OXIDATION OF A NAPHTHALENE PLUME AT A REMOTE PIPELINE RELEASE SITE

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ABSTRACT:

A product release at a remote pipeline site was determined to contain naphthalene concentrations at a level that prompted remediation. Unfortunately, the area of the plume requiring attention was located in a forested area that rendered conventional remediation techniques such as excavation, soil vapor extraction (SVE) or groundwater pump and treat systems impractical. A recently developed in-situ oxidation process, developed by William Lundy, was employed as the best candidate technology to address the problem.

The process proved to be a very effective remedial tool. The hand-held jet probe drilling technique used to place the oxidation reagent, eliminated the need for direct-push equipment at the injection points. And, the mixer/pump trailer was parked over three hundred feet away at a spot more convenient for mixing and efficient operation. The application resulted in a No Further Action (NFA) letter being issued by the State of South Carolina.

INTRODUCTION:

A product pipeline transporting fuel from refineries located in states bordering the Gulf of Mexico to markets on the east coast suffered a breach resulting in the release of hydrocarbons. Although the majority of the compounds appeared to be mitigating via natural attenuation, the more recalcitrant polyaromatic hydrocarbon, naphthalene remained at concentrations in excess of the State's Maximum Concentration Level (MCL) required for site closure. It was decided that aggressive remediation of the site should be undertaken. Unfortunately, the release had occurred in a remote area near a creek. The problem of access to the site was further exacerbated by the fact that the remedial zone was located in an overgrown forested area adjacent to the release point rather than in the cleared pipeline right-of-way. This posed a significant challenge for conventional remedial processes.

PROJECT BACKGROUND

The subject site is identified as a wooded area located in rural South Carolina. The pipeline operator maintains one (1) thirty-six (36) inch and one forty (40) inch diameter petroleum product pipelines in an approximate southwest to northeasterly orientation in the site vicinity. The thirty-six-inch line was breached approximately one hundred (100) yards southeast of a creek in May of 1979, resulting in the release petroleum products. The affected pipeline depth at the release point was approximately five (5) feet below grade surface. Groundwater elevation was approximately six (6) feet bgs at the point of the release. The soil was a very permeable sand thus facilitating the migration of the petroleum products in the groundwater. Although the majority of product was

contained at the time of the release, naphthalene as well as other constituents, was transported in the groundwater to the wooded area located to the southeast of the release point. Monitoring wells installed to delineate the contaminant plume revealed the concentration of the naphthalene in groundwater to be 44.7 mg/L. This concentration remained quite constant until after remediation.

PROPOSED REMEDIAL ACTION

The remediation technology proposed for the site was in-situ catalytic oxidation. Soil conditions at the site, e.g., permeable sand, was ideal for in-situ methods. Conventional remedial actions such as excavation or soil/vapor extraction were impracticable because the impacted area was located within an overgrown forested area (see **Figure 1**) adjacent to the cleared pipeline right of way.

Figure 1 Injection Area

A second injection area was delineated approximately seventy-five (75) feet southeast (deeper in the forest) of the area depicted in Figure 1, rendering access to direct push or boring equipment impossible. However, a recently developed in-situ chemical oxidation process that had been successfully used by the consultant (to reduce BTEX concentrations at a pipeline release site on the Gulf Coast[(1))], seemed appropriate for application here. The process had also been remarkably success when used to remediate PAHs (benzo(a)pyrene) at a railroad switch yard[(2)] in Chicago.

For shallow applications (less than twelve (12) feet) the process can be applied using a hand held hydraulic lance. This tool creates a high velocity, low volume fluid jet that cuts the soil immediately around the tip of the probe rod. As

the soil is displaced by the injection fluid, the lance can be easily advanced by hand. This method was used at this site. These injection points are closely spaced to ensure that the impacted soils and/or groundwater are sufficiently mixed with the reagent such that, the contaminants are thoroughly wetted. The pumping equipment can also be staged up to three hundred yards away from the injection zone making site access convenient, fast and thus very applicable for pipeline applications. Because the technology is safe and works fast, it was ideal for use at this site.

THE OXIDATION PROCESS

The process applied is based upon hydrogen peroxide chemistry. However, unlike conventional Fenton chemistry which injects liquid hydrogen peroxide, this technique generates hydrogen peroxide *in-situ.* This is accomplished by injecting a reagent that contains an aqueous suspension of peroxygens and amendment compounds formulated to control pH and catalytic activity as well as the production rate of hydrogen peroxide. Because the quantity of hydrogen peroxide available at any given time is minimal, the process does not generate the heat indicative of conventional Fenton chemistry. Therefore, loss of contaminants through thermo volatilization is obviated.

THE APPLICATION

Because the contaminated zones were confined in a wooded area and relatively small the project was similar to two pilot applications. The two impacted monitoring wells were selected as the center area of the injection zones. Based upon the soil type, the shallow distribution of the contaminant and experience at treating similar sites under similar circumstances, the following remedial action strategy (See Table I) was designed for the site.

Table I

Areal Extent:	two 825 square foot areas
Vertical Extent:	1 to 8 feet
Cubic Yards:	428
Injection Matrix (Point Spacing):	5 feet
Number of Points:	66
Total Gallons Reagent:	2,995
Gallons Reagent per Point:	~45
Gallons Reagent per Cubic Yard:	7
Days to Complete	2

An important point to note in the remediation of this remote site was the lack of availability of utilities; most notably, water. However, because a creek with relatively clean water was located approximately one hundred (100) yards from the injection zones, an alternative source was available. Creek water was treated to stabilize cations and subsequently used as makeup water for the reagents.

RESULTS

The naphthalene concentration in the groundwater prior to injection of the reagent on July 11, 2001 was 44.7 mg/L. Groundwater samples collected approximately ten weeks later on October 2, 2001 revealed the concentration had dropped to 20.2 mg/L and subsequent samples collected on November 30, 2001 placed the concentration of naphthalene at <10.0 mg/L. It is believed based upon microbial plate count data collected at similar sites, that the continued decline in contaminant concentration was due in large part to increased biodegradation activity attributed to the technology.

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