Force, at the Chanute AFB in Chanute, Illinois. The evaluation compared the efficacy of TPH*ENHANCED*™ vs. the O_2 based additive ORC to stimulate in-situ reductions of Site groundwater contaminated with VOC/BTEX contaminants sourced by residual mass present in saturated soils. The Site is a former Fire Training Center. Tables One and Two provide the results from both locations. Graph Three which follows, plots said data.

TABLE ONE

TPHenhanced®	April 4 (µg/L)	April 18 (µg/L)	May 2 (µg/L)	May 21 (µg/L)	%Reduction[1]
Benzene	606	1,780	8,350	24.6	99.7%
Naphthalene	197	178	302	2.02	99.3%
Toluene	2,360	3,620	8,370	13.4	99.8%
1,2,4-TMB	282	224	843	4.13	99.5%
pH	NT	5.7	5.3	6.1	NA

[1] reductions from peak bioavailability realized May 2

Table Two

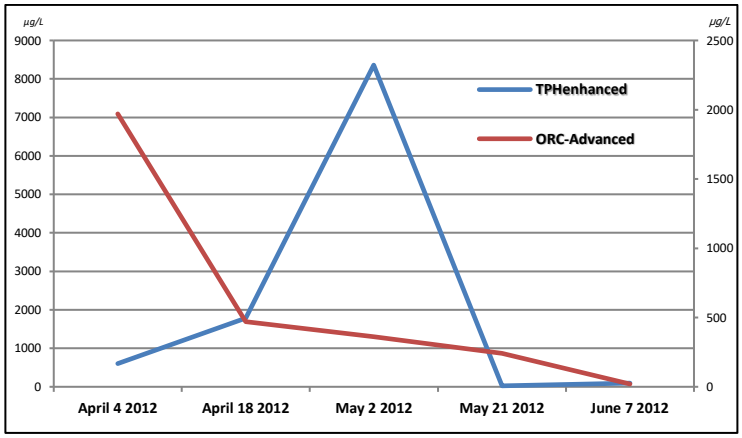
ORC®	April 4 (µg/L)	April 18 (µg/L)	May 2 (µg/L)	May 21 (µg/L)	%Reduction
Benzene	1,970	471	362	241	87.8%
Naphthalene	213	76.7	34.1	8.36	96.1%
Toluene	6,320	1,130	651	385	93.9%
1,2,4-TMB	349	80.7	37.8	17.1	95.1%
pH	NT	9.4	9.8	10.3	11.0

[2] reductions from peak bioavailability realized at the beginning of the evaluation process, April 4.

The test soils were collected by removing smear-zone saturated soils using a backhoe. Representative grab samples of approximate equal mass were then retained directly from the backhoe bucket. One grab sample was placed into one of three 55-gallon drums, a second in the next and third in the last. Each drum was backfilled with treatment zone groundwater. Two of the drums were individually amended with the respective additive, per Vendor instructions. The third drum served as Control, remaining non-amended. Baseline samples were collected prior to amending with three performance samples collected during the ≈7-week evaluation at approximate 2-week intervals.

Comparing [Benzene] at the beginning of the evaluation (Baseline/April 4) to evaluation end on May 21 we see the **TPH*ENHANCED***™ amended drum realized a 95.9% reduction; the ORC amended drum 87.8%. More importantly was the solubilization of residual source mass in the **TPH*ENHANCED***™ drum and none observed in the other two drums. Specifically, the >1,200% increase in [Benzene] during the first 4-weeks of the evaluation followed by an incredible, the 99.7% decrease in bioavailable dissolve phase [Benzene] present prior to initial amending and that released from the saturated soils. Therefore, over the 7-week evaluation, the **TPH*ENHANCED***™ amended drum destroyed >9-times the molar mass Benzene than each other drums.

GRAPH THREE



Graph Three summarizes the USAF sponsored evaluation initiated by CB&I

Compared TPHenhanced to ORC$_{advanced}$

Evaluation period extended ≈7-week period

Results observed include:

Superior residual mass solubilization

Increased contaminant bioavailability

Enhanced dissolved phase destruction >99.99% from peak availability

TPH*ENHANCED*™ destroyed ≈10x the Moles Benzene over same evaluation period while maintaining anaerobic conditions.

The evaluation demonstrated **TPH*ENHANCED***™ superior for long-term contaminant destruction; particularly, in the presence of residual source mass (LNAPL). Smear zones are the bane to in-situ remediation and long-term compliance. It is the source of rebound. It is very difficult to quantify. Even harder to remove. The Chanute Air Force base project involved the remediation of groundwater within the limits of a former fire training center. At evaluation start, it was believed most residual mass had been removed via excavation; as such, additive suppliers were advised 7-11 milligrams per kilogram (7-11 mg/Kg) of Gasoline/Diesel Range Organics (GRO/DRO) remained in saturated soils (smear-zone) and [GRO/DRO] in groundwater approximated 1-3 mg/L (milligrams per Liter) within the proposed treatment zone.

As seen in Graph One, over the 8+ week evaluation period, overall reductions in [Benzene] in Oxygen amended groundwater decreased ≈94% whereas **TPH*ENHANCED***™ amended drum-water decreased ≈84%, a significant difference; however, overall reduction results are often misleading, as they are in this case. Overall reduction was calculated dividing ([final]/[baseline]), subtracting the product by one (1) to establish percent reduction. It does not represent accurately actual performance. Graph One demonstrates solubilization of residual source mass in the **TPH*ENHANCED***™ amended drum with none observed in the other.

Without residual mass solubilization, long-term compliance will not be realized, with rebound and asymptotic concentrations of contaminants in the groundwater for months down the line. Expedited solubilization of residual source (LNAPL) mass is indirectly additive induced; Carbon degrading heterotrophic bacteria naturally, secrete/produce biosurfactants (secretions) lowering sorption coefficients of carbon based food sources (i.e. anthropomorphic PHCs). By lowering the sorption coefficient, flux of the residual contaminant (sorbed, ganglionic, blebs, etc) is expedited, increasing dissolve phase contaminant concentrations and bioavailability.

By 'getting the rebound out-up-front' **TPH*ENHANCED***™ ensures long-term compliance and the attainment of remediation objectives faster, safer, and with less impact. As we see in Graph Three and Table One, dissolve phase [Benzene]/PHCs in the **TPH*ENHANCED***™ amended groundwater increased ≈1,600% by week six of the evaluation; by week 7-8, *2-weeks later*, [Benzene] decreased **>99.99%!!** In fact, **TPH*ENHANCED***™ amended groundwater realized *≈10x greater reduction* Moles Benzene and PHC related contaminants. Realize greater, faster and more complete contaminant destruction sustainably with minimal site impacts.

Additional examples where, under regulatory purview, the biostimulation additive **TPH*ENHANCED***™ was evaluated and/or used under full-scale application to address dissolve phase and residual source mass VOC/sVOC/PHC contaminants in groundwater/saturated soils are referenced below. Case studies of each are included in Appendix B to this document. In addition to the MEDEP Argyle Pump Station Evaluation and the USAF Chanute Air Force Base projects discussed above, **TPH*ENHANCED***™ has been applied at the following locations:

1) ROUX Associates; Woodbridge, NJ – 1,2-Dichlorobenzene/1,4-Dichlorobenzene contamination in saturated silty-clay soils. PRS evaluation into on-going Full-Scale Implementation at currently operating manufacturing facility. Program performed under NJDEP authorization to proceed.
2) ET Technologies; Commerce City, CO – 1,3,5-Trimethybenzene contamination plume in groundwater migrating off-site. Direct Injection program initially intended as treatability study, realized results providing sufficient results to attain compliance at off-site locations and majority of on-site locations. Program performed under Colorado Division of Oil & Gas authorization to proceed.
3) GZA GeoEnvironmental, Inc. - Former Manufacturing Facility, Pennsylvania. Remediation of saturated soils and groundwater impacted by unauthorized release from 7,500 gallon heating oil UST. Program performed under PADEP authorization to proceed.
4) GZA GeoEnvironmental, Inc., Peterborough, NH – Rymes Petroleum Bulk Facility. PRS Pilot Study leading to expanded Treatability Evaluation to address BTEX contaminants in saturated soils and groundwater. Program performed under NHDEP authorization to proceed.
5) Pennoni Associates, Inc., Haddon Heights, NJ – Former Brocks Repair/Service Station, North Wildwood, NJ – Multiple direct injection deployment at former gasoline filling station with subsurface soils and groundwater impacts by [BTEX] components. Program performed under NHDEP authorization to proceed.

Currently, sites where **TPH*ENHANCED***™ is being applied for evaluation and/or Full-Scale remediation include, but are not limited to, the following:

1) LT Environmental, Arvada Colorado - Kerr-McGee Oil, Rankin Oil#1, Weld County Colorado. Full-Scale application via multiple PRS sock deployment at remote former upstream produce water collection pit. Program performed under Colorado Division of Oil & Gas authorization to proceed.
2) Cascade/AECOM, Omaha, Nebraska - McConnell AFB, Wichita, Kansas. Treatability deployment via pressure injection-fracking to address [Benzene] contaminants in groundwater and saturated 'tight' soil matrix. Injection operations performed by Cascade with the overseeing consulting group being AECOM.
3) ATC Associates, Inc., Indianapolis IN - Former Valspar Paint Manufacturing Facility, Indianapolis, Indiana. PRS-based Pilot Study using multiple deployment and Control locations. Purpose to evaluate additive efficacy and cost-effectiveness for vast treatment zone consisting of heterogeneous subsurface matrices (soils, clays, building demolition debris, etc.) within relatively fast-moving aquifer. Contaminants of concern include PHCs, Methyl isobutyl Butyl Ketone (MiBK), Benzene, Naphthalene, and others.
4) Spence Environmental Consulting, Inc., Anna Truck Stop, Anna, Ohio. Methyl tert-butyl ether (MtBE) groundwater contamination at operating truck stop; remediation implemented using multiple

PRS deployment units at several locations. Site currently under review for closure by Pennsylvania Under-Ground Storage Tank re-imbursement fund officials (BUSTR).

With respect to the fate of the components that make up **TPH*ENHANCED***™ and are used or injected (catalysts, oxidants, nutrients, emulsifiers, etc.) in the additive, as discussed above, the only known residue from the treatment process is expected to be increased population densities of heterotrophic soil bacteria; however, population densities are expected to ultimately return to baseline levels. To date, and with specific reference to NO_3, there has ***NOT*** been any reported excess of additive components (including Nitrate) post-completion of project operations which caused Regulatory action to be taken due to adverse impact(s) to any sensitive water source, potable water source and/or treatment zone groundwater. This is because *prior* to the implementation of any full-scale application of the additive we *require* the implementation of a PRS based Pilot Study to assist in our gaining a greater understanding of subsurface conditions with regards to the presence/absence of residual source mass, rates of dissolve phase contaminant destruction and, rates of additive utilization. Furthermore, to date, there have been no recorded air emission compliance issues associated with the use of the additive as well.

TerraStryke® recognizes it is often the remedial contractor(s) who are responsible for additive applications. On all project opportunities and applications, ***TerraStryke***® works with all Stake-Holders to ensure and remind contractors that notifications are typically required for sites treated using this additive. Additionally, although the responsibility to undertake notification is often that of the remedial contractor(s), ***TerraStryke***® will ensure no product applications are performed without proper notifications, regardless of site location, and we will work diligently to ensure compliance with items listed below, and acknowledged by the United States Environmental Protection Agency (EPA), in the December 27, 2000 Memorandum "Applicability of RCRA Section 3020 to In-Situ Treatment of Ground Water"[2]. These listed items include, but may not be limited to,

- The disclosure of the complete chemical analysis of the injected fluid (required by law; no exceptions; handling and safekeeping of confidential disclosures for proprietary formulations is available);
- Meeting all requirements that the chemical composition of the injected fluid meet the primary and secondary drinking water standards of the location of injection,
- Meeting the requirements that monitoring [of appropriate parameters with respect to both the constituents of the injected fluid and the type of petroleum contaminants present] be conducted,
- That the collection of background water quality samples be performed;
- That injections be conducted in such a way that unwanted migration of injected fluids [and/or contaminants] is avoided; and
- The inclusion of Contingency Plans for the above listed, and other related issues, in site specific Remedial Action Plan(s) which may arise during additive application and use.
- Identification of any special permits that may be needed.

TerraStryke® additive **TPH*ENHANCED***™ is a biostimulation product and ***does not contain*** microbial organisms. The additive contains only naturally occurring food-grade products, and typical inorganic nutrients which present no long-term risk to site groundwater conditions and/or human health at recommendation dosing applications. Please see the attached Material Safety Data Sheet. Again, the additive is formulated with agricultural-grade constituents with no fire and/or explosion safety and/or other prevention considerations.

[2]Refer to EPA's Technology Innovation and Field Services Division's Clean-Up Information web site for additional information. URL: *http://clu-in.org/products/regs/memo122700.htm*.

Typically, concerns regarding lower explosivity levels (LEL) are minimal; in fact, [Methane] regularly lowere with additive use due to the positive effects on treatment zone geochemistry which, allow the groundwater to leave methanogenic conditions, resulting in reduced methane production. This assists in mitigating potential concerns regarding vapor migration, either passively and/or by convection. Furthermore, the additive is non-exothermic, air/gases generated by the heat of an exothermic chemical reaction are typically not observed during application, neither is the vaporization of free product by such heat. **TPH*ENHANCED***™ is delivered in a solid (powder form). It does not contain volatile constituents. Lastly, proposed application rates for **TPH*ENHANCED***™ are not anticipated to be measurably exothermic. **TPH*ENHANCED***™ has a shelf life of 1-2 years when kept in dry room temperature conditions. The product should not be stored with electron donor (chemical reductants).

Application of **TPH*ENHANCED***™ requires mixing with makeup water to facilitate the injection process; hence, it is not anticipated to pose safety issues if applied as proposed. Blending ratios can be as great as 3.75parts product to one part water. With respect to the personal protection of workers, and the minimization of their exposure to hazards during handling, mixing, application processes, there are few anticipated hazards associated with the use of **TPH*ENHANCED***™ as intended. It is recommended that remedial contractors and others involved in applying the additive prepare Site-Specific Health and Safety Plans for such applications taking into consideration site conditions coupled with additive properties as described in the attached Safety Data Sheet and Product Detail Sheet.

Limitations

Identification of any limitations that may apply (i.e., not suitable for remediation of low concentrations of contaminants; not suitable for free product remediation, or free product exceeding a specified maximum thickness; not suitable for a specified range of soil permeabilities, soil types or characteristics, etc.) as discussed herein. **TPH*ENHANCED***™ is ***not*** applicable for ‘pooled’ separate-phased LNAPL; however, it has

been repeatedly proven an effective long-term strategy for the destruction of residual source mass ***and*** dissolve phase contaminants; allowing for the, low-impact cost-effective management of future plume migration via enhanced monitored natural attenuation (MNA). In addition, **TPH*ENHANCED***™ will have limited application in soils where hydraulic conductivity values are lower than 10^{-5} cm/sec unless engineering solutions are developed to achieve adequate areas of influence in the desired treatment zone.