EPA-560-F-08-244
February 2009

An Introduction to the Cost of Engineering and Institutional Controls at Brownfield Properties

Purpose

The purpose of this fact sheet is to introduce and explore the costs of site cleanup and, where cleanup leaves site contamination that restricts reuse, outlines the engineering and institutional controls and their monitoring and maintenance costs over a longer time frame. This document seeks to provide general information on long-term stewardship (LTS) costs and present property-specific examples on two brownfield properties.

Long-Term Stewardship (LTS)

LTS applies to sites and properties where some contamination remains and long-term management of contaminated environmental media is necessary to protect human health and the environment. LTS generally refers to the establishment and maintenance of physical and legal controls, authorities, accountability mechanisms, information and data management systems, and resources that are necessary to ensure that these sites remain protective over time. While LTS can include several types of activities, this fact sheet explores two of the activities common for incurring site costs—engineering controls and institutional controls.

Engineering controls (ECs) are the physical barriers used or constructed to prevent exposure or isolate materials from people, animals and the environment. These may include a fence, slurry wall, cap or other type of system. Operation and maintenance (O&M) costs associated with ECs should be considered throughout the lifecycle of site cleanup and post-cleanup care. O&M activities are conducted at a site after ECs are in place, to ensure that the action is effective and operating properly, and may include, but are not limited to, ground water monitoring, operating remediation systems, maintaining caps and system maintenance.

Examples of Engineering Controls

- Landfill Soil Caps
- Impermeable liners
- Other containment covers
- Underground slurry walls
- Fences
- Bioremediation
- Ground water pump-and-treat and monitoring systems

Examples of Institutional Controls

- Zoning
- Notices and warnings
- Easements
- Restrictive covenants
- Other land or resource use restrictions
- Permits/governmental controls
- Administrative Orders

Institutional controls (ICs) are non-engineered instruments, such as administrative and legal controls, that help to minimize the potential for human exposure to contamination and protect the integrity of the cleanup. ICs work by limiting land or resource use and by providing information that helps modify or guide human behavior at properties where hazardous substances prevent unlimited use and unrestricted exposure. At many sites, state or tribal response programs or EPA require ICs to be used to support ECs and generally encourage the use of both ECs and ICs.

Environmental Cleanup and Long-Term Stewardship Costs

With increases in the use of risk-based closures, a corresponding increase in the use of long-term stewardship has occurred. In a 2007 report created by the Association of State and Territorial Solid Waste Management Officials (ASTSWMO), 39 out of 41 states that participated in the project acknowledged the use of ICs in at least some of their cleanup programs.

The cost of LTS activities should be a key factor when making cleanup decisions. Risk-based approaches relying on LTS activities often appear as less expensive alternatives with their relatively low up-front, short-term costs. However, leaving waste onsite may restrict redevelopment options, reduce reuse options and property values and require long-term management for decades or longer. Costs associated with the LTS of these sites, including implementing and maintaining institutional and engineering controls, oversight and enforcement by governmental or other entities, and other monitoring and administrative activities may be significant. These costs need

to be calculated and fully considered when making remedial decisions at a site. It is also important to note the LTS may result in costs to private entities such as potentially responsible parties (PRPs), future land owners as well as state and local governments for oversight and enforcement. It is important to consider these LTS aspects when choosing a corrective action approach. The future use of the property may help dictate selection of a less expensive cleanup approach that leaves contamination onsite and requires LTS costs or a more expensive cleanup approach that removes all of the contamination and does not require LTS activities.

The project examples highlighted in this fact sheet do not address every LTS approach and every type of brownfields property. In addition, LTS cost information is not regularly reported or collected; therefore, the project examples do not address all of the associated costs of LTS. Among the costs that are difficult to capture are state staff time involved in discussing and reviewing cleanup options with the redeveloper, state costs associated with periodic inspections of ECs and ICs, and local government cost to file and process ICs to name a few. It is also important to note that the project examples are brownfield sites. Therefore, the LTS information and collection methodology may be different than what is collected for other cleanup programs, such as the Superfund and Resource Conservation and Recovery Act (RCRA) programs.

Project Examples

The two project examples discussed here include a former gas station and a shopping mall that contained dry cleaners and automotive uses that impacted soil and ground water. These sites were chosen because many communities in the United States face the challenge of vacant or underutilized gas stations and shopping areas. It is difficult, however, to draw generalities between these sites and the larger population of brownfield sites, cleanup and LTS costs because LTS cost information is not regularly collected or reported. These examples show the associated costs of two LTS approaches in communities with similar land uses that successfully redeveloped contaminated properties, and used ICs and ECs as part of the site cleanup. The first example, in particular, shows how a flexible corrective action decision making process can help minimize or eliminate LTS costs with the careful selection of ECs and ICs as part of the cleanup.

Closed, vacant or simply underused gas stations may leave petroleum contamination and underground storage tanks (USTs) buried beneath. EPA estimates that there are approximately 640,000 USTs nationwide that store petroleum or hazardous substances. The corrosion and leaking of bare steel tanks can lead to the contamination of soil and ground water with petroleum fuel, fuel additives or other hazardous substances.

Over the past 25 years, EPA's UST program has made great progress in cleaning up leaking underground storage tanks. In FY 2007 EPA and its state and tribal partners continued to make progress in cleaning up petroleum leaks by initiating 11,309 cleanups and completing 13,862 cleanups. According to a 2007 ASTSWMO study, the average cost of cleanup and closeout of a tank site is $115,744.

Petroleum contamination in the soil and ground water needed to be addressed at both the example former gas station and shopping mall. To address the soil contamination, both projects removed the petroleum contaminated soil. Both properties also addressed contaminated ground water plumes through the installation of ground water cleanup systems along with ground water monitoring wells. At the former shopping mall, cleanup also involved injecting nutrients and a carbon source into the ground water via wells to facilitate the biological breakdown of the contaminates. This procedure was extremely successful and cut the anticipated cleanup timeline and cost.

Similar ECs were successfully used at each property to prevent potential vapor intrusion issues, given the volatility of residual contaminants. At the former gas station an engineering control in the form of a vapor barrier was implemented to address the vapor intrusion to the indoor air pathway. The project team determined that the vapor barrier under the slab-on-grade building would adequately address the exposure concerns at an estimated cost of $2,500. After cleanup was completed at the former shopping mall, ventilation systems were installed under the new building structures to ensure protection of human health and the environment at an estimated cost of $80,000. The former shopping mall has O&M costs associated with the ongoing ground water monitoring and system monitoring which is estimated at $340,000 over eight years. In addition to engineering controls, an institutional control in the form of a deed restriction will be implemented at the former gas station to restrict land use and ground water use at an estimated cost of $1,175. This figure reflects the cost to implement the institutional controls, but does not address additional costs associated with maintaining, enforcing and possibly terminating the institutional controls.

Institutional and Engineering Control Costs at the Former McVay Gas Station

Introduction

Located along McVay Highway in the City of Eugene, Oregon, this 0.6-acre former gas station seemed destined to remain unused, an eyesore to passing drivers, and a hazard to the community due to contaminated soil and ground water. As part of the cleanup plan, engineering controls have been installed and institutional controls are slated to be implemented in the near future. This project illustrates how a thoughtful and flexible corrective action decision making process can help minimize or eliminate LTS costs with the careful selection of ECs and ICs as part of the cleanup. The successful cleanup resulted in the sustainable redevelopment of the property into a biofueling station.

The abandoned gas station site, prior to cleanup.

Background

From 1986 through 1991, the property served as a gas station—an activity that gradually contaminated soil and ground water on the property and surrounding area. From 1991 until 2004, the property changed hands several times until ownership was transferred to Lane County through tax foreclosure in 2004.

In March 2005, on- and off-site soil and ground water was assessed using the "Site Specific Assessment" process funded through an EPA-State Response Grant awarded to the Oregon Department of Environmental Quality (DEQ) Cleanup Program. With areas of sub-surface contamination defined, the county began cleanup of the surface debris that included the removal of more than 400 discarded tires, 15 drums of waste material, and hundreds of items of illegal drug paraphernalia from years of drug activity and illegal dumping on the property. A further cleanup effort was funded by a $197,520 EPA Brownfields Cleanup grant awarded to Lane County in May 2005 and $50,000 from SeQuential Biofuels, through a loan from the Oregon Economic and Community Development Department. Lane County managed the Cleanup grant and provided a portion of the grant matching funds through in-kind services. More than 620 cubic yards of contaminated soil were removed and a deeper aquifer ground water cleanup system was installed, along with ground water monitoring wells to ensure the cleanup's effectiveness. SeQuential Biofuels, an Oregon-based biofuel marketing and distribution company, then leased the property from Lane County and began redevelopment in the spring of 2006 into a biofueling station and convenience store.

Environmental Cleanup and Long-Term Stewardship

The project team originally planned on using a sub-slab ventilation system engineering control under the proposed SeQuential convenience store building, along with a vapor barrier to address any vapor intrusion. This initial plan included SeQuential constructing a basement under the convenience store. The project team's plans for the active venting system included equipment, consultant fees and maintenance costs as shown below.

Active Venting System Costs				
System Installation				
Activity	Unit of Measurement	Number of Units	Cost per Unit	Total Cost
Trenching and backfill	Linear feet	250	$11.50	$2,875.00
Vent piping	Linear feet	250	$1.00	$250.00
Turbines and connections	Lump sum	1	$1,000.00	$1,000.00
Compaction and restoration	Linear feet	250	$4.00	$1,000.00
Treatment enclosure	Lump sum	1	$1,500.00	$1,500.00
IDW and trench spoils disposal	Ton	60	$5.00	$2,000.00

Activity	Unit of Measurement	Number of Units	Cost per Unit	Total Cost
GeoEngineers oversight	Hour	36	$95.00	$3,420.00
Field equipment	Lump sum	1	$500.00	$500.00
1 Year Operation and Maintenance				
Contractor oversight	Hour	30	$95.00	$2,850.00
Mileage	Mile	880	$0.36	$317.00
Total				$15,712.00

Source reduction and soil cleanup more quickly than originally anticipated prompted SeQuential's decision to install a vapor barrier under the slab-on-grade building to address exposure concerns rather than construct a basement and active ventilation system under the convenience store as planned. The estimated cost of the revised engineering control was approximately $2,500. The cost savings were shifted to additional ground water pumping, treatment and discharge monitoring.

Aside from the implementation of the engineering controls under the convenience store, the project team anticipates that the final no further action determination of the site will include institutional controls that restrict residential use of the property and consumptive and non-consumptive use of the ground water beneath the property. The risk-based corrective action proposal and conceptual site model for this property did not include residential development as a reasonably likely future use and therefore requires a limitation of current and future uses to ensure remedy assumptions remain valid. The "Easement and Equitable Servitudes" document, which is used to outline the institutional controls at a site, will typically cost approximately $1,175 in associated fees for implementation as follows:

- $500 in DEQ staff time to prepare the document
- $500 in attorney review time of the document
- $100 in property owner time to record the document with the deed
- $75 in county recording fees

These figures reflect the cost to implement the institutional control, but do not address additional costs associated with maintaining, enforcing and possibly terminating the institutional control.

SeQuential Biofuels' new station in Eugene, Oregon, with photovoltaic arrays that gather solar energy.

During the corrective action decision making process, project partners specifically chose ECs and ICs that would limit LTS costs. Now that the cleanup is complete, there is no long-term equipment O&M for this site. Although there are some costs associated with the long-term maintenance and enforcement of ICs, these costs remain undefined. The state does track ECs and ICs with a recommended inspection frequency, but the state currently does not have a funding mechanism in place to pay for those periodic reviews. Therefore, it is difficult for the state to estimate what future IC long-term costs may be. This is one main reason the project partners chose a cleanup approach that would reduce as much as possible future LTS requirements.

Results

The result of this redevelopment, completed in August 2006, is the first station of its kind in the country—selling every SeQuential biofuels (including ethanol and biodiesel blends), and featuring photovoltaic panels above the pump stations that provide as much as half the station's electricity needs through solar power. The main building includes a convenience store that carries natural foods and drinks, most of which are produced by regional companies. A seasonal, fresh produce stand at the station is stocked by local farmers. The convenience store has an "eco-roof" with soil and thousands of plants that help keep the store warm in the winter and cool during the summer. The property also features stormwater retention "bioswales" in which plants filter rainwater before it runs off the site.

Cleanup and LTS at the Former Villa Italia Shopping Mall

Introduction

In the City of Lakewood, Colorado, a blighted former shopping mall was cleaned up and redeveloped into a mixed-use cultural and commercial district. The previous uses of the property left behind contaminated soil and ground water. After cleanup activities were complete, the project installed engineering controls and received a no further action determination from the state, allowing the project to move forward with redevelopment. This project illustrates how environmental cleanup and LTS are used together to meet cleanup standard objectives and protect human health and the environment. The once blighted area is now a mixed-use, sustainability-focused community that includes shops, restaurants, entertainment, cultural activities, homes, parks and office space.

The Villa Italia Mall in Lakewood, Colorado, after redevelopment.

Background

For 35 years, the Villa Italia Mall was the commercial and social center of Lakewood. Despite remodeling efforts, after Villa Italia sales peaked in 1994 and declined thereafter, the city became concerned over the mall's future and initiated redevelopment discussions with the community and developers. By 1999, the property was nearly 50 percent vacant, and in July 2001 the mall closed. Not only was the 104-acre site nearly idle, but Lakewood's budget was significantly impacted from the loss of sales tax revenue. Dry cleaners and automotive service shops that were previously part of the mall left behind contaminated ground water and soil. In 2002, the Colorado Brownfields Revolving Loan Fund (CBRLF) coalition issued a $1.95 million loan to Continuum Partners LLC, a private developer, for the cleanup of the former Villa Italia Mall property.

Environmental Cleanup and Long-Term Stewardship

In total, environmental cleanup activities and LTS cost an estimated $4.28 million. Continuum Partners demolished the Villa Italia Mall and removed asbestos and hazardous materials from existing buildings. Approximately 2,000 tons of soil that was contaminated with dry cleaning solvents and petroleum were removed from the property and successfully addressed. Site remediation also involved injecting nutrients and a carbon source into the ground water via wells to facilitate the biological breakdown of contaminants. Injecting carbohydrates into the ground water contamination plume was extremely successful and cut the anticipated remediation timeline and cost. Ground water contamination was cleaned up to meet Colorado ground water standards, however, there is still ongoing ground water monitoring being performed at the property to ensure that contamination levels do not return. In addition, after cleanup was completed, two subsurface ventilation systems were installed under the new building structures to ensure protection of human health and the environment.

The Continuum Partners are responsible for LTS activities that include long-term subsurface ventilation system O&M that costs approximately $5,000 a year. It is estimated that the long-term system O&M will be conducted for four years. In addition, the Continue Partners will perform ground water monitoring O&M for eight years at an estimated cost of $40,000 a year. These LTS activities will ensure protection of human health and the environment from hazards that may remain after the completion of cleanup, stabilization, or disposal of waste.

In addition to the loan received from the CBRLF coalition, Continuum Partners' successful negotiation with responsible parties resulted in the collection of $2.5 million dollars to assist in the cleanup costs.

The following is a breakout of cleanup and LTS costs for the 104-acre site:

Environmental Cleanup and Long-term Stewardship Costs	
Environmental Cleanup Costs	
Activity	Total Cost
Removal of asbestos & hazardous materials from existing buildings	$400,000
Contaminated soil removal (approximately 2,000 tons)	$60,000
Injection well installation	$1,200,000
Active Bioremediation	$2,200,000
Environmental Cleanup Cost Total	$3,860,000
Long-term Stewardship and O&M Costs	
Subsurface ventilation systems (2 Systems)	$80,000
Long-term system O&M (est. $5,000/year for 4 years)	$20,000
Ground water monitoring O&M (est. $40,000/year for 8 years)	$320,000
Long-term Stewardship and O&M Cost Total	$420,000
Total	$4,280,000

Results

In addition to cleaning up the property and returning the property to productive use, the City of Lakewood has adopted sustainable development practices that preserve the environment and reduce long-term cost. The savings from the sustainable development practices will help offset the LTS cost on the property.

The Belmar redevelopment project, formerly the Villa Italia Mall, provides the diversity of uses necessary to create a true downtown experience in Lakewood. Belmar, located 10 minutes from downtown Denver, is a walkable community that includes 70 shops and 14 restaurants, entertainment, cultural activities, homes, parks and office space.

The Belmar project's emphasis on sustainable, environmentally friendly building practices led to recycling more than 90 percent of the materials used to build the original mall and helped drive innovative energy-saving components of the project. The project features a public art project of 14 wind turbines that powers streetlights in part of the redevelopment and often feeds energy back to the main electrical grid. Solar-powered lights line two of the streets, and security personnel ride Segway scooters instead of gas-powered patrol cars.

Belmar's dedication to the responsible use of limited natural resources and the reduction of energy use are reflected in other aspects of the project, including:

- Transplanting 150 mature trees from the original mall site to a temporary nursery and then back onto streets and public spaces within the Belmar development
- Constructing a three-story mixed use building with office over retail space that was the first building of its type in the nation to receive a Silver-level Leadership in Energy and Environmental Design (LEED) certification
- Installing solar powered parking kiosks
- Using custom outdoor lighting to reduce light pollution
- Featuring a pedestrian and transit-friendly design

In addition, in October 2008, Belmar completed the installation of more than 8,000 solar panels on the roofs of three parking garages in the mixed-use development. The 1.75 megawatt array will generate approximately 2.3 million kilowatt hours of clean electrical energy per year. The solar panel array is one of the largest solar parking structures in the Western United States.