Evaluating Lifecycle Costs and Meeting Clean-up Goals at Petroleum-Release Corrective Action Sites

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Full consideration should be given to potential lifecycle costs when developing a closure plan to evaluate environmental liabilities associated with underground storage tank (UST) releases. Corrective actions must be conducted in a manner protective of human health and the environment and in compliance with the Bureau of Underground Storage Tank Regulations (BUSTR) corrective action regulations. In addition, if the site is eligible for reimbursement through the Petroleum Underground Storage Tank Release Compensation Board (PUSTRCB), it is in the best interest of all parties to conduct corrective action in compliance with regulations to meet reimbursement requirements in a cost-effective manner so that reimbursement activities can be efficiently completed, which will result in overall lower financial assurance costs and fees.

The first step in the corrective action process is to obtain a good understanding of the project and adequately characterize the site. Consideration must be given to the protection of human health and the environment, compliance with applicable laws and regulations, current and future use of the property, technical limitations, and reimbursement implications.

BUSTR's 1999 Risk-Based Corrective Action Rule must be followed for new releases. Corrective action sites which pre-date this 1999 rule can elect to transition to the new rule.

A risk-based clean-up approach, such as BUSTR's 1999 corrective action (CA) rule, should be considered because, in many situations, cleanup costs are generally lower and sites can achieve No Further Action status without compromising the protection of human health and the environment. Consideration should also be given to re-evaluating sites that have been in a non-risk-based corrective action program such as BUSTR's 1992 CA rulei[1]. This particularly applies to sites where remediation systems have been operating beyond estimated timeframes and further progress towards meeting cleanup goals has minimal value. To maintain eligibility with PUSTRCB and compliance with BUSTR, consultants must be sure to seek the proper approvals from BUSTR and the Fund when transitioning sites from the 1992 to the 1999 CA rule

A clear plan for closure, adequate site characterization, evaluation of BUSTR regulations, and compliance with PUSTRCB guidelines are the components that make up a methodical yet cost-effective model to help consultants or owner/operator's smoothly manage petroleum release sites to completion. Four case studies from actual UST sites in Ohio demonstrate the importance of considering these components to obtain closure in a safe, fast, and economical manner.

Case Study #1: Former Service Station

The Site operated as a retail gasoline and service station from approximately 1950 to 1989. A release was reported to BUSTR in October 1989 based on sampling associated with the closure of all site underground storage tanks (USTs) and dispensers. The UST owner/operator divested the property and the current owner operates an automotive repair garage.

Several phases of investigation culminated in a Remedial Action Plan (RAP) submitted to BUSTR in July 1995. Under the 1992 CA Rule the Site was classified as Category 2, and is located in a sensitive area. The approved remedial action consisted of a vacuum-enhanced groundwater pumping system. The remedial system was activated in June 1996 and operated until October 2000 when the system was shut down to evaluate petroleum hydrocarbon parameter concentration rebound. The 2001 groundwater analytical results indicated that the concentrations of chemicals of concern (COCs) in groundwater were approaching asymptotic levels. A comparison of pre- and post-remedial system groundwater concentrations indicated there was a 96% reduction in total benzene, toluene, ethylbenzene, and xylene (BTEX)

concentrations across the Site since remedial system activation; however, wells in the former UST excavation still contained approximately 130 ug/l benzene (down from over 10,000 ug/l pre-system activation). In addition, one monitoring well located near the property line/road and adjacent to buried utilities showed increasing BTEX concentrations in contrast to all other Site wells. The owner/operator performed an investigation that suggested that the well with increasing BTEX was being impacted by an off-Site source and submitted the data in an NFA request letter to BUSTR in April 2001. BUSTR denied the NFA request and asked for either a risk assessment or a revised RAP.

Additional investigation to prove the off-Site source was impractical. As initial remediation dramatically reduced BTEX concentrations to asymptotic levels which remained at concentrations above 1992 CA Rule action levels, it was doubtful that continued remediation would further reduce concentrations below action levels within a reasonable timeframe. Following a screening evaluation and consultation with BUSTR the consultant advised the owner/operator to evaluate the Site under BUSTR's 1999 CA rule. A Tier 1/Tier 2 risk-based evaluation report was submitted to BUSTR in July 2002 based on use restrictions.

For soil, the complete exposure pathways included soil to indoor and outdoor air. None of the benzene concentrations exceeded the Tier 2 site-specific target levels (SSTLs) based on commercial land use. Concentrations of chemicals of concern in groundwater did not exceed SSTLs for on-Site exposure pathways. Since drinking water supply wells are located within 2,000 feet of the Site, groundwater modeling was used to demonstrate the attenuation of COCs to the point of compliance. Following communication of additional information on utility and water well locations BUSTR subsequently issued an NFA subject to a non-residential use restriction in December 2002.

This Site was ineligible for reimbursement by PUSTRCB, but demonstrates the importance of CA rule evaluation. The 1999 CA Rule Tier evaluation afforded the owner/operator the opportunity to obtain a NFA from BUSTR at a much lower lifecycle cost than what would have been necessary to make the same demonstration under the 1992 CA rule. Original lifecycle costs to date for assessment and RAP implementation in accordance with the 1992 CA Rule were on the order of $400,000 without closure. Likely additional costs for proceeding with corrective action in accordance with the 1992 CA Rule would have cost at least an additional $80,000, with no guarantee that this effort would have reduced concentrations below applicable action levels or that a 1992 CA Rule risk assessment would have met criteria for site closure. The incremental costs to enter the 1999 CA rule was $25,000; a dramatic savings.

Case Study #2: Former Gasoline Station

This Site operated as a gasoline retail and service station from 1963 to 1992 at the corner of a busy intersection. A release associated with the former gasoline USTs, piping, and dispenser islands was reported in November 1989. BTEX concentrations in soil and groundwater exceeded both 1992 and 1999 CA rule action levels.

Numerous investigations were conducted at the Site from 1989 through 2002. The owner/operator eventually divested the property during the corrective action process and worked with the current property owner to minimize disruptions to his operating business. Hence, a cost-effective solution was initiated that would satisfy the requirements of BUSTR while minimizing disturbance to the ongoing business.

The various investigations initially conducted at the Site under the 1992 CA rule include site assessment, a UST closure, two soil excavations, periodic light non-aqueous phase liquid (LNAPL) recovery, installation of a contaminated groundwater and soil vapor interceptor trench, vacuum-enhanced groundwater pump and treat, and *in-situ* aerobic and anaerobic microbe bioremediation. Environmental costs associated with this work totaled over $400,000. To obtain closure under the 1992 CA rule, additional soil remediation would require removal of approximately 1,000 cubic yards of soil, and groundwater remediation would need to include a pump and treat system. Additional costs to obtain closure under the 1992 rule were estimated at over $110,000 for soil management and $200,000 for a pump and treat system.

The owner/operator elected to re-evaluate the Site under the 1999 CA rule in November 2000. Site-specific target levels (SSTLs) were developed, and the 95% upper confidence limit (UCL) was derived. Both indicated that some remedial action was necessary to obtain closure. Based on the new analysis, the consultant determined that soil excavation of approximately 400 cubic yards would be required. While this represented a significant savings, the anticipated duration of 2-3 weeks to complete the excavation and

repave the asphalt was still a concern to the current property owner because the work would have disrupted the operating business.

The consultant and owner/operator then met with a BUSTR coordinator to review Tier 2 options. The BUSTR coordinator advised further review of the 95% UCL. The consultant re-evaluated the source area using a distribution-free method for determining the 95% UCL and found it unnecessary to excavate, resulting in an additional cost savings of approximately $50,000 under the 1999 CA Rule without interrupting business. BUSTR issued an NFA for the Site in December 2002.

This case history demonstrates how not only is site re-evaluation under the 1999 CA rule important to lifecycle-cost reduction, but effective project management and sound scientific research can significantly reduce the lifecycle cost as well. The total lifecycle cost for this Site excluding well-decommissioning costs is $445,100. If the Site continued to be evaluated under the 1992 CA Rule, the projected lifecycle total would exceed $710,000, increasing lifecycle costs by as much as 60%. These costs were eliminated under the 1999 CA Rule. Plus, avoiding additional excavation reduced the total lifecycle cost by another 10%. Had the 1999 CA Rule been available when the project started, the savings would have been even more significant.

Case Study #3: Active Service Station

This Site is an active gasoline station that had intermittent free product in one well. After the site assessment was completed, a RAP was prepared and approved by BUSTR and PUSTRCB in accordance with BUSTR's 1992 CA rule. Concentrations of benzene in soil and groundwater were significantly above BUSTR Category 3 action levels. A remediation system was designed in 2001, including vacuum-enhanced groundwater pumping. The consultant recommended delaying the system installation so they could re-evaluate the COCs in accordance with the 1999 CA rule. This evaluation, though currently in progress, indicates that the concentrations of benzene in soil are below the Tier 2 SSTLs for non-residential property use. Additionally, the drinking water pathway has been eliminated; therefore, the sole groundwater exposure pathway is volatilization to indoor air. The concentration of dissolved benzene in groundwater is below the BUSTR Tier 2 SSTL for this pathway.

A thin layer of free product (i.e., less than one inch) appears to be intermittently present in one of the on-Site wells. Therefore, periodic long-term product recovery will be necessary to address this compliance issue. Because this product has not migrated since the release several years ago, it is unlikely that additional remediation will be likely beyond periodic manual bailing.

Costs to date for assessment, pilot testing, RAP preparation, and system design are approximately $142,500. Likely additional costs for proceeding with corrective action in accordance with the 1999 CA rule are estimated at $20,000.

Had the project proceeded under the 1992 CA rule, the owner/operator would have incurred additional costs estimated at $310,000 for equipment, permitting, system installation, operation and maintenance, and four years of groundwater monitoring. Had this release been investigated under the 1999 CA rule from the beginning, the owner/operator would have saved an additional $25,000 that was spent on developing the RAP.

Case Study #4: Former Service Station Site

The Site consisted of one 1,000-gallon steel gasoline underground storage tank (UST), one 2,000-gallon steel UST, one dispenser island, and associated product piping removed in 1998. Two dispensers were removed previously. A release was identified for the Site on April 1, 1998.

The Site was eligible for reimbursement and qualified for hardship status because the Site owner filed for bankruptcy. The estate was under the control of a Trustee. Although a buyer was interested in purchasing the property, the Trustee could not divest the property until regulatory closure was obtained for the environmental liabilities associated with the UST release. The Trustee hired a consultant to perform the

site assessment. Given the above, it was critical for all parties involved to develop a timely, cost-effective corrective action plan.

Site assessments conducted in 1998 and 2000 revealed high concentrations of benzene and methyl-tert butyl ether (MTBE) in soil and MTBE in groundwater. The Site was initially evaluated under the 1992 CA rule, but was transferred into the 1999 CA rule to employ risk-based standards.

Initially, the consultant recommended an interim response action consisting of limited excavation of the source area as the most effective means to closure. Pre-approval was granted by PUSTRCB to collect additional soil samples around the source area to delineate the extent of hydrocarbons in soil. However, close examination of the local zoning maps showed that much of the source area is contained within the right-of-way (ROW) of an adjacent state route. According to the Ohio Department of Transportation (ODOT), no structures may be built within a state ROW without obtaining a permit. The Trustee also agreed to placing land-use restrictions on the Site that would ensure the land be used for commercial purposes only and prohibit the installation of any wells on Site other than environmental monitoring wells.

The soil pathways were consequently considered incomplete based on the above restrictions. The groundwater pathways to off-site receptors were evaluated by modeling. Closure was ultimately obtained in June 2002 after two quarterly groundwater-sampling events verified the modeling results.
This environmental investigation exemplifies how diligent project management, working knowledge of the regulations, and a comprehensive review of all the available Site information resulted in not only valuable lifecycle cost savings of approximately $50,000, but also a relatively short lifecycle duration of four years. The total lifecycle cost for the environmental investigation was $51,115 of which $38,872 was reimbursed, or is pending reimbursement, after the $11,000 deductible was met. Overall, the lifecycle costs were reduced by 50% as shown on Figure 1.

DISCUSSION

The successful closure strategies discussed above may be applied to many UST Sites throughout Ohio, resulting in significant lifecycle cost savings while being fully protective of human health and the environment. Lower project costs not only result in lower direct costs to the owner/operator and PUSTRCB, they will also help PUSTRCB keep financial assurance program fees at lower levels. The two common themes among the four case studies are (1) establishing the Site under the 1999 CA Rule; and (2) effective project management.

Figure 1 illustrates the cost savings realized for each case study. Note that the potential maximum lifecycle cost for Case Study 4 is only 15%-25% of the total potential maximum costs associated with the other three case studies. One reason for the difference is because potential maximum lifecycle costs for case studies 1-3 were derived as if the Site would remain in the 1992 CA Rule, whereas the potential maximum lifecycle cost for Case Study 4 was estimated based on obtaining closure in the 1999 CA Rule. Hence, potential maximum lifecycle costs are typically much lower for UST Sites being evaluated solely in the 1999 CA Rule.

Successfully evaluating lifecycle costs requires sound science coupled with meticulous project management. All practical avenues must be explored to identify the most cost-effective closure strategy based on available Site data and the consultant must have a clear understanding of BUSTR regulations and PUSTRCB guidelines.

Lastly, as important as it is to lower lifecycle costs to keep financial assurance program fees under control, it is just as important to the owner/operator to receive reimbursement for corrective actions if the site is eligible. To do so, the owner/operator or consultant should perform the corrective action work within the guidelines set forth by PUSTRCB. If the PUSTRCB guidelines are followed, and receipts and invoices are retained and submitted in a reimbursement application in a timely manner, the owner/operator may increase his level of reimbursement and reduce related transaction costs.

Figure 1

	Max. Potential Spend	Actual Spend				
Case Study #1	$ 480,000	$ 400,000				
Case Study #2	$ 710,000	$ 445,103				
Case Study #3	$ 452,560	$ 142,560				
Case Study #4	$ 111,115	$ 51,115				
	Submitted	Reimbursed	Pending	reimbursed	potential	total
Case Study #2	$ 445,103	$ 304,548	$ 22,776	68%	5%	74%
Case Study #3	$ 109,515	$ -	$ 109,515			
Case Study #4	$ 51,115	$ 46,314	$ 3,558			

i[1] Risk assessments can be conducted under the 1992 Corrective Action rule; however, the risk goal is an order of magnitude less than the 1999 corrective action rule, making it considerably more difficult to obtain closure.