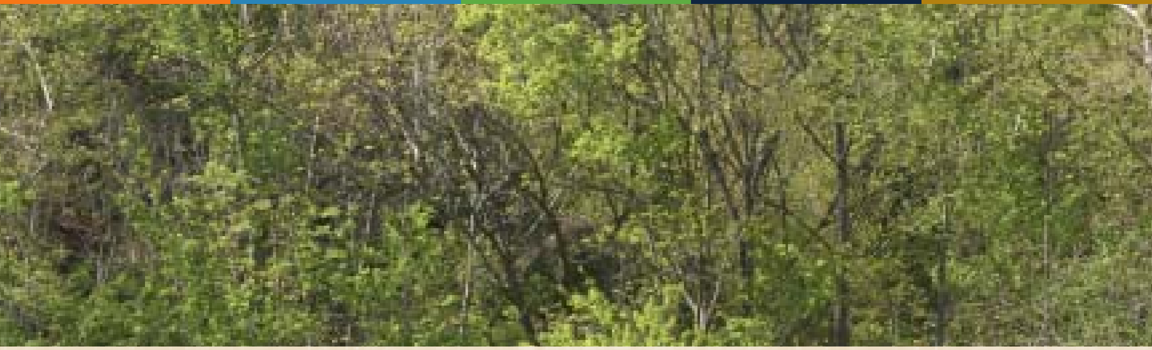
Technology Overview

Performance-based Management

Fifth in a Series of Remediation Process Optimization Advanced Topics



March 2006

Prepared by
The Interstate Technology & Regulatory Council
Remediation Process Optimization Team

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Disclaimer

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Performance-based Management

Introduction

This overview introduces the reader to the basic concepts of Performance-based Management (PBM). In 2004, the Interstate Technology and Regulatory Council (ITRC) Remediation Process Optimization (RPO) Team developed a technical regulatory guidance document titled, *Remediation Process Optimization: Identifying Opportunities for Enhanced and More Efficient Site Remediation*. Based on feedback to the RPO training and continued research into the topic, the RPO team identified the need for detailed information on PBM. As PBM in some ways is the overarching theme behind remedial process optimization (RPO), this overview will further develop the basic concepts of PBM and its potential application to site remediation projects. In addition, because the ITRC RPO Team is currently developing a Technical Regulatory Guidance Document on PBM, this articulation represents only a beginning of information on this subject.

Why is there a need for PBM? Congress, the United States Environmental Protection Agency (USEPA), state agencies, and, most importantly, the public, believe the pace of site cleanups needs to be increased, and that these cleanups must achieve the goals set for them. ITRC believes that a results-oriented, project-targeted process such as PBM can achieve these site cleanup objectives with the goals of reducing project schedules, managing resources, minimizing risk, and reducing waste.

PBM has long been used in such diverse as information technology development, government procurement, and human resources management. Although PBM is not a new concept, its application to the hazardous site remediation process has not been the norm. Thus, introducing PBM concepts to state regulators will help foster acceptance of PBM as a best business practice.

The PBM model presented in this overview uses a combination of eight project management resources or techniques linked together by an efficient communications hub. Through PBM, a high level of project performance is attained by effective coordination, cooperation, and communication, all of which build trust among all parties involved in the project.

Who We Are and the Intended Audience

The ITRC is a state-led coalition of regulators, industry experts, citizen stakeholders, academia, and federal partners that work to achieve regulatory acceptance of innovative environmental technologies. This coalition consists of 46 states and a network of some 7,500 people who work to break down barriers, reduce compliance costs, and make it easier to apply new technologies to solve environmental problems. Furthermore, ITRC helps maximize efficient use of state resources by creating a forum where innovative technology and process issues are explored. Together, the team members are building the environmental community's ability to expedite quality decision making while protecting human health and the environment.

The overview series on RPO have the following intended audience who are involved in either remediation process (RPO) or PBM of hazardous site remediation projects:

- State and federal regulators
- Facility owners and operators
- Engineers and consultants
- Interested stakeholders

States and federal agencies play multiple roles in the RPO and PBM processes: as regulators, and as facility owners and operators when public funds are used to conduct site remediation work. As regulators, state and federal agencies are charged with protecting human health and the environment. Also, facility owners, private or public, have the greatest interest in achieving the goals of the specific site remediation project. In addition, the engineering and consulting community who guide and provide professional opinions to the owners must have a deep working knowledge of techniques that can ensure fast and effective site remediation. To understand PBM and be full participants in environmental remediation efforts, public stakeholders must not only understand technologies used at sites, but also the underlying technical basis that supports the decision-making process.

While this document is intended as an introduction to PBM, users are encouraged to refer to the references provided at the end of the overview for additional information. In addition, the ITRC RPO Team is currently working on putting together a detailed technical regulatory guidance document on PBM, which will address many of these concepts in much more detail.

This overview is part of a five booklet series: *Performance-based Management, Analysis of Above Ground Treatment Technologies, Exit Strategy Analysis, Data Management, Analysis, and Visualization Techniques*, and *Life Cycle Cost Analysis*; each is an excellent resource for moving forward on their RPO and PBM projects

Performance-Based Management

PBM is a strategic, goal-oriented uncertainty management methodology that is implemented through systematic planning and dynamic decision-logic that is focused on the desired end results. Specifically, PBM promotes the accelerated attainment of Remedial Action Objectives (RAOs) through a series of tools, or strategy components. These strategy components, when used either individually or in concert, will promote efficiency in the site cleanup process. A framework of the eight strategy components, linked by real-time communication, will be the PBM model presented in this overview, see Figure 1. A case study demonstrating PBM concepts is included at the end of this overview.

Figure 1.
PBM Model
(AFCEE 2004, Galloly)

As presented in Figure 1, PBM can make use of eight major strategy components. An information and communication hub links each component. By breaking PBM up into strategy components, the PBM process can be managed effectively. In a resource-limited environment, the project team can simultaneously make use and plan certain strategy components. In an ideal situation, all of the components can be executed in a planned, staged or phased manner, and the results and findings coordinated through the information and communications hub. In either scenario, the findings of the individual strategy components will be used to the maximum extent possible in the execution of the overall PBM strategy.

Expert Team and Communication Hub

PBM, like RPO, requires an expert project team to ensure that the PBM process is managed properly (AFCEE 2001). The expert team size can vary by the size, nature, and complexity of the project. Likewise, the team can vary depending on the stage that the cleanup is in or where in the project timeline the work is being conducted. Team members can be brought into and may drop out at different stages in the life of a project.

A project manager with overall charge for the cleanup will generally head the team. Geologists, hydrogeologists, risk assessors, regulatory specialists, civil engineers, chemical (process) engineers, maintenance engineers, and contract experts or contracting officers will all be typical members of an expert team. These team members will ideally be people with years of strategic planning or on-site field experience. While junior personnel can be used in support positions and to develop their own experience, a team will not be considered expert without seasoned professionals taking the lead. No matter how big the team or how experienced its members are, the team must have the support of the highest possible level of authority in the organization's chain of command.

The communication and information hub allows each individual strategy component to benefit from the findings and activities of the other. Specifically, the team chooses communication methods appropriate for the information to be transmitted: email, web based documentation and team collaboration tools, public or stakeholder meetings, to more traditional "hard copy" letters and memos, etc. For complex projects, a communications or community relations specialist should be considered as a team member or in a close support position.

Furthermore, the communication hub allows for the development of trust among the project management team members, and between the team and stakeholders. Communication must be timely and accurate; out-dated or inaccurate data are inefficient and cannot be tolerated in the PBM process. Today's information management technology, particularly web-based project management and telecommunications conferencing, are examples of tools that can enhance timeliness. Also, timeliness and transparency in communication will help build the trust of the stakeholders; thus, without stakeholder trust and consensus, any project can expect serious delays.

Defined Problem and Objectives

A remedial action is typically required only if site contaminants pose an unacceptable risk to human health or the environment. Thus, an adequate understanding of site conditions (as summarized in the conceptual site model) and risk is the foundation of the site exit strategy and decision logic. Site conditions (i.e., nature and extent of contaminants and the physical and geochemical factors influencing their fate and movement), risk assessment results, statutory considerations, and community perception are integrated to form a concise statement of the environmental problem(s) that pose an unacceptable risk or hazard, and which therefore warrant a remedial action. Once stakeholders understand the scope and nature of the problem to be addressed, the process of developing remedial objectives - and selecting the means to achieve them - can begin.

Land use is pivotal to understanding the risk associated with site-related contaminants in the environment under both current and reasonable future exposure scenarios, and the types of remediation approaches best suited to mitigate that risk (Goodman 2001). Understanding current receptor exposure pathways, and predicting future pathways in light of expected future land use and changing site conditions (e.g., a shrinking or expanding groundwater contaminant plume), are essential for plotting and documenting an appropriate course of action (i.e., exit strategy). See “Documented Decision Logic,” below. Once current and potential future risks are identified in the context of current and predicted site conditions and plausible exposure (land-use) scenarios, the problem(s) identified at the site can be clearly stated, and the RAOs can be defined.

Remedial action objectives establish the “response completion criteria” that must be met to address the environmental concerns identified in the problem statement. Because the overarching objective of site remediation is the protection of human health and the environment, RAOs should define the site conditions under which risk to current and future receptors is reduced to acceptable levels. After consideration of statutory issues and public perception, RAOs ultimately should be selected based on the necessary degree of risk reduction, and on technical achievability. If an RAO is not necessary for reliable protection of human health or the environment, pursuing the RAO will waste valuable resources. If an RAO cannot be achieved in a reasonable timeframe using currently available remedial technologies, the remediation project cannot succeed. Documenting appropriate RAOs as the end-point of site remediation will guide development of the site exit strategy and the implementation decision logic. How else will the project team know how the remedy is performing, or when the project is complete (i.e., when protectiveness has been achieved)?

Figure 2. Land Use Examples
Recreational or commercial? Different remediation choices for different situations.
(O'Neill 2005, Air Force Center for Environmental Excellence 2001 and 2003)

Updated Conceptual Site Model (CSM)

The CSM is a comprehensive description of all available information about site conditions that could influence RAOs or remedy selection, design, or performance. Thus, the CSM forms the basis for developing the problem statement and the RAOs, and for developing and implementing a remediation strategy. A CSM can be in the form of a picture (e.g., hydrogeologic cross-section), a flow-chart, or a table. It is composed of several elements, including the following:

- Historical and current nature and extent of site-related contaminants (including sources, release mechanisms, and affected media)
- Site geology, hydrogeology; and hydrology (including identification of preferential migration pathways)
- Biological and geochemical conditions
- Contaminant fate and movement in the environment
- Historical, current, and expected future land uses
- Current and plausible future receptors, exposure points, and exposure pathways
- Risk assessment results (i.e., identification of contaminants of concern in affected media);
- Past remedial actions, locations of remedial components, and influences on site conditions
- Monitoring locations
- Other factors relevant to the understanding of contamination at the site

As monitoring and operation and maintenance activities progress at a site and additional information related to contaminant distribution, fate and transport, and receptors becomes available, the CSM should be validated and updated as necessary. The impact of new information on the remedial decision needs to be critically examined during routine remedy performance reviews and integrated into remedy optimization efforts.

Land Use Risk Strategy

Land use risk strategy refers to management of risks through control of the current and future use of real property. It is important for a remediation project to identify and take into consideration future land usage. Site RAOs, for example, will be different for land intended for unrestricted (e.g., residential) use as opposed land to be restricted to industrial uses. The CSM should be adequate to support assessment of risk under expected future land uses, and to guide selection of necessary and achievable RAOs and evaluation and selection of suitable remedial technologies. If a site is not ideal for the intended future land use (e.g., cleanup is not feasible), the planned land use must be modified and/or Land Use Controls (LUCs) should be a component of the selected remedy. The land use risk strategy provides the bridge between land planning activities and environmental cleanup activities.

The most recognized form of control for current and future use of real property is the application of LUCs that can include any type of physical, legal, or administrative mechanism (See Figure 4) . These LUCs restrict the use of, or limits access to, real property to prevent or reduce risks to human health and the environment or to safeguard the integrity of the remedy:

- Physical mechanisms encompass a variety of engineered remedies to contain or reduce contact with contamination or physical barriers to limit access to property such as: capping systems, fencing, grating, or signs.
- Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices. The legal mechanisms used for LUCs are generally the same as those for institutional controls (ICs) as discussed in the National Contingency Plan (NCP). ICs are a subset of LUCs and are primarily legal mechanisms imposed to ensure the continued effectiveness of land use restrictions.
- Administrative mechanisms include notices, adopted local land use plans and ordinances, construction permitting or other existing land use management systems that may be used to ensure compliance with use restrictions.

Figure 4. BEMS Big Hill Landfill, Southampton, NJ
State Lead, State Funded Site Remediation

BEMS is an example of a site that uses engineering, administrative, and legal land use controls:
Engineering: Fence, cap, and active gas migration control with flare.
Legal: Deed notice for solid waste.
Administrative: Classification Exception Area for ground water contamination.
(NJ DEP 2005)

Applicable or Relevant and Appropriate Requirement (ARAR) Analysis Strategy

As part of the dynamic decision analysis process and the development of the overall site exit strategy, the regulatory framework for the site must be assessed, and pertinent statutes and regulations must be reviewed. The applicability and relevance or appropriateness of various state and Federal statutes, promulgated regulations, and policies to the project given the site conditions (including contaminants, current and future land use, receptors, and physical features) must be evaluated both initially during remedy selection phase, and periodically thereafter following remedy implementation. As the understanding of the available remedial or corrective action technologies and risks posed by site contaminants evolves, the regulatory framework may change and the applicable or relevant and ARARs for the site may change.

PBM involves the thorough assessment of these ARARs to verify that the site goals that may be dependent on them are realistic (achievable), yet protective. This requires an understanding of the intent of the regulations and statutes, the application of these requirements at similar sites, and the true current or potential exposures, as well as realistic performance goals considering engineering performance and technical limitations of the remediation technology. The analysis of ARARs will involve team members that are familiar with current legal and regulatory developments.

For example, as noted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the periodic comparison of site conditions to current ARARs is necessary and is typically documented in the five-year review. The results of the periodic assessment of ARARs should be incorporated into such documentation and site planning documents. Consequently, revisions to site decision documents may be necessary.

New Jersey's: N.J.A.C. 7:26E Technical Requirements for Site Remediation ("Tech Rule").

South Carolina's: South Carolina Water Pollution Control Permits: Regulation 61-9.

California's: § 67391.1 Requirements for Land Use Covenants.

Figure 5. Examples of ARARs
(South Carolina Department of Health and Environment Control 2005, California Department of Toxic Substance Control 2005, USEPA 2005)

Remediation Decision Logic

To provide a flexible framework by way of decision trees or similar tools, the decision logic for various remediation and optimization scenarios should be documented. The framework will encourage remediation decision-makers to develop performance metrics to objectively assess progress toward achieving RAOs. Further, the documented decision logic offers a method to make decisions in a reasonable timeframe. The flexibility affords the project team a way to anticipate and plan for improved understanding of the CSM, and changes in site conditions (e.g., in response to remediation). Changes then can be addressed by deploying currently available technologies. The end result of well-documented and distributed decision logic: enhanced remedy effectiveness and efficiency.

Establishing and documenting a decision process in advance and gaining stakeholder consensus of such a plan can speed the cleanup process. For example: if regulator buy in to preplanned decision logic is obtained, it may be possible to proceed at certain decision points with little more than documentation that the conditions of such a decision point are met. Documenting the decision process will minimize disruption when personnel turnover occurs either on the project team, the owners, the regulators, or any other stakeholders. With a documented decision process, the "reeducation" process of new parties to the cleanup will be reduced.

Figure 6. Worst Case Scenario
(Air Force Center for Environmental Excellence 2005)
Is your decision logic well documented, distributed, and accessible?

Since one of the keys to PBM is flexibility, this flexibility must also be documented. If at some point conditions change, unexpected findings arise, or the initial and alternate plans are no longer feasible, the decision logic must be changed. As changes are made they, too, must be documented. A written record of the "why" of the cleanup and optimization decisions is just as important as the record of "what' was done to implement those decisions.

Exit Strategy

An exit strategy for a site is simply the detailed response completion plan for achieving the RAOs that have been selected as the endpoints of the RA. Stated another way, the RAOs are the overall goals that must be met for the site to either achieve response complete or be approved for closeout or reuse. An exit strategy represents a formalized long-range process for taking the site from its current state to closure or to its best long-term use, and is typically documented in the site decision document. The strategy represents a plan to actively manage the site and make decisions at various points that will best tailor the remediation and monitoring efforts to achieve the RAOs in the most efficient and effective manner. The strategy requires consideration of stakeholder and regulatory agency concerns, resource constraints, and technical realities; it also includes well-defined metrics to objectively measure progress, and a defined timeline. A well-developed exit strategy contains five principal elements:

1. A description of the environmental problem that warrants a response, based on the CSM and the results of the risk assessment
2. Identification of achievable remedial action objectives (RAOs) that must be met to assure protection of human health and the environment, and the statutory and risk-based rationale for selecting the RAOs

3. A description of the remedial components and actions to be implemented to achieve the RAOs
4. A list of performance metrics (including cost and schedule metrics) to objectively assess progress toward achieving RAOs, and to provide "trigger points" when contingent measures ("course corrections") are needed, and a performance monitoring plan
5. A written or graphical summary of the decision logic showing the planned action steps, performance metrics, decision points, conditions that would elicit alternative actions, alternative actions, and conditions required for response complete

Because it is difficult to optimize any element of a remedial decision if the overall objectives (remediation endpoints) and site-specific technical constraints are not well understood, any optimization effort should begin with an evaluation of the exit strategy. This evaluation must incorporate the RAOs and the CSM, as well as the RA components.

Furthermore, the exit strategy will help guide the PBM process by keeping the focus on the ultimate site goals. Other aspects of PBM, e.g. ARAR analysis, contribute to the development of the overall exit strategy and factor in the periodic evaluation of site progress and future direction. For the periodic evaluations, the RPO process (discussed later in this document), provides a detailed process for the evaluation of the performance of a remediation system and its progress to meet remediation goals outlined in the exit strategy.

For complex sites such as large industrial or military installations, sites with multiple areas of concerns (a.k.a. multiple operable units), a master exit strategy should be developed. The master exit strategy should be developed based on potential and applicable the future resources, e.g. land, use in mind. All individual area of concern exit strategies must concur with the master exit strategy for the overall site.

Much of the information that comprises the exit strategy may be developed for a site in multiple documents (e.g., site investigation, risk assessment, and feasibility study reports, decision documents, design documents, and monitoring plans). However, there often is little documentation on how to monitor progress toward site closeout or reuse in a reasonable timeframe. Furthermore, little discussion regarding what actions should be taken, and when, and if progress toward site closeout or response complete does not meet expectations.

Additional discussion on developing and implementing a performance-based exit strategy is available in the ITRC RPO Team's *Performance-Based Exit Strategy Overview*. A well-crafted exit strategy will help guide the PBM process by keeping the focus on the response-completion goals (the RAOs).

Remediation Process Optimization (RPO)

RPO is the systematic evaluation and enhancement of site remediation processes to ensure that human health and the environment are being protected over the long term at minimum risk and cost. The underlying principles of RPO are:

- Protectiveness of human health and environment
- Efficient use of resources
- Uncertainty analysis
- Clear exit strategy
- Periodic performance reviews
- Independent, multi-disciplinary assessment team

For more information on RPO please see the ITRC RPO Team Technical Regulatory Guidance *Document: Remediation Process Optimization: Identifying Opportunities for Enhanced and More Efficient Site Remediation*, September 2004. Download document number RPO-1 from www.itrcweb.org.

While many of the elements of RPO are very similar in nature to PBM, the difference is the scope and periodicity. RPO frequently addresses specific sub-sites rather than the entire site. Even when an RPO review addresses an entire site, it is just that, a review. RPO does not create the day-to-day management environment that PBM does. RPO is a tool to be used within PBM. RPO can set the stage, where PBM creates the environment where the project can move forward.

For more information on RPO please see the ITRC RPO Team Technical Regulatory Guidance Document: Remediation Process Optimization: Identifying Opportunities for Enhanced and More Efficient Site Remediation, September 2004. Download document number RPO-1 from www.itrcweb.org.

Performance-Based Contracting (PBC)

PBC is a method of contracting wherein the Government (buyer) defines the results it is seeking, rather than the process by which those results are to be attained. PBC is a mechanism that solicits bids on the basis of the desired results to be achieved rather than the activities to be conducted. The characteristics of PBC include clearly defined performance expectations (preferably with a defined exit strategy), clearly defined milestones, use of incentives for performance, and flexibility in exchange for accountability for results. Performance-Based Contracting is intended to improve cost and schedule performance while achieving effective and efficient protection of human health and the environment.

PBC includes Fixed-Price Remediation using a Statement of Objectives, Fixed-Price Remediation using Incentives, and Guaranteed Fixed-Price Remediation (GFPR), which may or may not include Cost Cap Insurance and/or Pollution Liability Insurance. GFPR is a type of PBC in which a single fixed price is established to achieve specific remedial goals. Also, GFPR, by design has a built-in incentive for the contractor to achieve the goals more expeditiously in order to reduce their cost to complete. It should be noted that PBC is a federal government-wide initiative. A significant portion of the Department of Defense (DoD) contracts over the past few years have been performance-based, and mechanisms are in place to continually increase these types of contracts. Another type of PBC being applied at DoD installations is the privatization of environmental cleanup, which involves contracts between the federal government and the state, and between the local reuse authority and the state, and also uses environmental liability insurance to cap costs.

Based on the Installation Restoration Program (IRP) history of all DoD components, there has been significant variation in program performance in which costs and schedule baselines are not uniform, and progress toward completion of goals has been slower than expectations. The standard IRP contracting process has not provided sufficient incentives for achieving results. Sites that have employed PBC have typically demonstrated higher percentage of completion of planned milestones than sites administered under standard contracts, thus driving the desire to see more contracts of this type awarded. There is a perception that a privatized cleanup is more efficient, and that innovation, safety, and quality of a remedial project is enhanced by incentives.

State Perspectives on PBC

One of the benefits of PBC includes the use of a single contractor, which enhances communication between the states and the regulated party. A contractor that is working under a PBC can be very responsive and highly motivated. As there is a single contractor for the life of the project, there is an ability to diminish the learning curve associated with establishing new contracting relationships at different stages of cleanup.

However, there also are challenges associated with PBC at the state level. State agencies have difficulties in providing the same rapid response as the contractor, and states are often not able to ramp-up in the same manner as a non-government company. State remediation project managers are burdened with increased expectations (e.g., for data and document review, and interim decision making) for a PBC site on top of other duties. In order to minimize these concerns, it is highly recommended that the states, regulated party, and contractor communicate early on and as often as possible during the remedial process. It is also critical to develop a clear understanding of the respective expectations and capabilities of the state agency, the PBC contractor, and the site owner.

PBM Case Study
Arctic Surplus Site, Alaska

Site Background

The Arctic Surplus Salvage Yard Superfund Site is a privately owned salvage yard located on 24 acres about 6 miles southeast of Fairbanks, Alaska. The Department of Defense (DoD) owned the site from 1944-1947 and created a small landfill on the property. In this site, salvage operations were conducted by a private company from 1959-1989, when the property accepted military equipment and materials, asbestos insulation, and various oils. Also, battery cracking and transformer burning took place to recover metals. In effect, the Tenana and Chena Rivers, located approximately 1 mile from the site, could become polluted by contaminants. Furthermore, a shallow aquifer, which underlies the Tenana-Chena flood plain, is the primary source of drinking water for residents living near the site. The 1,000 residents living within a 3-mile radius of the site are dependent on private domestic wells or bottled water.

In 1988, the Alaska Department of Environmental Conservation (AK DEC) conducted a site inspection and detected significant concentrations of metals in the soil. Piles of bulk asbestos and thousands of drums of liquid waste were also observed. Site groundwater was contaminated with trichloroethene (TCE), and soil was contaminated with industrial solvents, polychlorinated biphenyls (PCBs), and lead at concentrations determined to pose unacceptable risk to human health and the environment. Based on this information, the site was placed on the National Priorities List as a Superfund site in 1990.

Since then, about 10 years of groundwater monitoring data has been collected for the Arctic Surplus site. Except for two samples collected form an off-site well in which TCE was detected below concentrations of concern, no off-site migration of chemicals has been traced to wastes stored on site. A health assessment for the local area suggests that groundwater affected by contaminants released from the Arctic Surplus site does not currently pose a risk to the local population.

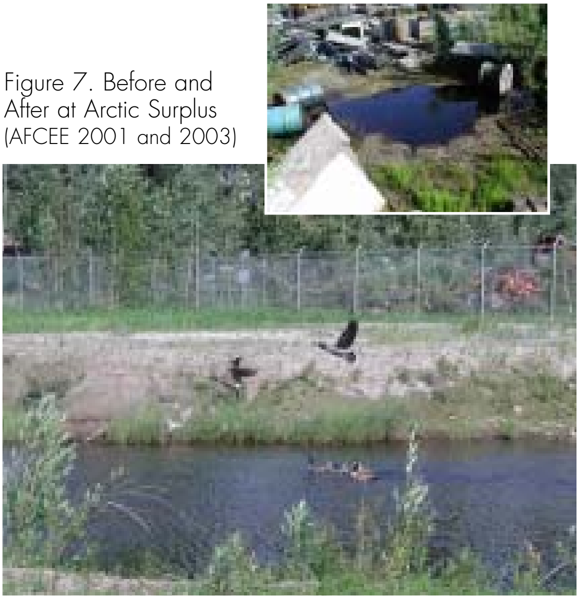

Figure 7. Before and After at Arctic Surplus (AFCEE 2001 and 2003)

Today, the remaining health risks are associated primarily with soil contamination inside the fenced area, with lower concentrations also extending into a small area outside the boundary.

In 1995 a Record of Decision (ROD) was signed USEPA that chose a remedy for the site. This included stabilization and solidification of soils contaminated with PCBs and lead. These soils are to be placed over an old landfill on-site, in a soil monolith (a low-level, concrete-like mound). DOD was able to obtain Defense Environmental Restoration Funding to complete the final Remedial Action in 2003. A Performance-Based Environmental Restoration Management Assessment (PERMA) Scoping Visit Report was completed on August 19, 2002 to maximize the environmental protectiveness of the active restoration projects and to minimize the costs while moving toward the goal of site closeout. Streamlined Site characterization techniques were used to update the Conceptual Site Model. This characterization work was completed in September 2002, and included additional soil sampling to delineate soil volumes and a stabilization and solidification treatability study. Also, the site fencing was repaired.

First PERMA Implementation

The Defense Logistics Agency (DLA) tasked the Air Force Center for Environmental Excellence (AFCEE) to procure services to conduct additional work at the site and attain site closure. This work was performed under a performance-based, firm-fixed-price contract that included additional stabilization and solidification of contaminated soils. Compressed gas cylinders were used in training exercises with the local fire department and properly disposed. Transformers were checked, tested for PCBs, and properly disposed. De-militarizing about 100,000 spent shell casings and collection and disposal of radium-contaminated instruments and soil were excluded from the PBC scope due to uncertainties related to the number of spent shells, live rounds, incendiary objects, and total volume of low radiation waste.

The USEPA provided DLA with an Independent Government Cost Estimate of $38 million to complete site remediation over a 4-year period. The PERMA team recommended using an alternate technology that would complete restoration in 1 year for $3.6 million, and requested that USEPA prepare an Explanation of Significant Differences. On October 2003, the final closure report was presented to USEPA and Alaska Department of Environmental Conservation at a public meeting in Fairbanks, AK. The PBC included restoration of the site in 2003, maintenance of the landfill cap, and annual monitoring of groundwater for 5 years. The contractor is conducting all maintenance and monitoring as agreed. This site was used to develop and test the strategy components that now form the basis for the AFCEE PBM diagram shown in Figure 1.

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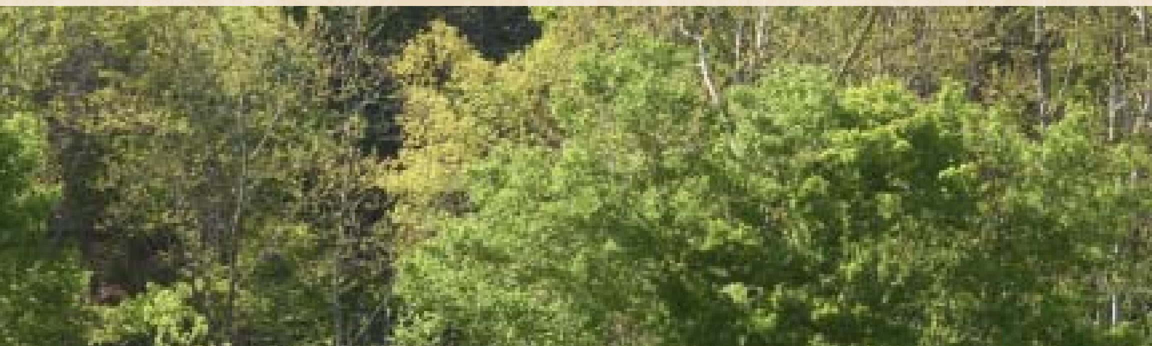

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