Association of State and Territorial

ASTSWMO

Solid Waste Management Officials

Analysis of State Operation and Maintenance Costs at Superfund Sites (Updated)

Prepared By:

Long-Term Stewardship
Focus Group

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It is important to note that this document does not establish any official opinions, positions, preferences, or recommendations by ASTSWMO or by any individual ASTSWMO member or their respective State or region.

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Analysis of State Operation and Maintenance Costs at Superfund Sites

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List of Acronyms

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980
In this report, references to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) mean the law as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the Small Business Liability Relief and Brownfields Revitalization Act of 2002.

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System
Superfund data (*e.g.*, facility names, locations, and other information) is stored in the CERCLIS database. View a graphic model of the CERCLIS database and table and column information (metadata).

ESD: Explanation of Significant Difference
Under CERCLA, if the USEPA determines that the remedial action at a site differs significantly in scope, performance or cost from the Record of Decision (ROD), than EPA shall publish an Explanation of Significant Difference (ESD) between the remedial action being undertaken and the remedial action set forth in the ROD and the reasons such changes are being made.

Fund-lead
The term "Fund" or "Trust Fund" means the Hazardous Substance Superfund that finances the assessment and cleanup of NPL sites. In this case, Fund-lead means those activities that are federally financed, as opposed to those financed by the State or a Potentially Responsible Party (PRP).

LTS: Long Term Stewardship
Long-term stewardship (LTS) refers to the management of issues and ongoing responsibilities at waste sites. Such management is necessary to protect human health and the environment over time. LTS activities include physical and legal controls to prevent inappropriate exposure to contamination left in place at sites. This can include groundwater monitoring, routine site maintenance and repair, ensuring that site restrictions remain in place, and other tools to preserve the remedy.

Mega Site
EPA defines Mega Sites as NPL Sites with cleanup costs of $50 Million or more, where cleanup involves total removal and remedial action and is funded by EPA or a PRP.

NPL: National Priorities List
The National Priorities List (NPL) is EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. The list is based primarily on the score a site receives from the Hazard Ranking System. EPA is required to update the NPL at least once each year. A site must be on the NPL to receive money from the Trust Fund for remedial action.

O&M: Operation and Maintenance

Operation and Maintenance (O&M) activities are those conducted at a site after a State Superfund site action is completed, to ensure that the action is effective and operating properly. O&M is an important component of a Superfund response to ensure that the remedy performs as intended. Actions range from maintaining engineering containment structures (e.g., landfill covers) to operating ground water remediation systems. Generally, O&M is the responsibility of the Potentially Responsible Parties, States, or other Federal agencies. EPA is responsible for ensuring that the work is adequately performed. EPA also retains funding and operating responsibility for Fund-financed ground water restoration systems for up to 10 years (called Long Term Response Actions) prior to transferring these systems to the States for O&M.

PCC: Post Construction Completion

The goal of Post Construction Completion (PCC) activities is to ensure that Superfund response actions provide for the long-term protection of human health and the environment. PCC activities also involve optimizing remedies to increase effectiveness and/or reduce cost without sacrificing long-term protection of human health and the environment.

PRP: Potentially Responsible Party

A PRP under CERCLA § 107(a) can be: (1) current owners and operators of the facility or vessel involved; (2) former owners and operators of a facility who were involved with the facility during the time any hazardous substance was disposed at the facility; (3) persons who arranged for disposal or treatment of hazardous substances which they owned or possessed at a facility; and (4) persons who accepted hazardous substances for transport to disposal or treatment facilities or sites which they helped select. These categories of liable parties are often referred to as: (1) owners and operators, (2) former owners and operators, (3) generators or arrangers, and (4) transporters.

Removal Action

Removal actions are responses performed at NPL and non-NPL sites that eliminate or reduce threats to public health or the environment from the release, or potential release, of hazardous substances or pollutants or contaminants which may pose an imminent and substantial danger to public health or welfare. These risk reduction activities can be conducted as emergency, time-critical, or non time-critical removal actions.

RI/FS: Remedial Investigation/ Feasibility Study

After a site is listed on the NPL, a Remedial Investigation/Feasibility Study (RI/FS) is performed at the site. The FS follows the RI phase, and includes a detailed evaluation of alternatives for cleaning up the site. The FS is the mechanism for the development, screening, and detailed evaluation of alternative remedial actions.

ROD: Record of Decision

The Record of Decision (ROD) is a public document that explains which cleanup alternatives will be used to clean up a Superfund site. The ROD for sites listed on the NPL is created from information generated during the Remedial Investigation/Feasibility Study (RI/FS).

Analysis of State Operation and Maintenance Costs at Superfund Sites

Purpose

The Association of State and Territorial Solid Waste Management Officials (ASTSWMO) Long Term Stewardship Focus Group (referenced hereafter as "the Focus Group") developed this report on State and Territorial costs[1] associated with the long-term operation, monitoring, and maintenance (O&M) of Post Construction Completion (PCC) activities at sites on the National Priorities List (NPL) and post-removal action sites. The report compares and analyzes factors affecting costs at sites where States are responsible for O&M. This report is an update to the June 2007 report of the same name (http://www.astswmo.org/files/publications/cercla/OM-Costs/OM-report-062207.pdf) incorporates data from a follow up research effort to support conclusions on a more robust data set.

Introduction

As Superfund matures, a significant number of NPL sites have reached the PCC phase and entered O&M. Under CERCLA, States are obligated to assume the O&M costs for Fund-lead sites that are defined in the Superfund State Contract. Some States have already begun to bear these costs, and all States will face and realize the full extent of this financial responsibility as additional sites reach O&M. Recognizing that each State's inventory of sites represents a different timetable and range of financial obligations, cataloging each State's experiences can provide instructive examples for other States.

For over 2 decades, the Superfund Program has clearly demonstrated that addressing complex environmental cleanups is expensive, and that achieving cleanup levels that allow unrestricted use is often not possible or practical. At the same time, Congress has elected not to renew the Trust Fund that initially financed Superfund cleanups. As a result, the funding of Superfund response actions has increasingly been provided by annual appropriation within USEPA's budget. As this trend has proceeded, focus has shifted from CERCLA response to State Response Programs and more risk-based cleanups. Risk-based cleanups are practical and consistent with the levels of funding currently available. Using the risk-based approach, more sites can be cleaned up and

[1] No information was received from the Territories for this research effort. For purposes of this report, "State and Territorial" costs are referenced as "State" costs.

redeveloped, which results in improvements to communities as these properties are returned to the tax rolls.

With more risk-based cleanup decisions and a shift to State response programs, States' cost obligations will continue to accrue. While most State Response Program sites are not CERCLA sites, many of these sites pose identical or at least similar challenges. At the time of remedy selection, States must be able to accurately determine the costs associated with O&M of the remedy, in order to be able to fund Long-Term Stewardship (LTS) activities at the site. States must be able to estimate their future financial obligations as accurately as they can evaluate the technical efficacy of the remedy. Remedy selection must balance remedial action costs with long-term costs to the State.

The data collected represents a subset of the total number of sites for which States are currently paying for the costs of O&M. Initially, the Focus Group hoped to compare estimated and actual costs and to identify factors to help predict increases or changes over time. The data collected by the Focus Group was not adequate to produce quantitative analyses or make predictions for future State costs, but a number of procedural, planning, and other qualitative conclusions are identified from analysis and discussion of the data.

This report incorporates data from a follow-up research effort that was conducted to develop a more robust data set t support Focus Group conclusions. The larger data set supports original conclusions and provides a greater certainty that the conclusions outlined later in the report are appropriately drawn.

Scope

The Focus Group defined the universe of sites for data collection as those NPL sites that are: Fund-lead and in PCC where States are paying for the costs of O&M; or, Fund-lead removal sites where the removal action is complete and States are paying for O&M.

Data collection efforts were aimed at all States and Territories with the goal of collecting data on enough sites to capture small/large sites, simple/complex sites, sites where O&M costs were driven by specific media, and sites where O&M costs were driven

Delivery of carbon for groundwater treatment units

by certain contaminants. Additionally, the Focus Group sought to obtain data on both estimated costs and actual costs.

Methodology

The Focus Group identified criteria for the above-defined universe of sites that would provide information on the costs to States where they have liability for O&M. These criteria included:

1. A Fund-lead remedial action; or a Fund-lead removal action where the removal process is complete and there are post-removal site control requirements; and
2. The site is PCC; and
3. The State is conducting and paying for O&M.

The Focus Group used USEPA data sources (*e.g.*, CERCLIS) to confirm the existence of a representative sample of sites meeting the qualifying criteria.

A standard data collection methodology and format was developed in an effort to gather data that could easily be used for comparison and evaluation purposes (see attached Excel workbook). Data collection focused primarily on site characteristics, contaminants and media affected, remedy components, projected O&M costs, actual O&M costs, and a description of any major changes in annual costs reported. The Focus Group tested the research tool by examining a limited number of sites in their own Regions to evaluate whether data could be collected and how difficult the tool was to use. The Focus Group collected both numerical and descriptive information on sites with the understanding that different types of data would have to be considered and analyzed in different ways.

Focus Group members used a number of methods to identify sites meeting the project criteria, including attempts to directly contact States, Territories, and EPA Regional Staff, and review of information available on-line.

Groundwater treatment system, part of State-funded O&M at an NPL site.

Limitations

As with any research effort, limitations in the data analysis became apparent as the data was received. The Focus Group attempted to directly compare data; however, because States have different planning and tracking mechanisms for O&M costs, the data lacked the uniformity needed for extensive comparison and interpretation. The following items outline the limitations.

- There is a limited amount of actual cost information available. O&M begins after remedy completion, which is relatively late in the Superfund cleanup process. While a number of sites have reached the O&M stage, the scope of this effort was limited to a smaller number of sites, namely those where States pay for O&M. Much of what is known or understood about O&M costs is speculative in nature.

- States are using different categories for describing and tracking O&M costs, so it is difficult to share and compare data across States. Additionally, State programs have developed different methods of record-keeping, and some information lacks the level of detail needed for direct comparisons.

- The data set presented in this report is a subset of the actual costs being supported by State programs nation-wide.

- Because the data are not directly comparable, it is difficult to draw generalities about the larger population of Superfund sites and their respective costs.

The factors above limit the analysis and types of conclusions that can be drawn, but also highlight the need for additional data collection and analysis. O&M Phase II Research Report (http://www.astswmo.org/files/publications/cercla/OM-Costs/OM-II-report-11072008.pdf) discusses the results of an additional research effort focusing on identifying states' fiscal basis for budgeting; defining how states estimate long-term costs; defining the types of funding mechanisms used by states; and whether or not funding sources are adequate.

Findings

Summary

- Intuitively, sites with impacted groundwater are thought to have higher O&M costs than sites with only soil contamination, although the data was too variable to evaluate this hypothesis. Most sites that were examined in this effort have groundwater issues (see Figure 3), but the Focus Group was unable to conclude that there is a direct relationship between groundwater-related O&M and total O&M cost.

- States are spending the most money in the contractual category. Costs associated with staffing (*i.e.*, personnel, fringe, and indirect) are the second greatest expense by a small margin as reported by States. (See Figure 6.)

- Optimization reviews can result in reduced O&M costs. This is shown at three sites and is graphically presented in Figure 9.

- Costs may be reduced significantly when States continue to identify and pursue other parties, such as previously unidentified PRPs. The study includes two sites (*i.e.*, New Lyme and Old Mill) for which PRPs were identified following site turnover to the State for long-term O&M. Figure 8 presents the New Lyme example.

- Data indicated that the cost estimates developed in the ROD bear little relationship to the actual cost of O&M. (See Figure 7.)

The Focus Group collected information on 64 Fund-lead NPL sites, where States were responsible for O&M of the remediation systems. As described above, each member of the Focus Group gathered information on those sites meeting the criteria. The information sought by the Focus Group included basic information on the site size, location, contaminants of concern, impacted media, estimated cost, actual cost, and information concerning any Five Year Review or optimization studies. This data was assembled into a Microsoft Access database to streamline the data analysis. (See attached PDF file that summarizes the data submitted by States.)

General Description of the Data Set

As described earlier in this report, the purpose of the study is to provide a general understanding of the potential costs associated with O&M activities at Fund-lead NPL and removal action sites. In order for States to best assimilate the data for their own purposes, the sites studied should be representative of the range of sites in O&M nationwide, both by geographic location and site size. The site data received by the Focus Group included information from 8 of the 10 USEPA Regions (Figure 1). The land size of the sites ranged from 1 acre to 302 acres and averaged 59 acres, as shown in Figure 2. Four sites did not provide size in acre units. The size of sites is somewhat misleading, as several sites do not have a defined size due to the nature and extent of surface or subsurface contamination. Some sites are former mining sites that encompass large tracts of land.

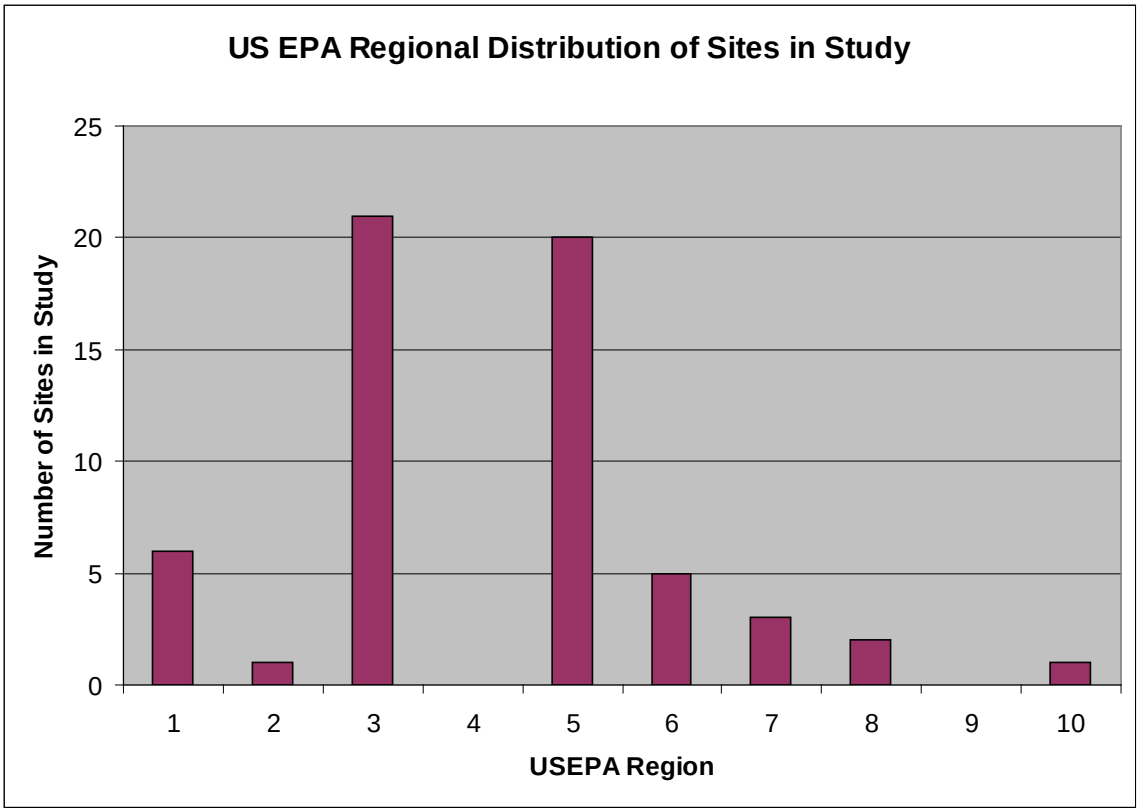

Figure 1: Regional Distribution of Sites in the Study

At 54 sites, groundwater contamination was identified as the primary environmental media responsible for driving O&M costs. Soil was identified as a cost driver for O&M at 12 sites, while surface water was identified at 4 sites. Figure 3 summarizes the number of sites and the primary impacted media of concern.

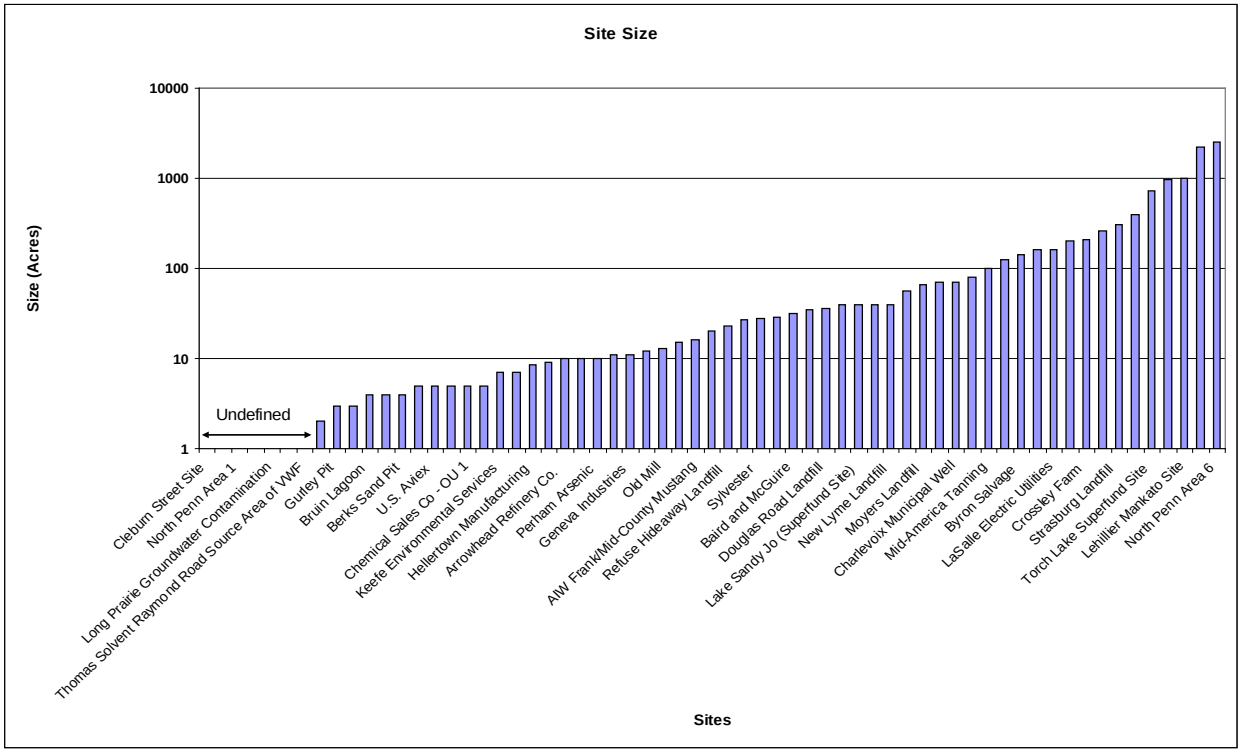

Figure 2: Distribution of Size of Sites in the Study

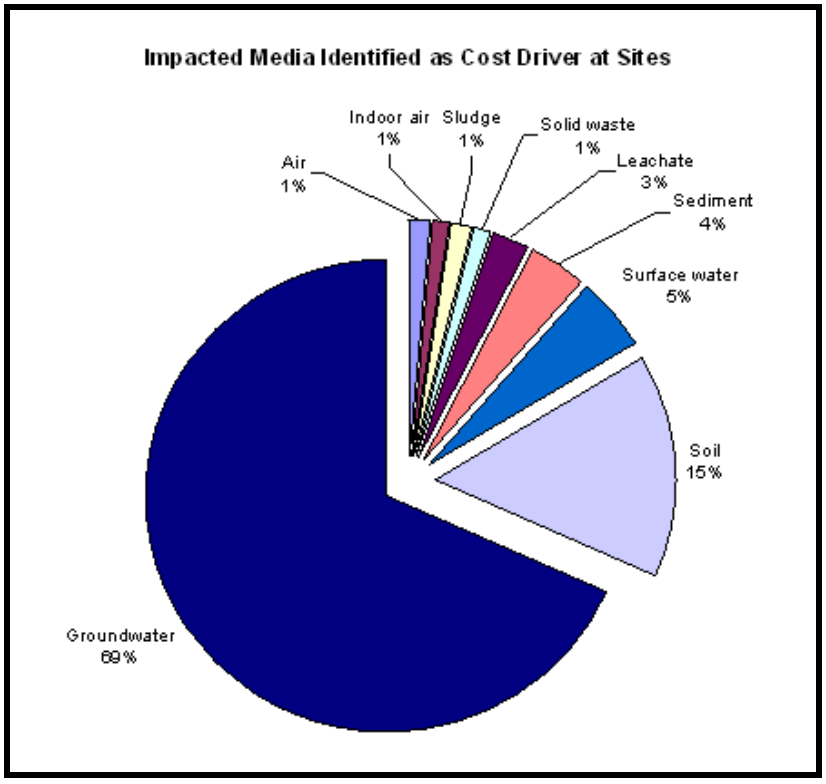

Figure 3: Impacted Media

Estimated Operation and Maintenance Cost Data

Only 32 of the 64 sites, or 50 percent, included detailed estimated cost data. Of the 32 sites providing the detailed estimated cost data, responses for 26 sites identified the O&M period as extending 30 years while 6 sites identified the O&M period as lasting 10 years or less. The average estimated cost for the 26 sites is $14,020,535.91 and the weighted average is $474,190.69.[2] The lowest estimated cost is $37,800 and the highest estimated cost is $265,996,197.

Actual Operation and Maintenance Cost Data

The Focus Group received detailed actual O&M cost data for 44 sites, or 69 percent. The average cost per year for the sites is $132,165.40, the average total cost per site is $935,673.92 and the weighted average annual cost per site is $112,178.89. The lowest actual total cost per site is $9,977.55 and the highest actual cost per site is $8,712,890.00. The average length of time for actual cost data available for evaluation is 8.52 years. The shortest period of time is 2 years and the longest period of time is 20 years. Figure 4 illustrates the average actual cost per year by site.

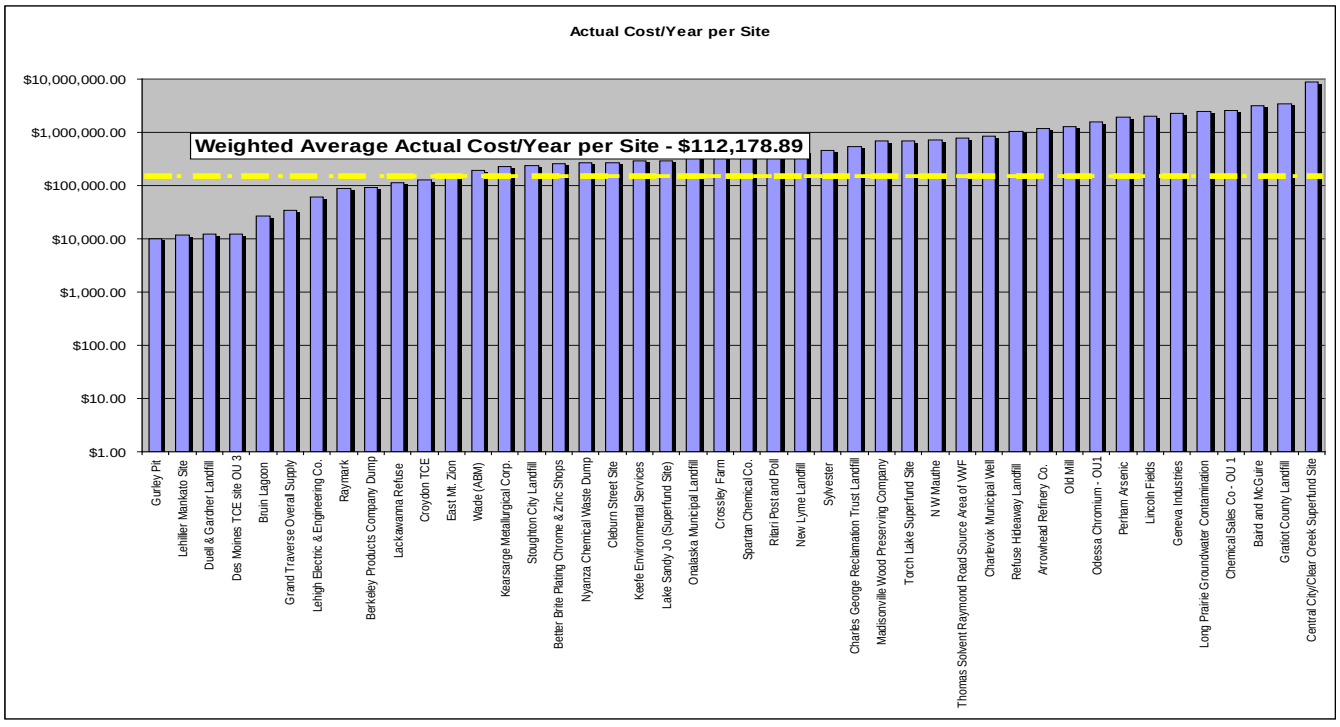

Figure 4: Average Actual Cost/Year to Number of Years, by Site

[2] The weighted average actual cost per year was calculated by multiplying the total number of years by the total average cost per year for all sites and dividing by the total number of years. This calculation was accomplished using the Excel function SUMPRODUCT (Total Number of Years x Total Average Cost) / SUM (Total Number of Years).

The data were also analyzed to see if there were long-term trends that would allow States to better plan for future costs, such as a steady decrease or periodic spikes in O&M costs. Figure 5 shows the Annual O&M Costs from 1 to 20 years. (The costs are averaged across the sites reporting for each year.) The Figure does not show clear trends. The variability of annual costs increases as the number of sites decreases (only 3 sites reported costs in years 17-19), underscoring the importance of site-specific factors on actual costs. (Note annual costs are present worth.)

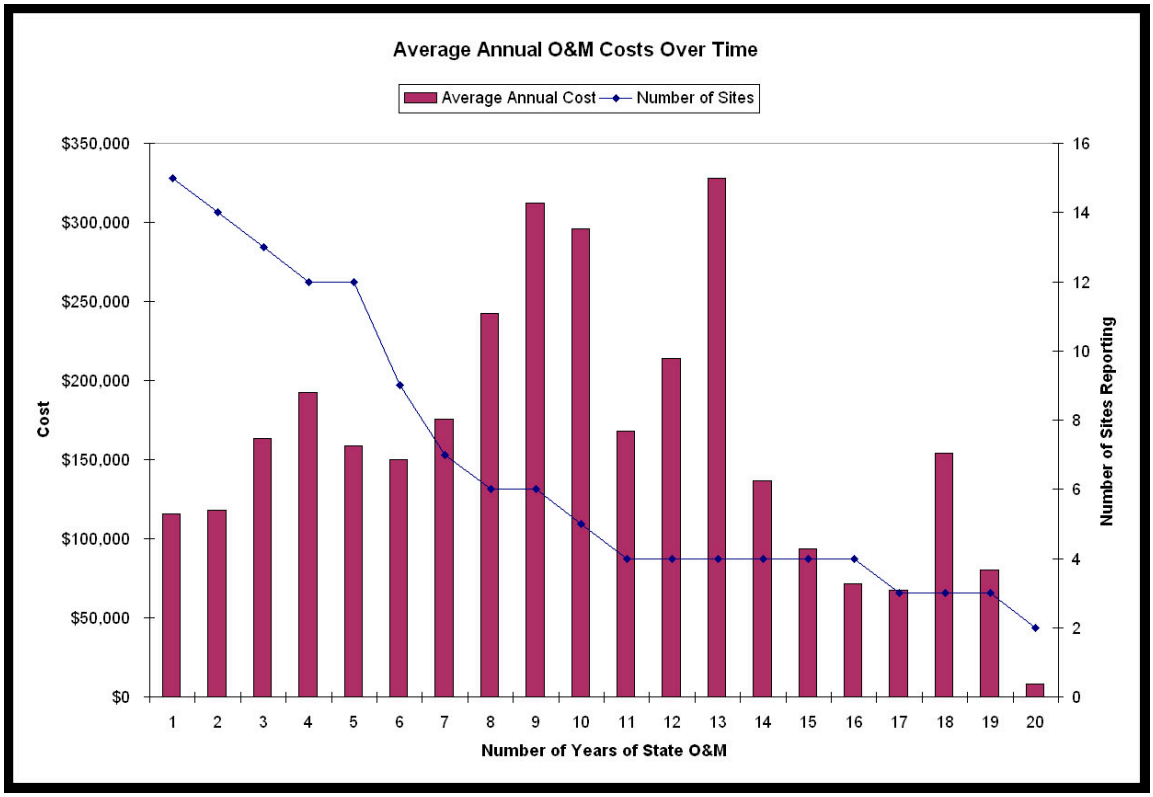

Figure 5: Average Annual O&M Costs Over Time

Table 1 identifies 44 sites for which actual O&M costs were provided. The table also contains reported information on the impacted media, the contaminants of concern that served as the cost driver for O&M, the remedy components, and information concerning whether optimization reviews were conducted. The number of years for which the 44 sites reported actual data varied. Gurley Pit has only 1 year of actual data while the Lehigh Electric & Engineering Superfund site has 22 years of actual cost data. The average number of years for which sites have actual cost data is 8.34 years.

In evaluating the data, the Focus Group considered whether the actual costs for the Central City/Clear Creek Superfund site skewed the data. Although the actual O&M costs for this site are significantly larger than the other sites in the study

($8.712M), it does not appear to skew the overall actual cost data. For example, the weighted average actual cost per site per year is $112,178.89, including the Central City site data. If this site's data is removed, the recalculated weighted average actual cost per site per year is 90,915.30.

The actual costs by category for each site were calculated as a percentage of the total costs (see Figure 6 below). Note the categories of personnel, fringe, and indirect costs were combined and are shown below as "PFI". The largest percentage of actual costs is captured by the contractual category. For 34 sites, the contractual cost category represents more than half of the actual costs incurred within the O&M phase. Contractual costs were noted as covering a wide range of activities, including but not limited to, sampling or operation of treatment systems.

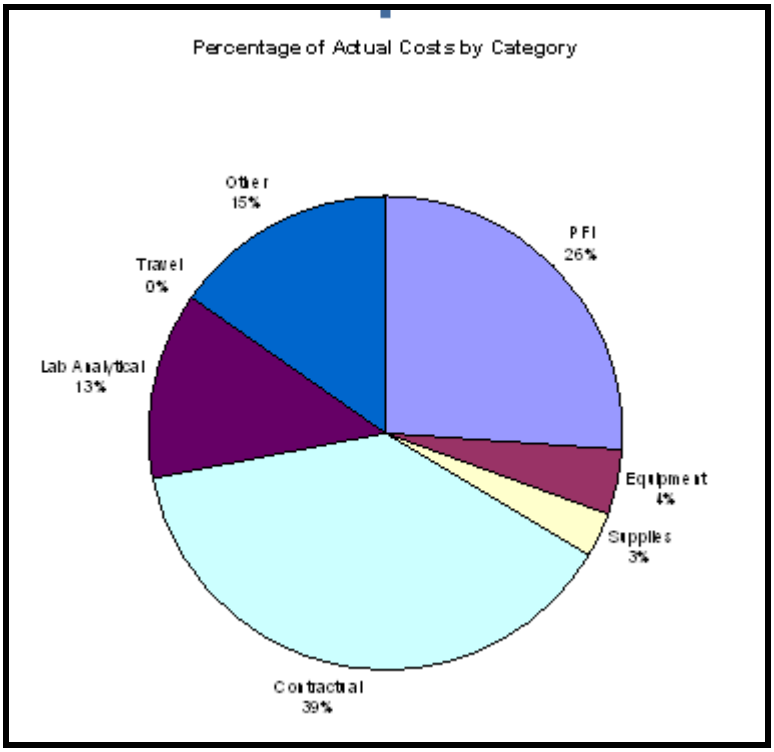

Figure 6: Percentage of Actual Costs by Category

Table 1: Summary of Research Results

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Arrowhead Refinery Co. - MND980823975	Groundwater / Carcinogenic PAHs were found in groundwater. PAHs, VOCs and heavy metals posed high human and environmental risks in soils and sediments.	Excavation, treatment on-site and off-site disposal was used for soil, sediments and source materials. The groundwater remedy consisted of a watermain extension and residential user connections and a french drain from which contaminated groundwater was pumped to a publicly owned treatment works.	No / Three 5-year reviews have been conducted since the completion of the remedy. The last one was completed September 2007.	$1,167,134.56
Baird and McGuire - MAD001041987	Groundwater / arsenic, naphalene	Soil and sediment excavation and on-site incineration; groundwater pump and treat system	Yes / yes the review was conducted by EPA in 2003	$3,126,999.00
Berkeley Products Company Dump - PAD980538649	Groundwater / VOCs	Site preparation. Consolidation of landfill wastes. Landfill cover system in accordance with PA Hazardous Waste Regulations. Security fence. Erosion control measures. Long-term monitoring. Institutional controls. Excavation, characterization, and offsite disposal of excess waste materials.	No	$93,140.00
Better Brite Plating Chrome & Zinc Shops - WIT560010118	Groundwater / Chromium, Zinc and Other Heavy Metals, Soil / Chromium, Zinc and Other Heavy Metals	onsite removal of contaminated drums and soil, groundwater collection system, discharge to sanitary sewer system and treatement at De Pere wastewater treatment plant	No	$442,220.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Bruin Lagoon - PAD980712855	Groundwater / Organics (BTX, MEK, TOC, TOX), TCL and TAL metals, total sulfates, Surface Water / Organics (BTX, MEK, TOC, TOX), TCL and TAL metals, total sulfates	Multilayer RCRA cap. Onsite stabilization and neutralization of sludge and perched liquid. Gas venting. Silt fence to control offsite transport. In-situ shallow groundwater/bedrock neutralization. Reinforcement of dike embankment. Grading and vegetation of the cap. Surface water diversion away from site. Post-closure monitoring.	No	$54,510.00
Central City/Clear Creek Superfund Site - COD980717557	Surface water / Iron, Manganese, Zinc	Active chemical precipitation treatment of mine drainage at the Argo Tunnel. Capping or other erosion control measures at a number of mine waste piles.	No / Not formally, but State Project Manager, Mary Scott's focus has been to reduce annual costs as we can. Treatment chemical changed from sodium hydroxide to lime. Operations more automated now than when plant first started. We hope to complete a form	$8,712,890.00
Charles George Reclamation Trust Landfill - MAD003809266	Groundwater / For groundwater component: iron, manganese	groundwater: groundwater extraction trench with 5 extraction wells; air: landfill gas collection/flare; containment: 70 acre capped landfill with leachate collection toe drain	No	$546,763.00
Charlevoix Municipal Well - MID980794390	Groundwater / TCE	Replaced municipal water supply (well) with surface water intake. Groundwater remedy is "limited action" with groundwater and surface water monitoring and institutional controls.	No	$849,133.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Chemical Sales Co - OU 1 - COD007431620	Groundwater / VOCs - PCE, TCE, and degradation products	SVE in place, well ban in place, indoor air sampling done but area is commercial, looking to ESD for closure of SVE plant and startup of "pocket" source areas focused rememdy (Chem Ox, Fentons, etc.)	Yes / one five year review, another one coming, trend charts showing SVE no longer efficient, ESD to look at alternate pocket treatment of source area soils	$2,609,001.50
Cleburn Street Site - NED981499312	Groundwater / PCE, Soil / PCE	For the primary source area, the former One Hour Martinizing facility, the selected remedy includes the use of a soil vapor extraction technology to address source soils. The selected remedies for the other two dry cleaner source areas include groundwater monitoring and institutional controls to restrict uses of groundwater in the vicinity of the source areas.	Yes	$882,000.00
Crossley Farm - PAD0981740061	Groundwater / TCE and cis-1,2-dichloroethylene	Provision of point of entry treatment systems for residential wells (OU1). Residential well sampling. Groundwater extraction and treatment using advanced oxidation process. Reinjection of treated groundwater and discharge to surface ponds. Institutional controls.(OU2) Removal action performed to remove and dispose of 1200 drums and 15,000 tons of contaminated soil.	No	$395,663.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Croydon TCE - PAD981035009	Groundwater / TCE	Connection to 13 residences to public water supply system (OU1). Groundwater extraction and treatment via air stripping and carbon adsorption. Onsite discharge of treated groundwater. Groundwater monitoring. Institutional controls (OU2).	No	$127,174.00
Des Moines TCE site OU 3 - IAD980687933	Groundwater / DCE, PCE	The remedy at this OU is dependent on the installation and operation of a groundwater extraction and treatment system consisting of groundwater extraction wells and an air stripper.	No	$12,500.00
Duell & Gardner Landfill - MID980504716	Groundwater / Gentian Violet, Chloroform, N,N-Dimethylaniline, Carbon Tetrachloride.	The Amended ROD (2001) required: excavation and appropriate disposal of contaminated soils, construction of a landfill cap, construction of a groundwater pump & treat system, long-term groundwater monitoring (30 years) and placement of use restrictions or ICs.	No	$12,490.00
East Mt. Zion - PAD980690549	Groundwater / Metals, VOCs (especially vinyl chloride and benzene), bis(2-ethylhexyl)phthalate	Multilayer cap with methane venting. Surface water control system for cap. Groundwater monitoring. Deed restrictions. Fencing.	No	$148,558.00
Geneva Industries - TXD980748453	Groundwater / TCE	Excavation and off-site disposal of PCB contaminated soils; construction of a cap with a slurry wall below the shallow groundwater around the perimeter of the site; and recovery of contaminated groundwater by carbon adsorption.	No	$2,316,432.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Grand Traverse Overall Supply - MID017418559	Indoor air / Trichloroethylene, tetrachloroethylene, cis 1,2 dichaloroetheylene, trans 1,2 dichaloroetheylene vinyl chloride, Soil, Surface water, Groundwater	SVE is currently operating (since end of 2005) to remediate air vapor migrating into adjacent Norris Elementary school; groundwater monitored with sampling every 6 months; source area soils are anticipated to be excavated and removed from under the GTOS facility (no depressurization units; indoor air contamination at trace levels) - implemented as a removal	No	$135,096.00
Gratiot County Landfill - MID980506281	Soil / Polybrominated biphenyls and metals	The MDNR initiated remedial measures at the landfill in 1984 in order to attempt to provide containment of the groundwater and to minimize migration of contaminants from the site. The activities included constructing a slurry wall around the perimeter of the landfill; constructing burial cells in the landfill for PBB-contaminated waste; excavating, transporting, and burying approximately 20,000 cubic yards of PBB-laden waste from property located on the other side of Jackson Road; installing a perimeter fence around the landfill; capping the landfill with a 5 foot-thick compacted clay layer; amd constructing a lagoon to collect and discharge surface water runoff.	Yes / DEQ has completed on in 2002	$3,426,889.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Gurley Pit - ARD035662469	Groundwater The impacted media have been treated, stabilized and place in a RCRA type vault. Any of the COC can be a cost driver if it leaks from the vault to the groundwater., Soil , Sediment , Surface water, Sludge	A volume of pollutants include 20,000 yd3 of sludge was treated, stabilized and place in a RCRA type vault.	No	$49,887.75
Kearsarge Metallurgical Corp. - NHD062002001	Groundwater / 1,1,1-TCA and 1,1-DCE	Facility abandoned in 1982. 1990 ROD required excavation of contaminated waste pile with off-site disposal (completed in 1992). Groundwater pump and treat (metals removal and air stipping VOCs) began operation in 1993. In 2002, a concentrated mass of cVOCs subsurface soil lead to an Explanation of Significant Differences in September 2003 to remove 5,670 tons CVOC impacted soil. Concentrations of contaminants in groundwater drpped significantly after the 2003 soil remova action and in December 2005 the treatment plant was temporaily shut down to mionitor and evaluate contaminant trends.	Yes / Evaluation of effectiveness of 2003 source removal and monitored natural attenuation of residual contamination in groundwater is ongoing.	$230,510.66

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Keefe Environmental Services - NHD092059112	Groundwater / 1,4-dioxane	The 1993 groundwater treatment system included metals removal, pressure filtration, air stripping, vapor treatment, sludge dewatering and effluent disposal via an on-site leach field and an off-site infiltrations trench. Discovery of 1,4-dioxane in 2003 required "freezing" the LTRA clock in order to modify the treatment train. An ESD was signed documenting a change in treatment technology. A high pressure oxidation system was installed and deemed operational at the Site. The chemical feed service has been discontinued and . The influent flows a high pressure oxidation system (HiPOx) feed tank. Currently, the air stripper and carbon adsorption units are being bypassed because the HiPOx unit is adequately removing all of the contaminants of concern. Groundwater is pumped from the HiPOx unit feed tank through the reactor where it is treated with hydrogen peroxide and ozone and discharged on-site. The Site's O&M was transferred to the State on June 30, 2005.	No	$288,685.97
Lackawanna Refuse - PAD980508667	Groundwater / VOCs, metals	Removal and offsite disposal of drums. Clay cap with gas venting. Leachate collection and treatment. Offsite soil disposal. Removal and offsite disposal of dried paint. Groundwater monitoring.	No	$112,397.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Lake Sandy Jo (Superfund Site) - IND980500524	Groundwater / Benzene	The remedy is comprised of an on-site disposal of excavated sediments, construction of soil cover, installation of groundwater monitoring system, alternative water supply system, and implementation of institutional controls.	No	$290,147.00
Lehigh Electric & Engineering Co. - PAD980712731	Groundwater / PCBs	Excavation and offsite disposal of soils. Demolition of onsite buildings. Backfilling, grading and re-vegetation to minimize erosion and runoff and to control percolation.	No	$60,145.00
Lehillier Mankato Site - MND980792469	Soil / TCE	Pumping groundwater from multiple extraction wells to control the groundwater gradient and to reduce the mass of trichloroethylene (TCE) discharging to the Blue Earth River, groundwater treatment using a packed tower air stripping system, extension of the LeHillier community water supply system to the affected residents and businesses, the proper abandonment of the individual drinking water wells, and long-term monitoring of groundwater for volatile organic compounds (VOCs).	Yes / A 5-year review was completed in 2006	$11,695.00
Lincoln Fields - OHD00000020487	Groundwater / PCE	The remedy alternative for this project involved implementation of a ground water pump and treatment system and development of a municipal water supply for a community.	No	$1,760,572.49

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Long Prairie Groundwater Contamination - MND980904072	Groundwater / Perchloroethylene (PCE)	Installation of groundwater extraction wells in the contamination plume; treatment of contaminated groundwater; and discharge treated groundwater to the Long Prairie River. Treat contaminated soil with an active soil venting system. Provide an alternative water supply including water main extensions and service connections to the municipal water supply for those residences in the health advisory areas or with a threatened water supply.	Yes / Yes - 5 year reviews were completed in 2002 and 2007.	$2,425,324.00
Madisonville Wood Preserving Company - LAD981522998	Groundwater / Creosote	1) Dig & Treat on-site; 2) DNAPL Recovery System; 3) Waste Water Treatment Plant	Yes / 5 Year Review - January 2004	$677,815.95
N W Mauthe - WID083290981	Groundwater / Heavy Metals, Soil / Heavy Metals	Site demolition, excavation, offise treatment of soils contaminated with chromium, capping the site with clay, groundwater collection trenches and a groundwater treatment facility with discharge to the sanitary sewer.	No	$1,416,463.96
Odessa Chromium - OU1 - TXD980867279	Groundwater / Hexavalent Chromium	Electro-chemical Groundwater Treatment Plant, Ferrous Sulfate in-situ treatment, Metals Remediation Compound in-situ treatment	Yes / 5 year reviews were conducted in July 200Yes and in September 2006	$1,560,826.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Old Mill - OHD980510200	Groundwater / TCE	From the 1985 ROD: Removal and off-site disposal of 95% of the contaminants in soil; demolition of buildings and silos located on the site and disposal of debris; ground water extraction and treatment for an estimated period of 30 years, until a target ground water risk level of 10E-5 is achieved; and placement of use restrictions on the ground water for as long as concentrations in the plume remain above a 1-E-6 carcinogenic risk level.	No / No formal Optimization Review was conducted; however, the MNA will increase costs initially with the hope for significantly reduced costs after the 4-year pilot study.	$1,238,059.51
Onalaska Municipal Landfill - WID980821656	Groundwater / VOCs	Landfill cover (cap), groundwater treatment and extraction system, and bioremediation system	No	$350,628.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Perham Arsenic - MND980609572	Groundwater / Arsenic	Excavation and disposal at an approved hazardous waste facility of approximately 200 cubic yards of arsenic wastes and contaminated soils containing greater than 500 parts per million (ppm). Backfilling the excavated pit with clean fill; re-establishment of the clay cap and installation of an impermeable membrane to minimize leaching of any residual arsenic; and continuation of ground water monitoring. After completion of the soil excavation in 1985, ground water contamination did not attenuate naturally so the following steps were taken: municipal water supply hookup for a nearby resident; installing ground water recovery wells to extract the arsenic contaminated ground water; treatment of the contaminated ground water through a series of treatment units including sand filters and alumina adsorbers; and discharging the treated ground water to an infiltration gallery.	Yes / One done in 2005 changed the alumina media to a iron enhanced, thus eliminating the need for nitric acid. Another will be completed in 2008 including a pilot test to fixate any remaining arsenic in situ and shorten O&M time.	$1,918,106.65

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Raymark - PAD039017694	Groundwater / VOCs	OU 1 - Vapor extraction of subsurface soils and contaminated bedrock. Carbon adsorption. Low permeability cap. Institutional controls. Additional sampling of soil for waste characterization. OU2 & OU3 - Groundwater remediation study. Operation and maintenance of public water supply wells. Operation and maintenance of air strippers on public water suppply wells. Installation and operation and maintenance of carbon adsorption units on PWS wells. Installation, operation and maintenance of groundwater extraction wells, air strippers and carbon adsorption units. Discharge of treated groundwater to storm sewer. Sampling and monitoring of treated water. Institutional controls.	No	$88,278.00
Refuse Hideaway Landfill - WID980610604	Groundwater / VOCs	Clay and soil cap and seeding cover; Methane gas and leachate collection system; Groundwater extraction and treatment.	No	$978,323.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Ritari Post and Poll - MND980904064	Groundwater / PCP and Dioxins in TCDD-Eq.	Building and equipment decontamination and/or disposal; investigation of soil washing options; excavation and off-Site treatment of approximately 1,800 cubic yards of dioxins-contaminated soil; excavation and on-Site biotreatment of approximately 3,000-8,000 cubic yards of PCP contaminated soil in a lined and bermed treatment cell; soil treatment cell monitoring to examine effectiveness of treatment; topsoil application and revegetation of Site; installation of a deep aquifer water supply well for the Ritari residence; and ground water monitoring at the Site.	No	$427,483.00
Spartan Chemical Co. - MID079300125	Groundwater / VOCs	In 1998 a remedy was selected that SVE as the preferred remedial approach. Because concentrations were not being signifacntly reduced, system O and M was discontinued on 2006. A 2007 ROD modifies the approach to do massive source removal through excavation and then finishing with the SVE option. O and M will continue after RD and RA occurs on the source material.	Yes / Yes, prior to shutting down the system in 2006, which also led to the 2007 ROD	$413,465.00
Stoughton City Landfill - WID980901219	Groundwater / Tetrahydrofuran (THF)	Selected: Waste consolidation, new multi layer cover, passive gas venting system, groundwater extraction, treatment and discharge, groundwater monitoring, fence, institutional controls.	No	$207,946.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Sylvester - NHD099363541	Sediment / Arsenic, Groundwater	1982 ROD called for Slurry wall and cap to contain source. 1983 Supplemental ROD called for groundwater pump and treat. Treatment of 300 gpm starts in 1985. Attainment of ROD cleanup goals in 1996 and State O&M begins April 8, 2002. Currently, Arsenic is an issue. No cleanup goal for Arsenic was in the ROD but concentrations exceed the State standard both inside and outside the slurry wall. Moniotring ansd evaluations ongoing.	Yes / Last Optimization Review was during LTRA.	$897,860.84
Thomas Solvent Raymond Road Source Area of VWF - MID039993902	Soil / Trichloroethylene, tetrachloroethylene, cis 1,2 dichloroetheylene, vinyl chloride, Groundwater	SOILS: SVE operated 1988-1992 w/ ~ 9 mo down time; EPA collected soil samples in 1992 that indicated soils seemed mostly clean w/ exception of a few locations. 2005: MDEQ collected additional soil samples using CH3OH preservation. Results indicated a few hot spots in the vados zone and contamination still present in smear zone. Currently evaluating how to proceed (possible air sparge pilot). GROUNDWATER: Ongoing pump and treat (air stripper) since 1987 with off-gas being treated with carbon. Need for continued carbon and/or air stripper use currently being evaluated.	No	$1,569,588.00
Torch Lake Superfund Site - MID13000003	Soil / copper and arsenic, Sediment	The selected remedy consists of 4 to 6 inches of sandy loam soil and a vegetative cover to minimize wind and water erosion of the stamp sand material into Torch Lake.	No	$1,389,694.00

Site Name / CERCLIS ID	Impacted Media and Cost Driver	Remedy Components	Optimization Review Comments	Cost Category Total
Wade (ABM) - PAD980539407	Groundwater / VOCs, semi-VOCs	Removal, decontamination and disposal of tankers, tires and debris. Removal of onsite waste piles. Demolition and removal of onsite buildings. Level, fill and grade the site. Removal of contaminated soil to a maximum depth of 5 feet. Cover with topsoil and seed.	No	$193,197.00
Grand Total				$43,615,692.84

Comparison of Estimated and Actual Costs

For 6 sites, sufficiently detailed estimated and actual costs were received to allow for a comparison of the two (see Figure 7). The estimated costs, generally taken from the Record of Decision (ROD), were most often expressed as a constant dollar figure for 30 years. For example, the estimated costs for the New Lyme Landfill were $252,000/year for 30 years. Actual costs vary year-by-year, but are expressed in Figure 7 as an average annual cost. While the Focus Group acknowledges that the data set is too small a data set to generalize nation-wide, the results indicate that the estimated costs in the ROD often vary significantly from the actual costs. Further, the estimated costs are not consistently biased in one direction. In 2 of the 6 cases (Cleburn Street and Gurley Pit), actual costs were significantly less than those estimated. In 3 cases (Old Mill, New Lyme Landfill and Odessa Chromium), actual costs were higher than estimated. Note, that using an annual average over 30 years masks substantial year-to-year variability of State O&M costs.

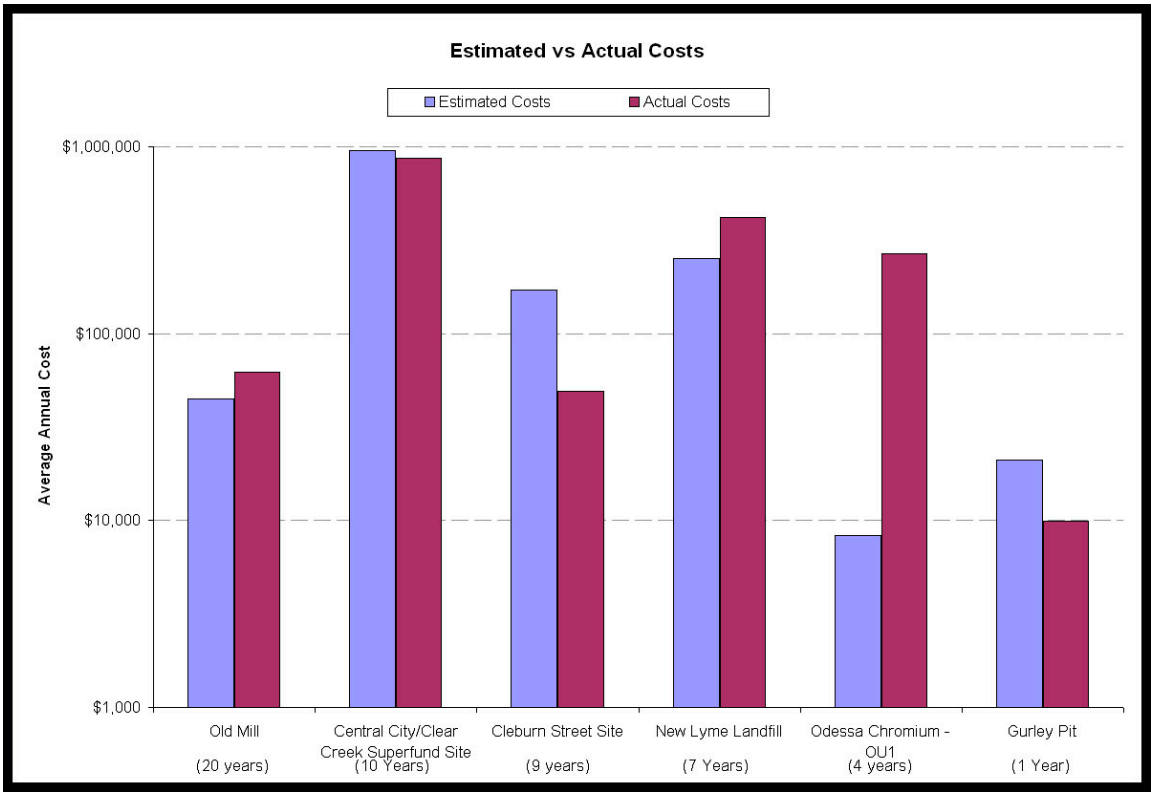

Figure 7: Estimated vs Actual Costs

In order to illustrate the year-to-year variability, the actual costs for the New Lyme Landfill site are presented in Figure 8. Following completion of the remedy by USEPA in 1994, the New Lyme Landfill has undergone two Five Year Reviews, a ROD Amendment and the assumption of O&M by the PRP. As a result, the costs incurred by the State have fluctuated substantially.

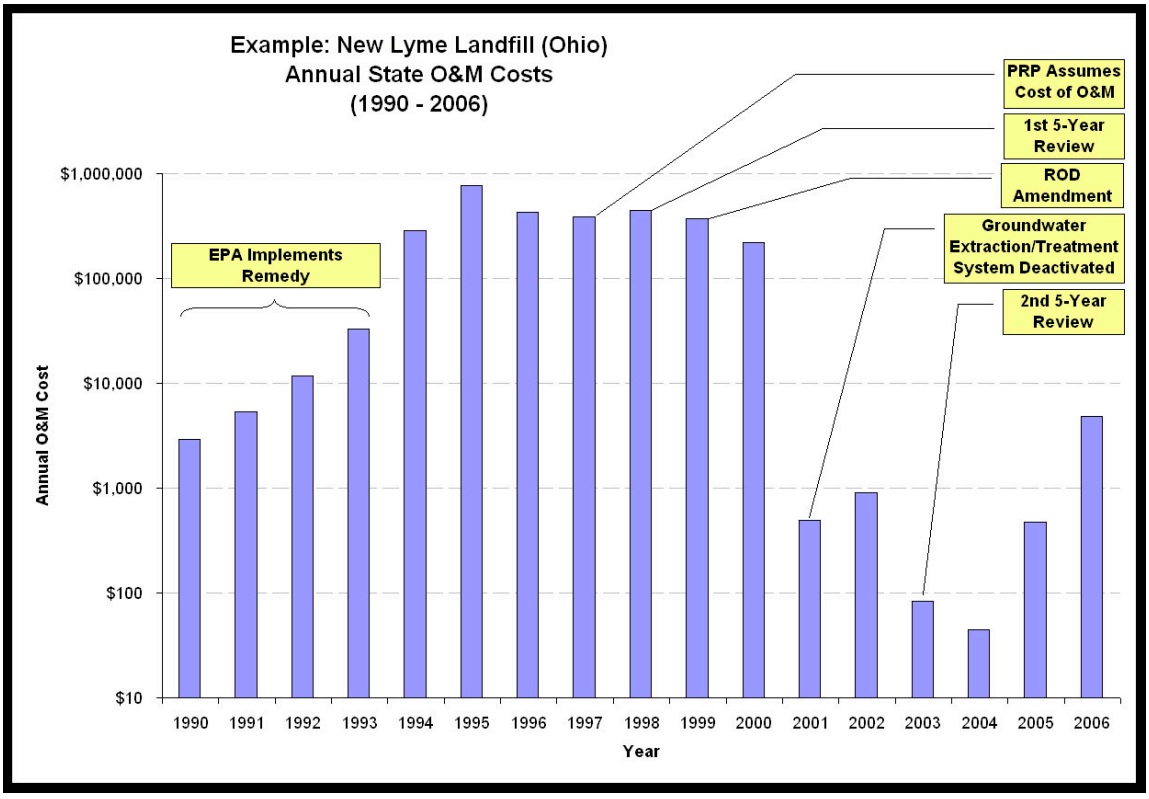

Figure 8: New Lyme Landfill Example

The State of Ohio assumed responsibility for O&M at the New Lyme Landfill in 1994. In 1997, Ohio EPA completed negotiations and signed an order with the PRP group for them to assume O&M responsibility for the remedial system. In 1998, the first Five Year Review was conducted, including a significant sampling effort to determine the need for the groundwater extraction/treatment system. As a result of the Five Year Review, a ROD amendment was issued recommending deactivation of the groundwater extraction/treatment system. This significantly reduced the annual cost of O&M. The costs reflected in this chart after 1997 are those that the State incurs, but are then reimbursed by the PRPs in accordance with the provisions of the 1997 order.

Three sites in this study have undergone Optimization during the State-funded O&M period: Odessa Chromium, Madison Wood Preserving, and Chemical Sales. The data provided for these sites offered an opportunity to look at the effect of optimization on State costs. As illustrated in Figure 9, costs generally decreased in the years following optimization, although there may be short-term costs associated with implementing changes to the remedy.

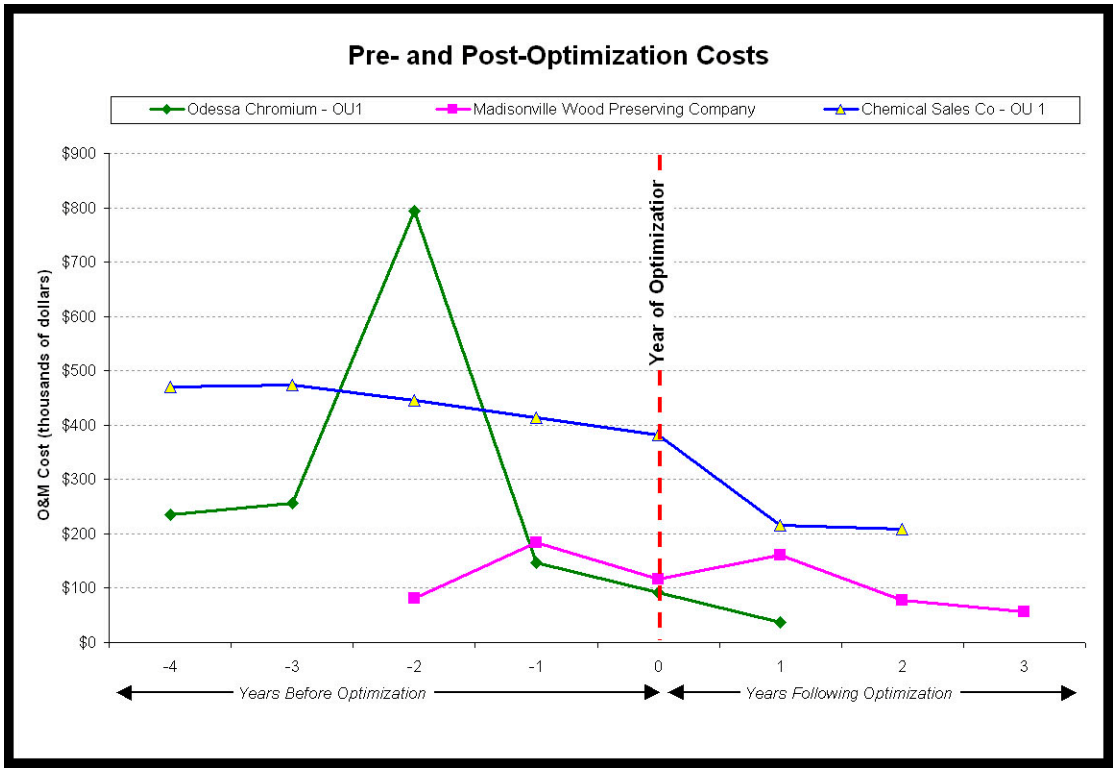

Figure 9: Pre- and Post-Optimization Costs

Other Interesting Findings

For each State facing the prospect of funding long-term O&M activities at NPL sites, the principal challenge is establishing a funding source that adequately covers the costs associated with long term O&M and that is available for up to 30 years. One component of this research project involved identifying innovative strategies employed by States to ensure adequate funds for long-term O&M.

Some States have created funding mechanisms to generate revenue specifically for the purpose of cleaning up hazardous waste sites. For example, Colorado has a Hazardous Substance Relief Fund, created and sustained by landfill tipping fees, which funds the remedial action and O&M obligations for Superfund sites.

Pennsylvania's major source of support for the clean up of hazardous waste sites is the Hazardous Sites Cleanup Fund (HSCF). Between 1988 and 2002, a portion of the State's Capital Stock and Franchise Tax supported the HSCF. This source of funding was eliminated in 2002, but the HSCF received temporary funding from the legislature through a transfer of 50 million dollars from the Environmental Stewardship Fund (ESF) in 2005.

In 2007, the Hazardous Sites Cleanup Fund Funding Act was passed by the Pennsylvania General Assembly and signed by Governor Ed Rendell. The act provides revenue to the Cleanup Fund over the next three fiscal years. A long-term solution is still needed to keep the full program operational beyond that time. The Hazardous Sites Cleanup Fund is essential to Pennsylvania's ability to address brownfield remediation, emergency response to toxic spills and cleanup of contaminated sites across the Commonwealth.

The Hazardous Sites Cleanup Fund (HSCF), a special fund established under the Hazardous Sites Cleanup Act (HSCA), provides the funding for the Department of Environmental Protection (DEP) to carry out a number of activities to address releases of hazardous substances to the environment. These activities include: Investigation and Response at Contaminated Sites; Participation in the Federal Superfund Program; Participation in the Federal Hazardous Waste Program; and Implementation of the Commonwealth's Land Recycling Program.

Revenue to the HSCF is generated from hazardous waste management and transportation fees assessed under Section 903 of HSCA; cost recovery; civil penalties; interest generated from the balance in the HSCF; and temporary funding provided under the Hazardous Sites Cleanup Fund Funding Act, Act 77 of 2007. Historically, the major source of revenue for the HSCF had been the Capital Stock and Franchise Tax (CSFT). Act 77 of 2007, signed December 18, 2007, provided for the transfer of prior year lapses from legislative appropriations to the HSCF in fiscal year (FY) 2007-08. Starting in FY 2008-09, this Act provides for the transfer of $40 million annually from the CSFT to the HSCF in each of the next three years. At that time, the CSFT is due to expire and the HSCF will be without adequate revenue to continue HSCA-funded programs.

Discussion

- Continued development and maturation of cleanup technologies has a significant impact on the cost. The early years of site cleanup often involved mass reduction, and typically involved long-term removal by pumping and treating groundwater. Newer cleanup technologies, such as the injection of oxygen releasing compounds, have proven to be a more cost-effective means of achieving remediation goals.

- Due to very little data associated with State O&M costs at Mega Sites, no definitive conclusions can be made about them. However, it appears that Mega Sites may need to be evaluated differently, primarily because of their magnitude and scale. A full realization of the cost associated with Mega Sites has not yet been reached, as many have not yet been closed out and relatively few have progressed to the point where States have taken over O&M.

- As shown in the Findings section, States may be able to reduce their share of costs by taking a proactive approach to pursue other funding sources, *e.g.*, PRP searches through use of tools such as the Internet, and land and insurance records.

- There are several possible explanations for the observed differences between estimated and actual costs.

    - There is often a substantial period of time between the ROD and the start of O&M.
    - There may be efficiencies realized through the remedy design.
    - Modifications to the ROD may occur and effect actual O&M costs.
    - Periodic reviews may identify opportunities for cost savings or failures of the remedy that need to be addressed.

    The difference between estimated and actual costs may also be explained by the primary purpose of the ROD cost estimate, which typically is taken from the Feasibility Study. The cost estimates in the Feasibility Study provide a basis of comparison among the remedial options under consideration, and are not designed for (or intended to be) estimates suitable for budget planning for the life-cycle cost of the remedy (including O&M).

- There are many other contaminated sites outside the CERCLA universe where States are paying for O&M. These include voluntary cleanup sites and other abandoned and uncontrolled hazardous waste sites.

- Some States have created funding mechanisms to generate revenue specifically for the purpose of cleaning up hazardous waste sites. Colorado has a Hazardous Substance Relief Fund, created and sustained by landfill tipping fees, which funds the remedial action and O&M obligations for Superfund sites, and Pennsylvania has developed the Hazardous Sites Cleanup Fund to help pay for O&M.

Recommendations

Based on the above conclusions, the Focus Group makes the following recommendations.

- States need to create approaches and processes to accurately predict long-term O&M costs in order to better predict future liabilities. Such processes should include comprehensively tracking actual costs in a manner that can be easily retrieved by others. This data can be used to

develop meaningful cost projections that can be used to secure long-term funding.

- States should share information with other States regarding lessons learned in developing cost estimates and in making certain funds are available to support the long-term maintenance of remedies, in order to ensure future protection of human health and the environment.

- State environmental programs can use this report to educate stakeholders (*e.g.*, State legislature and others) regarding the magnitude, uncertainties and unforeseen changes associated with long-term O&M costs at Superfund sites.

- States should strive to be involved, in order to protect their interests during development of the ROD. States should apply their own technical scrutiny to all NPL remedies and O&M plans at the time of remedy selection to ensure that: a.) the proposed remedy results in manageable long-term O&M costs; b.) a system is in place to periodically evaluate long-term O&M needs, *e.g.*, future changes to the selected remedy; and c.) there is an upfront, realistic evaluation of long-term O&M costs.

- States should request that a remedial process optimization program be built into the ROD that would allow for cost-saving adjustments more frequently than the Five Year Review process.

- States should evaluate whether an Explanation of Significant Difference (ESD) and/or ROD amendment would effectively reduce the overall life-cycle cost of remediation and long-term O&M.

- State and federal governments should work together to select remedies that are the most effective for over-all protectiveness, beneficial reuse, and cost at both the remedy and O&M phases. Recognizing that the regulating agencies each have an inherent interest in minimizing costs, there are times when disagreement at Fund-lead sites will arise over whether the greater cost should be incurred as an up-front, capital cost of implementing the remedy (incurred by the federal government) or as a long-term O&M cost (to be incurred by the State).

Next Steps

The following steps were identified in the original study and implemented by the Focus Group in 2008. Some of these results are documented in this report and in O&M Phase II Research Report (http://www.astswmo.org/files/publications/cercla/OM-Costs/OM-II-report-11072008.pdf).

1. The Focus Group anticipates conducting further research to capture additional State data on long-term O&M costs, with a specific focus on how States are estimating and projecting their future costs, and the sources of funding used to support long-term O&M activities at Superfund sites.

2. The Focus Group will continue to provide States with information that will assist them in developing and documenting O&M costs and estimating future O&M liabilities.

3. The Focus Group will continue to act as a resource for identifying unique and effective State practices for predicting long-term costs and providing adequate funding for O&M.

Attachments

The following documents were produced by the Long-Term Stewardship Focus Group as part of the Group's research on State O&M costs. These documents are available on the ASTSWMO web site (http://www.astswmo.org) or downloaded directly using the following links:

1. Data Collection Tool
   (Excel Spreadsheet, http://www.astswmo.org/files/publications/cercla/OM-Costs/om-data-tool.xls)

2. State-by-State Data Collected for the O&M Costing Project
   (PDF file, http://www.astswmo.org/files/publications/cercla/OM-Costs/om-data.pdf)