Recommendations

The current extent of emulsified product should be determined and compared with the original source area to determine the rate and direction that emulsified product is migrating. The extent of emulsified product may best be delineated using direct-push ground water sampling and a TRIAD-based dynamic work plan. Three permanent monitoring wells could then be installed outside of the area impacted by product to help monitor conditions over time. Figure 3 presents potential locations for direct-push sampling locations and permanent wells. Additional direct-push locations and the locations of the presented permanent wells are subject to findings from the initial direct-push results. The newly installed monitoring wells from this effort (plus S-88-2) should be sampled for PAHs and gauged for four quarters. Samples should be analyzed for PAHs even if product is identified in the wells to confirm that the product observed is a source of the observed dissolved contamination. The data should be reviewed along with the site conceptual model and historical source area data to determine the rate at which source material is migrating. If it is determined that source migration via emulsified product is occurring, it is a reasonable conclusion that contamination will have the potential to migrate beyond the boundaries of the proposed TI area above standards, and operation of the P&T system, or perhaps a modified P&T system, would be appropriate to provide hydraulic control. Based on the findings of this investigation, it may be necessary to revisit the boundaries of the proposed TI area.

If it is determined that the P&T system is not required to prevent the migration of emulsified product, the site team can use the information from the above characterization to determine the primary migration pathways at the site and the appropriate locations for point of compliance wells. S-85-6A/B can be used as point of compliance wells to the east, and S-88-3 can be used as a sentry well to help determine the degree to which contamination is migrating toward these co-located point of compliance wells. Appropriate sentry and point of compliance wells are not available to the northeast, but information from the above suggested characterization should be evaluated before locating such wells. Potential locations for sentry and point of compliance wells are indicated on Figure 3.

Sentry and point of compliance wells should be monitored quarterly for up to 15 years before making the determination that the plume is stable. This extensive monitoring duration is suggested because of the long time frames needed to observe actual increases in concentrations at S-88-3, S-85-6A/B, and other sentry or point of compliance wells that might be located to the northeast of the source area. For reference, the table below provides the anticipated naphthalene concentrations at S-88-3 using the previously noted BIOSCREEN parameters and assuming S-88-2 (approximately 300 feet upgradient) is a source area with a concentration of approximately 10,000 ug/L.

Time	Anticipated S-88-3 Naphthalene Concentration (ug/L)
3 years	0
6 years	0
9 years	8
12 years	57
15 years	184

Note: Recalibration of the model with new data could significantly affect the above-noted anticipated naphthalene concentrations at S-88-3.

Quarterly monitoring is suggested because of the historical high variance in concentrations at some locations. Each year, with four new quarters of monitoring, the concentration trends can be evaluated and an appropriate transport model recalibrated. Despite the quarterly frequency for monitoring, overall trends will occur sufficiently slowly that annual reporting and analysis is sufficiently frequent. If monitoring and modeling results suggest potential migration of contamination above standards beyond the proposed TI area, then the P&T system should be restarted. Additionally, if the concentration of a site contaminant equal to 50% of the ARAR is detected at a point of compliance well in more than one event (not necessarily consecutive), then the P&T system should be started within 90 days of receiving the result from the laboratory. If after 15 years of quarterly monitoring and rigorous modeling/evaluation, plume stability is clear and concentrations outside of the TI area will not exceed ARARs, then the proposed TI area is likely appropriate and active remediation would not need to be resumed.

Based on the reviewed information, it does not appear that the town well is a likely potential receptor of site-related contamination. There is generally an upward gradient from bedrock to the surficial aquifer, so downward migration of dissolved contamination to bedrock is not expected. The most likely potential pathway (if any) for contamination to reach bedrock would be vertical migration of DNAPL from the surficial aquifer to bedrock. Source area data, however, suggest that concentrations decrease with depth (see S-93-2S and S-93-2D). In addition, S-88-8b is slightly to the side of the direct path between the source area and the town well and has had favorable analytical results. The highest naphthalene concentration in over 20 samples was 1.1 ug/L in 2002. It is reasonable to conclude that site-related contamination will not leave the southern boundary of the proposed TI area (in the direction of the town well) at detectable levels. If additional assurance is needed, then another bedrock monitoring well could be installed midway between the S-85-8 cluster and S-85-7 and sampled for four quarters. This well would be located in the direct path between the source area and the town well. If contamination is detected above a given threshold (perhaps 10% of the ARAR value), then monitoring could continue on a quarterly basis along with the surficial aquifer monitoring. If an increasing trend is noted, then additional characterization and evaluation would likely be required.

A study, independent of this review, was conducted by Mindy Vanderford of GSI Environmental, Inc. (another contractor of U.S. EPA OSRTI). Conclusions of the GSI study are similar to those made by GeoTrans in this study. Similarities between the two studies include the variance in site data (e.g., the variability observed at S-88-2), the insufficient information available in a 2-year time period to evaluate plume stability, the relatively long period of time (e.g., on the order of 10 years) to collect sufficient information regarding plume stability, and the need for sentry and point of compliance wells. The GSI study also provides several valuable suggestions regarding statistical evaluation of data and the use of the MAROS software. This study conducted by GeoTrans focuses more on modeling results and visually observable trends than on statistical analysis; however, if statistical analyses are performed in conjunction with the GeoTrans recommendations, GeoTrans recommends following the advice in the attached study regarding the use of the appropriate software and techniques.

Recommendations

- *Prepare and maintain a comprehensive Site database with analytical results and sampling location information.* The database provided for the monitoring network review did not contain data for TPAH or CPAH that that are the basis for evaluating the achievement of monitoring objectives and remedial goals. A comprehensive database would include geographic coordinates and well screened intervals for current and historical monitoring locations as well as ARARs or other regulatory screening levels applicable to the Site and geographic information system files showing institutional boundaries. An updated database should be made available to Site decision-makers after every sampling event.
- *Establish point of compliance (POC) monitoring locations.* Install a monitoring location between S-91-2 and S-85-6b to monitor the proposed boundary of the TI zone on the northeast side, addressing the monitoring objective of demonstrating containment of the plume.
- *Designate AMP wells within the plume and calculate AALs*, which would be maximum concentration levels that would be still protective at the regulatory boundaries.
- *Identify data points that are statistical outliers and expand the statistical analysis to include 95% upper confidence level for priority constituents at plume stability monitoring locations.* Consider finding a 95% UCL on expected rebound concentrations using historic or modeling data. Summary statistics for data sets with >30% non-detect results should be analyzed using Kaplan-Meier method using ProUCL software.
- *Expand the reporting of Mann-Kendall test statistics.* Include the detection frequency and other summary statistics in the monitoring report. Add concentration vs. time graphs for key locations (AMPs above). Plot Mann-Kendall trends on the Site map to demonstrate trends spatially; consider layering geochemical data (DO, ORP) on the map to link trends with geochemical processes.
- *Estimate slow desorption and biodegradation capacity based on a thorough literature review and published models of the physical processes.* Due to the age of the Site, PAH constituents in the subsurface are most likely highly sorbed, or 'aged', in sediments (Alexander, 2000). Aged constituents desorb very slowly under most environmental conditions. The concentration at which the plume will "stabilize" will reflect the desorption rate from affected sediments as well as the Site-specific biotransformation rate and hydrogeology. More effort should be made to quantitatively assess the physical process of slow desorption at the Site and its implication for long-term management.
- *Establish monitoring objectives* for long-term demonstration of remedial protectiveness and identify triggers for implementation of contingent remedies to control the plume.
- *Re-evaluate the monitoring program at the end of the interim monitoring period.*