SOLVAY CHEMICALS

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SOLVAY

a Passion for Progress®

ENHANCED BIOREMEDIATION Amendments

with IXPER® 75C

CONCLUSIONS

The following conclusions can be drawn from the results of this effort:

1. Use of an oleophilic nutrient in combination with IXPER® 75C, a chemical oxygen source resulted in subsurface hydrocarbon reduction at this site.
2. The multiple slurry applications did not impact the downgradient stream from either the hydrocarbon or slurry constituent residuals.
3. A rule of thumb approach provided sufficient support to the indigenous microorganisms to enhance the rate of hydrocarbon disappearance in this application.
4. The TEA compounds infused increased the number of indigenous. To date, BTEX concentrations in groundwater samples collected from downgradient well MW-10 have not rebounded above detection levels.
5. Future situations that require “polishing” of the site to meet regulatory criteria such as this can benefit from a similar approach using an estimate of TEA needs to achieve results. A strong understanding of site geology and lab studies built into the project costs can optimize TEA selection, application rates and volumes to enhance the probability of success.

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Description

Contamination

A major natural gas company's compressor station facility located in Pennsylvania State forest property was impacted by petroleum hydrocarbons.
The releases at the site included natural gas distillates and a variety of lubricating oils occurring as recently as 2005.

The primary areas of impact to soil were remediated through excavation between 1992 and 2005; however, residual impacts in the underlying aquifer continued thereafter in many areas at the site (Figure 1).

The remedial response to the release identified in 2005 by URS Corporation included excavation of approximately 60 cubic yards of impacted soil. Limited amounts of impacted soil were left behind.

The impacts were observed to have infiltrated the bedrock at the base of the excavation. Underlying groundwater and groundwater downgradient of this area was also known to be impacted with BTEX constituents.

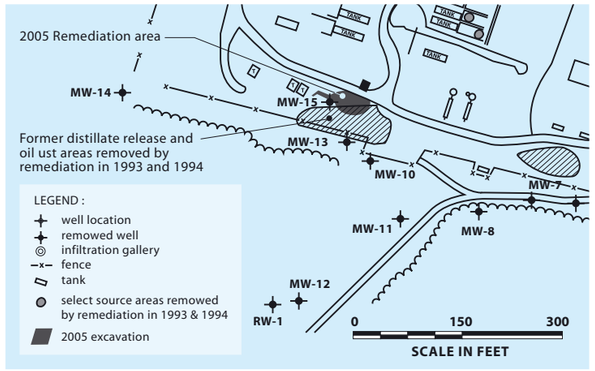

Figure 1 : Site map showing the historical release and remedial action locations

Hydrogeology

Prior to this remedial effort, site investigations had been completed to understand the transport mechanism of the impacts at the wells, downgradient of the site.

Groundwater was found to flow primarily through a fracture system, dominated by a primary fracture zone trending northeast-southwest, with roughly perpendicular cross-cutting feeder fractures.

Groundwater at the site ranges from approximately 60 to 100 feet below ground surface with depth to water varying in some wells as much as 30 to 35 feet during any given year resulting in a thick smear zone for BTEX and Light Non-Aqueous Phase Liquids (LNAPL).

The wells are not equally connected to bedrock fractures as confirmed through aquifer testing.

Remedial Strategy

The regulatory agency, the client and URS concluded that the remaining soil remediation could be completed by enhancing the natural attenuation capacity of the area through the addition of amendments to the excavation.

Evaluation of the data identified a need for the addition of TEAs (terminal electron acceptors) used by microorganisms during the metabolism of hydrocarbons.

The URS project team selected a slurry of TEA amendments that was infused into the subsurface via an infiltration gallery.

URS identified two commercially available agents for use in the TEA slurry. These are

- An oleophilic nutrient (BioNutraTech's VB-591)
- An oxygen containing single metal peroxygen compound of calcium peroxide (Solvay Chemical's IXPER® 75C Calcium Peroxide) which is a food grade product.

Application rates for VB-591 and IXPER® 75C slurry were determined using a "rule of thumb" approach. The estimate was based on the number of impacted cubic yards of soil and the level of hydrocarbons present using existing site data.

Remedial Strategy (continued)

The infiltration gallery consisted of a 4-inch, schedule 80 PVC vertical riser and horizontal pipe slotted with 1/2 inch holes to allow the slurry of amendments to diffuse into the subsurface. The horizontal section of the infiltration gallery was embedded in a gravel reservoir and covered with a thick felt to minimize infiltration of fines.

The TEA agents were mixed with water to form a slurry that was introduced into the infiltration gallery. The slurry was expected to slowly percolate into the aquifer and migrate downwards towards the impacted areas via a similar route that the hydrocarbons released upgradient and in this area most likely followed.

Three application events were completed at the site at roughly seven weeks interval in October 2005, November 2005 and January 2006. Approximately 265 pounds of VB-591 and 160 pounds of IXPER®-75C were added to the aquifer through the infiltration gallery.

Results

Comparison of the March 2005 and December 2006 quarterly groundwater monitoring results indicates a significant decrease in BTEX constituents resulting from the various remedial efforts. Examination of the BTEX data in combination with the monitored amended parameters reveals that the enhanced natural attenuation effort appears to have significantly affected the rate of reduction of BTEX constituents.

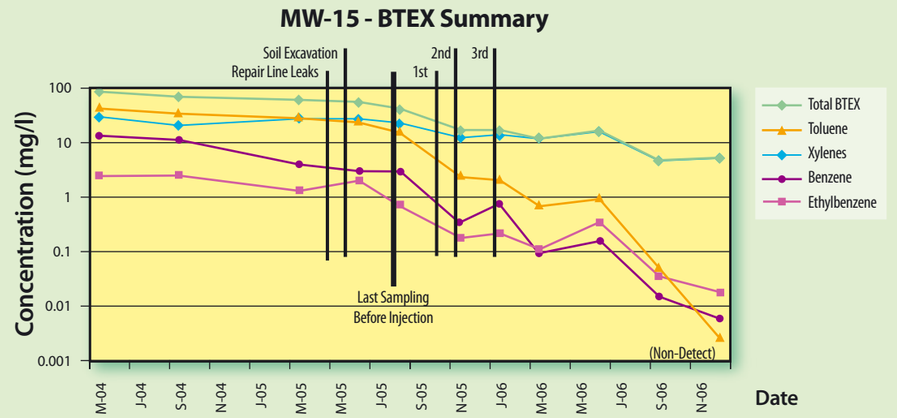

TABLE 1: Values of BTEX in monitoring well MW-15 and corresponding changes in bioremediation parameters through time.

In March 2005, the concentrations of benzene and xylenes in a sample from monitoring well MW-10 were approximately 9 ppb and 12 ppb respectively.

After treatment, analysis of the sample collected during the January 2006 monitoring event indicated that elevated levels of sulfate (a lower redox potential TEA used as a marker) began to appear.

As of the March 2006 groundwater monitoring event, the levels of benzene and total xylenes in MW-10 had dropped below the laboratory detection limits.

Samples were collected in January and September 2006 to identify changes in the number and speciation of microbes that may have resulted from the introduction of amendments to the subsurface.

A significant increase in total heterotroph (TH) counts and total hydrocarbon degraders (THD) counts in the monitored wells has been identified. These data offer anecdotal evidence that the increased numbers of microbes, particularly THD organisms in the aquifer, resulted in a reduction of the concentration of BTEX constituents.