INTERSTATE TECHNOLOGY & REGULATORY COUNCIL

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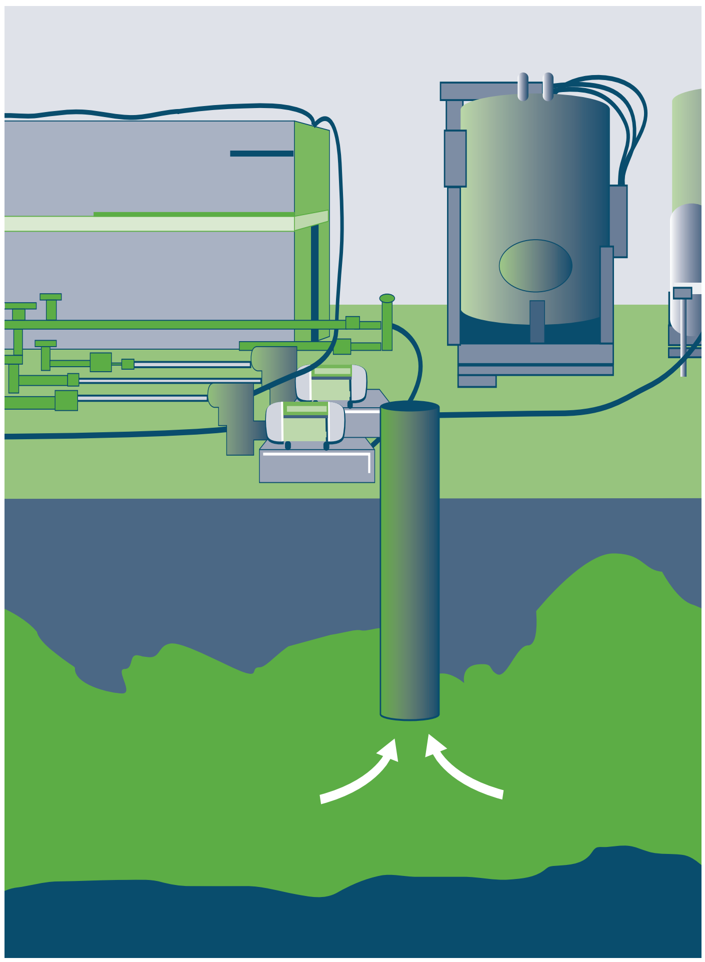
INTERSTATE TECHNOLOGY & REGULATORY COUNCIL

Technical and Regulatory Guidance

Improving Environmental Site Remediation Through Performance-Based Environmental Management



November 2007

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

ABOUT ITRC

Established in 1995, the Interstate Technology & Regulatory Council (ITRC) is a state-led, national coalition of personnel from the environmental regulatory agencies of some 48 states and the District of Columbia, three federal agencies, tribes, and public and industry stakeholders. The organization is devoted to reducing barriers to, and speeding interstate deployment of better, more cost-effective, innovative environmental techniques. ITRC operates as a committee of the Environmental Research Institute of the States (ERIS), a Section 501(c)(3) public charity that supports the Environmental Council of the States (ECOS) through its educational and research activities aimed at improving the environment in the United States and providing a forum for state environmental policy makers. More information about ITRC and its available products and services can be found on the Internet at www.itrcweb.org.

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EXECUTIVE SUMMARY

As noted in the Interstate Technology & Regulatory Council (ITRC) Remediation Process Optimization (RPO) Team's first technical regulatory guidance document, *Remediation Process Optimization: Identifying Opportunities for Enhanced and More Efficient Site Remediation* (ITRC 2004), federal, state, and private-sector organizations will continue—for the foreseeable future—to spend billions of dollars on the characterization and assessment of contaminated environmental media and on the selection, construction, operation, maintenance, and monitoring of environmental remediation systems. As numerous environmental cleanup statutes and their implementing regulations evolved, it was initially assumed that these programs could follow a basic "study, design, build" linear paradigm. However, years of experience have led to the realization that the significant uncertainty inherent in environmental cleanup requires more flexible, iterative approaches that manage uncertainty. Uncertainty, as demonstrated by frequently missed target dates, has forced the development of mechanisms that allow for both the systematic reevaluation of initial objectives and the continuous improvement and optimization of remediation technologies and techniques. These mechanisms and reevaluations are known collectively, or generally, as RPO. The team has identified a related concept—performance-based environmental management (PBEM), a method of project management that relies on establishing, and working towards, performance objectives rather that managing only the process. The ITRC RPO team developed this guide to respond to that realization. Schedules for projects in the operating and maintenance or long-term remedial action phase are frequently measured not in years but in decades. In such instances, RPO and PBEM are not just desirable; they are essential.

Some state agencies (such as South Carolina) have embraced some form of PBEM in their remediation programs. The federal government considers performance-based management such an important concept that federal agencies are being required to implement performance-based management and performance-based contracting (PBC) as part of their business practice. This document provides practical information and guidance to interested parties—regardless of role (responsible parties, regulators, stakeholders)—who need to systematically evaluate and manage uncertainty associated with the remediation process by using PBEM. This document provides information and tools to help ensure that the remediation process is progressing toward acceptable and feasible site cleanup objectives and that selected remediation approaches attain those objectives and remain protective of human health and the environment.

This document offers guidance on the different PBEM frameworks that exist in different programs. It identifies issues affecting state regulators related to the differences between the traditional linear process paradigm and the more holistic PBEM process. The relationship between RPO and PBEM is presented. The document also explores what could and should be included in an effective PBEM program, including what PBEM and PBC are, the regulatory framework that PBEM and PBC must operate within, references that provide examples of successful PBEM and PBC, and resources for further examination of PBEM and PBC.

The traditional, linear cleanup process has been focused on the "how" of remediation, such as the technologies in place. This document continues to look not just at the "how" of site cleanup but

also at the "why." The "why" can be described as the conceptual site model (CSM), which considers all factors involved with the site remediation, such as the environmental and land-use (current and future) plans, site-specific chemical and geologic conditions, and the regulatory environment. The exit strategy or the conditions that must exist to reach an end point in the remediation are also discussed. PBEM creates a framework that links the development or renewed CSM with the exit strategy.

The regulatory environment establishes the need to review and possibly revise cleanup goals to ensure that the target goals are still applicable. As a result, scientific advances and regulatory changes—such as the movement towards risk-based goals and reevaluation of technologies deployed—are core features of PBEM. Therefore, consideration is given to the reevaluation of remediation goals and to ways that potentially inapplicable or unattainable goals can be updated based on these and other new regulatory approaches.

The guidance identifies and describes the applicability, advantages, and disadvantages of various approaches, as well as where they are most appropriate for use. The ITRC RPO Team acknowledges that there are several PBEM formats and has tried to identify as many as possible to familiarize state regulators with these formats so they can anticipate the needs of the PBEM process.

Depending on site-specific conditions and the status of current phase in the overall cleanup process, this document provides examples of when and where a PBC can be appropriately applied for cleanup. There are obvious situations (e.g., excavate and remediate a known amount of soils in a well-delineated case) where a PBC can be used easily compared to other complex situations. An example is completing the definition of free-phase product at a site with a complex geology. However, experience suggests that it is not often clear-cut where PBCs can and cannot be applied. The program areas and regulatory framework under which the remediation is being conducted, site-specific geological and hydrological conditions, and the vision and ability of potential responsible parties, among other relevant things, are all keys to successful application of PBCs. Knowing where a PBC will and will not work is a challenge to predict in complex situations; however, many cases have shown that PBCs were successful even in challenging conditions. At the same time PBCs have been unsuccessful in other cases of remediation that were thought to be clear-cut. Our experience concludes that neglecting the quality issues during the performance criteria determination while emphasizing only time and money issues certainly will contribute to the failure of a PBC process.

This document clarifies some of these issues and emphasizes that approaching remediation in a holistic manner, keeping the end goal all through the process, is an essential way to reduce the uncertainty in remediation decision-making process. That, we believe, is the essence of PBEM approach to site remediation.

This document uses many acronyms throughout that may make reading this document a challenge. After numerous discussions, the RPO team agreed to respect different agencies and organizations that consider those acronyms important within their entities and included them all in this document. The team acknowledges and apologizes for any distress these acronyms may cause to general reader. Please rely on the acronym list in Appendix G at the back of the document.

Lastly, please note: PBEM and PBC seem to be similar and are sometimes used together, but not interchangeably, when appropriate in this document. The ITRC RPO Team emphasizes that performance-based *contracting* is a *tool* that helps in the successful implementation of performance-based *environmental management*. PBEM is a project management process that uses better techniques—such as PBC and other components or tools—to manage contaminated site cleanups.

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1. INTRODUCTION

For the purposes of this document, performance-based environmental management (PBEM) is defined as a methodology that is implemented through the use of systematic planning to enhance site cleanup. Through a series of strategic components discussed throughout this document, PBEM is expected to efficiently attain remedial action objectives (RAOs).

The expert team serves as the core group to implement the eight components of PBEM through the systematic planning process:

- remediation problem statement and objective
- land-use risk strategy
- updated conceptual site model (CSM)
- decision logic
- remediation process optimization (RPO)
- applicable or relevant and appropriate requirement (ARAR) analysis
- exit strategy
- performance-based contracting (PBC)

Several of these items have been the subject of previous guidance from the Interstate Technology & Regulatory Council (ITRC) RPO Team (ITRC 2004, 2006a–e). In preparation for writing the current document, determining information needs by state, and understanding of PBEM concept, the RPO Team surveyed all ITRC member states through the ITRC State Point-of-Contact Network to elicit states' knowledge, use, and opinions of PBEM and PBC. The survey results indicated that although most of the respondents (21) were familiar with the principles of PBEM, only 11 states have implemented PBEM projects, and only 13 states have implemented PBC projects. Additionally, most of the states with PBEM/PBC projects have only a few examples of projects, and many have not yet been completed. This metric could indicate that many of the PBEM/PBC projects have recently begun or have yet to complete their restoration goals, except for a few sates such as South Carolina, where the elements of PBEM/PBC have been in practice for more than a decade now. For the most part, PBEM/PBC is a relatively new concept for state regulators but one that is becoming more significant to states in both their implementation and oversight roles. The full survey results can be found in Appendix A.

1.1 Problem Statement

While performance-based management is an accepted management philosophy, it is still relatively new in the environmental field. PBEM addresses common environmental problems that have developed over time, including unsuccessful process-driven cleanups, ill-defined or unclear project goals, inexperienced project teams, lack of incentives to complete cleanups, and a lack of understanding of constraints and communication requirements. PBEM can be applied at a site-specific project level or at a programmatic level for an entire agency. For example, a state may permit using the PBEM approach for all projects in its dry-cleaning or underground storage tank (UST) program.

1.2 Purpose

The ITRC RPO Team selected PBEM as the focus of its second technical regulatory guidance document because it is the overarching theme of optimizing environmental management embedded in RPO. As the RPO Team presented its initial training, the audience requested additional documents detailing some RPO elements. After producing five fact sheets (ITRC 2006a–e), the team wanted to go a step beyond mere RPO that effectively addresses the cleanup technology already in place at contaminated sites. One obvious alternative was an approach that would select the most appropriate remediation system for site-specific conditions, thus reducing a need for RPO. Using a goal-oriented approach that results in an appropriate remediation action puts RPO in a whole new perspective. This goal-oriented approach resulted in PBEM process development. Results-oriented, project-targeted processes can achieve the goals of national, state, and local environmental programs by efficiently managing limited resources, minimizing health risks, and reducing environmental cleanup costs and schedules.

1.3 Contents

This document is organized to be a useful reference for state and federal regulators as well as nonregulatory entities, including federal agencies, private-sector companies, consultants, etc. After defining PBEM and explaining the process and its components, this first chapter details several state and federal agency perspectives on the PBEM, the regulatory framework under which it can be successfully applied to site remediation, and relationship to other ITRC teams and products. Chapter 1 also discusses the concerns the state regulators may have (ASTSWMO 2004) in the implementation of PBEM process. Chapter 2 details the basic concepts that underly the principles of PBEM approach, along with a description of other PBEM-related concepts. Chapter 3 discusses PBEM components in detail and explained the nuts and bolts of PBEM implementation. Chapter 4 gives details of stakeholder perspective and how PBEM process should incorporate their input in to the process. Chapter 5 provides a summary and conclusions.

In addition to the results of the state survey (Appendix A), other appendixes provide examples of decision logic (Appendix B), real field PBEM case studies (Appendix C), and an example of a PBC (Appendix D). The toolbox in Appendix E builds on the earlier toolbox from RPO-1 (ITRC 2004). The document concludes with RPO Team contacts and a list of acronyms.

1.4 Relationship to Other ITRC Teams and Products

The RPO Team recognizes that PBEM has a strong link to the concepts and tools represented by other ITRC teams and documents and has attempted to enhance rather than duplicate those efforts. For example, the principles of Triad—defined by the ITRC Sampling, Characterization, and Monitoring Team—provide synergy to PBEM's discussion of systematic planning. Triad concepts are complementary to PBEM principles, and the two go hand in hand with each other. As PBEM has wide applications throughout the remediation process, it is possible that the principles overlap and complement with the projects and products of other teams, such as the Enhanced Attenuation: Chlorinated Organics Team. The ITRC Risk Assessment Team's resource documents provide examples of additional considerations that may used in the PBEM process. Links to these other teams and documents can be found on the ITRC Web site at www.itrcweb.org.

1.5 Regulatory Framework

Most regulatory programs—such as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), UST and brownfields programs—have provisions to implement PBEM to differing levels. UST programs can more easily apply the comprehensive PBEM approach at a project level, whereas CERCLA National Priorities List (NPL) sites need to take a larger, program-wide approach. Nevertheless, PBEM is equally applicable in many programs under all regulatory frameworks. Agencies are taking advantage of the benefits of a properly designed and executed PBEM process.

1.5.1 Regulatory Perspectives on PBEM in Different States

State approaches depend on the programs involved. Regulatory oversight and publicly funded remediation programs have different concerns. For example, oversight groups maybe concerned with a perceived loss of control of the cleanup or the resources need to participate in a performance-based cleanup. Publicly funded groups may have issues with procurement regulations and finding qualified contractors. In short, states generally have little experience (see Appendix A), and the experience they have is mixed.

South Carolina has long experience with performance-based initiatives. Many elements/components of PBEM have been successfully and comprehensively implemented in South Carolina since 1994. “Pay-per-Performance,” as the state calls it, combined with a risk-based corrective action approach has made the UST Program a successful operation with a number of sites where investigations/assessments are completed and remediation alternatives selected with several cleanup completes within a short period of time—all using PBEM-like steps. In RCRA and CERCLA programs, PBCs have been successfully implemented at some of the U.S. Department of Defense (DOD) and Department of Energy (DOE) facilities in South Carolina (see Appendix C for details). The state’s regulatory oversight group has welcomed performance-based initiatives; federal agencies have presented initiatives to the regulators with plenty of time to establish staffing involvement. However, the publicly funded element is having difficulties educating the purchasing office as to the benefits of PBC and is yet to gain commitment from the purchasing authority to even review performance-based background information.

1.5.2 Summary of Various Agency PBEM Approaches

1.5.2.1 Department of the Navy

Department of the Navy’s Environmental Restoration (ER) Program routinely applies all of the key components of PBEM—ARAR analysis, land use risk strategy, updated CSM, decision logic, exit strategy, contract strategy, RPO, and defined problem—through implementation of the Navy’s optimization policy and acquisition strategy. The Naval Facilities Engineering Command (NAVFAC) manages the Navy’s ER Program, which consists of munitions response and installation restoration. Although NAVFAC does not currently employ the term “performance-based environmental management,” there is a strong emphasis on using the key components to achieve site closeout described in this document.

The Navy Optimization Policy (DON 2004) requires optimization of remedial actions at each phase of the ER process (remedial investigation [RI]/feasibility study [FS], remedial design [RD], record of decision [ROD], remedial action [RA], and long-term management [LTM]) through careful evaluation of project goals, remediation system effectiveness, life-cycle design and cost analysis, and data management and reporting. The NAVFAC Workgroup on ER Process Optimization has developed guidance documents for optimizing actions throughout the ER process and supports remedial project managers (RPMs) and installations for implementing the Navy's optimization policy and guidance. *Guidance for Optimizing Remedy Evaluation, Selection, and Design* (NAVFAC 2004a) provides guidance on key concepts, including CSMs, RAOs, performance objectives, life-cycle design and cost analysis, flexible RODs, and general concepts for optimization during the design phase. *Guidance for Optimizing Remedial Action Operation* (NAVFAC 2001) provides a stepwise process for optimizing remediation systems, and *Guide to Optimal Groundwater Monitoring* (NAVFAC 2000) provides a stepwise process to optimize groundwater monitoring programs. The stepwise processes from both of these guidance documents are included in the ITRC RPO technical/regulatory guideline (ITRC 2004).

Navy RPMs are actively conducting optimization studies at their sites and implementing recommendations from these studies. For teams that conduct site optimization evaluation studies, Navy policy directs RPMs to include "third-party" members who are not involved in management, design, or operation and maintenance (O&M) of the remediation system at the site. In addition, Navy policy requires RPMs to track the progress of optimization efforts. This optimization tracking is included in the NAVFAC-wide database of all Navy ER sites. The optimization workgroup provided guidance in developing the optimization module for this database.

The ER optimization workgroup has also prepared the *Guidance to Document Milestones throughout the Site Closeout Process* (NAVFAC 2006) to provide a consistent approach for Navy RPMs to recognize and document completion of various milestones in achieving site closeout. Currently, the ER optimization workgroup is revising and expanding the guide for optimizing groundwater monitoring to include monitoring optimization for other media and site types.

The Navy's acquisition strategy for the ER Program integrates and uses PBC to varying degrees throughout its acquisition process. In October 2004, NAVFAC issued specific PBC guidelines (NAVFAC 2004b) that explain the elements of the method, call for its increased use, address PBC eligibility, designate responsibilities and level of approval, and establish reporting requirements. PBC allows the Navy to specify work for a contractor in terms of what it wants the outcome to be and places responsibility on—and transfers risk to—the contractor for determining how to produce the desired outcome. This approach encourages innovation and contractor expertise to achieve the desired outcome.

NAVFAC's guidelines for PBC include the following elements that must be present in a performance-based contract:

- Performance Work Statement—Describes requirements and performance standards

- Performance Assessment Plan—Identifies acceptable quality levels and describes how performance will be measured against performance standards
- Incentives/Remedies—Addresses incentives when performance exceeds performance standards, and remedies when performance standards are not met
- Performance Requirements Summary Matrix—Provides a summary table that lists the main components of the above elements

PBC has been used for environmental work at Charleston (S.C.) Naval Station, Naval Air Station Whiting Field (Fla.), Naval Submarine Base Kings Bay (Ga.), Naval Communications Station Stockton (Calif.), Mare Island Naval Shipyard (Calif.), and in other remediation contracts Navy-wide. The Navy also uses a Performance Environmental Restoration Multiple Award Contract to combine design and construction under a fixed price contract.

Providing training to Navy RPMs on topics relevant to optimization and PBEM remains a Navy priority. Relevant courses are offered to the Navy RPMs, contractors, and regulators through the Civil Engineer Corps Officers School and Remediation Innovative Technology Seminars organized by the NAVFAC Engineering Services Center. In addition, to enhance NAVFAC-wide application of PBCs, NAVFAC Headquarters and component commands have sponsored training sessions for technical and acquisition personnel to ensure a common understanding of PBC.

1.5.2.2 Department of Army–U.S. Army Corps of Engineers PBEM Policies and Approaches

The U.S. Army Corps of Engineers (USACE) strongly supports the concepts under the PBEM umbrella and has a number of related initiatives, including guidance, contracting approaches, and policies, which have been developed under broader Army requirements. USACE promotes systematic planning for all phases of ER projects. *Technical Project Planning (TPP) Process* (USACE 1998) describes the approaches in detail. The TPP process has been mandated, for example, in performing work at formerly used defense sites (FUDS), including for munitions response (USACE 2004). Other guidance relevant to systematic planning includes *Conceptual Site Models for Ordnance and Explosives (OE) and Hazardous, Toxic, and Radioactive Waste (HTRW) Projects* (USACE 2003) and *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001). USACE has widely applied the Triad approach for planning and data collection.

RPO has also been integrated into USACE through the development of the Remediation System Evaluation (RSE) process, developed to assess the performance and potential cost savings for sites and to identify site exit strategies. Per USACE regulation, RSE is required for FUDS where annual O&M costs exceed $100,000. The RSE process has been adopted by EPA for use at Superfund sites. A description of the RSE process and tools related to the RSE process are available at www.environmental.usace.army.mil/rse_checklist.htm.

Use of PBC for ER has increased significantly since 2003 in response to DOD and Department of the Army requirements and goals. As informally defined by USACE, PBCs involve the competitive bidding—by at least three potential bidders—of a performance-based scope of services under a generally fixed-price contract. The contract can be a simple fixed-price contract, a fixed-unit-price contract, or a guaranteed fixed-price contract with insurance. Progress on use of PBCs is measured by the dollar value of the projects awarded under these contracts.

USACE has provided significant training on aspects of PBEM, including general training on the TPP process and Triad-based work strategies, in addition to facilitated TPP meetings on specific projects. Presentations on the RSE process and Triad work strategies have been given widely at USACE conferences and through EPA-sponsored and -publicized Internet training seminars. Training on PBC has also been developed and provided at various USACE district offices.

1.5.2.3 U.S. Air Force

The Air Force Performance-Based Management (PBM) initiative provides a framework for initiating environmental cleanup actions and optimizing those actions as they progress. Application of PBM is required by the Air Force Cleanup Program Performance-Based Management Policy, Air Force Instruction 32-7020, and the Defense Environmental Restoration Program (DERP) for all active Air Force installations and those in the Base Realignment and Closure (BRAC) Program.

The Air Force recognized that many of its cleanup actions were not performing as originally expected and began to develop guidance for optimizing performance. The first was a *Long-Term Monitoring (LTM) Optimization Guide*, released by the Air Force Center for Environmental Excellence (AFCEE) in October 1997. Optimization of treatment system equipment was addressed the following year through participation in a joint Army, Navy, and Air Force effort that resulted in the RSE guidelines and optimization checklists that are available from USACE. The RSE approach looks at the performance and maintenance of individual pieces of remediation equipment (e.g., extraction well performance).

Beginning in 1999, the Air Force's RPO initiative took a broader view by addressing the performance of the selected remedial technologies. RPO considers whether the technology can be optimized or whether a change of technology would be appropriate at that point in time. A draft RPO handbook was prepared in 1999 to guide the application of RPO at Air Force and Defense Logistics Agency (DLA) installations. The final draft of the handbook in 2001 incorporated lessons learned in the field. An RPO Outreach Office was established in 2002 to coordinate RPO efforts and assist the major commands with implementation. RPO Inventory and Performance Software (RIPS) is used through the Air Force to maintain an inventory of remediation systems, prioritize cleanup actions, and track performance. The RPO Outreach Office provides training and technical support for implementation of the RIPS tool.

In addition to optimizing remediation systems, the Air Force RPO process periodically evaluates the LTM plan and analytical protocols in place at each site. Groundwater, soil, and system monitoring can be a significant cost items in the annual O&M budget. Monitoring and Remediation Optimization System (MAROS) software was developed to provide site managers with a strategy for formulating long-term groundwater monitoring programs that can be implemented at lower cost. MAROS is a decision support tool based on statistical methods applied to site-specific data to suggest an optimization plan for a current monitoring system. This public domain software, developed for AFCEE, is available for download at www.gsi-net.com/software/maros/Maros.htm.

Optimization was broadened in 2004 by the release of guidance for assessing the RAOs that form the basis of a cleanup effort. The purposes of an objectives assessment (OA) are to determine whether the current RAOs (for a site, a program, or an installation) are still appropriate, given the current knowledge of the site(s) and the capabilities of the technologies selected, and to manage uncertainty in the remediation process. The test of appropriateness is based on the three tests of necessity, feasibility, and reasonableness (AFCEE 2007).

The Air Force PBM initiative formally began in 2003 with the same eight components that compose PBEM. Air Force PBM is an approach or philosophy for managing environmental cleanup projects that uses communication among the stakeholders, systematic planning, and a thorough understanding of the site conditions to reach an economic site closure by focusing on the project goals and the results achieved. PBM minimizes the Air Force's environmental liability by clearly defining the problem, identifying stakeholder objectives, establishing an exit strategy, and tracking performance-based metrics toward reaching site closure.

The PBM components form a "toolbox" of project management methods or techniques. The central, indispensable ingredient that makes PBM work, however, is communication among the stakeholders, including the Air Force (major command and the installation), the regulators (EPA and/or state), the service center, and the public. Representatives from each of these groups form the core project team. To be effective, the core team must be nonadversarial, with all members working toward the common goal of site cleanup. A spirit of teamwork and trust is developed among the core team members (the concept of social capital) as a common ground for dialog. With good communication, the project can move effectively and efficiently to resolution. Without good communication, PBM is not possible, and the project will revert to the old stepwise way of managing environmental projects.

It should be emphasized that PBM is applicable to the management of all types of environmental projects, regardless of the contaminants, media, or regulatory arena. PBM has demonstrated the potential to shorten the timeline to site closure and result in substantial savings. PBM uses a variety of contracting strategies, but PBC is preferred where appropriate. The Federal Acquisition Regulations (FARs) define PBC as "…structuring all aspects of an acquisition around the purpose of the work to be performed with the contract requirements set forth in clear, specific, and objective terms with measurable outcomes as opposed to either the manner by which the work is to be performed or broad and imprecise statements of work."

The Air Force has found that PBC may be the right approach when the project has well-characterized sites, clearly defined performance expectations or objectives, and measurable and verifiable performance measures and standards. Conversely, PBC is not be the right approach if the project has poorly characterized sites, inordinately high risk to the contractor resulting in limited competition, or a lack of adequate time and/or resources to conduct substantial initial planning. Successful use of PBM should result in well-characterized sites, defined exit strategies, and performance objectives that are clearly defined and measurable. If milestones can be established and payments linked to specific objectives, PBC may be a feasible approach. An guidebook on implementing PBC within the ER Program has been developed. *Performance-Based Management Master Guidance* (AFCEE 2005) provides an overview of PBM and describes each component to familiarize new staff with the PBM approach and the tools available.

1.5.2.4 U.S. Army—Army Performance-Based Acquisition Program

The U.S. Army implemented performance-based acquisition (PBA) as a Business Initiative Council (BIC) project by piloting PBCs at two active installations in fiscal years (FY) 2001–2002. In April 2003, the Army introduced a new cleanup strategy and accompanying plan to create consistency and accountability across the Army's cleanup program. One of the main objectives of the strategy is to support the development and use of cost-effective cleanup approaches and technologies to improve program efficiency without sacrificing the protection of human health and the environment.

In FY03, the Army Chief of Staff for Installation Management tasked the U.S. Army Environmental Command with the technical implementation of the PBA program for active and excess Army installations. The Environmental Command subsequently implemented an Army-wide PBA initiative as a preferred business strategy, standardizing the use of PBA for environmental cleanup and incorporating the use of proven commercial-sector practices and incentives into the environmental cleanup process, with assistance and cooperation from multiple USACE districts across the country. The Army believes that PBA can significantly improve overall project performance by curtailing schedule and cost overruns and getting more dollars on the ground to do the actual cleanup.

Table 1-1 shows the Army's implementation goals, indicated by the percentage of the total ER budget, and performance against those goals. Note that the overall goals eventually level off at 60% of the total program because there are installations and sites where PBA may not be the most appropriate tool.

Table 1-1. PBA goals and actuals for Army environmental restoration

Fiscal year	PBA goal	Actual
FY01–02	BIC Initiative	Pilot PBCs
FY03	3%–5% ($12–20 million)	9% ($37 million)
FY04	30% ($120 million)	36% ($141 million)
FY05	50% ($200 million)	51% ($202 million)
FY06	60% ($240 million)	54% ($214 million)
FY07+	60% ($240 million)	

Since the PBA initiative began, the Army has awarded 52 PBCs worth $577 million at 87 active installations. The contracts cover cleanup activities in 38 states and Puerto Rico and in all 10 EPA regions. The PBA efforts have locked in cleanup schedules and costs at 643 Installation Restoration Program (IRP) sites. The original cost-to-complete estimates for those 643 sites were about $854 million, resulting in a cumulative cost avoidance of $277 million (33%). Note that the cost-to-complete estimates do not have the same level of certainty as a contract bid and that

PBCs may not address the full future costs for the site if the contract duration is limited relative to the time frame for achieving Response Complete.[1]

Within the Army's current framework of PBA implementation, PBCs exhibit the following characteristics:

- use of firm-fixed price contracts
- defined performance objectives, milestones, and standards
- use of incentives or environmental insurance to enhance performance
- flexibility and accountability for results

PBC requires the contractor of an environmental cleanup project to achieve specific cleanup objectives outlined in the performance works statement, usually for a fixed price. Projects range in complexity and price and include such activities as conducting remedial investigation and characterization and achieving Remedy-in-Place[2] and/or Response Complete at any number of site types, including soil, sediment, and groundwater sites or at sites where there is known or suspected unexploded ordnance (UXO) and chemical and biological warfare materiel. The contractor may be required to buy environmental insurance to cover additional costs that may occur if cleanup expenses exceed the contract price. A PBC for environmental cleanup does not relieve the Army of the environmental liability for the project; however, it does shift more responsibility and accountability for the cost, schedules, and results of the project from the Army to the contractor.

The Army plans to continue implementing PBA at the active installations on IRP sites and applying this contracting mechanism for remedial action operations and LTM actions. In addition, the Army plans to implement PBA for cleanup of other Army environmental liabilities, such as Military Munitions Response Program (MMRP) sites, BRAC sites, and compliance-related cleanup sites.

The Army has developed a PBC guidebook that is available online and is updated regularly. The guidebook, as well as the Army Cleanup Strategy and generic templates for Performance Work Statements, is available at http://aec.army.mil/usaec/cleanup/pbc00.html.

1.5.2.5 U.S. Environmental Protection Agency

EPA embraces the PBEM concepts described in this document. EPA has applied components of PBEM through various mechanisms but does not have a formalized PBEM program applied throughout the agency. Below is a description of several initiatives related to PBEM, including the Triad approach, optimization, value engineering, and PBA.

[1] Response Complete: The remedy is in place and the required RA operations have been completed. If there is no RA operation phase and all RAOs have been achieved and documented, then the RA construction end date will also be the Response Complete date.

[2] Remedy-in-Place: A final RA has been constructed and implemented and is operating as planned in the remedial design. An example of a Remedy-in-Place is a pump-and-treat system that is installed, is operating as designed, and will continue to operate until cleanup levels have been attained. Because operation of the remedy is ongoing, the site cannot be considered Response Complete.

In cooperation with ITRC and other federal agencies, EPA has developed a work strategy framework called the "Triad." The Triad framework applies many components of PBEM, including systematic planning, CSM development, and real-time decision making using dynamic work strategies and decision logic. Triad is supported by offering site-specific technical assistance to many EPA programs, providing extensive training to EPA and non-EPA staff, and preparing case studies and other informational documents.

In 2004, the EPA Superfund Program issued *Action Plan for Ground Water Remedy Optimization* (OSWER Directive 9283.1025), which formalizes the use of optimization at EPA Superfund-financed pump and treat sites and calls for optimization reviews at up to eight sites annually, tracking of implementation progress, and preparation of annual reports. Optimization reviews, completed by independent, third-party technical experts, focus on reviewing CSMs, including a focus on short- and long-term operational goals, as well as reviewing opportunities for efficiency improvements. This has been a successful program, and more than 50 sites with operating pump and treat systems have been evaluated as of 2007. EPA is now considering expanding the optimization concepts to sites earlier in the pipeline, such as during the predesign or design phase. In April 2006, EPA reaffirmed the requirement to apply value engineering (VE) to all Superfund-financed sites during remedial design and remedial action project (see *Value Engineering for Fund-financed Remedial Design and Remedial Action Projects*, OSWER Directive 9335.5-24). The goal of VE reviews is to identify cost efficiencies prior to construction and during RA and O&M phases.

With respect to PBA, EPA has endeavored to comply with the Office of Management and Budget "Memorandum for Chief Acquisition Officers Senior Procurement Executives" target of 40% or more of eligible contracts be issued as PBAs. Although it has instituted a variety of mechanisms to encourage the use of PBAs, as of 2006 EPA achieved a PBA rate of only 21%. Further, much of the remediation-type work relevant to PBEM has been declared exempt from these targets according to the "Architect-Engineer Services 40 U.S.C. 541-544-C Exclusion" included in the OMB memorandum. Thus, the majority of the RA contracts issued by EPA are not issued as PBAs. However, many EPA regional offices have elected to prepare work assignments with performance-based components on a case-by-case basis. Additional training and specific contract language examples are necessary for more widespread use of PBAs for remedial work.

1.5.2.6 U.S. Department of Energy

The Government Performance and Results Act (GPRA) of 1993 required each department in the federal government to submit annual budgets tied to specific, measurable performance objectives. In 1994, GPRA statutes and recommendations from oversight groups initiated contract reforms at DOE. The precedent of using management and operating (M&O) contracts at DOE facilities, exempt from open competition by definition, shifted to performance basis. Historically, DOE began using M&O contracts during the Manhattan Project and beyond, where the capability of industrial and academic institutions was needed to form an ongoing partnership devoted to the development of nuclear weapons and testing, deterrence, and national security. M&O contracts were eventually viewed as inefficient due to lack of competition, resulting in excess cost. Reliance on subjective performance measures resulted in growing perceptions of contractor lack of accountability and of scope expansion toward inherently governmental mission areas. Since 1994, DOE has competed more than 70% of its then existing M&O contracts (32 in number); most now contain specific performance objectives, measures, and targets that focus on results in mission-critical areas.

In 2001, an external review of the Environmental Management (EM) Program concluded that process, rather than cleanup results, had been the basis for performance measures. DOE EM was directed to make PBC a core business process, manage cleanup as a project, and encourage innovative contracting strategies, as well as incentives to accelerate risk reduction and cleanup. EM's efforts to implement PBEM were realized in 2003 with establishment a centralized Office of Acquisitions at headquarters, as well as the Consolidated Business Center in Ohio to support EM on procurements and contracts. Since 2002, EM has replaced traditional M&O contracts with focused cleanup contracts for large and small business leads at several Field Site Offices (FSOs).

In 2004, EM's Office of Engineering initiated RPO reviews at select FSOs following the methodology published in ITRC 2004. Through a memorandum of understanding with USACE, Omaha District, EM assembled RPO review teams of experts led by USACE and with representatives of industry, EPA, and the national laboratories. To date, EM has completed nine RPO reviews: two pump and treat system optimizations, a monitoring program optimization, two in situ barrier performance improvements, two remedial design reviews, and two analyses of strategic planning for feasibility study/exit strategy.

RPO review reports provide independent findings and recommendations to improve the effectiveness and efficiency of remedial and monitoring systems, planned engineering systems, and exit strategy documents. At a higher level, RPO report observations provide DOE valuable insights as to how the basis of environmental contracts can be improved to define cleanup goals and incentive fees, implement emerging technologies, and measure performance against appropriate metrics. For example, at the Hanford Site in Washington, RPO recommendations were used to update the Integrated Groundwater and Vadose Zone Management Plan to establish results-oriented performance measures and institute regular evaluations to gauge the improvements' effectiveness.

At the Paducah Gaseous Diffusion Plant (PGDP) in Kentucky, an RPO review of the thermal treatment remedy for trichloroethylene source area reduction led to recommendations for more technically appropriate performance metrics, improvements to the remedial design basis, and an independent evaluation of remedial costs. At PGDP, the FSO follows RPO reviews with a project-specific implementation plan of accepted recommendations. The FSO works in conjunction with headquarters and the environmental regulators to develop and implement the RPO recommendations.

DOE's Office of Acquisitions and the Consolidated Business Center capture RPO recommendations as lessons learned at a higher level to provide process improvement to the centralized PBEM and contracting system. Beginning with 1994's GPRA, DOE has established a centralized infrastructure, process, and implementation procedure to support its FSOs in successful PBEM. As DOE works toward improving its PBEM approach, alliances with other federal agencies will prove valuable in sharing evaluation methods, contracting strategies, software, cost and performance reports, and lessons learned.

1.6 Federal Acquisition Regulations Performance-Based Concept

According to FAR definition of the PBC, the contract describes the requirements in terms of results required rather than the methods of performance work. It uses measurable standards (in terms of quality, timeliness, quantity, etc.) and quality assurance (QA) surveillance plans. A PBC also specifies procedures for reductions of fee or reductions to the price of a fixed-price contract when services are not performed or do not meet contract requirements. FARs also recommend performance incentives, where appropriate.

The FAR process can easily be adapted to the procurement of service for a process (as opposed to a product) such as PBEM. In this process, once a team of experts decide on the goals for the problem that requires solution and potential solutions are examined both in private and public sector, a detailed performance work plan or a statement of objectives is prepared. Metrics to measure the progress and manage the performance are developed, and then the contractor procurement process begins. Once the contractor is selected and the project is awarded, the PBC goes into management phase. Figure 1-1 shows the seven steps included in a typical FAR procurement process.

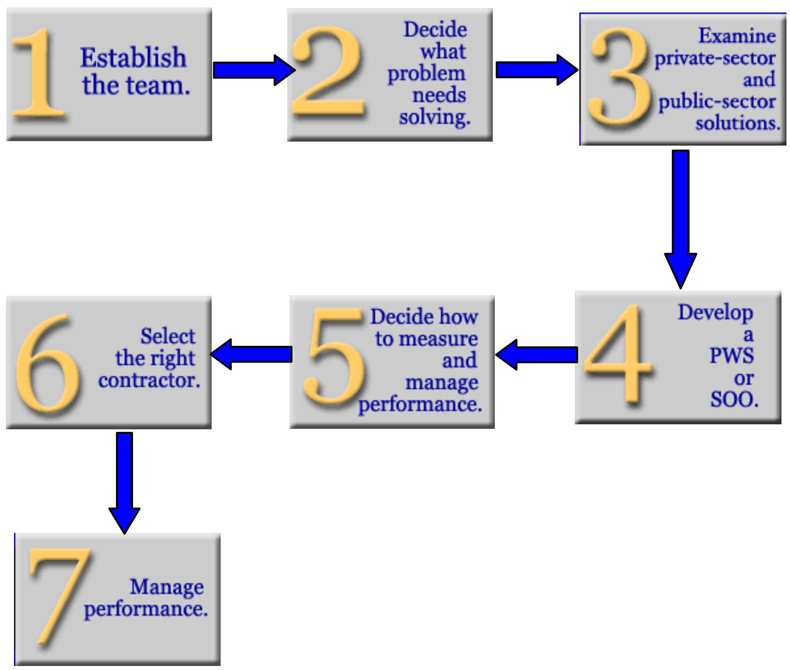


Figure 1-1. Steps in the FAR procurement process. A similar method is easily applicable in a process such as PBEM. Adapted from http://acquisition.gov/comp/seven_steps/index.html.

1.7 Concerns of the Regulators

Concerns have been expressed by the regulators (as obtained through discussions and surveys with other state and federal regulators) and their representatives regarding PBEM and more particularly PBCs. The implementation of PBEM should not be considered a significant deviation in the remediation process but rather one that will result in enhanced progress for site remediation. PBEM will improve communication and transfer of information between all stakeholders (including regulators) at every stage in a site remediation project. This approach of openness and constant communication throughout the project will ultimately lead to more rapid remedial actions being made. Regulators are a valuable part of PBEM, and their involvement is crucial for such a system to be truly effective. The ITRC RPO Team wants to address these concerns directly and does not minimize these or other regulatory concerns. Some of the concerns that have been voiced by regulators regarding PBEM/PBC implementation are provided below:

- staffing requirements
- loss of control of the project
- shift from responsible party (RP) to contractors
- establishment of diminished or unacceptable cleanup/remedial goals
- breakdown in the standard report submittal and review process
- diminished opportunities for involvement of public
- reduction in documentation supporting decisions

Although these concerns have been identified, a properly structured and implemented PBEM process reduces these issues or eliminates their impact. The recognition of problems early in the process is important so that these issues can be addressed and the PBEM process can achieve the expected outcomes. The following sections discuss how each of these concerns can be addressed to ensure that it does not develop into a problem limiting the success of a PBEM process.

1.7.1 Staffing Requirements

The PBEM process will require more up-front involvement of the regulators (including multiple agency involvement) in the planning of projects to clearly define the direction and objectives. Traditionally, the review process has not included regulatory input in the project scoping. Therefore, this early involvement represents a departure from the system in which regulators have typically operated, but it does provide an opportunity for the regulators to voice their site-specific concerns in this early planning stage. It is also critical to have involvement from senior managers early on or to have decision-making authority delegated to the project manager at the start of the project to expedite the internal regulatory approval process.

Once the PBEM process has been agreed to by the regulators, it is expected that the use of electronic communications will decrease the time demands on regulators. A functional, expedited communication process will provide regulators with full real-time knowledge of the status of the project and should decrease the need for daily oversight. However, the issues of adequacy of submittals and time frames for review of critical documents should be properly communicated, and consensus must be reached well in advance for a successful implementation. For complex sites, it is possible that there might not be a reduction in regulator resources due to the nature of the project. In many cases, fewer formal submittals may be needed, and there will be a decrease in the need for document reviews, thus freeing up regulatory resources. Those resources can then be focused on other priorities, depending on the program areas' needs and capabilities. For some projects handled under PBCs, there may be a greater reliance on regulatory agencies for technical review as the RP (e.g., DOD) may not provide as detailed reviews with its own technical staff. Proper oversight by the responsible parties should continue to ensure that quality targets are achieved.

That regulators will be more involved in the initial stages can be perceived as a staffing issue since regulators may be overburdened. Conversely, problem with job security could be perceived as the work is completed and less time is required for regulatory oversight. These issues are again addressed through the involvement of the senior managers early on in the project and are mitigated by adequate work forecasting.

1.7.2 Loss of Control of the Project

Since one goal of PBEM is to design a process that facilitates systematic decision making and expedites implementation of the agreed-upon decisions, there is a concern that the regulator (EPA or state) may lose the ability to truly understand the decisions made, the reasons behind them, and whether these decisions are meeting the expected and accepted cleanup criteria goals and the agency-approved remedial process. Agreeing to the cleanup plan and establishing procedures for routine communications with the regulator—which includes an acknowledgement and approval step—will alleviate this concern. Additionally, if decisions are made and a course of action is taken without the involvement or approval of the regulatory agency, it is always possible for the regulator to refrain from approving the next formal document prescribed in the process or to disallow site closeout until all requirements have been met. In most cases, the regulatory agency will maintain final authority over RCRA-based RI and those sites on the NPL. For CERCLA sites not on the NPL, DOD or another lead federal agency will remain committed to working with regulatory agencies to achieve agreement.

1.7.3 Shift from Responsible Party to Contractors

Regulators have expressed a legitimate concern about not wanting to deal directly—and exclusively—with the consultants and contractors on a project. As more and more projects are scoped out as PBEM-based contracts, there is continued pressure to allow the contractor to essentially take over total management of the job, and there is a perception that the contractor will assume all liability, which is not correct. In most state and federal regulatory programs, the RP is clearly identified, and a PBC does not change the responsibilities of such an identified party/entity/agency. Therefore, it is essential to have regulators work directly with the site owners/responsible parties in all decisions; the contractors should go through the site owners to solicit input from regulators. It is important for all of these parties to work together and maintain constant communication throughout the entire project.

1.7.4 Establishment of Diminished or Unacceptable Cleanup/Remedial Goals

As a PBEM approach is implemented, one concern is that remedial decisions may be made in which the state-approved cleanup goals are not met or an unacceptable remedial approach is taken because the regulator is not involved during the evaluation and decision-making process. Establishing lower cleanup standards is not a part of the PBEM objectives. If lower standards are applied, the PBEM is not being implemented correctly. PBEM is designed to identify and achieve agreement on the remedial goals early in the process by all parties, including the regulators; therefore, it will prohibit the establishment of any unacceptable cleanup level.

1.7.5 Breakdown in the Standard Report Submittal and Review Process

There is a perception that when PBEM is implemented, decisions and approaches may be adopted that are outside of the RCRA or CERCLA reporting process. PBEM must be implemented following all applicable regulations and statutes, and these reporting requirements cannot be overlooked. However, the documentation submittal/review process can be expedited through ongoing communications and allowing real-time decisions to take place that are approved as a product of the "expert team." As a remedial effort is being implemented, there is a high likelihood that a change in the approach—such as addition or subtraction of monitoring wells, locations of monitoring wells or sampling locations, or varying implementation of remedial design approaches—will occur as site knowledge increases. A good PBEM system should avoid being bogged down by the constant submittal of revisions to work plans and reports; it should design dynamic work plans that do not constrain the process but set achievable objectives. All results and decisions will be documented periodically and then captured in more formal and final reports that meet the RCRA or CERCLA requirements. These final documents should be extremely familiar to the regulator based on the dynamic and constant communication among the expert team; as a result, the documents will be easy to review and approve.

1.7.6 Diminished Opportunities for Involvement of Public

The rapid and timely decision making that is a part of PBEM is perceived to lead to situations where work is performed without a sufficient record of the decisions in a formal document, thereby decreasing the opportunity for public participation. This perception is unfounded since the PBEM approach must be implemented to meet all applicable regulations and statutes, including all public involvement requirements. Since all documents and reports required by any regulatory framework (e.g., CERCLA or RCRA) will be completed, there is no reason that the public notices and public participation requirements associated with these regulatory processes cannot be fulfilled. As long as these public involvement criteria are known early in the process, they can be completely accounted for and placed into the project management goals. One possible way to build public involvement outside of any required public notice or meeting is to design publicly accessible resources—such as Web sites that capture the decision logic, communication, and knowledge gains—so that all stakeholders can receive updates on the site cleanup progress. In some situations where a site decision document has not yet been prepared, contractors may have proposed a specific technology as part of their bid on the PBC. The process of public (and regulatory agency) participation in remedy selection must still be followed, even if stakeholder preferences would lead to the selection of another technology. This is a risk assumed by the PBC contractor.

1.7.7 Reduction in Documentation Supporting Decisions

A final concern is that the PBEM process may not allow regulators to properly review key documents, such as RCRA Facility Investigation (RFI) Reports or Corrective Action Plans (CAPs). This is not the intent of the PBEM process; in fact, the process should facilitate regulatory review of such documents. Implementation of PBEM should actually see a reduction in the number of document revisions through the implementation of a more dynamic decision/review process. When it is time for submittal of a required milestone report, such as an RFI Report, CAP, or ROD, the product will be entirely familiar to the regulators, reducing the number of critical problems and questions that typically originate in the regulatory review process. A decrease in draft documentation revisions does not represent a reduction in the effectiveness of the remedial investigation or affect the issuance and regulatory review of all legally required corrective action reports.

1.7.8 Transfer of Conflict of Interest

In a traditional contract, there is a natural conflict of interest between the RP and the regulator due to the RP's liability and the regulator's enforcement. The RP hires one contractor to complete the investigation and design, and another to perform the cleanup. The conflict of interest is created if, to reduce the bottom line, the RP tries to influence the contractor to follow a more economical approach that may not lead to acceptable cleanup levels (exit strategy). If the contractor disagrees with the RP, the contractor can maintain its stance and not significantly hurt its reputation or financial situation. Without backing of technical expertise, the RP eventually must concede to the regulator. If the contractor does back the RP, it would probably only do so if there were solid evidence to support the merits of the inferior alternative as opposed to risking its reputation. Thus, the RP only has indirect control over the technical expertise resources backing a weaker stance on cleanup standards.

In a PBC, the contractor assumes all liability for the end state for the contract price. Thus, there is a more direct monetary incentive, along with more severe consequences for underestimating, for the contractor to follow a cheaper alternative that fails to achieve acceptable cleanup levels, and the contractor can no longer walk away without significant damage. This situation gives motivation for the contractor to provide technical expertise (that it controls) backing an inferior cleanup alternative or standards. Conflict of interest arises between the regulator and the contractor over differing expert opinions over cleanup methods and project end state (exit strategy). As the contractor has direct control over his technical expertise resources to support his position, the conflict may become more difficult to resolve. Such a conflict resolution requires a more open communication and consensus agreement between the contractor and the regulator. Progress toward cleanup complete becomes very critical in such cases.

In summary, regulatory agencies—especially state agencies—will be directly impacted by the implementation of any PBEM process, and the success of PBCs very much depends on regulatory participation and concurrence in the processes. At every stage of PBEM implementation, adherence to state-promulgated regulations, compliance with all ARARs, pubic participation and inclusion as needed, maintenance of quality in reporting and data submissions, and accommodation of state regulatory processes to work seamlessly are all essential and critical. As discussed in the following sections, systematic planning processes and open communication throughout the process are essential.

2. BASIC CONCEPTS

PBEM is a common-sense approach for reducing the uncertainties in site remediation and enhancing the decision-making process to achieve effective and efficient cleanups. It is nothing new but a systematic compilation of several components that can make the remediation of contaminated sites reach the cleanup goals and thereby reducing the impact that contamination may have on water and land resources. Performance-based approaches in government (Virginia Department of Planning and Budgeting 2007) and in the information technology (Cokins 2004), medical (Chapin and Fetter 2002), and insurance (Hall 2003) industries have been implemented for a long time. This document aims to apply tools successfully applied in other areas to contamination remediation activities.

The RPO Team reiterates that the individual elements of PBEM are concepts that have been in existence for a long time, but the process discussed in this document helps, in a systematic way, in reaching the final goals of a remediation process with a focused and optimal approach that puts emphasis on results rather than milestones.

2.1 Relationship of PBEM to Other Related Concepts, Key Components, and Basic Concepts

As defined above PBEM is an approach to site remediation that uses a variety of basic concepts and key components or tools to achieve remediation goals. Several related concepts are variants on the same core theme of PBEM: efficient and protective site remediation. Section 2.2 presents related concepts, such as Triad, data quality objectives (DQOs), and others. This document is not intended to promote PBEM over any other concept; it is simply a presentation of PBEM as one option that a remediation program may choose to use in conducting efficient and effective site remediation. As presented in this document, PBEM is not a fixed, "must-do" set of steps or a rigid process to achieve site remediation; it is a recommended framework that can be modified to suit the needs of individual site remediation programs or projects.

Another important aspect of PBEM is that it can be applied to solving problems at a variety of levels. For example, from a programmatic level, an entity or agency can apply PBEM over a wide area. The Air Force can apply this approach at various bases for the implementation of remediation at a contaminated site. A state agency UST program can apply PBEM on a program-wide basis. At the same time, PBEM can just as effectively be applied simply at a single site (for example in a voluntary cleanup program). PBEM can be successfully implemented at almost every stage of the remediation process—in initial site characterization, assessment, complete characterization, pilot studies for remediation, implementation of a selected remedy, and LTM. Of course a PBC can also be applied at each of these stages in appropriate circumstances. PBCs are best applied where clear goals and metrics can be set and where all parties understand how risk and liability will be shared or allocated.

PBEM uses a series of eight key components (described later in Section 3) to manage site remediation. These components can be used individually, such as RPO. However, a PBEM project or program is a long-term, ongoing effort managed by an expert team that uses systematic planning to use the key components, as needed, over the life of the project. Key components may be applied at different points throughout the remediation, and a few are used throughout the process, such as the living CSM, but they are not a project management methodology on their own. These key components can also be thought of as best management practices (see Figure 2-1). Systematic planning is visualized as the thread that connects all these related topics and can be an important aspect of the entire PBEM process.

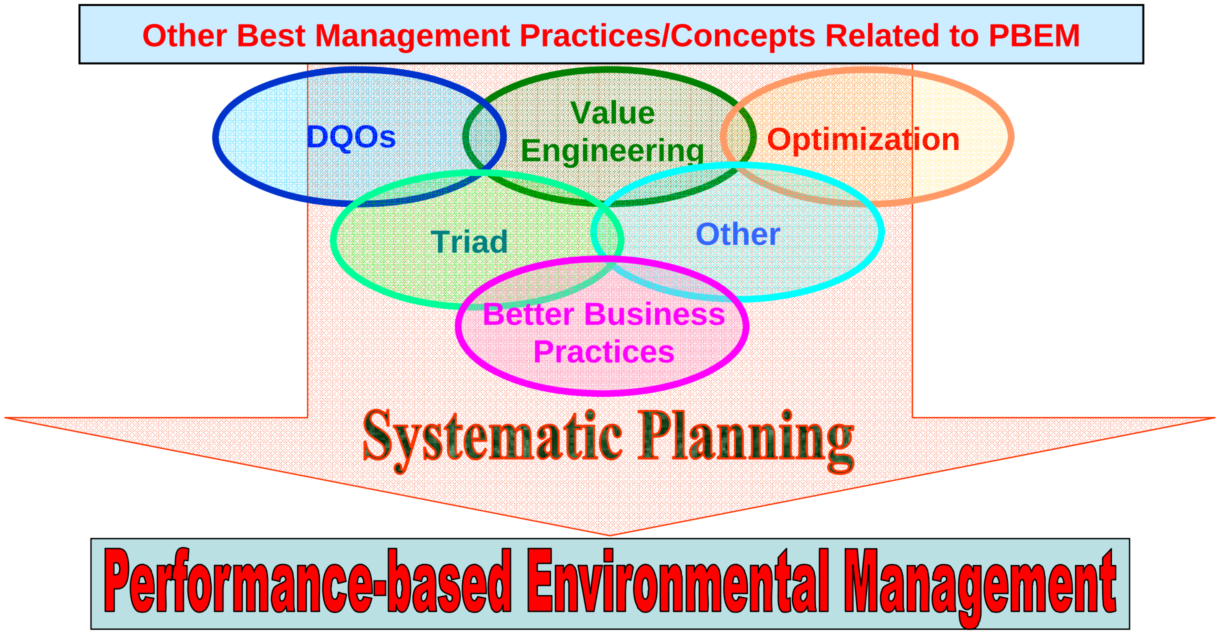


Figure 2-1. Best management practices.

Figure 2-2 depicts another way the relationship of the systematic planning and the role an expert team plays in the PBEM process can be explained. PBEM makes use of two basics concepts, the expert team and systematic planning, which are described below. The expert team uses systematic planning throughout the project to coordinate the use of various tools and resources, such as the key components and social capital to the best effect. Figure 2-2 presents the relationships between the expert team, systematic planning, and the key components. PBEM is the implementation of the project plan by the expert team. Systematic planning is discussed in further detail in Section 2-3.

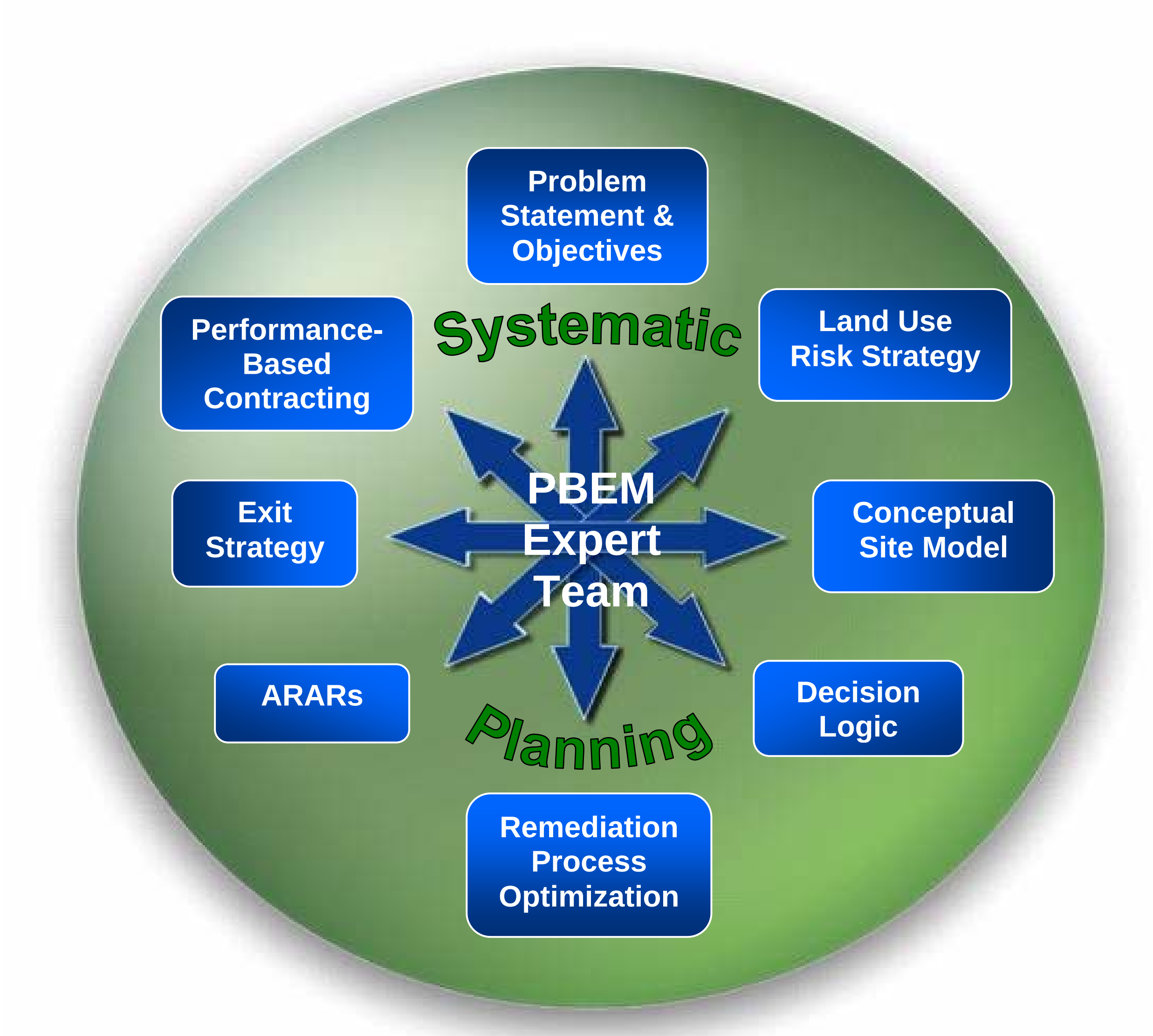
2.2 Other Related Concepts

The elements that are part of PBEM were discussed and implemented in concepts such as risk assessment, DQOs, Triad, VE, etc. To recognize and emphasize these concepts, and summarize how they are related to PBEM, the following sections are presented. The ITRC RPO Team takes care in this document to clarify that all these related concepts are complementing rather than competing concepts when compared to PBEM.

2.2.1 The Triad Approach for Site Cleanup

In cooperation with ITRC and other federal agencies, EPA has developed a work strategy framework called "Triad" to manage decision uncertainties related to the cleanup and reuse of contaminated sites. The Triad framework manages decision uncertainty by using the following:

- intensive, thorough, and systematic planning to define the technical and nontechnical issues and goals impacting the project
- a CSM constructed to reflect those issues and goals, which then serves as the hypothesis to be tested and refined over the life of the project



- **Figure 2-2. Relationships between the expert team, systematic planning, and the key components.**

- adaptive, real-time decision making using dynamic work strategies and preapproved decision logic to the greatest extent possible to increase project efficiency, transparency, and decision confidence, while decreasing project costs, time frames, and overall workload

By including dynamic decision logic, scientifically sound CSMs can be developed and corrected in real time, streamlining site activities and cutting life-cycle costs and lifespan. Systematic planning keeps all concerned parties informed, involved, and focused on project objectives throughout the cleanup process. Many of the principles of PBEM—expert team and communication hub; defined land use, problem statement, and objectives; and exit strategy—are essential components of the Triad approach as well. The Triad approach and PBEM are complementary, and both can be used to update the CSM and manage decision uncertainty site-wide and throughout the cleanup process.

ITRC published a technical/regulatory guideline (ITRC 2003) that describes the Triad approach in detail. Further information can be found at www.triadcentral.org.

2.2.2 Value Engineering

Developed at General Electric during World War II, VE was and is widely used in industry and government, particularly in areas such as defense, transportation, construction, and health care. The Office of Federal Procurement Policy requires every federal agency to maintain a VE program. VE is defined as "an analysis of the functions of a program, project, system, product, item of equipment, building, facility, service, or supply of an executive agency, performed by qualified agency or contractor personnel, directed at improving performance, reliability, quality, safety, and life-cycle costs" (see http://ve.ida.org/ve/ve.html). VE has proven to be highly cost-effective, but its use has been reduced or modified and incorporated into new processes that basically accomplish the same or similar objectives. VE was one of the first strategies whose goal was similar to performance-based service contracts. The Value Engineering Change Proposal Program was developed to find a process by which contractors could be rewarded for finding ways to procure services and goods for a lower cost (see www.vecp.com).

VE is applied to a specific product or service, for example, an assembly line where the same action is repeated at each line location. VE would seek to optimize the step so that it is conducted in the most efficient and cost-effective manner. Since each environmental project is unique, VE can be applied in only a limited manner. The basic principles of VE are implemented in PBEM; however, PBEM is designed to be more dynamic and holistic to adapt to the complex situations presented by restoration projects.

2.3 Systematic Planning

Systematic planning can be used by the expert team to manage the social and physical uncertainties that stand in the way of confident decision making to achieve the desired project outcome and is the forum for developing site-specific performance objectives.

2.3.1 What is the Systematic Planning Process?

The Systematic Planning Process (SPP) is an integrated and overarching approach to develop management plans that uses both the scientific method and nonscientific issues that influence site remediation, such as uncertainty about budgets and contracts, stakeholder interests and fears, legal concerns, and regulatory interpretation. To be effective, SPP must address all uncertainties that affect how a project's end goals are framed, shaping the decisions that must be made to bring the site to closure and reuse. The "human factor" is as integral to successful SPP as technological and scientific issues.

Whereas the SPP generates the environmental management plan, PBEM focuses on the process and the mechanism to implement the management plan. PBEM seeks to shift the focus of remediation efforts from process and milestones to performance and results. Performance and results are determined by objectively assessing progress toward RAOs and other site closeout criteria. Having a clear, widespread agreement on how to measure environmental progress, understanding what performance data tell us about the state of the environment and its impact on public health, and examining a range of strategies for achieving environmental goals are prerequisites for using PBEM successfully. To make PBEM a success requires using SPP in a results-oriented context, where performance goals and project uncertainty management strategies are transparently discussed and documented in the CSM.

Effective SPP consists of several activities, including the following:

- *Stakeholder involvement* builds a cohesive team of involved parties including the site owners, regulators, community members, tribes, and technical specialists suited to address site- and project-specific issues.
- *Identification of project objectives and goals* based on property reuse scenarios, known end uses, and probable remedies drives the decisions that need to be made.
- Design of sampling and data management activities to achieve project objectives manages the principal sources of uncertainty that affect decision making.
- *Design of the remediation approach, performance objectives, and performance metrics* enable the site to implement, monitor, optimize, terminate, and manage remedy performance.

SPP encompasses activities that extend beyond data collection to determine compliance with some action level or cleanup goal. During SPP, the CSM is used to help evaluate site reuse options, guide remedial design, and develop LTM strategies. SPP addresses the following key considerations:

- building consensus among project stakeholders
- clearly identifying project objectives, timelines, and other constraints
- developing a CSM and defining potential exposure scenarios
- addressing data and resource needs
- identifying project boundaries and decision criteria
- developing acceptable levels of uncertainty
- achieving agreement on ARARs and exit strategy
- developing approaches for managing programmatic and project nonscientific and scientific uncertainties
- translating project needs into sampling, analysis, and decision-making requirements

The foundation of SPP is formed by identifying stakeholders, articulating objectives, addressing constraints, recognizing the regulatory framework, and specifying decision statements. Achieving stakeholder consensus on reuse goals is an integral part of SPP, along with risk management, redevelopment concerns, scientific and legal defensibility, and site closeout.

2.3.2 When Is Systematic Planning Performed?

SPP is practiced throughout a project, not just in the beginning phases. It is an iterative process that continues as the CSM evolves. In building stakeholder consensus, developing a CSM, and defining potential exposure scenarios, SPP is applicable to most environmental remediation projects, from those for site assessment and investigation, to cleanup design and implementation, and to long-term operations and monitoring. For example, a site that is aiming to achieve closure can use SPP to bring together the key stakeholders needed to agree on the steps to reaching closure even when those steps do not include performing additional field activities.

2.3.3 Why Use the Systematic Planning Process?

Too often during the course of performing environmental investigations, insufficient attention is directed to establishing clear objectives for the work, which can lead to unproductive investigations that fail to efficiently gather the information necessary for scientifically defensible decisions. There are certain benefits that result from using SPP:

- encouraging comprehensive, careful planning by soliciting input from concerned customers and stakeholders
- addressing costs and schedule in the design phase, the critical time to address total project constraints
- communicating and documenting proposed activities and decisions to be made so that *everyone* has a common understanding of requirements when considering the data collection or work design, strategies, and the end use of products
- addressing the concerns of customers, suppliers, and relevant technical experts for products, services, and activities, thus minimizing the possibility of repeating work because of inappropriate or inadequate project implementation
- facilitating the application of promising innovative technology by reconciling technology capabilities with site-specific considerations

2.3.4 Products of Systematic Planning Process

There are several ways to document the progress of the SPP, such as correspondence, after-action reports, progress reports, and meeting or planning minutes. The products of the SPP include living CSMs, dynamic work strategies, demonstrations of methods applicability as necessary, and standard project planning documents (such as QA project plans, field sampling plans, environmental health and safety documentation, and standard operating procedures).

2.4 The Expert Team

The expert team plays an essential role by ensuring that the PBEM process is managed properly. The appropriate size and composition of this team will depend on the size, complexity, and specific features of the project; however, the collective knowledge of the expert team must cover all of the technical, regulatory, environmental, and contextual issues that pertain to the site.

2.4.1 Composition of the Expert Team

The expert team is led by a project manager with overall responsibility for the remediation project. The team must include experienced professionals. The exact composition of the expert team depends on the needs of the project but typically includes persons knowledgeable and experienced in geology, hydrogeology, risk assessment, chemistry, statistics, regulatory requirements; civil, process, and maintenance engineering; contracting; and stakeholder perspectives, etc. Ideally, the team includes experts with years of experience in systematic planning and on-site work. Members of the expert team must be conflict-free, and technical recommendations must be independent of any financial interests of the team members. The expert team must have the support of the highest possible level of authority in the organization's structure. To effectively execute a dynamic work strategy, the team members participating in the systematic planning must have the authority to make financial and programmatic decisions for the organizations they are representing.

The expert team employs consensus-based decision making. To be successful, team members must be able to work through technical issues in a nonadversarial manner. While team membership may changed through the course of a multiyear project, continuity over the life cycle of a project is beneficial since the team maintains a collective understanding of the technical and political issues.

Through systematic planning, the expert team implements the eight components of PBEM. An effective system for communication and information management is essential to successful implementation. The individual components of PBEM must be able to access the data and the findings of one another. The communication and information hub enables timely and efficient interaction and data transfer among the team members and between the team and the public and tribal stakeholders.

2.4.2 Social Capital

> It is not a matter of providing more information. It is a matter of understanding the basic beliefs of the other people at the negotiation table. (Heugens 2003)

An essential part of PBEM SPP is the development of "social capital"—the assets that enable disparate groups to achieve a common goal. Achievement of that goal does not necessarily require agreement, but it does require that all parties understand each other. Building social capital persuades parties to develop trust, express concerns, acknowledge the concerns of others, and become invested in finding creative, equitable, "win-win" solutions. Successful environmental remediation projects require that the responsible parties and their contractors, the regulators, and the tribal and public stakeholders work together. These parties have different perspectives and different interests in the projects; bringing these parties together to achieve remediation goals is an integral part of good project management.

2.4.3 Who Are the Parties among Whom Social Capital Must Be Developed?

Public and tribal stakeholders live with the effects and potential effects of both the contamination and the remediation project. Through their taxes, citizens finance the investigation and cleanup of these sites and have a major stake in understanding how the decisions are reached, what the impact of those decisions will be, and the long-term outcomes of those decisions. Therefore, public and tribal stakeholders need to be included in the decision-making process (see Section 4).

The RPs and Potentially Responsible Parties will fund restoration activities, so they have a vested interest in ensuring that decisions are legitimate and scientifically valid but not overly conservative.

Finally, the regulator plays a vital role in the restoration process to ensure compliance with laws and regulations, ensure technical competency throughout the process, and help all of the other parties come to consensus for action. These public employees may include the federal, state, and local levels; tribal regulators will also play an integral role in cases where tribes have regulatory oversight.

Other unique needs for individual sites can also come into play. Historical and archeological finds—including burial sites—have frequently affected restoration and future development decisions. An important consideration at some sites is sacred lands for indigenous people, which will have a major impact on restoration activities as well.

2.5 What Must Be Communicated?

The first obligation of the environmental practitioner is to communicate information that is current, accurate, and verifiable. The CSM is a powerful communication tool to gather all known technical data in one place, usually enhanced through graphical presentations. However, the CSM also offers a tool to record more qualitative ideas about the site. In particular, future land-use scenarios can be graphically presented in the CSM to assist in determining the level of precision and accuracy required for an investigation. For instance, preparing a site for use as a landfill requires significantly different levels of precision and accuracy than preparing it for a day-care center.

2.5.1 How Should Communication Be Established?

Communication among the parties must be established early, occur frequently, and continue throughout the project. All parties must be encouraged to hear and to understand the concerns of the others. RPs should be encouraged to communicate with regulators and with public and tribal stakeholders before a remediation contract is signed, since some remediation decisions may be explicitly or implicitly incorporated into the contract. All of the parties should have representation in the establishment of the expert team.

2.5.2 Benefits of Social Capital

A number of benefits come through the process of building social capital. One is decreased conflict and the concomitant decrease in the toll that the project takes on the participants. It lowers the "transaction costs" (investment of time, money, and stress) for people to work together cooperatively. If they have confidence that mutual cooperation is to their benefit, they are more likely to believe that the other parties are also cooperating in good faith. Social capital sets the stage for meaningful dialogue. The airing of competing interests and acknowledgement of uncertainties helps to lead to creative problem-solving to resolve issues (Pretty 2003).

Having defined PBEM, discussed similar and related concepts, set the stage for systematic planning, and established the need for an expert team and the importance of communication, we are now in a position to explain the elements of PBEM in detail.

3. PBEM COMPONENTS

During the development of this document, the ITRC RPO Team has considered and systematically arranged all aspects involved in the environmental cleanup process, from the time a release is reported to final cleanup complete stage is reached. The eight components (shown in

Figure 2-2) considered critical to most remediation sites are discussed in detail in the following sections. This document stresses that there is no specific requirement that all these components should be developed at each and every site. Some are more critical than others, depending on site-specific conditions. For example, if a state has maximum contaminant levels (MCLs) as the cleanup goals, further ARAR analysis may not needed at particular sites in that state. As another example, if reaching preestablished goals (MCLs or risk-based screening levels) is critical to a particular state, then the exit strategy for sites in that state may be achieving the goals for a chemical of concern being addressed in the cleanup process. No additional exit strategy development may be needed other than documenting "achieving the goal" as the appropriate exit strategy in a decision document.

Traditionally, implementation of any segment of a complete process is measured successful if it meets the appropriate challenges of the process involved at the time of the implementation of that segment. In the PBEM approach, however, each segment of a system is deemed successful only if it contributes to the overall goals of the system as a whole. In other words, the successes of individual segments or elements are not relevant as long as the overall objective of the entire process is not met. Thus, the PBEM process rewards the systematic approach in which overall success of a project is ensured as opposed to rewarding the meeting of milestones, as traditionally done. From this perspective, we now present the elements of the entire site remediation process—from initial investigations to final remediation complete and system removed from the site—that are essential in understanding and implementing the PBEM process.

3.1 Problem Statement and Objectives

To have a successful project using PBEM, the project objectives must be clearly identified at the beginning of the project so that the performance goal of PBEM can be established. The problem statement associated with the objectives then drives the approach to solve the problem to achieve the objectives and derive appropriate performance measurements during implementation to minimize the risk in achieving the objectives.

The first step in the process should be defining the environmental issues and developing an understanding of the project from the perspective of a well-staffed planning team. For an ER project with either RCRA- or CERCLA-based cleanup activities, the environmental issues associated with a project must be identified by the planning team. These issues could include broader concerns than the protection of human health and the environment of a site, including more specific issues for general beneficial uses, such as residential or industrial use of the site, or tailored concerns with a specific development, such as current or future development plans for the site. The planning team should consist of experts representing various stakeholders for the site, including—but not limited to—land use planners, environmental technical members, environmental regulators, financial analyzers, and possibly others. Other experts, as described Section 2.4, may be also involved in the planning team pending on the nature of the project.

Based on the understanding from the project team, a concise problem statement should be prepared to capture the environmental issues. The problem statement may include the following:

- the current and past conditions at the site causing the concerns

- the reasons for undertaking the actions to resolve the concerns, such as levels of protection of human health and the environment or compliance with regulations
- the remaining problem not resolved previously
- the regulatory, political, and nontechnical issues affecting how to resolve the concerns, such as ARARs or considerations for the environmental stakeholders
- the timeline to complete the remedial action to meet the ultimate site-use objectives
- the uncertainties and associated CSM assumptions made by the team, their impact on the effectiveness of decisions if they are determined to be incorrect, and approaches for uncertainty management

The project team may divide a more complex project into segments so that more specific problem statements can be used to address a phase or section of the project. However, the specific statements for each segment of the project must ultimately be consistent with the overall problem statement of the project.

With an understanding of the environmental issues and more concise problem statement, the planning team then can develop the performance objectives to resolve the environmental issues and to meet the goals of a remedial project. The performance objectives should consider the ultimate goals in social, economical, and political settings of the site, including the future land development and social and economical impacts to the communities. However, the performance objectives should also include a reality check in comparison to the site goals, such as the available resources (funding, staffing), constraints (regulatory, political, and third-party stakeholders), and schedule of implementation.

3.2 Land-Use Risk Strategy

Land use is how a contaminated property will be used after the completion of remedial activities—commercial, industrial, residential, agricultural, or recreational, for example. "Land-use risk strategy" refers to the management of risks through control of current and future use of real property. It is important for a remediation project to identify and take into consideration future land use. The land-use risk strategy provides the bridge between land-planning activities and environmental cleanup activities.

Land-use controls (LUCs) have become an important part of remediation actions nationwide. Major cleanup decisions are being made with LUCs in place. They are being applied not only on the properties owned and controlled by RPs but also for off-site properties owned by others and stakeholders.

RAOs are specific goals to protect human health and the environment. Usually developed in the RI/FS phase of a project, they provide the foundation upon which RA cleanup alternatives are developed. These objectives are developed considering exposure routes; human, ecological, and environmental receptors; protection of groundwater resources; and potential future land use.

PBEM promotes the targeted attainment of RAOs. PBEM is a strategic, goal-oriented, uncertainty-management methodology that is implemented through systematic planning and dynamic decision logic focused on the desired end results. RAOs are developed to allow a contractor to perform or implement the selected remedy based on desired goals associated with future land use, instead of the traditional system where remediation means and methods are specified, with only the expectation that the goals will be achieved.

RAOs are usually based on available information, standards such as ARARs, and risk-based levels established in risk assessments. Projects are specifically designed to meet the RAO requirements. However, it is possible that the desired land-use application may not be practical based on data from the RI/FS. The remedial alternatives chosen for consideration to achieve a level of cleanup consistent with the anticipated future land use may not be cost-effective. These conditions may result in revising the RAOs, which may in turn result in selecting a different land usage and a different remedy.

Application of LUCs is the most recognized form of control for current and future use of real property. LUCs can include any type of physical, legal, or administrative mechanism that restricts 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 Oil and Hazardous Substances Pollution Contingency Plan. 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 management systems to ensure compliance with land-use restrictions.

As an example of applying LUCs, the EPA has developed guidance for consideration of land use during the remedy selection process under CERCLA at NPL sites. CERCLA, also known as "Superfund," authorizes EPA to clean up uncontrolled hazardous substance releases and was originally established as a fund to pay for such cleanups.

EPA encourages early community involvement, with emphasis on desired land uses, to promote a more democratic decision-making process; greater community support for selected remedies; and more expedited, cost-effective cleanups. After a remedy has been selected, based on the RAOs, EPA's ROD then describes the site and the contaminants associated with the site, along with the effected medium or media. The selected remedy determines the cleanup levels and the volume of contaminated materials to be treated and contained. Consequently, the selected remedy determines the size of the site that can be returned to productive use and the specific types of uses that may be implemented after construction is completed.

EPA has an incentive to reuse remediated contaminated sites, if feasible. However, based on various regulations and guidance, there are risks associated with deciding on land use and properly applying federal, state, and local requirements. The volume of contaminants to remain on site and the degree of residual risk at a site may affect future land use. According to EPA guidance, sources and types of information that may aid in determining the reasonably anticipated future land use include, but are not limited to, the following:

- current land use
- zoning laws
- zoning maps
- comprehensive community master plans
- population growth patterns and projections (e.g., Bureau of Census projections)
- accessibility of site to existing infrastructure (e.g., transportation and public utilities)
- ICs currently in place
- site location in relation to urban, residential, commercial, industrial, agricultural, and recreational areas
- federal/state land-use designation (Federal/state control over designated lands ranges from established uses for the general public, such as national parks or state recreational areas, to governmental facilities providing extensive site access restrictions, such as DOD facilities.)
- historical or recent development patterns
- cultural factors (e.g., historical sites, Native American religious sites)
- natural resources information
- potential vulnerability of groundwater to contaminants that might migrate from soil
- environmental justice issues
- location of on-site or nearby wetlands
- proximity of site to a floodplain
- proximity of site to critical habitats of endangered or threatened species
- geographic and geologic information
- location of wellhead protection areas, recharge areas, and other areas identified in a state's Comprehensive Groundwater Protection Program

These types of information should be considered when developing the assumptions about future land use.

In addition to CERCLA, there are various established programs to address properties to be remediated. Congress enacted RCRA primarily as a means to prevent accidental or negligent uncontrolled releases of hazardous substances, but RCRA also has provisions for corrective action when such releases occur. Generally, RCRA is delegated to state waste management programs, which write RCRA permits for financially solvent facilities so that permitted facilities may generate, store, treat, or dispose of a specified list of hazardous substances.

Both CERCLA and RCRA permit the use of ICs or LUCs, along with treatment and encapsulation of contaminants, as part of an overall site remedy. Both public and private LUCs may be used to protect the encapsulation of contamination. Private or (proprietary) LUCs include deed restrictions, covenants, and easements. Public (or governmental) LUCs include zoning ordinances and groundwater permitting programs.

Brownfields are real property, and the term refers to the expansion, redevelopment, or reuse of property that may have the presence or potential presence of a hazardous substance, pollutant, or contaminant. Fear of residual contamination and other factors leave these sites in disuse for years; however, the pace of brownfields redevelopment is increasing. A major reason for the acceleration has been a series of state regulatory strategies that allow partial cleanups as long as the materials remaining at a site do not create public health risks. The vast majority of the states, as well as Puerto Rico, have some form of voluntary cleanup program, based in either law or regulation, that allows for risk-based redevelopment of lightly contaminated sites. ICs are an important part of these programs.

DOD's environmental cleanup program, the Defense Environmental Restoration Program, was established by Congress to identify, assess, and clean up past hazardous waste sites on DOD installations. The DERP and MMRP are DOD's programs for meeting its responsibilities under CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986, Executive Order 12580 as amended by Executive Order 13308, and for eligible sites identified under RCRA.

Land Use Resources

The Land Revitalization Initiative (www.epa.gov/oswer/landrevitalization/basicinformation.htm) assists EPA managers and staff as they work closely with federal, state, tribal, public, and private stakeholders to facilitate contaminated property cleanup and reuse. Cleaning up previously contaminated properties for reuse can help reinvigorate communities, preserve green space, and prevent sprawl. Revitalized land can be used in many ways, including the creation of public parks, restoration of wetlands, and establishment of new businesses. EPA created the Land Revitalization Agenda to integrate reuse into EPA's cleanup programs, establish partnerships, and help make land revitalization part of EPA's organizational culture.

Sustainable Management Approaches and Revitalization Tools electronic (SMARTe, www.epa.gov/swerosps/bf/tools/tti_smarte.htm) is a joint effort of the U.S. German Bilateral Working Group, EPA, and the ITRC Brownfields Team. The tool is intended to be used by brownfields project stakeholders for assessing both market and nonmarket costs and benefits of redevelopment options, clarifying both private and public financing options, evaluating and communicating environmental risks, and facilitating access to pertinent state-specific information that relates to specific projects. SMARTe provides analytical tools needed to implement and integrate each component of the decision process.

DOE's EM Program was established in 1989 at offices around the country to address the environmental impacts associated with more than 50 years of nuclear weapons production in the United States. The EM Environmental Restoration Division is specifically charged with assessing the nature and degree of contamination at these testing areas, as well as developing appropriate cleanup strategies or corrective actions.

Additionally, military/federal facility sites also often have unique contaminants not typically found at other sites—including UXO and radiological contamination—that cannot be remediated to unrestricted use standards. Thus, at military/federal facility sites, LUCs are primarily employed in lieu of complete remediation for the following reasons (or combination of reasons):

- A determination has been made that the redevelopment and reuse of the property (as directed in the reuse plan and subsequent documents) does not require remediation to unrestricted use standards.

- The costs associated with remediating the property to unrestricted use standards makes reuse unfeasible.

The following example illustrates how land-use risk strategy should have been applied to prevent the aftermath of Hurricane Katrina in New Orleans. New Orleans has been deemed a land-use risk since the area is located below sea level and is usually inundated with tropical storms or hurricanes that have caused severe flooding and damage. On August 29, 2005, a Category 5 hurricane swept over and flooded the New Orleans area. Several Superfund sites were affected by Hurricane Katrina, with storm waters causing remediated sites to spread contamination. One such site, the Agriculture Street Landfill site, was located between the French Quarter and Lake Pontchartrain. The 95-acre Superfund landfill contained municipal garbage and industrial waste containing lead, arsenic, dioxin, carcinogenic hydrocarbons, and DDT. Prior remediation measures included fencing, an impermeable liner, and two feet of clean soil. As the result of the hurricane, several feet of floodwaters from the storm and collapsed levee system inundated the site. EPA is currently investigating to find out whether the floodwaters released contaminants contained in the capped site and caused the spreading of hazardous waste. There are other Superfund sites in the New Orleans area with similar situations. In these cases, RAOs were not developed or did not consider the consequences of potential flooding caused by storms.

PBEM is a good tool to apply in these types of situations, especially since the potential risks (flooding from tropical storms and hurricanes) are known and the desired goals (RAOs) for implementation could be determined.

While it was reported that the risk of failure of the industrial canal levee system was deemed low, the consequences of failure to the sites were great. Therefore, the potential hazard would justify a more extensive protective system. The potential for contaminants to migrate is real, and the multimillion dollar remediation completed a few years ago is now considered to be worthless.

The PBEM tool factors the probability of failure by the consequence of failure to develop a consistent overall risk coefficient. This method can be used to rank the different potential solutions and is useful when various parameters can be quantified. Table 3-1 offers an example with three options for site remediation. Where unified factor = probability of failure × consequence of failure, Option C provides the lowest unified risk.

Table 3-1. Ranking of potential solutions

	Option A	**Option B**	**Option C**
Probability of failure, %	50	20	5
Consequence of failure, units of material	1	1	1
Unified factor	50	20	5

Applying PBEM becomes problematic when the criteria are difficult to quantify. For example, it is difficult to determine how groundwater contamination will flow in fractured bedrock. Developing a useful groundwater model is difficult due to uncertainties in the input data in such circumstances. If the assumption of flow direction is incorrect, the contamination will not be contained and the site will not be remediated.

Another problem is encountered when using criteria that are extrapolated beyond reasonable certainty. For example, a site near a river could be determined to be safe from erosion for a limited number of years, but it may be in danger of containment failure due to the river meandering if the design life is too long.

By applying PBEM in developing land-use risk strategy, contaminated site remediation will have a greater probability of success because various parameters will be included in the development of the remedy. The site will be constructed to withstand severe situations, investment in the project will be protected, and the cost savings over the long term will be beneficial. The various programs previously explained have useful specific guidance to be applied to sites to be remediated.

3.3 Conceptual Site Model

The CSM synthesizes and crystallizes what is already known about a site that is pertinent to decision-making requirements. It is a mental picture of how the contaminants released at a site interact with the environment and potential human and ecological receptors. It is built on all currently available information about site conditions that could influence future remedy selection, design, or performance. Thus, the CSM forms the basis for defining and implementing an overall strategy for the site under PBEM.

A CSM incorporates several diverse elements:

- nature and extent of contaminant (including source types and affected media, as well as contaminant variability in time and space)
- contaminant fate and movement in the environment
- site geology and hydrogeology
- biological conditions (e.g., microbial communities, available habitat)
- geochemical conditions
- monitoring points
- risk assessment
- receptors and potential receptors under current and reasonably expected future exposure scenarios
- past remedial actions and locations of remedial components and monitoring points
- historical, current, and expected future land uses
- other factors relevant to the understanding of contamination at the site

The understanding of these site mechanics is always imperfect. Any CSM has aspects that are not as well understood or are poorly defined; thus, there are likely "data gaps" that will need to be filled to improve the CSM. The CSM should guide data collection at any stage of the project (ITRC 2003). As new data are collected and interpreted, their consistency with the existing CSM must be evaluated. If the data appear to be inconsistent with the CSM, they are subjected to increased technical scrutiny for validity. If the data are valid, the CSM is updated to reflect this new information. While it is expected that data gaps will be reduced as new data are integrated, additional data gaps may become apparent as the CSM evolves. This loop of using the CSM to focus data collection and using the collected data to update the CSM is fundamental to PBEM.

Using best management practices, such as a Triad strategy or rapid site characterization, uncertainties in the CSM should become small and manageable for making necessary site decisions.

The CSM should be developed by a multidisciplinary team including various technical disciplines, such as risk assessors, hydrogeologists, biologists, chemists, and managers. Each discipline provides key pieces to the CSM, and communication among these team members is critical. Each discipline is also be responsible for critical review of the CSM in light of its work. Further, the "living" CSM should be documented by the project team to provide a concise summary for new team members. The documentation should include text and schematic drawings that highlight the interdependencies of the site physical, chemical, and biological aspects. It must be routinely updated to reflect additional information on site conditions and land use. Finally, the CSM is a necessary tool throughout the life cycle of a project, from site discovery to site closure. Additional information relevant to updating the CSM is collected throughout the project life cycle from initial site investigation phases, to bench or pilot studies, remedy performance monitoring, and finally, confirmatory sampling taken at the end of site cleanup.

An example can illustrate the significance and the importance of a CSM. Figure 3-1 illustrates an original CSM based on initial understanding of the geological and hydrological conditions at a contaminated site. The primary receptor to be protected is the main aquifer zone, which is a potential source of drinking water. As more data are gathered and additional information is compiled, the initial clay layer separating the upper and lower aquifer is found to be less competent and less continuous than originally believed. After revising the geological details from additional wells, cone penetrometer points, etc. at the site, the CSM is revised (Figure 3-2) to include a permeable layer within the original confining layer between the two aquifers, suggesting a potential downward movement of contamination.

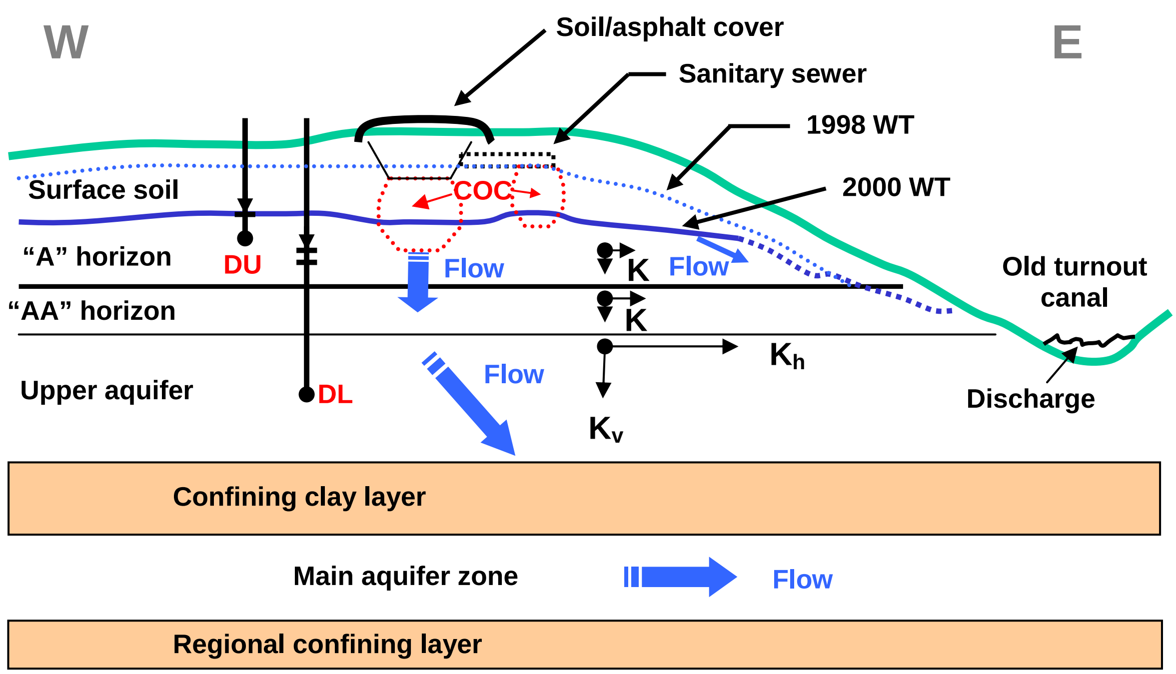


Figure 3-1. Initial conceptual site model showing a confining layer between two aquifers.

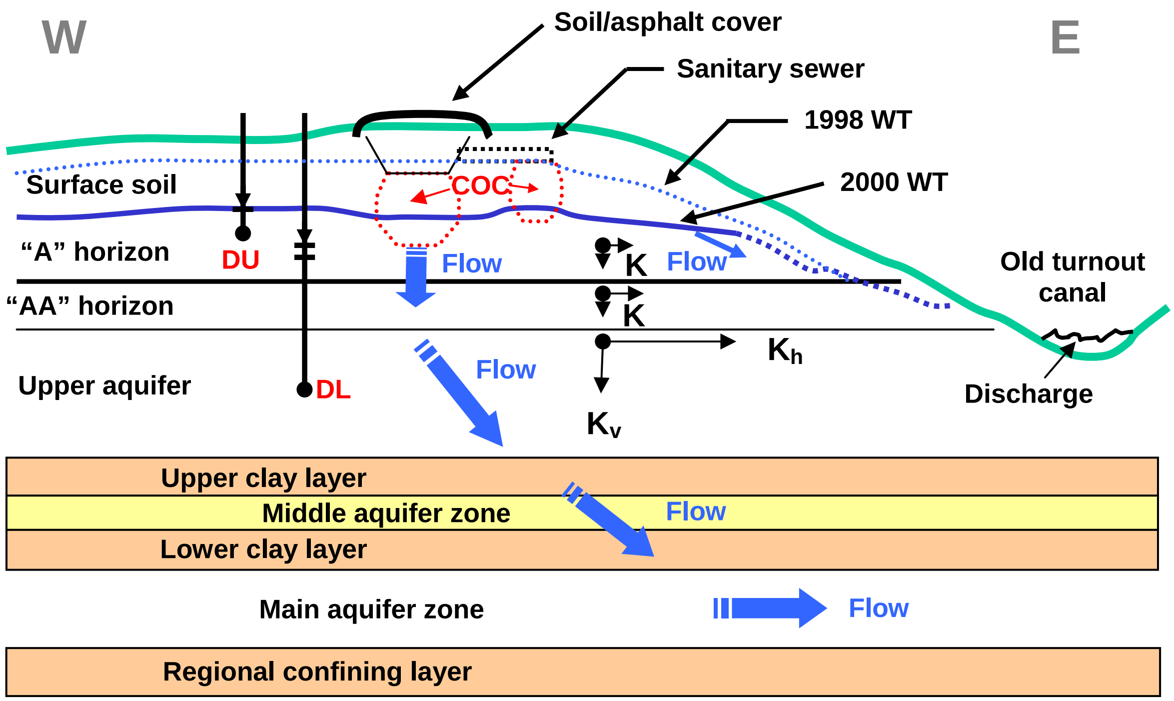


Figure 3-2. Revised conceptual site model suggesting a potential downward movement of contamination.

3.4 Using Decision Logic in PBEM

To provide a flexible and expedited framework by which decisions can be made, decision logic can be prepared to document key milestone events when performance metrics can be compared to expectations and goals. The framework will encourage remediation decision makers to develop performance metrics to objectively assess progress toward achieving RAOs. Further, documented decision logic offers a method to expedite decision making by preestablishing a consensus on appropriate actions given a set of assumed conditions. 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 on the project team, among the owners, on the regulatory staff, or with any other stakeholders. With a documented decision process, the "reeducation" process of new parties to the cleanup will be reduced. Since one of the keys to PBEM is flexibility, this flexibility must also be documented.

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

3.4.1 Levels of Decision Logic Development

Applications for decision logic for environmental management are diverse. From the PBEM perspective, decision logic is applied at the program level to address facility-wide management issues, at the project level to address adaptive site management, or at the field level to address how decisions regarding the need to collect additional data to support CSM refinement will be made.

3.4.1.1 Program-Level Decision Logic

Sites are typically addressed as individual projects or operable units (OUs), even if the projects or OUs are adjacent to one another. At the program level, decision logic links all of the projects located on a facility or managed together by the responsible organization with a vision for site restoration, reuse, or transfer. This step is particularly important when considering such issues as contaminated groundwater and future land-use options. Applying a program-level viewpoint may reveal that a group of sites can be efficiently handled together as opposed to remaining separate entities and may impact the goals for individual sites. Factors such as the need for rapid cleanup to support property transfer or the need to level environmental cleanup expenditures over time are considered in developing program-level decision logic. Appendix B provides an example of program-level decision logic.

3.4.1.2 Project-Level Decision Logic

Decision logic for a project addresses possible future actions on the individual project based on observations made at the project site. The project decision logic identifies the steps and decisions for the entire process of moving the site from its current state to closure and is modified with additional detail as the site evolves through various phases (e.g., technology screening, O&M, or site closure). Example project decisions include whether or not to conduct an RI, the need for remedial or corrective action following characterization, the appropriateness of a specific cleanup technology, modifications to LTM programs, and the attainment of cleanup. Goals for the field activities may even be reprioritized based on findings to address new issues. Decision trees and flow diagrams with supporting text provide the necessary structure and documentation of the process.

3.4.1.3 Field-Level Decision Logic

Decision logic for field work focuses largely on issues such as where to locate soil borings, what depth(s) to sample, and when to stop step-out sampling. Though most common in the site characterization phase, such work can also be part of other phases, such as pilot testing or confirmatory sampling for cleanup. An excellent example is EPA’s Triad approach, which emphasizes rapid decision-making based on real-time data collection and analysis. Prior to any field work, the project team must develop a clear understanding of the decisions that might be required during data collection, as well as who is responsible for making those decisions and informing other team members. This step may involve detailed decision trees or flow diagrams and specific decision criteria that are included in the dynamic work plan. These decision tools enable the field team to make valid decisions without delays to consult the project team or the regulators on what should be routine decisions. The decision criteria also have to account for circumstances that would require input from the project’s full decision-making team. In doing so, the planning of field-level decision logic can distinguish between decisions to be made in the field and those that require additional input from a larger set of decision makers.

3.4.2 How Is Decision Logic Developed?

The project team must translate the site strategy into documented project decision logic. This step begins with identifying the overall decisions to be made and developing alternative approaches to sequencing the data collection and decision making. The data to be collected (soil or groundwater concentrations, land-use observations, flow rates, etc.) and intermediate decision criteria are identified, as are various contingent actions based on the decisions. The intermediate criteria have to be measurable or answerable (clearly based on measurements or observations). The overall decision, including the criteria used to make the decision, are also be identified in the documented logic. The overall decision criteria (e.g., for cleanup alternative analysis or for site closure) may, for example, include specific ARARs or risk-based criteria.

Note that stakeholder input is critical to the development of decision logic that can be effectively implemented. The decision logic developed through such a consensus-building process allows decisions to be made and implemented without the need to reconvene the project team and stakeholders. Many decision points require input from the larger team and should be transparently discussed and documented.

Decisions may be based on uncertain and necessarily incomplete observations. The project team faces many decisions where the answers fall into three categories: clearly affirmative, clearly negative, or still uncertain. Where the answer for the decision is uncertain, the project team needs guidance from stakeholders; contingencies must be developed for unexpected but conceivable outcomes. Because decision logic cannot anticipate all conceivable outcomes, it may be necessary to reconvene the project team to evaluate alternatives in light of the unexpected information. However, the goal in developing decision logic is to minimize the effort necessary to reach consensus on the path forward.

3.4.3 Documenting Decision Logic

Documenting decision logic for future use is critical to provide continuity for a changing team. It also facilitates consensus among stakeholders by concisely summarizing the decisions to be made and what factors are considered in making decisions.

Decision logic can be written out as a text document. However, the most useful tools for both developing and following decision logic are graphical. Two types of graphical tools are in common use: decision trees and flowcharts. They can be developed manually using the graphical symbols and tools in Microsoft PowerPoint. There are also a number of commercial software packages available for producing graphical decision trees and flowcharts.

3.4.3.1 Decision Trees

A decision tree diagram (Figure 3-3) represents the series of decisions required for a given situation and shows the possible outcomes of each decision. More sophisticated decision trees can represent the probabilities of different possible outcomes, allowing the project team to evaluate risks and assist with decision making.

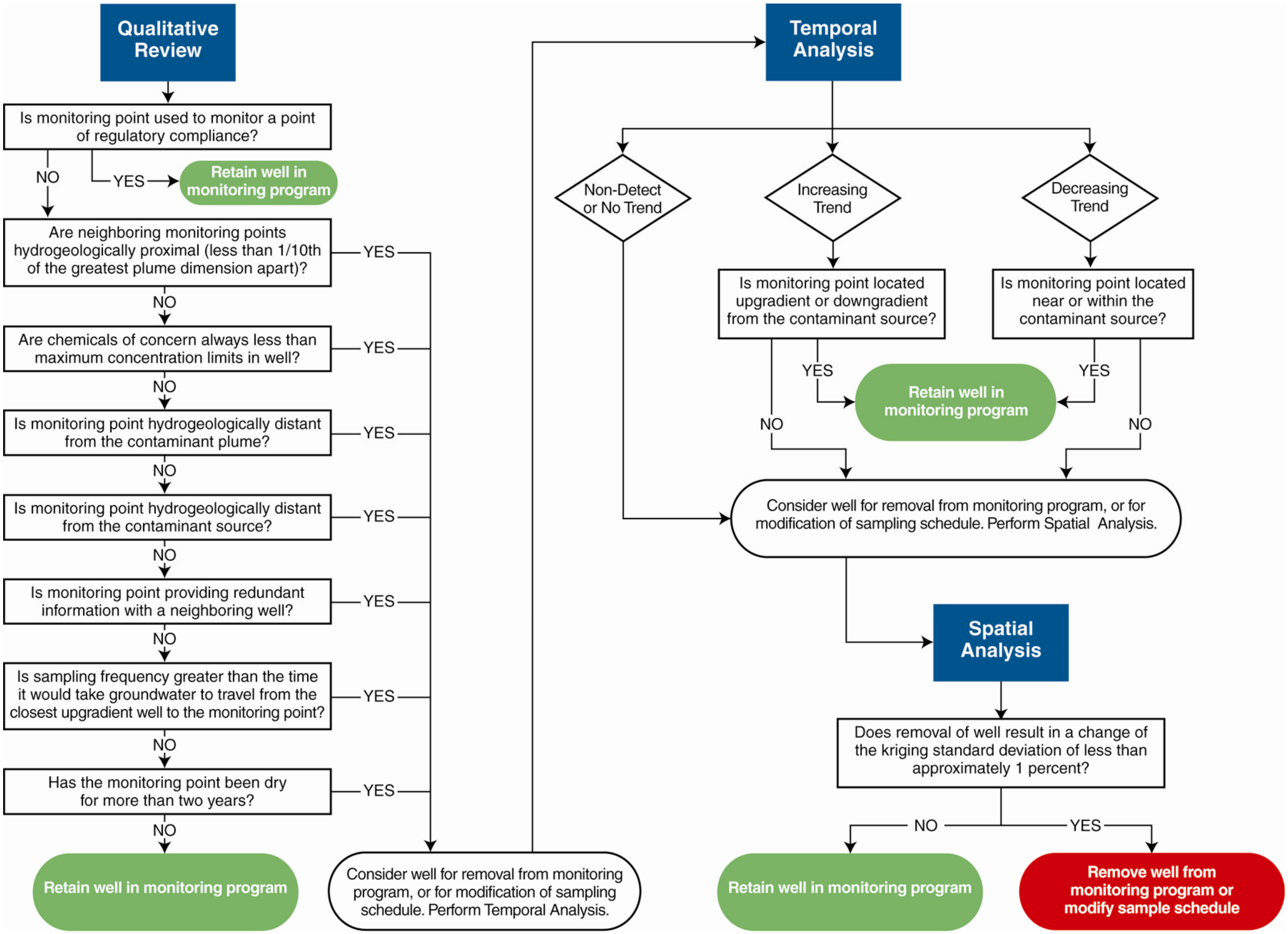


Figure 3-3. Example of a decision tree.

3.4.3.2 Flowcharts

A flowchart is a diagram that represents a process or a plan. It is useful because it can break down a process into individual steps or components with specific shapes used to denote actions and decisions (e.g., actions are shown as rectangles, decisions are shown as diamonds). Thus, the flowchart can be used to identify uncertainties, identify bottlenecks and inefficiencies, and explain the process to other people. Flowcharts should clearly spell out the steps to be implemented and identify who holds the responsibilities for different parts of the process, thus providing a basis for identifying potential problems.

3.4.4 Project/Field Decision Logic Through the Phases of Cleanup

As stated above, an overall decision logic for the project through site closure should be developed as a living document, periodically refined as the project evolves through different phases. Appendix B provides an example overall decision logic. The following sections discuss the more detailed decision logic that may be developed for individual project phases.

3.4.4.1 Characterization

Decision logic in the characterization phase is typically developed to guide the field activities to support site decisions such as whether remedial or corrective action is needed and, if so, what technologies may be appropriate. The decision logic includes both an overall characterization strategy for all site media and field decision logic to guide phased field work. For example, a major component of the Triad approach is the development of detailed decision logic to guide rapid characterization of the site. Appendix B contains an example of such field logic for characterization.

3.4.4.2 Feasibility Studies

Decision logic can be useful in assessing the applicability of various technologies to achieve environmental cleanup goals. The CERCLA feasibility study process, including screening of alternatives against nine specific criteria, is in essence a decision logic. Appendix B contains an example of decision logic for application of a specific technology relative to site conditions.

3.4.4.3 Remedial Design and Construction

Decision logic can be developed to guide design of specific cleanup components. Such a decision logic would be highly site- and technology-specific (see the example provided in Appendix B). Construction or short-term implementation of a cleanup technology may be phased in such a way as to take advantage of the site condition information generated as part of the initial installation (extraction or injection well installation, excavation and sampling, etc.). These data can be used to make decisions about the ultimate extent of the extraction or injection network or excavation limits. In other words, the construction information is used to further characterize the site. Construction can be blended with remedy operations through the phasing of the implementation of the remedy. Various components of the cleanup can be phased based on the results of the operation of the initial construction. For example, extracted soil vapor may be initially treated with a mobile thermal oxidizer, but when concentrations decline, construction of a long-term carbon treatment unit may begin, in accord with documented decision logic.

3.4.4.4 Post-Construction and Site Closure—the Exit Strategy—Decision Logic Inputs

As part of periodic remedy performance reviews, monitoring data are compiled and used to validate or update the CSM, the RAOs (including the ARAR analysis), and design and exposure assumptions. This updated information then is compared with expected conditions and the established performance metrics to assess remedy effectiveness and efficiency. A performance-based exit strategy ensures that most eventualities during remedial action implementation are readily managed by a predetermined decision logic that has stakeholder buy-in. This approach facilitates corrections that keep the strategy focused on the end goal of cost-efficient protectiveness in a reasonable time frame. Decision criteria can be developed to identify how performance monitoring data are used to assess performance and which conditions are cause for concern. A separate decision logic can be developed for tailoring the LTM program based on the progress of the cleanup. Appendix B contains an example of such decision logic.

In any long-term remediation effort, the potential exists for undesirable migration of the plume, persistent contaminant concentrations, or rebound of concentrations following cessation of active treatment or extraction systems. An appropriate exit strategy decision logic includes provisions for contingent actions in the event of such observations. When a remedy is failing to achieve RAOs, the underlying reason must be determined, and the RAOs, the means to achieve them, or both must be modified. Actions to improve the means include remedial system optimization involving replacement or supplementation of the selected remedy or a technical impracticability evaluation. Any modification to RAOs should be based on a reassessment of the need to achieve specific objectives to be protective of human health and the environment and the applicability or relevance and appropriateness of regulatory numeric criteria.

For example, if portions of a groundwater plume addressed by an extraction system are below cleanup standards for a predetermined time, the remedy should be scaled back and extraction focused in the high-concentrations areas. The decision logic should identify contingent actions based on continued monitoring for concentration rebound in the former footprint of the plume. Appendix B contains an example of the decision logic developed as part of a site exit strategy.

3.5 Remedial Process Optimization

RPO is a key element of PBEM and, as such, is a dynamic and flexible process that can be applied at any stage of cleanup. RPO allows for systematic evaluation and refinement of remediation processes to ensure that human health and the environment are being protected over the long term at minimum risk and cost. This section presents an overview; *Remediation Process Optimization: Identifying Opportunities for Enhanced and More Efficient Site Remediation* (ITRC 2004) details RPO strategy.

When RPO is applied early in a remediation project's planning phases, it ensures that appropriate and attainable cleanup goals are established using a recently updated CSM as the foundation for decision making. The life cycle of a remedy should be carefully planned, and a completion strategy to achieve site closeout should also be developed that recognizes the need for enhancing or revising the remedial approach as conditions change over the life of the project.

When RPO is applied during the remedial action operations phase of the project, there are often many opportunities for improving effectiveness of the remedy and reducing cost without negatively impacting protectiveness. Typical optimization recommendations include reducing redundant aboveground treatment processes, adding or deleting groundwater extraction wells to better address a changed plume, reducing O&M costs by identifying more efficient practices, and eliminating redundancy in monitoring. Candidate sites should be identified where the return on investment in RPO is likely to be high, for example, where the current system is not achieving remedial goals effectively or efficiently or where there are high annual O&M costs associated with systems anticipated to operate for many years.

There are several steps involved in performing an RPO evaluation on an existing remedy. First, the RPO review team should be carefully assembled, considering their objectivity, technical qualifications, and experience. Also, the regulatory framework should be well understood, as regulatory requirements can strongly influence which elements of a remedy can be targeted most successfully for optimization.

The first step of the RPO review team is to evaluate the exit strategy, the detailed plan for achieving the remedial action objectives. The exit strategy review includes an evaluation of the RAOs to verify that they are measurable, realistic (achievable in a reasonable time frame), and consistent with ultimate land use. The RAOs and the basis for selecting them should be articulated clearly in the decision document so that appropriate performance metrics can be developed and monitored to track progress toward achieving the objectives. Once the RPO team has reviewed the RAOs, the CSM should be carefully reviewed and updated as necessary to reflect current site conditions and evolving site and technical information. Finally, the RPO review team's exit strategy review should involve verifying that the approach to achieving closure or reuse is logical and realistic, from both technical and regulatory perspectives. It should be recognized that various remediation activities may be reduced or eliminated prior to site closure or attainment of long-term goals when continuation of these activities no longer contributes meaningfully to progress toward the RAOs. The decisions as to when and how to implement these interim changes should be planned for in an exit strategy document, such as in a decision tree or flowchart, and decision points should be based on reasonable metrics.

The next two steps in RPO are to assess the remedy performance and cost-efficiency. The remedy performance assessment refers to the progress toward meeting cleanup goals, and includes a system performance evaluation to determine whether a particular remedial component is meeting its design expectations. The groundwater monitoring program should also be evaluated for optimization opportunities. To evaluate remedial performance, O&M data are analyzed and compared with the cleanup criteria established in the RAOs. Common O&M data used for performance evaluations include contaminant concentrations, groundwater elevations, nonaqueous-phase liquid thickness, geochemical parameters, and system operating parameters. Plotting this data through time is one method for identifying trends and determining the progress towards cleanup goals. To evaluate the performance of specific engineered remedial components, O&M data are compared with the specifications from the original design and installation of the remedial system.

Remedy cost-efficiency assessment compares the actual O&M cost of a remediation system against projected costs and its progress toward achieving RAOs. Typical O&M costs include costs for labor, materials, utilities and fuel, monitoring, equipment lease, disposal fees, and administrative costs. Plots of cost and performance data should be used to track remediation system O&M costs, mass of contaminant removed or destroyed, and cost per pound of contaminants removed or destroyed through time since startup. Cost-efficiency plots can help to draw general conclusions such as that the system is operating efficiently as demonstrated by low O&M cost and high mass removal or that the system is experiencing a low efficiency as indicated by increasing O&M costs or decreasing mass removal or frequent system shutdowns.

Once the exit strategy is reviewed and validated in the context of the refined CSM and regulatory framework and after cost and performance data for the current remedy are evaluated and a need for system optimization is identified, modifications to the current remedial approach may be considered. Some modifications may require amendments to formal decision documents, so early involvement of regulators and stakeholders can facilitate acceptance and implementation of the modifications.

Optimization recommendations may include modifying the RA objectives based on updated site conditions or ARAR analysis, further refining the CSM, using new technologies to expedite attainment of goals, and optimizing the monitoring program. Optimization recommendations may include altering the existing remedial system and making minor modifications to existing operations (e.g., adjusting flow rates) or adding/removing or replacing components (e.g., downsize pumps, change off-gas treatment, and remove extraction wells). If evaluation of the existing remedial system reveals that it cannot be reasonably modified to achieve RAOs in a reasonable time, then the overall remedial strategy needs to be revised. Outcomes may include performing additional source reduction or hot-spot treatment, replacing or supplementing the current technology with a new technology (e.g., monitored natural attenuation), or expanding the use of ICs to achieve protection. In any case, a cost/benefit analysis using life-cycle costs should be performed for each alternative. Once an optimization strategy is selected, an implementation strategy should be developed that considers technical, institutional, contractual, and regulatory challenges. This implementation strategy should also include a tracking system to periodically review the progress and to identify any barriers for implementing optimization recommendations.

3.6 Applicable or Relevant and Appropriate Requirement Analysis

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 RAO development and remedy selection 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 ARARs for the site may change.

As defined in *CERCLA Compliance with Other Laws Manual* (EPA 1998), a requirement under other environmental laws may be either "applicable" or "relevant and appropriate," but not both. Identification of ARARs must be done on a site-specific basis and involves a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate.

- *Applicable* requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- *Relevant and appropriate* requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

- *To-be-Considered Material* (TBCs) are nonpromulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. However, as described below, in many circumstances TBCs are considered along with ARARs as part of the site risk assessment and may be used in determining the necessary level of cleanup for protection of health or the environment.

ARARs can be one of the following types (see EPA 1998 for details):

- ambient or chemical-specific requirements
- performance, design, or other action-specific requirements
- location-specific requirements

PBEM involves the thorough assessment of ARARs to verify that the site goals that may be dependent on them are realistic (achievable), yet protective. This assessment 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 should involve team members that are familiar with current legal and regulatory developments.

As mentioned in EPA 1998, subsequent to the initiation of the remedial action, new standards based on new scientific information or awareness may be developed, and these standards may differ from the cleanup standards on which the remedy was based. These new ARARs or TBCs should be considered as part of the review conducted at least every five years under CERCLA §121(c) for sites where hazardous substances remain on site. The review requires EPA to ensure that human health and the environment are being protected by the remedial action. Therefore, to ensure that the remedy is still protective, it should be examined in light of any new standards that would be applicable or relevant and appropriate to the circumstances at the site or pertinent new TBCs. In certain situations, new standards or the information on which they are based may indicate that the site presents a significant threat to health or environment. If such information comes to light at times other than at the five-year reviews, the necessity of acting to modify the remedy should be considered at such times.

As noted in 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 any revisions to site planning documents.

3.7 Exit Strategy

An exit strategy is a detailed plan for accomplishing site-specific objectives to reach site closure within a defined period. Its purpose is to document clearly the pathway leading to closure/ response complete status, including consideration of contingency measures to be implemented should the progress vary from the plan. Preparation of a written exit strategy is an important component of performance-based management practices. As this component of the PBEM process is considered an important element of the entire process, a little more emphasis is placed on this section by the ITRC RPO Team.

The exit strategy describes how progress toward performance expectations and goals will be pursued and measured. A performance-based exit strategy focuses on performance (i.e., progress toward achieving RAOs) to routinely optimize the selected remedy and RAOs as information improves. Such exit strategies are dynamic and explicitly incorporate the flexibility needed to refine the strategy as site and technical knowledge improve over time and emphasize assessment and optimization of remedy performance to ensure timely, cost-efficient protection of human health. A performance-based exit strategy is based on sound scientific and technical understanding of site conditions and remediation technologies and is iteratively validated and updated through routine review to take advantage of lessons learned. These exit strategies should be constructed using objective metrics and transparent decision logic to describe how progress toward achieving RAOs will be measured and ensured and how "course corrections" will be implemented should the remedy fail to perform as expected.

Depending on the maturity of the environmental program at a given site, exit strategies reflect varying degrees of confidence in goal identification and attainment. Exit strategies for sites still in the remedial decision planning process are necessarily more conceptual in nature. When the remedial decision is finalized, the exit strategy should be updated to reflect the RAOs, the remedial components, and the implementation plan. As noted, stakeholder input is an important part of the response decision planning process. Therefore, good communication among stakeholders during remedy evaluation and selection is essential to establish common ground for dialogue so that expectations and concerns are identified and considered in the exit strategy. Military installations or facilities with multiple cleanup sites should develop an exit strategy for each site (Figure 3-4) and an overall comprehensive exit strategy for the installation or facility (Figure 3-5).

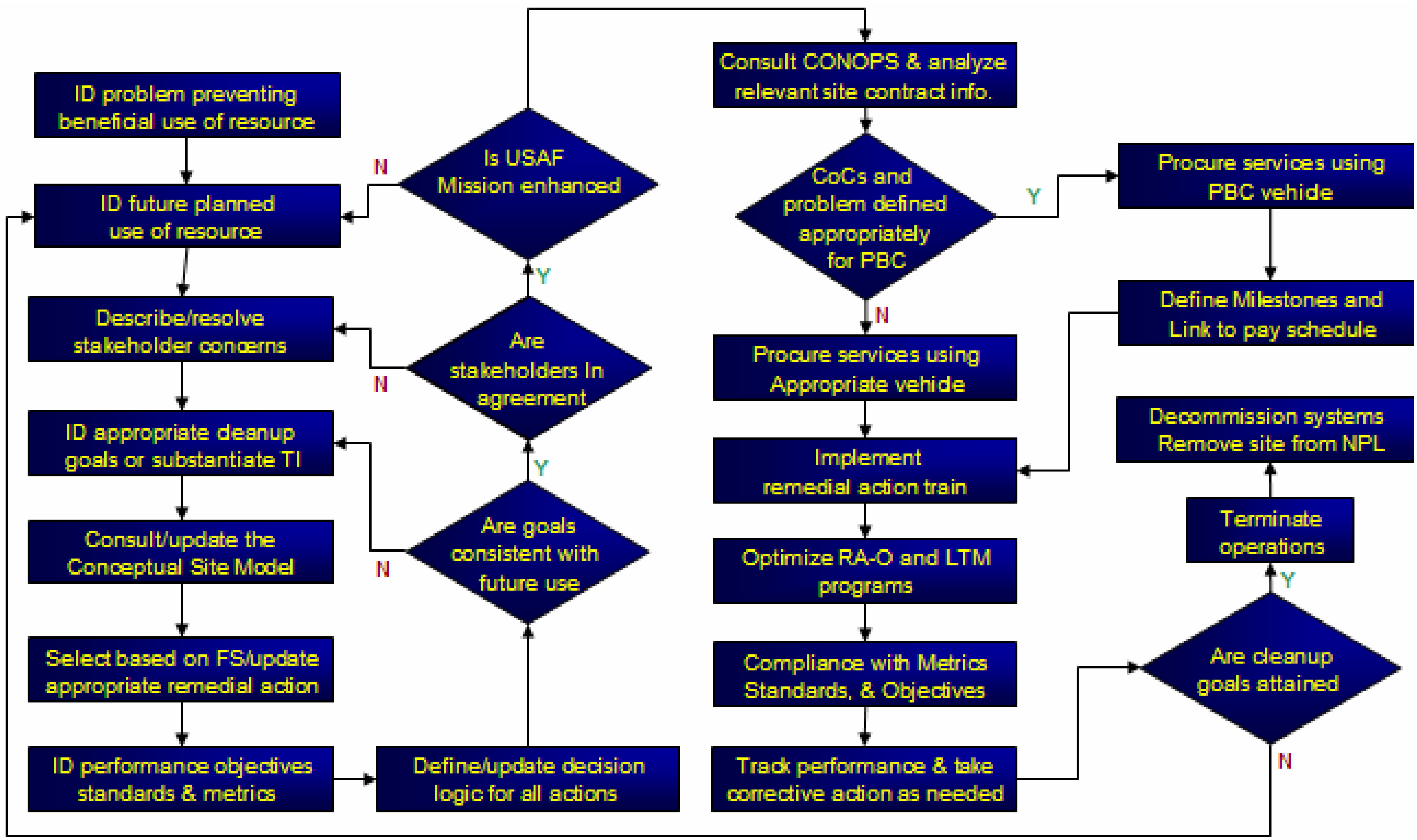


Figure 3-4. Sample U.S. Air Force site-specific exit strategy.

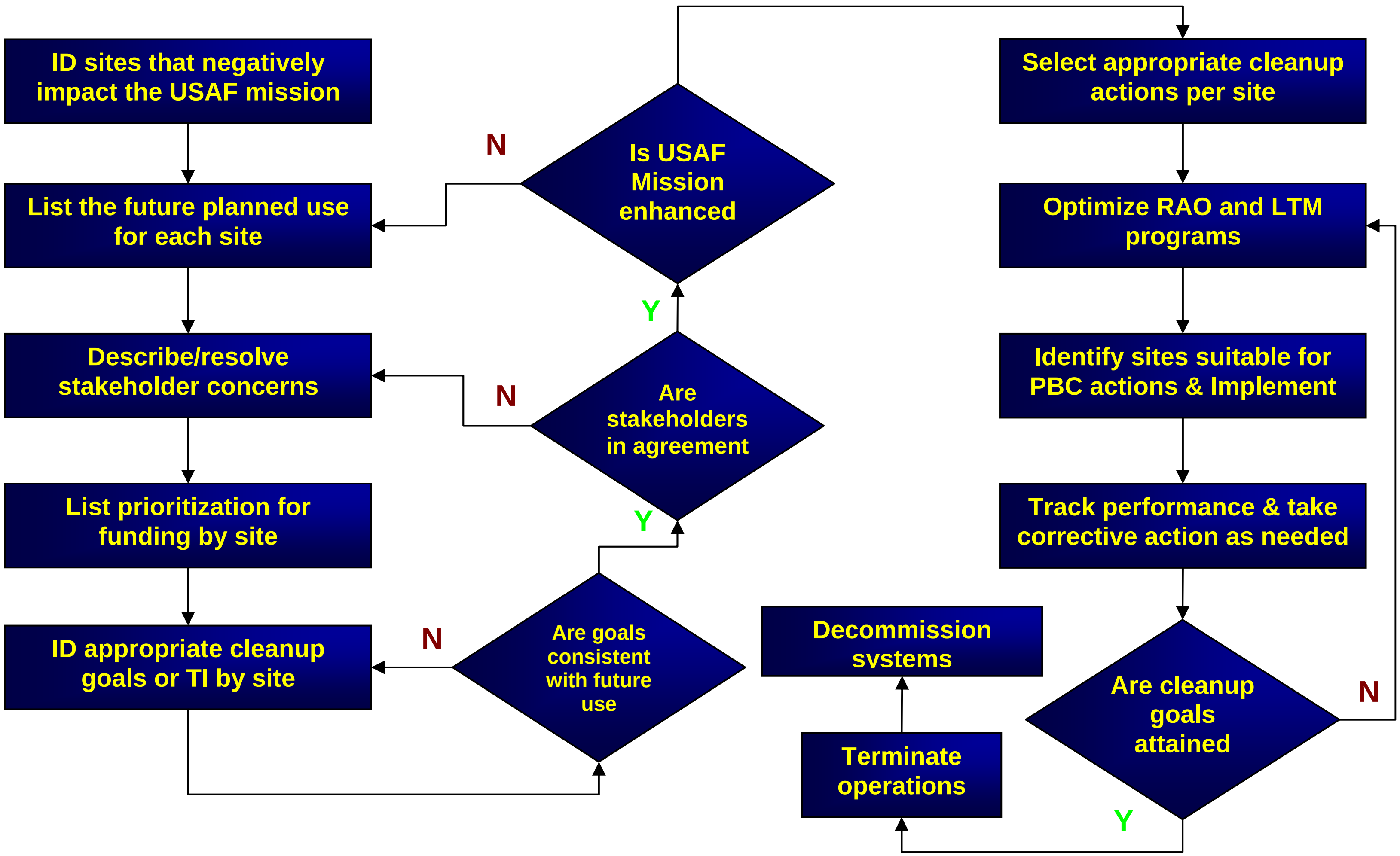


Figure 3-5. Sample U.S. Air Force installation-wide exit strategy.

3.7.1 The Benefits of an Exit Strategy

Preparation of a written exit strategy can benefit a cleanup program in the following ways:

- Planning and documenting the exit strategy provide an opportunity to obtain buy-in to future actions and contingency measures from all stakeholders, thus avoiding potential disagreements when contingency actions are implemented.
- A carefully planned and documented exit strategy is a necessary part of an installation's Management Action Plan or Base Closure Plan.
- A planned and documented exit strategy is needed to prepare the annual cost-to-complete (CTC) estimate, as required by the DERP.

3.7.2 Components of an Exit Strategy

The necessary components of an exit strategy are described generally here; specifics differ from one site to another. The exit strategy document should include at least the following elements:

- a summary of the technical and regulatory basis for the selected action
- a description of the remedial components and actions that are planned
- a remediation and monitoring schedule
- a list of metrics to be used to measure progress
- a description of potential contingency measures
- a description of conditions required for site closure
- a written or graphical summary of the decision logic showing the planned action steps, performance metrics, decision points, conditions that elicit alternative actions, contingency actions, and conditions required for response complete

3.7.3 Technical and Regulatory Basis for Cleanup

A defensible exit strategy starts with a summary of necessary and practicable cleanup expectations and goals. Cleanup goals should be defined by the nature of the problem being addressed, the scope of the action to be taken (e.g., containment, removal, or other remedial action), and the expected results or outcome of the action.

The CSM presents the status of engineering and institutional controls implemented at the site as well as current environmental risks and expected future land use considerations. An up-to-date, comprehensive CSM is required so that an accurate analysis of reasonable and achievable performance goals can be prepared. The current CSM, results of a risk evaluation, and consideration of statutory requirements form the basis for developing RAOs. Clearly defined and achievable RAOs are vital to efficient site remediation, and care must be taken to ensure that only necessary and practicable remediation commitments are made. As CSMs and RAOs are refined in the dynamic decision process, the exit strategy should be reviewed to determine whether is still applicable in light of the updated and more representative site characterization.

3.7.4 Description of the Planned Remedial Components and Actions

Once performance expectations and goals have been established, the means used to achieve those performance goals must be identified and implemented. An exit strategy includes a description of the selected remedy and its planned implementation, including the types of treatment and monitoring being performed. All selected remedies should be carefully evaluated for necessity and practicability (e.g., feasibility, reasonableness). In cases where there is potential for LTM after the remedy is in place or there is a potential for contaminant rebound after the remedy is completed, planned actions should consider contingencies as needed. For remedies with longer times to completion, phased performance expectations and goals may need to be considered to provide the basis for documenting protectiveness while still recognizing the potential for future opportunities to improve the reliability and permanence of environmental response actions. Remedial actions requiring more than 10 years to complete should be seriously scrutinized to determine whether human health and environmental protection is adequate during the interim.

3.7.5 Remediation and Monitoring Schedule

The exit strategy should include estimates of the expected time to implement the remedy, achieve intermediate milestones in the cleanup, and achieve site closure. These schedule estimates are useful for checking progress and verifying that the cleanup is on track as planned. A monitoring program is intended to accomplish the following:

- ensure protection of potentially exposed populations
- monitor changes in site conditions
- assess the efficiency and effectiveness (performance) of the remedy at meeting RAOs
- support decisions regarding the need to optimize the remedy
- support site closeout

Monitoring programs should be routinely reviewed and optimized to ensure that these objectives can be evaluated and that adequate and appropriate data are being collected at appropriate intervals. As remediation progresses and subsurface conditions change, the monitoring program should be optimized. The exit strategy should address how the monitoring program will change as the conditions change. While the monitoring program likely will be reduced as performance metrics are met consistently, the exit strategy also must plan for monitoring program expansion in the event of unforeseen changes in site conditions that adversely affect remedy performance (e.g., a new source, recognition of an emerging contaminant of regulatory interest, changes in land use or climate, plume expansion, undesirable by-product of remedial action). The basis for these changes should be documented in the exit strategy and in remedial action planning documents (e.g., site Sampling and Analysis Plan, O&M Plan). Iterative assessment and optimization of the monitoring program also should be performed to ensure that information required to document that closure criteria have been reliably met is well defined and is being reported as the project progresses. If there is any ambiguity as to what is to be documented or why, the potential exists to overlook important information or to accumulate unnecessary data, either of which will likely have negative impacts on exit strategy cost and schedule. Monitoring program reviews can be implemented annually as part of the annual groundwater monitoring and O&M reporting and can be conducted during RPO evaluations and periodic protectiveness reviews.

Execution of a performance-based exit strategy requires routine monitoring and comparison of observed site conditions to those predicted during the remedy planning process to assess the relative effectiveness and efficiency of the remedy. Most environmental regulatory frameworks require such routine performance assessments to ensure protectiveness and to document when RAOs and closeout criteria have been met. Although CERCLA requires that the performance of the remedy be evaluated every five years through a Five-Year Review, more frequent reviews of site data will evaluate performance and indicate in a timelier manner when corrections may be needed. These reviews provide an opportunity to accomplish the following:

- update site and technical information
- monitor progress toward achieving strategy objectives
- revisit ARARs, RAOs, and the selected remedy in the context of updated information and performance monitoring data
- apply lessons learned to optimize the exit strategy to achieve timely, cost-efficient, and reliable protection of human health and the environment

For performance reviews to be effective, appropriate evaluation metrics must be established, and performance monitoring data suitable to the metrics must be collected throughout the period of performance. Monitoring frequency and sampling locations need to be clearly defined, as well as how the data will be interpreted. The RAOs may specify that an average of the compliance points concentrations will be used to track performance and verify cleanup attainment as long as any exceedances are not greater than a specified value.

3.7.6 Performance Metrics

The exit strategy should describe in detail the metrics that will be used to assess the performance of the remedy. These metrics may include rate of mass removal, decrease in contaminant concentrations, changes in groundwater geochemical conditions, or other relevant parameters. These metrics may be measured at scheduled milestones or decision points and compared with project goals to assess progress of the remedy. When the remedy is performing as designed, the cleanup goals should be met within the design time frame unless unforeseen circumstances (e.g., changed site conditions) impact the performance of the remedy.

Metrics and interim milestones are the yardsticks against which progress—and success or failure—are measured. Performance metrics should be objective and specific and should represent stakeholder consensus so that the metrics are not subject to “second-guessing” as the project team changes. Performance metrics typically fall into three general categories:

- operational metrics for engineered systems (e.g., fluid extraction rates, treatment system efficiencies; discharge requirements)
- risk-reduction metrics (e.g., plume stability or recession, product or soil removal, and LUCs)
- Response completion metrics or site closeout criteria (e.g., RAOs, confirmatory monitoring requirements)

Operational and risk-reduction metrics also may serve as the basis for contingency triggers for supplemental or alternative measures, including focused RPO evaluations, if these metrics are not met within prescribed constraints. For example, if an operational performance metric of 99% average removal efficiency is established for an air stripper, with the metric based on the monthly average of weekly influent and effluent measurements, deviation from this metric during any three consecutive months might be used to trigger addition of a carbon polishing unit as a contingent measure. For phased remediation projects that include several steps between initial efforts and final site closure (e.g., initial removal actions or other interim remedies, phased implementation of the primary remedial action), interim metrics (milestones) should be developed to trigger the next phase of action. Also, there may be the stepwise optimization (scale-down) of remedial actions and monitoring as risks are reduced (e.g., as a plume footprint diminishes or influent concentration trends become asymptotic). The exit strategy should identify these interim steps and provide clear decision logic that specifies what conditions must be met before proceeding with the next modification, expansion, or contraction of the remediation.

The basis for the decisions can be simple economic (e.g., when funding is available for additional remediation wells) or engineering considerations (e.g., treatment process effectiveness as a function of concentrations) for the timing and scope of the changes. In other cases, the milestones may include the attainment of specific concentration goals in the subsurface or in extracted groundwater or soil vapor. Interim milestones also identify the targeted time frames for attainment of these goals. Modeling may be used to develop the target concentrations and time frames. Appropriate interim metrics and change milestones should be identified in the exit strategy and should consider both subsurface (e.g., change from active remediation to natural attenuation) and aboveground systems (e.g., change from thermal treatment of off-gas to carbon adsorption). The decision logic for making any changes should be reasonable, consistent with technical and regulatory constraints, and compatible with RAOs. Furthermore, practicability constraints are an important consideration in developing exit strategy performance metrics and RAOs and should be clearly defined and agreed upon by stakeholders during strategy development and refinement. Practicability constraints may include time, cost, accessibility, and technical limitations that are used to define what is reasonable and achievable within a reasonable time frame for reasonable cost (e.g., cost/benefit considerations). For more information on life-cycle cost and its potential application to site remediation projects, see the RPO Team's *Life-Cycle Cost* overview (ITRC 2006d).

3.7.7 Description of Potential Contingency Measures

Failure to meet the planned performance metrics at a decision point suggests that the remedy is not performing as designed and that contingency measures or alternative courses of action should be considered. For example, contingency measures may include steps to be taken when an annual performance evaluation discloses that a response is not performing as expected and alternative actions are necessary to achieve response complete in the scheduled time frame. An exit strategy should describe these potential contingency measures. The following alternatives should be considered as a minimum:

- optimization of current remedial technology or approach
- selection of a replacement remediation technology or approach
- revision of performance expectations and goals

Optimization of, or changes to, the currently implemented remedial technology or approach are usually made to enhance the effectiveness or efficiency of the remedy at attaining the performance expectations and goals initially established. These changes are usually a consequence of unexpected or unknown site-specific conditions that adversely impact remediation performance. Optimization is conducted by reviewing system performance and design and analyzing the source(s) of suboptimal performance, followed by design changes intended to overcome the site-specific conditions that affected performance. Section 6 contains references with guidance on system optimization from several sources, including EPA, ITRC, USACE, and AFCEE.

If it is clear that an existing remedial technology or approach will not be able to achieve initial performance expectations or goals even after optimization, alternative remedies should be evaluated. If all known technologies fail or the resource consumption is more harmful than the site conditions, the case should be reviewed to determine whether alternative methods of risk reduction should be implemented, a Technical Impracticality waiver should be attained, or it is advisable to document a decision to comply with alternative performance expectations and goals, which may involve formally waiving compliance with justifiable ARARs.

3.7.8 Description of Conditions Required for Site Closure

An exit strategy should include a description of the conditions that are required to achieve closure/response-complete status. Achievement of cleanup goals signifies that reduction and/or management of unacceptable risks has been completed. Completion of necessary and practicable response obligations means that the installation has addressed its currently known environmental response liabilities. Long-term environmental management strategies then would focus on facility-specific operational compliance issues and resource management, rather than past environmental damage.

3.7.9 Documenting the Exit Strategy Decision Logic

The exit strategy should incorporate the logic by which environmental, performance, and closure decisions will be made. This logic should include key milestone events when the performance metrics will be compared to performance expectations and goals. Results from these decision points could cause consideration of an alternative course of action as described above. Refer to Section 3.4 for detailed information on decision logic.

3.7.10 Common Obstacles to Implementing a Performance-Based Exit Strategy

Stakeholder disagreements regarding risks, ARARs, RAOs, selected remedy, practicability constraints, costs, and the schedule to achieve the RAOs are generally resolved during the remedy planning process. Resolution of these issues is documented in the formal exit strategy for the site and requires consideration of public input and concurrence among decision makers. Therefore, a well-planned, technically defensible exit strategy that has been agreed to by the facility owners/operators, regulators, and other stakeholders should be implementable in an efficient and effective manner. A sound CSM, necessary and achievable RAOs, well-defined performance metrics and monitoring requirements, and a clear decision logic that is consistently applied during routine performance reviews minimize implementation and optimization difficulties and are recommended for any new exit strategy. Primary obstacles to executing an exit strategy generally can be traced to deficiencies in the strategy elements themselves and are often encountered in attempting to execute poorly conceived or incomplete exit strategies. Many older exit strategies do not incorporate the elements of a flexible, performance-based strategy as defined herein and rarely incorporate decision logic for dealing with unexpected conditions or poor performance. These older exit strategies need to be carefully evaluated during performance reviews, and the basis for recommended improvements must be clearly explained and well supported. There are several key elements of an exit strategy, any one of which can undermine the success of the strategy if it is not based on sound science and a comprehensive understanding of site conditions, risk assessment, statutory considerations, and technical/practicability constraints. Potential obstacles to efficient and effective exit strategy execution could include the following:

- If the CSM is inadequate to support the risk assessment, ARAR analysis, or remedy decision, the exit strategy may require modification as additional data become available.
- If the RAOs are not necessary to protect human health and the environment, cost will be incurred on unnecessary actions.
- If the RAOs are not achievable, the exit strategy cannot be successful.
- If the remedy is impracticable or infeasible, the RAOs are unlikely to be achieved in a reasonable time frame.
- If performance metrics are unclear or the performance monitoring plan is inadequate to provide appropriate evaluation data, the effective and efficiency of the exit strategy cannot be assessed, and optimization needs may go unrecognized, resulting in wasted resources and delayed protectiveness.
- If performance assessment and contingency decision logic are not well defined and agreed to by all stakeholders, expeditious implementation and optimization of the exit strategy is unlikely, and stakeholders may be disappointed in the outcome of the remedy and the time and cost to achieve protectiveness for optimizing and terminating a response action.

Routine validation of the CSM and exposure assumptions; proper monitoring; periodic performance reviews; unambiguous metrics; transparent performance assessment, optimization, and contingency decision logic; and prompt communication of performance information to all stakeholders facilitate expeditious achievement of RAOs and site closure.

3.7.11 Changes to an Exit Strategy

Changes to the exit strategy are typically proposed due to a change in the understanding of site conditions. The change may be the discovery of a new source or a new receptor, historical monitoring trends that indicate a change in monitoring frequency may be appropriate, treatment systems that have not performed as well as expected, or a promising new remedial technique. The exit strategy is intended to be an ongoing plan and should be evaluated periodically to ensure that the foundation for corrective actions is still relevant for the current site conditions. If flexibility has not been built into the project, changes may require reopening decision documents.

3.8 Performance-Based Contracting

PBC has been applied by project owners for a diverse range of project types, but it has only recently become more common for environmental services such as site assessment and remediation. Due to the success of many completed PBCs and through lessons learned from less than successful applications, project owners are increasingly looking at PBCs as a means to optimize resources. When properly applied, PBC can be superior to traditional fixed-price, time-and-materials, or cost-plus-fixed-fee contracting approaches. For many programs, PBCs can result in better-managed, faster-executed, and more cost-effective site cleanups. However, readers should note that PBC is not a one-size-fits-all approach. PBCs work well in some, but not all, places and under certain, but not all, conditions. Having a good understanding of site-specific conditions is essential in determining whether a PBC is the best contracting choice. In some cases, properly managed and periodically optimized remediation systems (see ITRC 2004) may offer similar benefits in terms of reduced time to completion but at a reduced cost relative to PBCs. This section provides an overview of the benefits and potential pitfalls of PBCs.

3.8.1 Overview of Performance-Based Contracting

PBC emphasizes that all aspects of purchasing environmental services be structured around the *purpose* of the work to be performed, as opposed to the *manner* in which the work is to be performed. Under a PBC, a contractor has the freedom to determine how to meet the client's performance objectives and achieve the appropriate performance

Typical Contracting Methods Related to PBC

Fixed Price
Fixed-price contracts are appropriate for services that can be objectively defined in the solicitation and for which risk of performance is manageable. For such acquisitions, performance-based statements of work, measurable performance standards, and surveillance plans are ideally suited. The contractor is fully responsible for performance costs and enjoys (or suffers) resulting profits (or losses). The contractor is motivated to find improved methods of performance to increase its profits.

Cost Reimbursement
Cost-reimbursement contracts are appropriate for services that can be defined in only general terms or for which the risk of performance is not reasonably manageable. One example is the cost-plus-fixed-fee contract, in which allowable and allocable costs are reimbursed and the negotiated fee (profit) is fixed. Consequently, the contractor has minimal responsibility for or incentive to control performance costs. To the maximum extent practicable, PBC methods should be used for these contracts. Where possible, they should include specific incentive provisions in addition to the award fee to ensure that contractors are rewarded for good performance, as well as quality assurance deduction schedules to assure satisfactory performance. Several variation are possible:

- Fixed-price incentive contracts—final contract price and profit are calculated based on a formula that relates final negotiated cost to target cost (either a firm target or successive targets)
- Fixed-price contracts with award fees—used to "motivate" a contractor when contractor performance cannot be measured objectively, making other incentives inappropriate
- Cost-reimbursement incentive contracts—used when fixed-price contracts are inappropriate due to uncertainty about probable costs (may be either cost-plus-incentive-fee or cost-plus-award-fee)

Time and Material/Labor Hour Contracts
When the use of time and material/labor hour contracts is appropriate, employed when site conditions are not well defined, all risk is on the agency. Agencies should employ PBC methods to the maximum extent feasible.

(Adapted from Office of Management and Budget 1998 and Integrated Acquisition Environment n.d.)

quality and quantity levels. PBCs are highly efficient because they are structured to encourage contractors to perform only those activities that serve to meet the client's objectives.

PBC is not limited to use by private-sector companies or nonregulatory federal agencies (e.g., DOD, DOE). States such as South Carolina have been successfully implementing PBCs for several years in both site assessment and cleanup contexts. Other states are considering the use of PBCs as a means of improving the efficiency and effectiveness of their publicly funded cleanup programs.

PBCs can be used for individual sites, as well as for bundles of sites. PBC can be applied as early as initial investigations to all the way up to and including post-closure monitoring, as appropriate, provided there are clearly defined goals and financial flexibility. It is important to note that PBC is not universally applicable—its applicability must be evaluated case by case. Later, this section provides guidance on evaluating whether a project is ripe for PBC.

PBCs focus on the purpose of the work and have contract requirements set forth in clear, specific, and objective terms with measurable outcomes. In contrast, traditional contracting approaches focus less on the requirement to meet project owner objectives and more on the requirement to perform work in a specified manner. A well-structured PBC is beneficial to both parties and promotes cost-effective services that enable the procurement system to achieve its goals. A good PBC fosters a customer/contractor relationship that emphasizes clear expectations and roles and responsibilities, which in turn, enhances performance and timely problem resolution. The mutual benefits of PBC are perhaps best understood within the context of the general contracting preferences of each party, as outlined below.
The owner/customer generally prefers the following:

- performance that follows the specifications and schedule, with all work performed in accordance with applicable laws, regulations, and accepted industry practices
- contract terms that define and limit costs and reduce exposure to cost overruns (Note that the shift of risk to a contractor does tend to increase the cost of the work.)
- flexibility to allow for optimization to improve remedy effectiveness and/or reduce costs, based on changing site conditions, newly available technologies/equipment, or other developments

The contractor generally prefers the following:

- a clear scope of work that accurately defines the services associated with the cost proposal
- a project schedule that reflects the scope of work and is flexible to accommodate unforeseen items
- contract terms that fairly address financial risk associated with the given scope of work
- fair and timely payment for services rendered

A typical PBC involves the following:

- definition of the scope of the work to be done under PBC:
    - well-defined CSM and exit strategy

  - clearly defined performance goals and metrics
  - for remedy or corrective action implementation, good understanding of the problem
- selection criteria for the PBC contractor—qualifications (company and individuals), capabilities, financial ability, etc.
- implementation schedule—must anticipate regulator approval and stakeholder acceptance process

In summary, PBC does not fit all cases. Completion of characterization and an understanding of the problem in advance are essential. PBC can be applied at various stages, from initial scoping to all the way to post-remediation monitoring. Different agencies or programs have different need and limitations and can apply PBC at various stages. In South Carolina, for example, PBC is applied in UST program in many ways. In the assessment phase, it is divided into Tier I and Tier II assessments. Sites are divided into individual specific sites for bid solicitation as well as bundled into packages with several sites for PBCs. Appendix C provides more details on the considerations necessary to assess whether PBC is applicable to a particular site or for a group of sites or for an entire program.

3.8.2 PBC Development Steps and the Role of Regulators

The following seven-step process is based largely on existing government information on PBC. It is important to note that Integrated Project Teams should be well-trained in PBC strategies and methodologies and strive to have an up-to-date understanding of lessons learned from the use of PBCs by other project owners at similar sites. The role of regulators in the development of PBC can be complicated due to potential conflicts of interest or liability concerns, particularly when the regulatory agency is not the project owner. However, input and guidance from regulators is an essential prerequisite for a PBC strategy to be successful. Achieving the proper balance of regulatory involvement is of immense importance.

3.8.2.1 Establish an Integrated Project Team

The regulatory agency has the option to be involved in this step but generally is not or should not be part of the team unless it is the lead agency responsible for hiring and overseeing a contractor for a state-funded cleanup project. In fact, the policies of many states do not permit the involvement of regulatory agencies at this stage. If a regulator is involved in a non-state-funded program, the involvement should be limited to receiving information about the formation and purpose of the team in relation to which projects are being considered for PBC.

NOTE: The designated point(s) of contact between the project team and the regulator should be identified as early in the process as possible. Oversight control documents may require modification to designate or delegate authority to the point of contact between the team and the regulator.

3.8.2.2 Describe and Develop the Problem that Needs to Be Solved and the Link to the Department's Strategic Plan and Objectives

This step ensures that the team is aware of the regulatory requirements applicable to the site and that the expected outcome is clear. If a specific regulatory process (e.g., RCRA) must be followed, then the goals of this process (delineation of site contamination, determination of risk, and development of site cleanup goals) will need to be clearly identified. In addition, some regulatory agencies may require involvement in developing the problem statement through partnering team discussions and other approaches.

NOTE: Use of PBCs for remediation of sites without clear, current, and accurate CSMs should be subject to significant caution and scrutiny. Sites lacking a CSM are likely to have a high level of technical uncertainty and an associated high level of cost overrun risk that will greatly limit the number of interested bidders, as well as the availability and/or effectiveness of certain third-party forms of performance guarantees (financial assurance). Performance bonds and environmental insurance policies are the most pertinent examples. The exit strategy is also directly linked to the CSM. Objectives need to be defined during this step to develop the exit strategy (or strategies) to be used on the project.

State regulators should not be opposed to a multitiered or contingent plan for solving the environmental problem identified during this step. If a decision tree can be agreed upon between the project team and the regulator, then more timely approvals of submittals can be achieved. Although not all contingencies or uncertain outcomes can be anticipated, many can, and the process of preparing robust decision logic trees should serve to increase the effectiveness of the process. As long as the ultimate goals are agreed upon and regulatory limits are addressed, regulators should be willing to accept the PBC process.

3.8.2.3 Contractor Selection Solutions from Both Private and Public Sectors

The team should identify and consult with other project owners that have used PBCs for the investigation or remediation of similar sites, as applicable. This step applies to nonregulatory project owners, as well as to regulatory project owners working on state-funded sites. Reviewing the results of completed state-funded PBCs will provide valuable insight on how or how not to establish a PBC. If the regulator is not the lead hiring agency, its involvement should be limited (possibly to providing sources of PBC examples to the responsible party). Some state agencies do not recommend involvement of the regulators during the solution selection process. Furthermore, some lead agencies are not delegated procurement authority. Time must be allocated to allow all necessary parties to provide input on the development of selection criteria. For example, in New Jersey, the Department of Treasury holds the contracting authority, and state environmental regulators work with a treasury representative to develop contracts. Contractor selection and contract award go through a two track approval process.

3.8.2.4 Develop Performance Work Statements for the Work to Be Accomplished

In this stage, the input from the regulator is important to ensure that agency-specific statutory requirements are properly reflected in the performance work statement. Location-specific environmental regulations may define the scope of some types of work. For example, the number of post-excavation samples and number of samples from a disposal pile are often regulated by state agencies. If waivers or modifications to regulatory limits are to be sought, time must be factored into the scope of work development process.

3.8.2.5 Decide How to Measure and Manage Performance

For non-regulatory-lead sites, it is recommended that the regulator not be involved in the payment measures and milestones development process for various contract liability reasons. However, if regulatory metrics are not properly addressed in identifying milestones, the PBC will fail to satisfy regulatory needs. The contracting authority will need to balance the progress payment system from the standpoints of both contractor satisfaction (ability to move forward with the work) and regulatory review. Regulators want assurance that progress has been made in accord with the schedule and in compliance with all regulations. Carefully crafting the payment metrics and milestones can help meet both needs.

3.8.2.6 Select the Right Contractor(s)

For non-regulatory-lead sites, the regulator should not be involved in this process for various liability reasons. Most state agency policies do not allow any participation. However, if contractors wish to discuss requirements with the regulators, in some cases, states will have information sessions with all bidders as a group while avoiding any direct involvement in the bidding process. Using the New Jersey example from above, the Department of Environmental Protection would have to consult with the Department of Treasury before any contact could be made while bidding was under way.

3.8.2.7 Manage Performance

An important element of a successful PBC is the measurement and management of performance, as well as submittal of progress and status reports to regulators as needed. As noted above, the PBC should satisfy the needs of regulators and the requirements of regulatory programs. Critically, regulatory input should be stressed in the PBC process during the definition of the exit strategy goals of the contract. The PBC will not be successful if its goals are not compatible with the regulatory goals. Furthermore, if the goals are not compatible with regulatory concerns, they are highly unlikely to be accepted by the stakeholder community.

3.8.3 Financial Assurance

The goal of financial assurance is generally to eliminate or reduce the financial risks faced by the project owner if the contractor is unable or unwilling to meet the contractual obligations of the PBC. While a wide variety of financial assurance instruments exist, they take three basic forms:

- cash or cash equivalents
- performance bonds and insurance
- self-guarantees

It should be noted that the types of financial assurance instruments available depend on the nature of the performance work statement. Specifically, performance bonds and insurance are generally available only for remediation scopes. Project owners seeking financial assurance for an RI/FS PBC, for example, are normally limited to cash and equivalents, as well as contractor self-guarantees.

Project owners should be aware of the factors necessary to determine appropriate types and amounts of financial assurance. The inherent financial risk of the performance work statement (including both the probability that actual costs exceed the contractor's bid and the potential severity of the overrun), the contractor's ability to perform the work (technical and management skills, past performance, etc.) and the financial strength of the contractor (ability to absorb a loss and continue operating) all impact the decision.

3.8.3.1 Cash or Cash Equivalents

From a project owner's perspective, cash or its equivalent is often the preferred form of financial assurance because it is the most secure and readily available in the event the contractor fails to perform obligations required by the PBC. Forms of cash or equivalents include certificates of deposit and other deposit accounts, government bonds, cash, and irrevocable letters of credit.

3.8.3.2 Performance Bonds and Insurance

Performance bonds and environmental insurance are similar in that both are risk-transfer mechanisms, both are regulated by state insurance commissioners, and both provide protection against financial loss related to the inability or unwillingness of a contractor to perform a contractual scope of work. Certain general differences in the characteristics of the two products are listed below.

- Performance Bond
  - A performance bond is a written agreement that usually provides for monetary compensation in case the contractor fails to perform acts as promised.
  - In traditional insurance, the risk is transferred to the insurance company. With a performance bond, the risk remains with the principal (remediation contractor). The protection of the bond is for the obligee (usually the project owner).
  - Current underwriting standards are fairly restrictive, making it difficult to obtain performance bonds for large environmental remediation contracts.
  - Contractors must have a very strong balance sheet and long history of successfully completing similar types of cleanup under similar contracts.

- Environmental Insurance
  - Provides coverage for remediation cost overruns.
  - Terms, coverage, and premiums are determined based on evaluation of the performance work statement, associated cost estimate, and remediation contract.
  - Policies normally require a self-insured retention (SIR) and may use a co-pay provision.
  - The SIR is effectively an insurance deductible, often about 10% of expected remediation costs. The SIR is typically paid by the remediation contractor and serves as an incentive to avoid cost overruns.

3.8.3.3 Self-Guarantees

Corporate guarantees and other forms of self-guarantees are generally based on certified financial statements that help evaluate a company's assets and liabilities and its ability to pay the cost of completing the performance work statement in the event actual costs exceed the contractor's bid. The contractor is typically required to demonstrate a specified ratio of assets to liabilities indicating the ability to pay for cost overruns. In evaluating the ability of a contractor to pay for cost overruns, project owners should also consider the existence of off-balance-sheet liabilities, such as other executed PBCs that have not been completed by the contractor. Evaluating the utility of self-guarantees requires a relatively high level of financial and risk analysis expertise.

3.8.4 PBC Lessons Learned

When Not to Do a PBC

- Inadequate time or resources to preplan
- Poor or incomplete site characterization
- Inordinate amount of risk to contractors, resulting in limited competition and/or increased costs to the government
- Requirement for large early capital investment with uncertain return
- Uncertain funding during the contract period of performance
- Contractor community says "No"
- Likelihood that stakeholders are not onboard and may drive risk inordinately high

State and federal agencies that have applied best management practices and are experienced in PBC have realized significant advantages and improved the overall management of sites in their programs. Agencies are learning that, even in the same program, PBCs may have different requirements and need different approaches to be successful. In South Carolina, for example, contracting approaches that work well in the coastal plain region do not work in the upstate region, which is characterized by more complex geology. CSMs are better defined in the coastal plain and harder to define in the complex upstate geology. PBC requires different approaches based on regional differences within the same state.

It has come to the light that several programs provide a variety of conditions for the PBC process. Some programs are flexible for the contractor to modify the contract based on unknown or new conditions at a site. Some programs do not give any flexibility during execution of a PBC, resulting in contractors being required to perform at a more stringent levels or being responsible to do much more cleanup than originally anticipated. The RPO Team believes that, for a PBC to be successful, there should be clauses that address additional releases/cleanups beyond the originally anticipated extent and the allow the contractor to walk away from the contract or propose modifications as appropriate. See Appendix D for an example PBC from the South Carolina UST program.

Furthermore, an approach that works for assessment may not work for remediation. In a situation where tight clays are present, the definition of the problem may not be as challenging as the remediation of the contamination in the specific geological units. The South Carolina UST program has been continuously learning and refining the process to gain the maximum benefit for the state. Refinements have included the contents of the bid package and defining which sites to bundle under a single contract and which to handle separately. A contractor certification program was developed for all those working in the PBC program. Quality of work is monitored continuously and updated.

The remainder of this section outlines several lessons learned that regulatory and nonregulatory project owners may find useful to consider in applying PBC to their individual circumstances.

3.8.4.1 Adverse Influences on Pricing

Once a PBC has been identified as the preferred contracting approach, project owners should be aware of avoidable factors that commonly impact the pricing behavior of contractors. Avoiding higher-than-necessary bids by contractors requires thoughtful collaboration between functional elements (procurement, management, and technical, for example) of the owner's project team. Understanding the elements of a market price for environmental services allows project owners to screen their specific projects for characteristics that cause contractors to make assumptions that result in higher bid prices and but can be changed or eliminated to reduce expected bid pricing. Factors commonly cited by contractors that lead to adverse pricing for the project owner include the following:

- vague, inconsistent, or ambiguous wording of performance work statement
- vague, inconsistent, or ambiguous allocation of risk between the project owner and contractor
- insufficient time to bid
- unfriendly pre-bid meetings (either with the project owner or, in the case of nonregulatory project owners, with the regulatory agency)
- issuance of many addenda or complicated addenda close to bid date
- onerous terms and conditions (schedule, liquidated damages)
- unpredictable market prices for required labor and materials
- low number of bidders due to highly specialized qualifications or more attractive market opportunities (lower-risk, higher-profit, or higher-profile bidding opportunities)

3.8.4.2 Unbalanced Incentives and Disincentives

Project owners may include financial incentives and disincentives within the terms and conditions of PBCs in an effort to influence the timing of milestone completion. For example, a project owner might provide an additional \$5,000 compensation to the contractor as a reward for date-certain milestone completion. The project owner might also subtract \$5,000 from the contractor's compensation for failing to achieve a milestone by a certain date. In practice, many project owners have used disincentives that are much larger than incentives (\$5,000 incentives and \$25,000 disincentives, for example). This practice may produce unintended results by influencing the contractor to focus on managing the project to avoid disincentives rather than to achieve incentives.

3.8.4.3 Risk Allocation Disconnects

Associated with the full spectrum of typical contracting methods presented earlier is a full range of allocation of financial risk between project owner and contractor. The spectrum ranges from cost-reimbursement approaches, where the project owner assumes nearly all financial risk and retains all rights to potential cost savings, to PBCs where nearly all financial risks and rights to cost savings may be assumed by the contractor.

However, true meeting-of-the-minds between project owner and contractor regarding risk allocation may not be achieved unless the contractor's risk-allocation assumptions are clearly (and affirmatively) identified in its bid. In simple terms, a risk-allocation disconnect occurs when the project owner assumes it is paying for a PBC where legitimate contract change orders are very unlikely, but the contractor is assuming otherwise. The result of a risk-allocation disconnect can be unexpected future costs for the project owner, disputes, and schedule delays. Project owners may consider using simple tools to help avoid risk-allocation disconnects, such as requiring bidders to include a detailed list of specific conditions that would render their bid price invalid and requiring certification of the list by a high-level officer of firm.

3.8.4.4 Avoiding Unwanted Financial Assurance Surprises

The goal of financial assurance is to eliminate or reduce the financial risks faced by the project owner if the contractor is unable or unwilling to meet the contractual obligations of a PBC. As noted earlier, from a project owner's perspective, cash or its equivalent is often the preferred form of financial assurance because it is the most secure and readily available in the event the contractor fails to perform. However, when financial assurance is required and neither cash/equivalents nor self-guarantees are practical options, there are important elements of performance bonds and insurance products that should be understood to help avoid the potential for future surprises.

Most importantly, project owners should be aware that the terms and conditions of commercially available, third-party financial assurance contracts are highly negotiable and often require changes from boilerplate language to be effective. Moreover, regulatory and nonregulatory project owners face significantly different challenges in financial assurance, particularly in the case of environmental insurance.

What Type of Insurance and How Much Does It Cost?

- Cleanup Cost Cap ranges 8%–13% of the contractor bid price
- Pollution Legal Liability ranges 2%–9% of the contractor bid price

The contractor is generally responsible for purchasing the financial assurance product if it is required under the PBC. In this case, an important question is how effective the product will be in eliminating or reducing the financial risks faced by the project owner.

NOTE: It is not enough that the contractor purchase financial assurance; the financial assurance also needs to be effective.

Specific exclusions in the terms and conditions, especially cost item exclusions in insurance policies, can result in unwanted surprises for the project owner. Policies almost always exclude the cost of certain activities from coverage, effectively raising the SIR if the activities are necessary for the performance work statement. Suppose the insurance policy excludes underground demolition but the scope requires $1 million of underground demolition work. In this case, the SIR would in effect be increased by $1 million because that much additional cost would need to be incurred before triggering coverage. Since the SIR acts like an insurance deductible, from the project owner perspective, a lower SIR is better than a higher SIR.

It is also common for policy language to exclude loss or claims arising out of the insolvency or bankruptcy of the contractor performing the work. Often the only circumstance under which a contractor would fail to perform is in the case of insolvency or bankruptcy, so such a policy would offer little protection to the project owner. In general, all proposed exclusions should be carefully reviewed against the performance work statement, and terms and conditions should be appropriate to protect the interests of the project owner.

Additionally, care must be taken to fully understand and appropriately monitor triggering and notification requirements for financial assurance instruments. For example, a policy may require monthly progress reporting (from the contractor to the insurer) and written notification upon discovery by the contractor in such case that costs representing 85% of the SIR have been expended. Failure by the contractor to provide the required reports or notice of a potential claim may impact the willingness of an insurer to pay the claim.

Likewise, an insurer typically has no obligation under a policy to any third party whatsoever and specifically no obligation to make payment to anyone except the named insured. Therefore, a policy that does not name the project owner as insured or additional insured may prove to be inadequate. Importantly, insurers often resist naming a regulator as an insured or additional insured because the regulator could "self-trigger" the policy by using its authority to make the cleanup more expensive. To avoid the potential for future surprises, regulatory project owners should review policy language and understand whether they are being granted coverage as an insured.

3.8.5 Regulatory Concerns

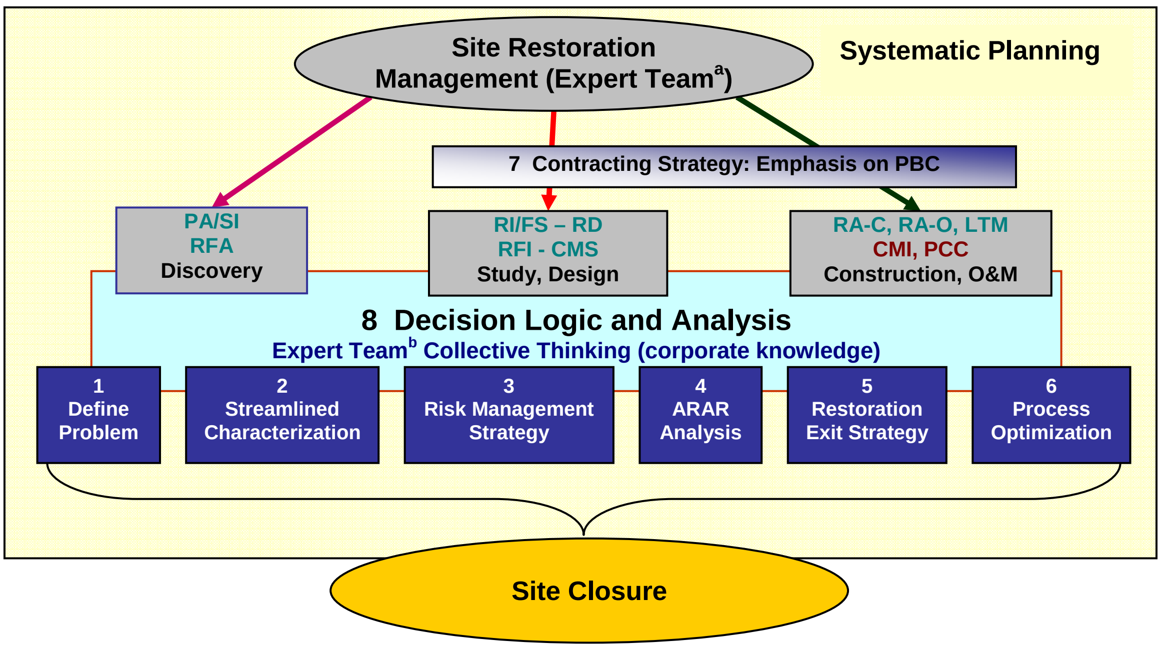
In addition to the general regulatory concerns relevant to PBEM and PBC discussed in Section 1.7, here we consider a couple of important concerns specific to PBC.

One concern voiced by some regulators is a perceived loss of control. This can apply to both regulatory oversight and publicly funded contract lead roles of state regulators. As noted earlier, one of PBC's benefits is reduced or preestablished reporting points with preestablished review periods are agreed to in advance. PBCs rely on quick turnaround and fewer review points to accelerate cleanup. If a regulatory agency feels it is not getting the information needed to be assured that the site is "under control" (within regulatory limits and progress is being made), agency may feel a loss of control. Through Web-based tools, real-time or near-real-time access to data at the discretion of the regulator can help alleviate this situation. If the regulator knows that the data are within reach at any time, the gaps between the reporting periods will not appear to be so significant. The RPO Team recognizes that the traditional monthly or other reporting frequency may be familiar and therefore comforting to the regulator, but agreeing to a performance-based management process can free up valuable time for both the regulator and the project team.

Time is another regulator concern. The PBC process requires significant and time-consuming up-front work (scoping, planning, and scheduling) on the part of the regulator. However, establishing a flexible plan (the decision logic) early in the process allows more freedom later in the process. Reports and reviews will be laid out in advance of the project kick-off. The schedule is defined so the regulator can plan ahead. Ideally, this approach allows balancing of project loads with minimal interference. Management software programs can be applied to aid in regulatory review scheduling, and having the project management team and the regulator use the same software could be a benefit to the project.

3.9 Implementation Approach

In general, PBEM can be implemented at any stage of a restoration project where confidence in the decisions made needs to be known. The following examples describe how the elements of PBEM that can be used at the various stages of an environmental project and how they are related to the traditional remedial process. Certain PBEM elements may be more applicable than others for certain remedial activities and site-specific conditions. It is important to recognize that the PBEM is intended to emphasize a goal-oriented rather than process-oriented approach. Figure 3-6 illustrates the similar relationships of implementing PBEM elements with the traditional remedial process under CERCLA and RCRA programs.



NOTES:

a. This expert team provides support to the site owner or upper management of large facilities. The support is administrative and programmatic in nature with minimum emphasis on the restoration details. This team is generally small (<10), composed mostly of responsible party personnel (site owner) and a few consultants. Large facilities with multiple sites use this team to prioritize sites, select project managers, and generally make program strategic decisions.

b. This is the expert implementation team. Restoration details are this team's primary emphasis. In general, team b is larger (>10) than team a, but some of the team a members form part of team b. Team b is responsible for conducting all systematic planning and developing and updating the project's decision logic.

Figure 3-6. Relationship between PBEM elements and the traditional remedial process.

3.9.1 Air Force Installation Restoration Project Examples

PBEM can use the strategic components best suited for the particular project restoration phase; not all components are required to be applied. However, the products of previous PBEM components are generally used to successfully enhance the projects overall performance. Examples provided here show how sites of varying complexity were addressed under PBEM and how sites can enter the PBEM approach at any restoration phase. Points of contact (POCs) are provided for those who would like to contact the implementers. The numbers in parenthesis in the following paragraphs refer to the numbering in Figure 3-6.

The most complex implementation of PBEM components was performed for Pacific Air Forces (PACAF) Major Command. Six of its 47 installations were selected for evaluation of their restoration programs. Eielson's long-term monitoring program (6) was reviewed and optimized. At King Salmon, two remedial actions implemented at multiple sites were evaluated (6), terminating operation or implementing alternative technologies. At Hickam, the operation of the remedial action was optimized (6). Anderson's primary issues were landfills; LTM was optimized (6) for the installation. At Elmendorf, operation of remedial actions were assessed and optimized. Galena was in the preliminary assessment/site investigation stage. Problem and objectives (1) were defined during the PBEM/RPO visit. It was at this RPO visit that the team identified a significant potential risk to a new school building. A vapor intrusion prevention system was installed within a month, prior to the opening of the school. Rapid site characterization (2) was used at Galena to delineate all contaminants. The result of all the above activities identified $22 million in cost avoidance that PACAF will be able to use to address other restoration projects, accelerating the final cleanup of all PACAF sites. Project POCs are Chris Wright, PACAF, chris.wright@hickam.af.mil, 808-448-0483; Dave Hertzog, PACAF, dave.hertzog@elmendorf.af.mil, 907-552-7261; Mike Raabe, PACAF, michael.raabe@eielson.af.mil, 907-377-1164; Manish Joshi, EarthTech, manish.joshi@earthtech.com, 210-271-0925; Javier Santillan, AFCEE, javier.santillan@brooks.af.mil, 210-536-4366; and Patrick Haas, P.E. Haas and Associates, phaas@phaas.net, 210-887-4227.

DLA was tasked with cleaning up a third-party site where DLA, the Army, and the Air Force were identified as PRPs. EPA was the lead agency for this site, and DLA was tasked by DOD with the execution of the cleanup. EPA had a cleanup proposal and estimate of $38 million to treat all polychlorinated biphenyls (PCBs), lead, and dioxin/pesticide contaminated soil. The PBEM/RPO team evaluated the site, and the ROD-specified cleanup technology. The team selected an alternative technology that reduced the cleanup cost by 90% and the time to complete by 75%. An Explanation of Significant Difference was prepared to update the ROD. This work was conducted under a firm-fixed-price PBC. The site's exit strategy (4) and decision logic (8) promoted rapid conclusion of the project and removal of the site from the NPL. Project POCs are Bruce Noble, DLA, bnoble@mail.drms.dla.mil, 269-961-7412; Dennis Lillo, DLA, dennis.lillo@dla.mil, 703-767-6241; Manish Joshi, EarthTech, manish.joshi@earthtech.com, 210-271-0925; and Javier Santillan, AFCEE, javier.santillan@brooks.af.mil, 210-536-4366.

3.9.2 Private-Sector Brownfield Project Example

A known future development of a brownfield site includes buildings with basement construction. Extensive horizontal and vertical delineation of the contaminants and full baseline risk assessment in the proposed excavation area will not be necessary. Instead, the waste characterization for excavated soil disposal and health risk during construction may be focused on as the primary concerns during the initial phase of the project as the performance criteria. With a known land development plan and building usage, the land use risk strategy should have been well understood. Thus, at this stage, with a good CSM and using decision logic, a more focused investigation could be conducted. PBC may be used as a tool for the investigation since the intent and extent of the investigation may be better defined to minimize the uncertainty during investigation.

However, if the preliminary data indicate that the excavation may potentially pose a risk during the construction, secondary performance criteria may be developed at this stage to remediate the excavation area to a level of safe working conditions. The secondary performance criteria may include limited delineation of the contaminants and evaluation of alternative approach for short-term remediation.

Therefore, in addition to the CSM and decision logic, other elements of the PBEM, including exit strategy, RPO, ARAR analysis, and PBC would be integrated at this stage. The PBEM elements implemented for this brownfield project are illustrated in Table 3-2.

Table 3-2. PBEM implementation for a brownfield project example

PBEM element	Brownfield project remedial stages				
	RI	FS	ROD	RD/RA	O&M/ 5-Year Review
Systematic Planning	√	√	√	√	√
Expert Team	√	√	√	√	√
Problem Statement and Objectives	√	√	√	√	√
Land Use Risk Strategy	√	√	√	√	√
Conceptual Site Model	√	√			√
Decision Logic	√	√	√	√	√
Remedial Process Optimization		√		√	√
ARAR Analysis		√	√	√	√
Exit Strategy		√	√	√	√
Performance-Based Contracting	√			√	√

NOTE: √ indicates that the PBEM element is considered and applicable to the specific brownfield project example discussed in the text, where specific land use and development are already known.

4. STAKEHOLDER CONSIDERATIONS

The success of the PBEM process relies on the inclusion of all parties from the beginning of the site assessment and/or remediation activities. The sooner the project team, the RPs, and the regulators are involved, the more successful the PBEM process will be. Other stakeholders are also considered critical to the entire process, and this chapter addresses the issues involved with the stakeholders outside of agencies and regulatory agencies.

For the purposes of this document, “stakeholders” include affected tribes, community members, representatives of environmental and community advocacy groups, and local governments. Stakeholders often have valuable information about site characteristics, history, and future intended use that can improve significantly the quality of remediation process decisions. Stakeholders generally show great interest in the contamination problem, in the restoration process, and in the effects that these have on human health and on the environment. Given the financial, technical, and regulatory complexities inherent in the remediation process, it is highly recommended that affected stakeholders be involved in all phases of the decision making. If the stakeholders have the opportunity to have meaningful and substantial participation in the decision-making process, they are more likely to support the difficult policy, budgetary, and technical decisions.

It is important to note that affected stakeholders are not necessarily limited to those immediately adjacent to the site. For instance, those who live downstream of a site may be affected even if they are not in the immediate vicinity of the site. In the identification of affected tribes, it is necessary to consider that tribes may have treaties or other pacts with the federal government that grant them fishing, hunting, or access rights in places that are not necessarily near their present-day reservations. Furthermore individual states and the Indian community recognize tribes that are not necessarily recognized by the federal government. A list of federally recognized tribes can be found at www.ihs.gov/generalweb/webapps/sitelink/site.asp?link=http://www.artnatam.com/tribes.html. A list of tribes that are not federally recognized can be found at www.ihs.gov/generalweb/webapps/sitelink/site.asp?link=http://www.kstrom.net/isk/maps/tribesnonrec.html. Tribes have regulatory oversight on some sites and in such cases play a more substantial role.

Early involvement of stakeholders is important to project success. Since some remediation decisions are often made at the contracting stage, potential problems could arise if communication with the stakeholders is not established at this stage. Exclusion of the stakeholders at critical decision-making points can engender public opposition, which in turn can lead to substantial delays and increased costs.

All interested stakeholders must have access to critical information, the opportunity to provide input to decisions at strategic points in the remediation process, and, where appropriate, representation on the expert team. It is particularly important to involve stakeholders in collaborative decision making at the site level. Effective stakeholder participation can promote a more accurate understanding of the relative risks of various technologies and remediation options. Participants gain a greater understanding of the regulatory requirements and processes, as well as a greater understanding of the novel technologies and techniques that might lead to less costly remediation solutions. The likelihood of public support for remediation decisions is significantly increased through effective involvement of and communication with stakeholders.

The level of stakeholder participation and the appropriate process for the inclusion of stakeholders must be tailored to each site and situation. However, from the formulation of the problem through the exit strategy, stakeholder issues, needs, and concerns must be taken into account. An effective communication mechanism between the expert team and the stakeholders must be in place throughout the remediation process. For example, DOD requires that stakeholders be involved through the Restoration Advisory Board process (codified in Title 32, Code of Federal Regulations, Part 202; the final rule appeared in 71 Federal Register 27610 on 12 May 2006).

In the implementation of PBEM, stakeholders can assist in the understanding of site history, the definition of the environmental issues, the formulation of the problem statement, the risk assessment process, the definition of intended future use of the site, and the development of remediation objectives. Stakeholders will be directly affected by LUCs. There should be public discussion of proposed LUCs so that stakeholders have the opportunity to voice their concerns.

As situations in the field cannot always be anticipated, PBEM builds flexibility into the remediation management process. This flexibility itself may be a cause for stakeholder concern. Indeed, it is sometimes perceived that PBEM results in loss of regulatory control of the remediation process. It is the duty of the regulator to address these concerns directly. Such concern is most effectively addressed by the inclusion of public and tribal stakeholders in the problem definition, strategic planning, and decision logic processes and by early, frequent, and ongoing communication with the stakeholders. Stakeholders can make substantial positive contributions to a successful remediation process. The key is to involve them early and often.

5. SUMMARY AND CONCLUSIONS

State regulators can expect to see proposals to conduct remediation activities using some form of PBEM. Federal agencies are required, by presidential order, to incorporate performance-based techniques into their business practice, including their environmental activities. Several types of PBEM have been identified by this report, and components of each variant have been discussed so regulators can better anticipate the needs of these programs and determine whether they can effectively participate as part of the PBEM process.

Agencies and departments have identified their own ways to achieve PBEM. This document has focused on the examples from the Department of the Navy; USACE; AFCEE; and the multiagency, EPA-hosted Triad Community of Practice. These are not the only performance-based programs either in the environmental field or the business world, but among them they identify the major types of PBEM a regulator may encounter. This document is not intended to recommend one program over another; it is intended give the regulators the information they need to anticipate the needs of a regulated entity that may propose a PBEM or PBC program.

This document identifies key concepts, most of which are common to the different PBEM programs. From systematic planning to PBC to evaluating an exit strategy, this document serves to inform the regulator about the scope and work involved with each concept. Some PBEM programs are more structured and create a formal process that is intended to be followed through to success. Others are more flexible and recognize that projects and responsible entities have different needs and resources to apply to PBEM.

All the PBEM programs attempt to shift thinking from the traditional, linear, cleanup process that focuses on the “how” of remediation, such as the technologies in place. This document continues to look not just at the “how” of site cleanup but also at the “why,” as captured in the CSM. The CSM considers all factors involved with the site remediation, such as the environmental and land-use (current and future) plans, site-specific chemical and geologic conditions, and the regulatory environment, as well as the exit strategy or the conditions that must exist to reach an end point in the remediation. PBEM creates a framework that links the newly developed or renewed CSM with the exit strategy. Since this concept is core to RPO as well, the document explains the difference between RPO and PBEM. RPO is a periodic reevaluation process, whereas PBEM is an ongoing strategic project management process.

The application of PBEM within various regulatory frameworks has also been reviewed. CERCLA, RCRA, and UST programs are as high-probability programs for PBEM implementation. Each subphase of work has been compared against key PBEM concepts for application. Although PBEM is an overall project management process, at different phases within the life cycle of a remediation program, certain key element come into play, and others fade into the background.

As noted above, this guidance identifies and describes the applicability, advantages, and disadvantages of various approaches, as well as where they are most appropriate for use. The ITRC RPO Team acknowledges that there are several PBEM formats. The team has tried to identify as many as possible with the goal of educating state regulators so they can anticipate the needs of the PBEM process.

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Appendix A

Survey of State Interest in PBEM/PBC

SURVEY OF STATE INTEREST IN PBEM/PBC

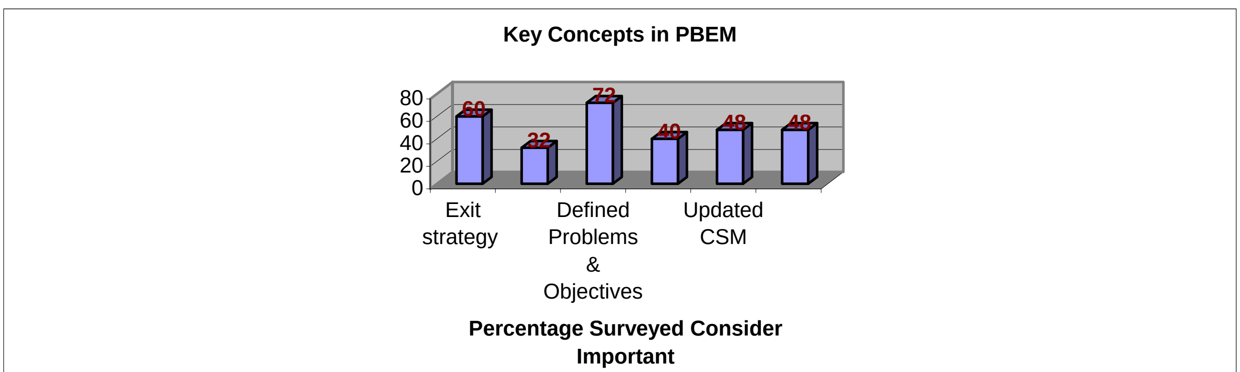
To determine states' understanding of the concept of PBEM and their information needs, the ITRC RPO Team surveyed ITRC member states through the ITRC POC network. The survey was designed to elicit states' knowledge, use and opinions of PBEM. Twenty-five people representing 20 states responded to the survey. The majority of the respondents (14) worked in Superfund/CERCLA programs. An additional five respondents were from RCRA programs, and the others worked in underground storage, brownfields, voluntary cleanup, or other program areas. Although most of the respondents (21) were familiar with RPO and the principles of PBEM, only 11 of the represented states have implemented PBEM projects.

The survey also focused on the use of PBC. Thirteen states said that they had implemented PBC projects, but most did not have a lot of experience. Only a few had more than 20 projects, and most had fewer than five, indicating that many PBC projects have just begun and have yet to complete the restoration goals. For the most part, PBC is a relatively new concept for state regulators but one that is becoming more and more significant in their implementation and oversight roles.

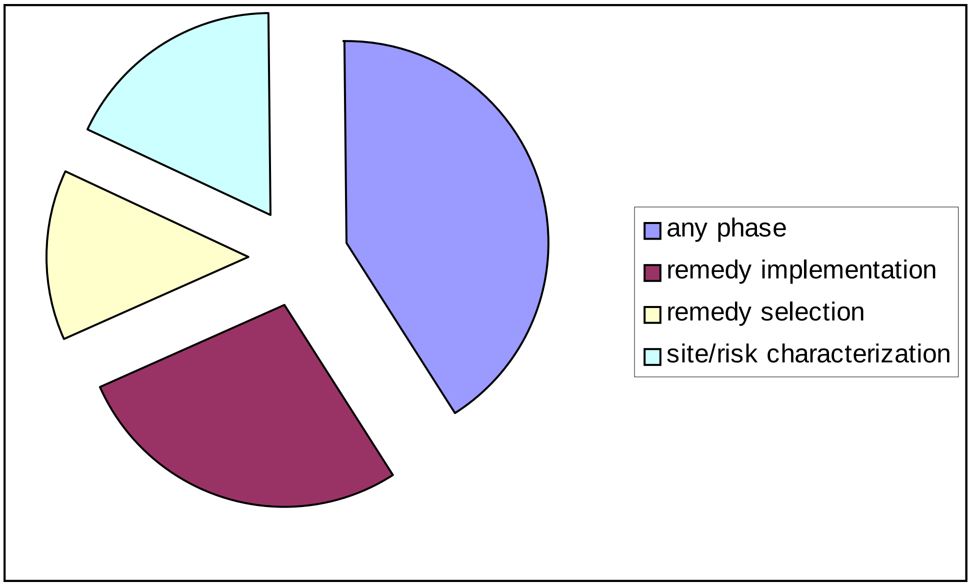
States were asked their opinions on a series of PBC questions with the choice of answers including "critical," "secondary," "negligible," and "cannot assess." The following table summarizes those questions and responses. Comments and the results from the survey were incorporated into Section 1.7, "Concerns of the Regulators." A copy of the survey instrument is included at the end of this appendix.

SUMMARY OF SURVEY RESULTS

Of the 25 respondents to the survey, 21 stated that they were familiar with the PBEM process and almost half (10) of those actually reported that PBEM projects are implemented in their states. Most (72%) recognized having a well-defined problem and objectives as the most important among the PBEM components, with exit strategy being a close (60%) second.



Though many respondents identified that the PBEM is best introduced at remedy implementation or remedy selection stage, a plurality agreed that it can be applied at any phase of the remediation process.



Above pie chart shows the respondents view of "when the introduction of PBEM principles would provide the most value." Explanations are provided in the following table:

Once the problem is defined, a performance based contract can be awarded.
To reduce the time frame for reaching remedial goals, if possible
The evaluation of what is needed to get the site remediated starts with characterization. If you don't collect the right information, you can't evaluate whether an alternative will work until you go back and get more data.
It is at this point where the decision is made as to the type and therefore speed of remedy and the related costs involved.
Note: Answers to PBM are based on programs in the state that use "PBM-like" principles, although not specific to the ITRC Fact Sheet. Answer #16: Implement as soon as possible to achieve best/desired results through the rest of the project.
In Oklahoma we have adopted a pay-for-performance (P-F-P) program that is applied to the remediation phase of corrective actions. Under this program, the remediation consultant is paid when defined cleanup level milestones are attained. This program includes both remediation system installation, O&M and system decommissioning. Although titled differently, it is correlative to PBM.
Performance of the cleanup technology/attainment of RAOs is more easily recognized.
EPA Superfund regulations may make it hard to do PBM for anything but remedy implementation.
It is important to have a well-defined scope of work (or CSM) as the basis to the CA process. This should have a formal review/approval process so that the ongoing studies, data objectives, and exposure pathways of concern are identified (sort of a "base map"). The site risk/characterization process is also a stage that the regulatory agency needs to know what was found and interpreted and to help determine whether interim measures are needed or whether further studies are needed (determining whether the map was followed and potential optional routes). By the time one gets to the section of remedy, all parties have a good understanding of what the problem is and PBM is appropriate to allow more independent pursuit of remediation options, pilot studies, etc. so that ultimately the final proposal can be agreed upon for addressing what has been defined earlier. From this stage on, a more adaptable/flexible process can be used to achieve results for the defined problem.

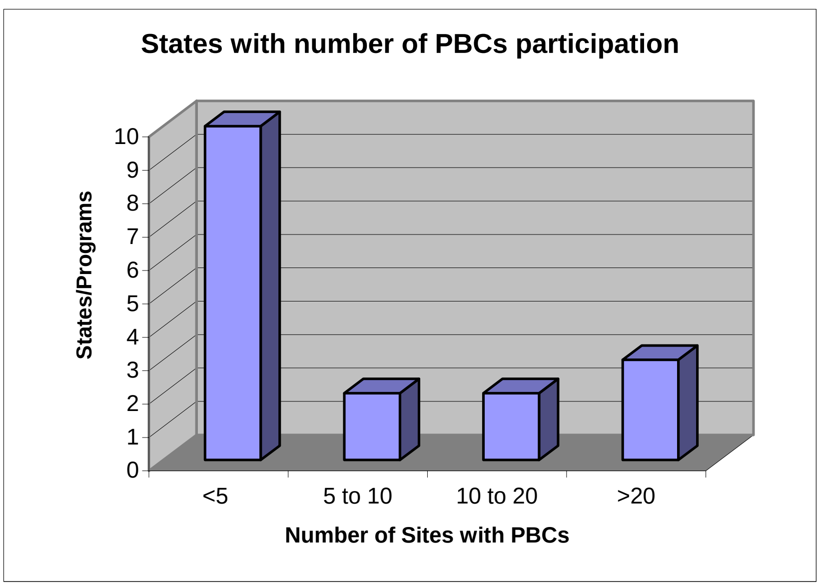
The State of Iowa has well-defined risk-based corrective action (RBCA) requirements under our regulations governing assessment. These items could be changed, but with significant effort. We have more flexibility in applying these types of principles when a site has been classified as high risk and requires corrective action. We have a process for meeting with stakeholders and discussing important aspects of the approach for corrective action.
At the remedy implementation phase, remedial decisions/objectives have been decided, and the process should move forward without much administrative interference, whereas the other phases would require more administrative involvement to complete.
Components of PBM have been applied at some sites in remedy implementation. This has given the responsible party flexibility in implementing a remedy; however its usefulness depends upon the type of remedy.
The entire process enhances and encourages the idea of thinking the entire site through. This rather than the typical way of drawn-out investigation, etc. this usually saves time and $$ in the process.
Familiar in general terms but not incorporated in state regulations for definition or as a requirement.
The entire process has shifted 180 degrees. Initially the consultants try to get on the Federal gravy train and do as much work as possible, doing more work than necessary. With PBC, the consultants try to do as little work as possible, cutting corners and quality of the final product.
You need to do this at the outset so there's no time and resources wasted.
The principles would focus on the remedial objectives so that a remedy to clean up the site could be selected
PBM is a useful tool to coordinate and manage a project throughout the remediation process and not only at certain phases of CERCLA
Performance based rewards are a good framework for almost any contract work.
As long as the goals are finite and an exit strategy is developed another entity can accomplish the work. They can participate in those determinations or pick up the remediation along the way and adjust it to still accomplish the goals.

Regarding their agency's participation in public or stakeholder meetings in support of PBEM, a majority said that they participated in such meetings. By a margin of ten to three, the respondents whose agencies participated in such meetings described that the effects of PBEM on project management and execution has been more positive than negative. The reasons for such a positive or negative feedback are given below:

Generally Positive	Ends regulator oversight.
Generally Positive	
Generally Positive	
No Difference	Stakeholders are involved in the entire decision making process. PBM is not singled out.
Generally Negative	This is based on a very small sample size and most probably due to contractor's lack of familiarity with the process and this type of contracting.
Generally Positive	Helps to expedite work and to avoid conflicts throughout the process.

Generally Positive	Oklahoma's P-F-P program requires input from the remediation consultant, regulatory agency, and the party deemed responsible for the fuel release. All three parties must agree to and sign off on a P-F-P contract that defines the cleanup goal(s) for the site, monitoring criteria, performance milestones, and time frame for completion of remediation.
Generally Negative	Monetary issues are even more prominent.
Generally Positive	PBM to a limited extent has been used in our corrective action process. It hasn't followed the traditional definition of PBM as discussed in documents, but some basic goals are similar. In Iowa, if a UST site is high risk, we meet and talk with stakeholders about the stages of the project and what is expected and when, and we have had great success. Everyone enjoys the improvements in communication and what is expected to meet a goal.
Generally Positive	Some contractors have an incentive to achieve specified objectives within a specified time frame. Particular care is taken to ensure projects are explicitly planned. Schedules of implementation are more complete/accurate.
No Opinion	
Generally Positive	However, the regulator must watch to ensure that shortcuts are not taken.
Generally Negative	Once the project plan has been approved, the military base environmental personnel have minimal feedback on the final product. The state regulator, not the military, becomes the gatekeeper dealing directly with the consultant. Consultants want to move in and move out as quickly as possible, cutting corners as much as possible, and quality of the final product suffers.
No Opinion	PBM has not been implemented.
Generally Positive	It is definitely a positive thing to use PBM during planning and execution of any remediation project to be able to achieve agreed-upon remediation goals.
Generally Positive	Contractors have been involved in developing performance-based bid and contract specifications. Contractor input has resulted in a more workable approach.

Thirteen out of 25 respondents said that they were familiar with the use of PBC and actually implemented it. Five said that they were familiar but did not use in their programs, and seven were not familiar with PBC.



These sites include UST and DOD sites, are mostly well-characterized, have both soil and groundwater remediations ongoing, and use conventional as well as site-specific innovative technologies for remediation.

Only seven out of 17 respondents stated that the PBC projects in which their agency was involved actually completed. All these seven were completed on a faster time frame, a majority of them actually decreased the involvement of the regulatory agency, and the overall cleanup has been received favorably by the regulators compared to conventional (time and materials) cleanups.

Some of the other highlights of the responses include the increased participation of the regulators in the prebid preparation, a decrease in the number of comments on key documents, with no substantial increase in project team meeting participation or inter-regulatory-agency coordination.

Out of 25 state respondents, suitability of a site for environmental remediation using PBC (17), setting up PBC goals that reflect the acceptable regulatory standards (23), clearly defining the roles and responsibilities of all stakeholders (18), acknowledgement that the federal facility (responsible party) as ultimately liable for unresolved concerns (16), clear expectations regarding anticipated level of and schedule for regulatory agency project support and oversight (20), and continuation as public participation were recognized by a majority of regulatory agency representatives ranked as "critical."

Following were given as the greatest benefits of PBC cleanups:

Speed up the process, give contractors additional flexibility.
The site is cleaned up in 1/8th the time and at 2/3rd of a time and material contract price. The more PBCs awarded, the cheaper the cleanups get.
Faster cleanups, and $ savings in the long run. This means more protection and less process.
Should result in less change orders, claims; could result in lower project management oversight costs; delay costs (if any) borne by the contractor; can add penalties. Project cost and completion date is theoretically firm, provided site conditions are very similar to bidding assumptions.
I don't think there is any benefit to the regulatory agency. For the responsible party, it provides certainty to the cleanup cost (maybe) because if the contractor who has entered into the performance-based agreement fails to complete the cleanup to the agency's satisfaction, the RP is still liable.
Cleanup is completed cheaper and faster with less paperwork for the agency.
Single, motivated contractor.
Quick reactions to changing situations. Emphasis on goals.
Remediation contractor warrants cleanup of site. Payment for successful cleanup based on performance goals spelled-out in PBC. Penalties for failures to meet goals w/in specified periods of time.
Theoretically, sites are cleaned up faster.
Money savings.

The greatest benefit of environmental cleanup under PBC is well-defined goals. Everyone understands the goals and the performance that is expected. If those are not achieved, you don't pay for the result. This ideally eliminates the change order loop.
Accelerated cleanup.
Accelerated cleanup.
Can be faster.
Reduced cost and time.
I've not seen this done in PA, but from reading this I can see where it could make a great deal of difference because you're holding people's (esp. contractor's) feet to the fire.
The end result may possibly be achieved sooner.
(1) Accountability. (2) Focusing on performance is very important and critical in achieving the cleanup goals. (3) Will stop wasting valuable federal funds on unimportant issues and go towards the actual cleanup for the protection of public health and the environment.
Incentive to make progress; can be faster
Quicker, less expensive remedies for states.

The following were given as greatest drawback of cleanups under PBCs:

Not much control over the process.
A little more up-front work and cost to determine the scope of work to be performed.
FYI, it may cost more initially.
Inability to provide complete information about (changed) site conditions; need good design cost estimate to form basis for evaluating (under)bidding; low bidder probably has little contingency added. No itemized cost/price basis for change orders, claims. Could encourage shortcuts in materials used, quality. Any change in remedial objectives (standards), site conditions/assumptions is a problem.
Getting contractor and staff buy-in. Difficult to use for site characterizations.
Unrealistic expectations from state.
Limited opportunity for focus on details.
Corporate failures involving remediation contractors have caused significant delays in site cleanups. New PBC has to be negotiated with another contractor.
Remedial action selection between regulators and contractors can get more contentious.
Loss of regulatory control.
Not sure how PBC would apply to RCRA-regulated facilities. Liability is always transferred with the land unless specific legal arrangements are entered.
At present, PBC has some logistics issues with how we implement cleanups in our state. For one, the premise of RBCA doesn't always agree with PBC. Under RBCA, the goal is to find the highest concentration but does not necessarily indicate you have a full conceptual model of contamination at the site. If contractors are going to assume all the added risk of a site, they want to have a better understanding. They typically require a complete reworking of all data before starting. These projects are not easily started. In addition, the silty/clayey soil types we have in our state make some corrective action strategies seem riskier under PBC. It has generally been perceived that overexcavation activities are risky to the contractor if they don't ask for enough to cover what they take out, and risky to the funding agency paying for the work, if the contractor asks for too much and doesn't take out as much soil as proposed.

Overwhelming document review by regulator.
Sites may not be adequately investigated and/or remediated, and the ability of the regulatory agencies to ensure that this does not happen.
Must watch closely to ensure shortcuts are not taken to save /make $$.
Reduced quality of the final product.
Unless there are some well-defined milestones, contractors could skimp and cheat just to get to the end.
Disputes are not readily resolved, and cleanup actions could cease.
Sites have to be well characterized, and continuous communication between contractor and the responsible party is very critical.
Minimum flexibility once a contract is signed; may stifle innovation.
Eliminating the shortcuts that might be taken that will lead to failed remedy.

Following additional comments were made by the respondents on the PBEM/PBC state survey:

Question 26 needs a zero option. I do not modify contracts in any way after they are awarded. We have never issued a change order. If there is a major problem as a result of something WE missed, I cancel the contract and reconsider the site.
FYI, PBM and PBC are very useful concepts and best practice in any field.
PBC federal facilities questions: Q.52—We do not want to interface with federal facility contractors but would send all of our questions to the federal facility directly. Q.54—We already have a dispute-resolution process in our DSMOA agreement; would not need anything else.
Our state's environmental cleanup regulations under Part 201 of Act 451 are Land-Use Risk-Based criteria. The basis of these regulations was to help streamline the “risk assessment” process and have several of the risk factors defined (with some options/exemptions available). Many guidance documents have been developed to assist decision making and the approval process. With this regulatory basis, I believe the state has initiated a fair amount of PBM but has not been formally adopted/authorized by federal programs other than the FY work plan and MOUs as to what the state uses for CA criteria. As for PBC, the hazardous waste program works directly with the regulated community. We do not use contractors, but rather the owner of the land holds the liability.
Our state has completed only a few PBC projects so far. There has been a general reluctance for several reasons. The contractors and funding agency have been reluctant to ease on some of the contractual requirements. We have had months of contract revisions between the two sides having their attorneys review contractual language. I have also observed a hesitancy to let go of the traditional role of oversight on project choices by all parties. These may improve with time, but these factors have generally limited the number of projects where PBC has been attempted.
Good idea but must be properly managed to prevent confusion, reduced quality of final product.
The PA Act 2 is really a PBM under the site-specific standard. That standard says reduce the risk by cutting off pathways to get to the point where the site can be reused.

ITRC Performance-Based Management (PBM) and Performance-Based Contracting (PBC) Survey of State Regulators

Please note: You have 1 hour to complete this survey, starting from the time you loaded this Web page.

1. **Name** [ ]

2. **Name of your State Agency**

[ ]

3. **Name of your State Regulatory Program**

[ ]

4. **Street Address (line 1)** [ ]

5. **Street Address (line 2)** [ ]

6. **City** [ ]

7. **State** AK

8. **Zip Code** [ ]

9. **Telephone Number** [ ]

10. **E-mail Address** [ ]

11. **For what regulatory program(s) are you answering this survey? *(Check all that apply.)***

- [ ] CERCLA (state lead)
- [ ] CERCLA (federal lead)
- [ ] RCRA (state lead)
- [ ] RCRA (federal lead)
- [ ] 'Brownfields' program
- [ ] 'Voluntary Cleanup' program
- [ ] 'UST' program
- [ ] Other (please specify under Question 13, below)

12. **If you checked 'Other' in Question 11, please specify here.**

[ ]

PERFORMANCE-BASED MANAGEMENT (PBM):

For the purposes of this survey, PBM *is a strategic, goal-oriented uncertainty management methodology that is implemented through systematic planning and dynamic decision-logic focused on desired end results. For environmental cleanup programs, PBM seeks to shift the focus of cleanup efforts from process and administrative milestones to performance and results. Performance and results are determined by objectively assessing progress toward, and efficient and effective attainment, of remedial action objectives (RAOs) and other site closeout criteria. In particular, Federal agencies such as DOD Components and DOE are increasingly adopting elements of PBM in response to requirements established under the 1993 Government Performance and Results Act (GPRA).*

13. **Are you familiar with the principles of PBM?**

☐ Yes ☐ No

If you answered "No" to Question 13, please skip to Question 19.

14. **During what phase of an environmental project do you believe that introduction of PBM principles would provide the most value?**

☐ Site/Risk Characterization ☐ Alternatives Evaluation ☐ Remedy Selection

☐ O&M ☐ LTM ☐ Any Phase ☐ Never Useful ☐ Remedy Implementation

15. **Please briefly explain the basis for your response to Question 14.**

16. **Have you or others in your Agency been involved in public/stakeholder meetings in support of PBM for an environmental project?**

☐ Yes ☐ No

17. **If you answered "Yes" to Question 16, how would you describe the effects of PBM on project planning and execution, based on your experience (check one)?**

☐ Generally Positive ☐ Generally Negative ☐ No Difference ☐ No Opinion

18. **Please briefly explain the basis for your response to Question 17.**

PERFORMANCE-BASED CONTRACTING (PBC):

Pursuant to GPRA and current Administration policy, the Federal government is dramatically expanding its percentage of performance-based contracts, including firm fixed-price (FFP) or guaranteed FFP (GFFP) contracts. Performance "guarantees" typically are provided through the use of environmental liability or cost-cap insurance. For the purposes of this survey, PBC *is defined as a PBM contracting tool that explicitly specifies the funding Agency's end objective (e.g., site closeout, delisting from the NPL) for environmental remediation, and defines interim and final performance expectations, measures, and milestones that must be met as conditions for release of funds to the contractor. Because PBC ties contractor performance to achievement of a specified end-state objective, rather than to work performed, the contract is inherently flexible and is not prescriptive as to the methods to be used to achieve the end objective.*

PBC transfers risk and accountability for environmental cleanup from the responsible party to the contractor. Because the contractor assumes considerable risk in achieving the end objectives for a fixed cost, PBC requires more upfront due diligence to assure that site conditions, program requirements, and regulatory expectations are fully disclosed to prospective bidders, and uncertainties are well understood by all parties. Therefore, sites that have been well characterized are the best candidates for PBC. PBC provides improved cost certainty for the funding Agency and selection of a single contractor to complete a project can provide continuity of expertise and *site knowledge. The degree of contractor oversight exercised is generally reduced under PBC from that provided under conventional remediation contracts, which can lead to increased regulatory oversight.*

Under PBC, statements of work are replaced with statements of objectives, as the responsible party seeks to harness the initiative and creativity of the contractor community by specifying **what** *end objectives the contractor must achieve, but not* **how** *best to achieve them. The contractor is challenged ("incentivized") to develop and apply innovative solutions to the specified environmental problems in exchange for the opportunity to increase profit through creative solutions that will achieve the end objective in the most expedient manner. PBC is expected to accelerate site cleanup while managing costs without increasing the risk to human health or the environment by tying compensation to performance and results, rather than providing reverse incentives to extend the cleanup process by paying for work (process) rather than performance (results).*

19. **Are you familiar with the use of PBC for environmental projects?**

☐ Yes ☐ No

If you answered "No" to Question 19, Please Skip to Question 55.

20. **Does your Agency have direct experience with PBC cleanup projects?**

☐ Yes ☐ No

If you answered "No" to Question 20, please skip to Question 55.

21. **In how many PBC cleanup projects has your Agency participated?**

☐ < 5 ☐ 5 to 10 ☐ 10 to 20 ☐ >20

22. **Please briefly describe the type(s) of PBC environmental projects with which your Agency is or has been directly involved (e.g., types of sites, types of contaminants, affected media, remedial technologies):**

23. **Have any PBC environmental projects in which your Agency has been involved been completed?**

☐ Yes ☐ No

If you answered "No" to Question 23, please skip to Question 28.

24. **Were the specified end-state objectives met within the original terms of the performance-based contract?**

☐ Yes for all ☐ No for all ☐ Mixed results ☐ No PBC project completed

25. **For completed PBC projects that have required modifications of the original contract terms, approximately how many modifications per contract have been required, on average?**

☐ 1-2 ☐ >2 ☐ Not Sure ☐ No PBC project completed

26. **How did the cost to complete a performance-based environmental project compare with costs for other, similar projects completed under conventional contracts?**

☐ PBC costs lower ☐ PBC costs higher ☐ No material difference ☐ Not sure

27. **How did the time required to complete a performance-based environmental project compare with time frames for other, similar projects completed under conventional contracts?**

☐ PBC faster ☐ PBC slower ☐ No material difference ☐ Not sure

28. **How would you describe the effects of PBC on the level of regulatory agency involvement on the project relative to involvement under conventional cleanup contracting, based on your experience?**

☐ Increased ☐ Decreased ☐ No Change ☐ Not Applicable

29. **How would you characterize your overall impression of environmental cleanup projects administered under PBC relative to projects implemented under conventional (e.g., time and materials) contracts?**

☐ Favorable ☐ Unfavorable ☐ Neutral

To follow up your responses to Questions 28 and 29, please indicate how your Agency's involvement has been affected for the general categories listed below in Questions 30 through 40.

30. **PBC pre-bid participation (e.g., contractor interviews):**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

31. **Project Team meeting participation:**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

32. **Intra-Agency program coordination and management:**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

33. **Inter-regulatory-agency coordination:**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

34. **Your Agency's coordination with responsible party:**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

35. **Your Agency's coordination with the remediation contractor:**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

36. **Number of requests for document reviews**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

37. **Requests for expedited (< 30 day review period) document reviews**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

38. **Number of substantive regulatory agency comments on key documents:**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

39. **Time required to negotiate final cleanup goals:**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

40. **Requests to renegotiation previously documented basis for or terms of a remediation project (e.g., exposure/land use assumptions, cleanup objectives, points of compliance, long-term management requirements, schedules, or other performance measures):**

☐ Increased ☐ Remained the Same ☐ Decreased ☐ Not Applicable

41. **What effect would decreased oversight of contractors by the responsible party have on project execution?**

☐ Negative ☐ Positive ☐ No Effect ☐ Not Sure

42. **Has your Agency taken steps to address any anticipated changes in resource requirements that may be necessary for PBC cleanup projects?**

☐ Yes ☐ No

In *Performance-Based Remediation Contracts White Paper and Compendium of State Lessons Learned* (November 2004), the Base Closure Focus Group of the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) assessed potential benefits and pitfalls of DOD's use of PBC for environmental remediation. This survey seeks to solicit further input on some of the PBC issues identified by ASTSWMO. As a factor in determining your Agency's support for PBC as constructive PBM tool to expediting cleanup and close out of federal facility sites, please indicate the **relative importance** of the issues listed in Questions 43 through 52.

43. **Regulatory Agency input on suitability of a particular site for environmental remediation using PBC:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

44. **Clearly defined roles and responsibilities of the funding Agency, Service Center, regulatory Agencies, and the selected contractor:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

45. **Acknowledgement that the federal facility is ultimately liable for unresolved environmental concerns:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

46. **Regulatory Agency participation in pre-award meetings and contractor interviews:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

47. **Clear expectations regarding anticipated level of and schedule for regulatory Agency project support and oversight:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

48. **Revision of federal funding documents as necessary to reflect changes in support requirements for State Agencies:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

49. **Contractual requirement for regular contractor interface with regulatory Agencies:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

50. **Consistent PBC approach within and among all responsible parties or regulated entities:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

51. **Confirmation of dispute-resolution process under PBC:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

52. **Continuation of public participation process:**

☐ Critical ☐ Secondary ☐ Negligible ☐ Irrelevant ☐ Cannot Assess

In summary, please complete the statements in Questions 53 and 54.

53. **The greatest benefit of environmental cleanup under PBC is:**

54. **The greatest drawback of environmental cleanup under PBC is:**

55. **Please share any additional comments on PBM, PBC, or this survey:**

56. The greatest drawback of environmental cleanup under PBC is:

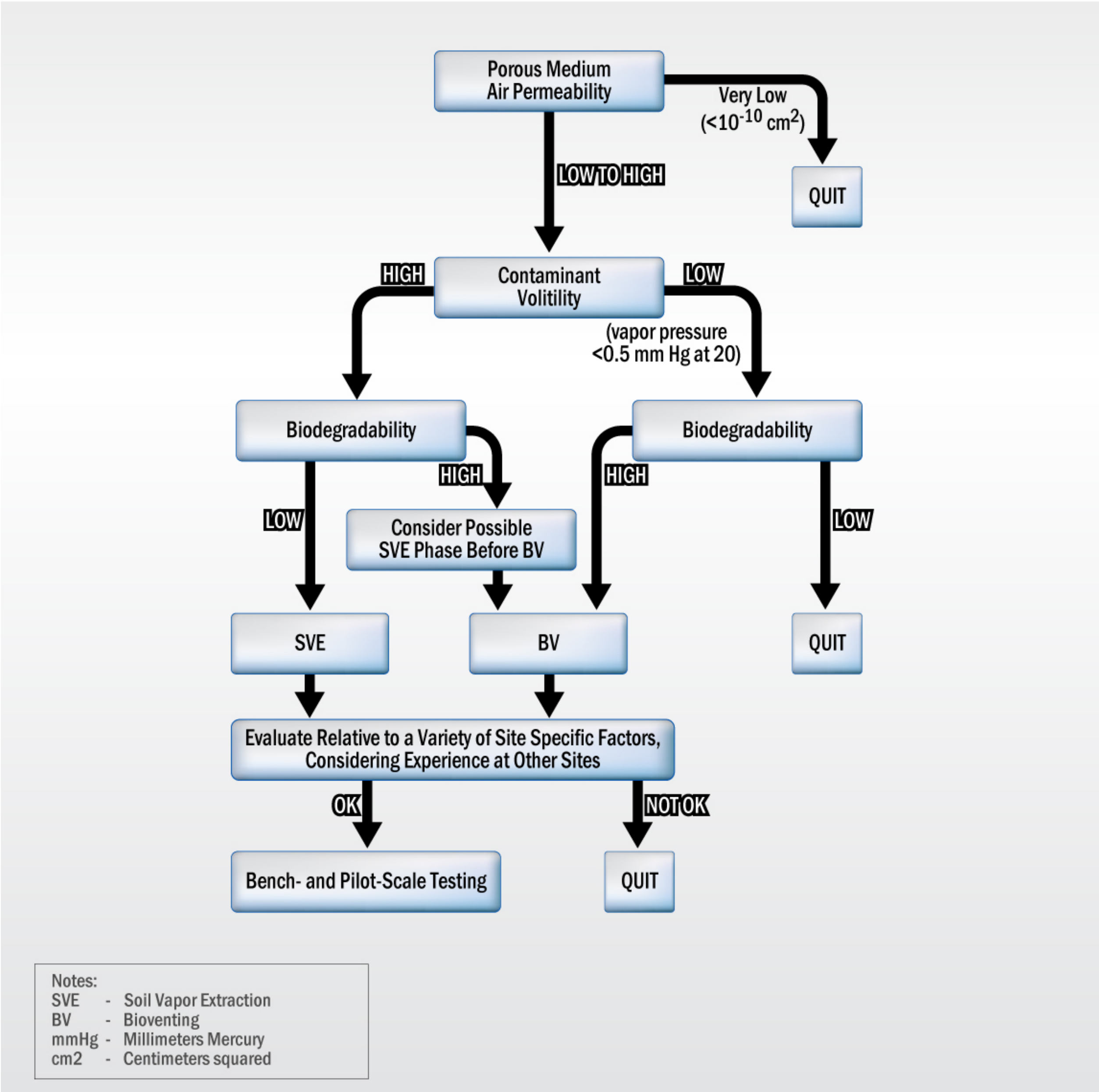
57. Please share any additional comments on PBM, PBC, or this survey:

Appendix B

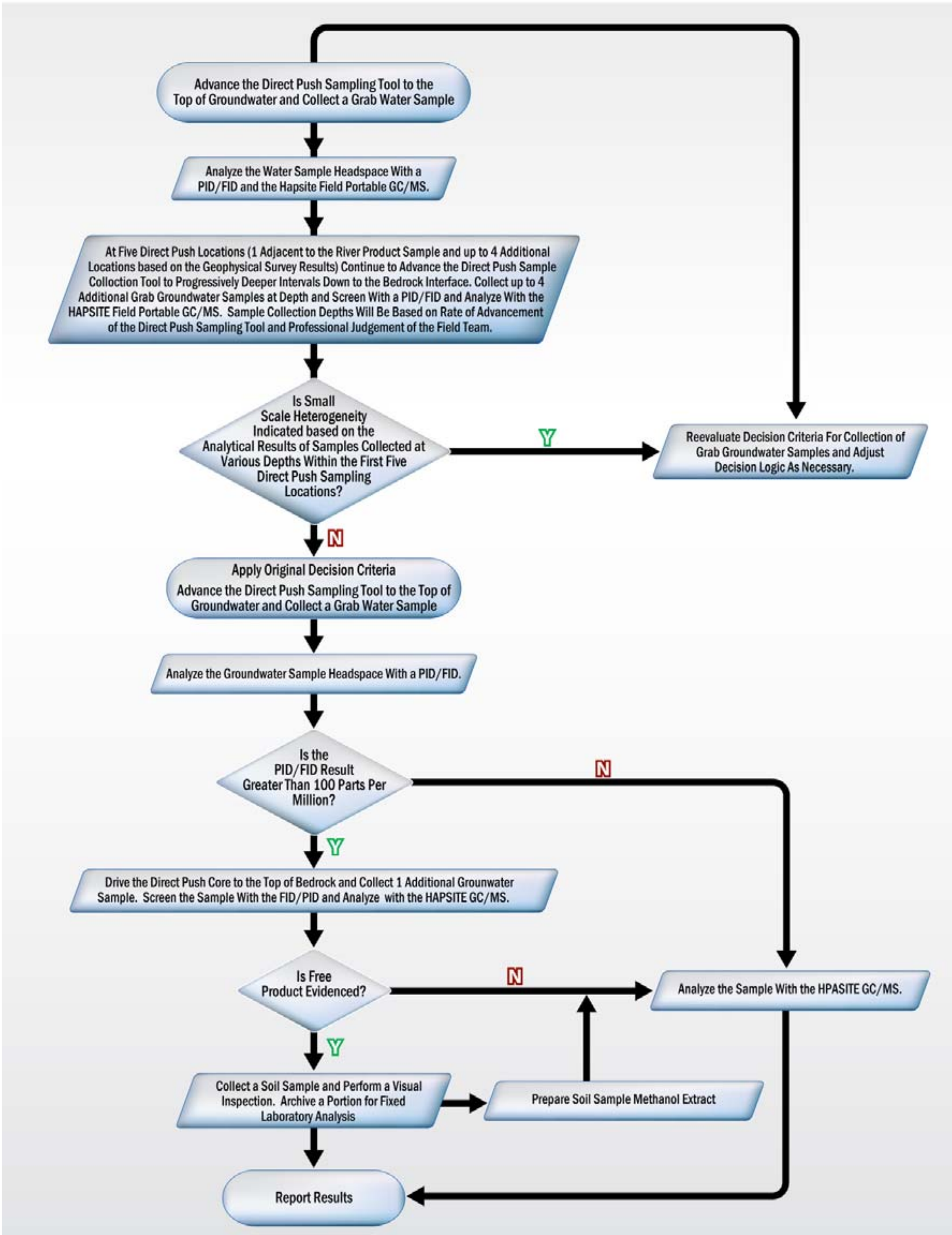
Decision Logic Examples

DECISION LOGIC EXAMPLES

Example Decision Logic for a Feasibility Study Comparison of SVE and Bioventing Technologies Soil Vapor Extraction



Example Decision Logic for Site Characterization Using Direct Push Sampling Techniques



Example Decision Logic for Soil Excavation Project
(Remedial Design & Construction)

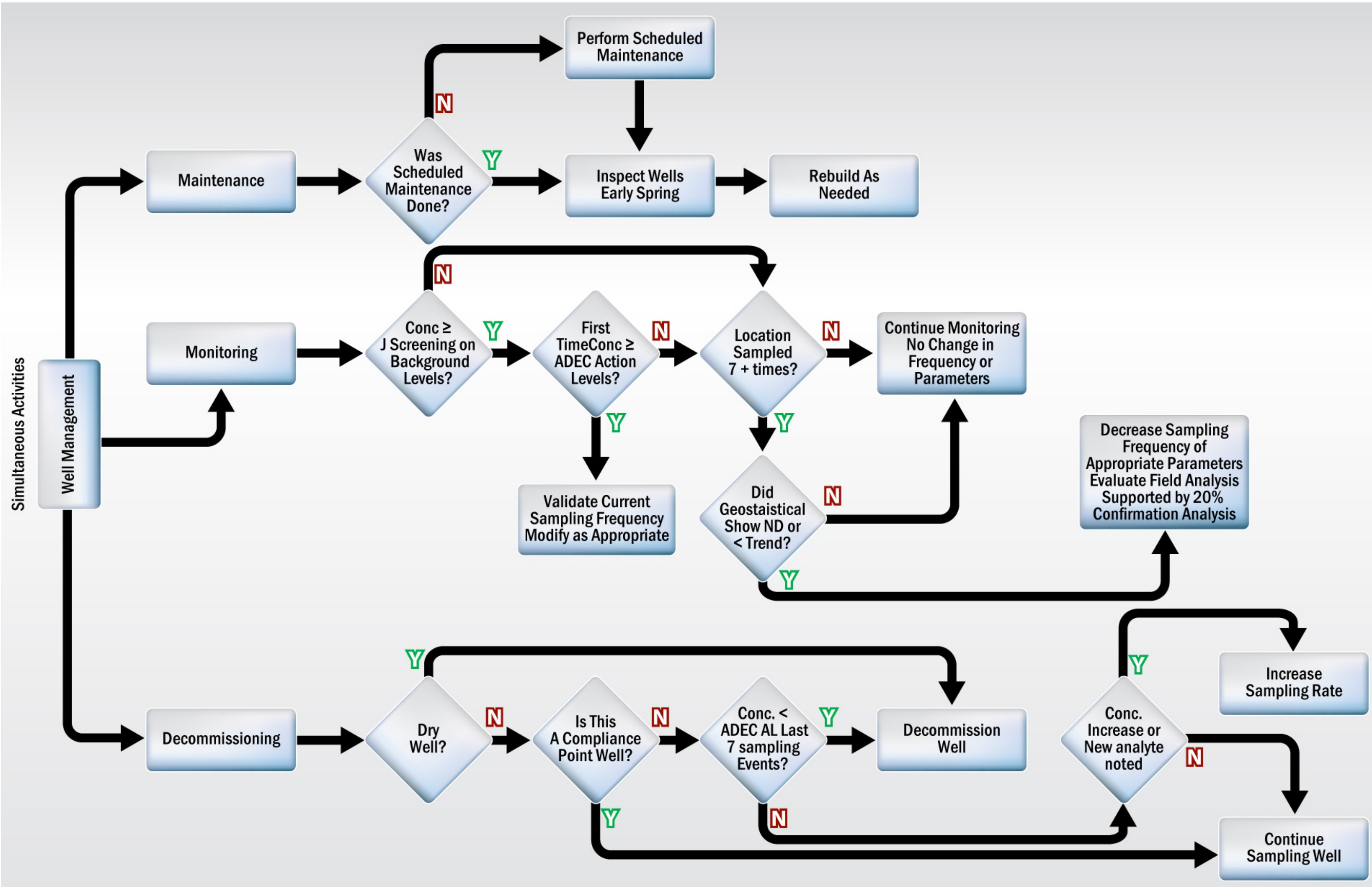
Removal Decision Matrix for Shallow Disposal
(Contamination above MTCA Method B/Field Kit Action Level at depth)

Scenario#	0 to 24”	12 to 24”	24 to 36”	36 to 48”	48 to 60”	60 to 72”	Action
1	No	n/a	n/a	n/a	n/a	n/a	Confirmation Sampling
2	Yes	No	n/a	n/a	n/a	n/a	Find contamination in 0-12” sample, field sample 12-24” sample. Find no contamination in 12-24” sample above MTCA: Remove 0-12” of soil. Confirmation Sampling. No Further Action.
3	Yes	Yes	No	n/a	n/a	n/a	Find contamination in 0-12” sample, field sample 12-24” sample. Find contamination in 12-24” sample, field sample 24-36” sample. Find no contamination in 24-36” sample above MTCA: Remove 0-24” of soil. Confirmation Sampling. No Further Action.
4	Yes	Yes	Yes	No	n/a	n/a	Find contamination in 0-12” sample, field sample 12-24” sample. Find contamination in 12-24” sample, field sample 24-36” sample. Find contamination in 24-36” sample, field sample 36-48” sample. Find np contamination in 36-48” sample above MTCA: Remove 0-36” of soil. Confirmation Sampling. No Further Action.
5	Yes	Yes	Yes	Yes	No	n/a	Find contamination in 0-12” sample, field sample 12-24” sample. Find contamination in 12-24” sample, field sample 24-36” sample. Find contamination in 24-36” sample, field sample 36-48” sample. Find contamination in 36-48” sample, field sample 48-60” sample. Find no contamination in 48-60” sample above MTCA: Remove 0-48” of soil. Confirmation Sampling. No Further Action.
6	Yes	Yes	Yes	Yes	Yes	n/a	Find contamination in 0-12” sample, field sample 12-24” sample. Find contamination in 12-24” sample, field sample 24-36” sample. Find contamination in 24-36” sample, field sample 36-48” sample. Find contamination in 36-48” sample, field sample 48-60” sample. Find contamination in 48-60” sample, field sample 60-72” sample. Find no contamination in 60-72” sample above MTCA: Remove 0-60” of soil. Confirmation Sampling. No Further Action.

Notes:
MTCA: Washington State Model Toxics Control Act Method & Levels
n/a: Not applicable
Field analysis for contaminants of concern perfomred using … See report for more details.

Reference:
Remedial Action Management Plan Wenatchee Tree Fruit Research Center Test Plot Remediation, August 1997, U.S. Army Corps of Engineers

King Salmon Airport Well Management Decision Tree



Appendix C

Case Studies

CASE STUDIES

This appendix presents case studies collected from various state and federal agencies and the private sector.

PBC CASE STUDY QUESTIONS

Interviewee:
Site name:
Site location:
Agency responsible for cleanup:
Service center/contracting agency:
CTC:
Contract value:
Contract type:
Contract award date: period of performance:
Insurance:
  Type
  Have any claims been made thus far against any of the policies?
Incentives:
Site information:
  Contaminants
  Geology
  Groundwater/soil
Regulatory agency with authority:
Regulatory status of the site (DD's):
Modifications required to the contract?
End-state performance objective(s):
Lessons learned for state regulators:
  What went right:
  What went wrong:
Disadvantages/advantages of a PBC for contractors:

FORT GORDON, GEORGIA

Interviewee: Christopher Hurst
DOD Remediation Unit
GA EPD-HWMB
Phone: (404) 463-7508
Email: Chris_Hurst@dnr.state.ga.us

Date: August 21, 2006

Site name: Fort Gordon, Georgia, which is an active army installation. Used for signal and communications training. The PBC covers 26 of the 35 active Solid Waste Management Units (SWMUs) on the base. All 26 sites are on Fort Gordon—there are no outliers or off-base sites.

Regulatory agency with authority to oversee cleanup: All 26 sites are being cleaned up under RCRA—so the state regulatory agency has authority over the cleanup (e.g., Georgia Environmental Protection Division).

Service center/contracting agency: Army Environmental Center/U.S. Army Corps of Engineers—COE Savannah District

CTC: $0.4 M

Contract value: $19.5 million through FY 2008—Chris believes the contract was awarded in early 2002.

Contract type: GFPR w/insurance

Contract award date/period of performance: Chris stated that the regulators weren't involved in the contract development or negotiations, so he had to defer on this question.

Insurance: Chris didn't know exactly what type(s) of environmental policies Arcadis G&M purchased. Chris is following up on this with others involved in the project to try to get an answer—he did find out that, to date, no claims have been filed.

Incentives: There were no specific incentives written into this PBC. Chris believes that this contract was one of the first for the Army (for environmental restoration) so these types of things were not considered.

Site information: At the time the PBC was awarded, the majority, if not all, of the sites were in the Remedial Investigation phase—with varying degrees of characterization having been completed at the sites. Since the PBC was awarded, 20 sites have received "No Further Action" status. For the six remaining sites—two will possibly receive No Further Action status after the completion of the remedial investigations and four will continue on into some type of Corrective Action Plan (CAP). The major contaminant of concern at the 4 sites likely to require a CAP is chlorinated solvents.

Modifications required to the contract? There was only one change to the contract along the way which expanded the scope of the remediation work for two specific sites to include the demolition and removal of buildings on site. Additional funding was allocated by the Army Environmental Center to the Contractor to cover this additional work.

End-state performance objective(s): Achieving No Further Action at all 26 sites.

Lessons learned for state regulators:

- Positive Aspects of the Fort Gordon PBC

  - Having a single contractor to interact with on all 26 sites simplifies the regulatory oversight process**.** The challenges associated with building a relationship and trust with a new contractor are minimized when you just have one contractor addressing the majority of sites at a facility.
  - Due to the "performance-based" nature of the contract, the contractor has been responsive and highly motivated to accomplish the performance goals.
  - PBC appears to be better suited for larger-scale projects where there is flexibility for the contractor to work with multiple sites or corrective action units.
- Not-So-Positive Aspects
  - It was difficult for the regulatory agency to provide as rapid a response (i.e., harder for the regulatory agency to "ramp-up") compared to the contractor.
  - Project managers with the regulatory agency are burdened with increased expectations for a PBC on top of other duties.
  - Contractor has expectations that corrective action review process can be expedited beyond the capabilities of the state agency.
- Suggestions for Improvements
  - At the beginning of the PBC, Arcadis G&M had a dedicated staff for the work at Fort Gordon. Initially the contractor had expectations that there would be a similar group within the regulatory agency focused just on the DOD PBC contracts within Georgia—thus, the contractor thought they would get immediate turn-around on their document reviews. This was not the case—while the GDEP has recently started a new group (funded through DSMOA) to focus just on Georgia military installations, they did not have a dedicated staff just to service Fort Gordon. So the contractor and the regulators had to come to terms with each other's expectations. Chris suggests that a PBC contractor may want to evaluate the possibility of shifting some of their resources to other projects when appropriate during a PBC instead of having a dedicated staff for one installation.
  - Communicate early on and frequently throughout the entire process.
  - Develop a clear understanding of the expectations and capabilities of the state agency, the PBC contractor, and the DOD installation.

KANSAS SITE

Interviewee:

Site name: Confidential

Site location: Kansas

Agency responsible for cleanup: U.S. Army Corps of Engineers (USACE)

Service center/contracting agency: Kansas City District (USACE)

CTC:

Contract value:

Contract type: Guaranteed fixed price with insurance

Contract award date: period of performance: 2004, 5 Years

Insurance
Type: Unknown
Have any claims been made thus far against any of the policies? No

Incentives:

Site information:
Contaminants: Trichloroethene
Geology: Fine-grained glacial till with limited sand layers (probable ice-contact deposits)
Groundwater/soil: Both media impacted, also contaminated sediment in sewer/sumps

Regulatory agency with authority: Kansas Department of Health and Environment

Regulatory status of the site (DD's): Record of Decision in preparation

Modifications required to the contract? No

End-state performance objective(s): "Response complete" though may not necessarily meet regulatory definition of "cleanup"

Lessons learned for state regulators:

What went right: Expedited progress on project, including time-critical removal action.

What went wrong: Contract bid had presupposed remedy, leading to risk of inadequate consideration public and regulatory input in feasibility study and proposed plan. Pilot testing results for in situ bioremediation equivocal regarding likelihood of success, contractor still pursuing technology. May affect ability to attempt other technologies if this fails.

Disadvantages/advantages of a PBC for contractors: Advantage is there is strong motivation to make progress on site. Disadvantage is the potential to circumvent public participation required by CERCLA, as well as residual risk for responsible party.

FORMER EVERGREEN INFILTRATION RANGE

Interviewee: Kym Takasaki, USACE Seattle District

Site name: Former Evergreen Infiltration Range

Site location: Fort Lewis, Washington

Agency responsible for cleanup: Fort Lewis Public Works

Service center/contracting agency: USACE Seattle District

CTC:

Contract value: $697,225

Contract Type: Fixed fee

Contract award date: 9/22/04, period of performance end date: 5/30/05, amended to 6/30/05

Insurance: NA

> **Type**
>
> **Have any claims been made thus far against any of the policies**

Incentives: NA

Site information:

> **Contaminants:** Lead in soil

Regulatory agency with authority: Washington Department of Ecology

Regulatory status of the site (DD's): RCRA Interim Closure

Modifications required to the contract? Yes

End-state performance objective(s):

- Excavation of site soils to 250 mg/kg for lead—Initial excavate to depths shown on the drawings. After excavation to the limits indicated on the drawings, the excavation shall be examined for evidence of contamination. If the excavation appears to be free of contamination, field analysis shall be used to determine the presence of lead contamination using XRF. Excavation of additional material beyond the limits indicated on the drawings shall be as directed by the Contracting Officer.
- Separation of bullet fragments from the soils—For every 500 cubic yard of soils, a treated subsample with volume equivalent to approximately 5 gallons will be collected and the retained material will be hand searched for bullet material. The treated portion must contain less than 0.1% bullet material for the total sub-sample volume. This is approximately equivalent to one bullet per 5 gallons soil.
- Stabilization of the remaining soils to pass TCLP criteria—The stabilization performance must meet or exceed the performance of 3% Enviro 50:50 additive to soil (defined as TCLP less than or equal to 5.0 mg/L). The pH of the soil must be maintained between 6 and 9. If the native soil is outside this range, the pH shall not be allowed to change more than 1 pH unit. The pH cannot be lower than 2 or greater than 12 to avoid being classified as RCRA hazardous waste criteria. Additionally, the stabilization process must not cause the soil to exceed any criteria or to cause the soil to be classified as a Federal RCRA hazardous waste or to be classified as a State of Washington Department of Ecology Dangerous Waste. The specified frequency of sampling was a 30-point composite per 100 CY stockpile.
- Placement of stabilized soils onto active ranges at Fort Lewis.

- Confirmation sampling to ensure clean closure—After XRF analysis demonstrates that the site is compliant with all chemical parameters and respective action levels, collaborative samples shall be collected and lab analyzed for total lead. The decision on whether an area complies with a cleanup level is based on three criteria: 1) the upper 95% confidence limit (UCL) of mean concentration calculated from sampling data cannot exceed the cleanup level of 250 mg/kg; 2) all samples will have measured concentrations less than twice the cleanup level, i.e., 500 mg/kg; and 3) less than 10% of the samples exceed the cleanup level.

Lessons learned for state regulators:

What went right:
- The CSM was adequately refined to transparently manage project uncertainties prior to remedial action contracting with a PBC.
- Triad work strategy utilized throughout characterization and remediation.
- Performance and decision criteria developed cooperatively with the customer and regulators to ensure successful project completion.
- Performance criteria put the responsibility of the design of the removal on the contractor.
- Contract oversight focus required for the following activities:
  - Overseeing general site conditions (dust supression, road conditions, tree preservation)
  - Monitoring performance criteria compliance
  - Verifying treated materials and residual handling was appropriate
  - Observing and advising on health and safety issues (excavation safety, air monitoring needs)
  - Assisting in directing extent of excavation—contract officer approval required
- Due date in contract helped ensure project completion to meet needs of customer.
- Established contingencies in the contract to allow for extra volume to be removed, if encountered without a contract modification.
- Obtained statistically defensible data to support site closure by using collaborative data sets.

What went wrong: Weather delay clause was not included in the contract. The contractor filed a rain delay claim and request for extension on performance end date, based on precipitation slightly above average.

Disadvantages/advantages of a PBC for contractors:

Advantages:
- Performance monitoring allowed for real-time modification to sieving and stabilization process.
- Maximization of innovation allowed since method of attaining performance criteria was up to the contractor.
- Since the only contractual requirement was date of completion, the contractor was fully responsible for sequencing and project scheduling.

Disadvantages:
- Initial bench testing performed by contractor not in the scope of contract, so had to be considered in the overall bid cost.

- The methods selected by contractor to perform task were not initially as successful as they hoped. This required modification to methods, including rehandling of materials. The cost of the modification was absorbed by the contractor.

Program-Wide Performance-Based Management: South Carolina Underground Storage Tank Program

In 1996, the South Carolina UST Program formally adopted risk management regulations for addressing petroleum releases from USTs. Subsequently, the new approach was dovetailed with PBC following a competitive bidding protocol. Over the last decade, the efforts have allowed South Carolina Department of Health and Environmental Control (SCDHEC) to enjoy a systematic approach to case management that mandates contractor performance and in a fiscally responsible manner. The risk-management approach allows for systematic and streamlined approach that encourages a rapid site characterization and rewards appropriate remediation. The South Carolina UST Program incorporates many aspects of the PBEM process and has been successful in addressing contaminated sites. The program certifies the consultants and contractors who are involved with the assessment and remediation of these sites.

There are two main ways to proceed with site rehabilitation activities in South Carolina UST Program: (1) State-lead sites where the program takes the lead in directing assessment and remediation actions and (2) RP-lead sites wherein the responsible parties actually keep control of the site rehabilitation activities at their sites.

In the South Carolina UST Program the site assessments are done using a tiered approach:

Tier I—The standard plan investigation used in the Tier I includes a thorough survey of the receptors, potential sources, investigations to determine the nature and extent of chemicals of concern (COCs) in soils and groundwater using soil borings and monitoring wells, and a risk evaluation. The report generated through such a standard plan requires submission in a standard format and the costs associated with the report are reimbursed through an online form. There is a base price for the assessment based on the location of the site within the state. Costs are then reimbursed based on actual performance that is approved for the site. There is a time limit for submitting the investigation report, usually within 60 days from the approval of plan.

Tier II—Site-specific Tier II assessment includes a standard form for filling in the site-specific plan that can be used to explain the characterization methods. Field screening methods can be used to completely characterize the nature and extent of both the horizontal and vertical extent of the plume. Throughout the field screening process, the project manager is informed of the results and is involved in the decision making process for the final location and sampling of the wells. An aquifer test, pumping or slug, is conducted as part of the Tier II assessment. A free-product recovery test is conducted if necessary. Based on the results of the assessment, a model (analytical or numerical) is simulated to understand the flow and movement of the contaminant plume. A prediction is made for the future flow and extent of the plume. A final report is completed and submitted to the Department for review, usually within 90 days of the approval. At the end of this tier, the UST site is required to be completely characterized. If additional assessment is required, an addendum to Tier II or a more site-specific Tier III assessment is conducted, and only then is the site investigation considered complete.

An expert team within the agency evaluates the completeness of the site investigation and makes a decision on the remediation requirements at the site. At this point the pay-for-performance (PFP) for remediation comes into use. Since 1997, all active corrective actions (ACAs) started to be open for bidding under PFP following state-approved procurement procedures. Both the state-lead as well as RP-lead sites have a clearly defined process for bidding. Depending on the need sites may be packaged together during the bidding process.

Average costs for assessment as well as cleanup costs fluctuated over the years. But overall, the costs have decreased considerably in the PFP process compared to time and material processes that were in practice prior to the pay-for-performance.

The following table shows costs for corrective actions under earlier time and material methods.

Time and material average costs	
Initial system installation and start-up	$150,000
O&M for five years at $35,000 per year	$175,000
Total costs	$325,000

The following table shows the annual number of cleanups and average bid costs since 1997.

Year	# Cleanups	Average bid cost
1997	16	$128,396
1998	68	$154,880
1999	43	$112,404
2000	25	$103,411
2001	47	$138,758
2002	62	$84,187
2003	48	$102,208
2004	52	$102,520
2005	44	$169,050
2006	23	$229,607

South Carolina UST Program Lessons Learned

During the last few years, the progress towards meeting the ACA goals has been steady at the sites under the PFP process in the South Carolina UST Program. Figure C-1 shows the number of sites reaching interim goals towards 100% of their cleanup complete goals. It appears that many sites reach the initial 50% or 75% goals and even 90% goals rather easily, but meeting the last 10% of the cleanup goals seems to be a challenge. This calls for innovative methods to complete cleanup, which is currently being implemented or considered at several sites.

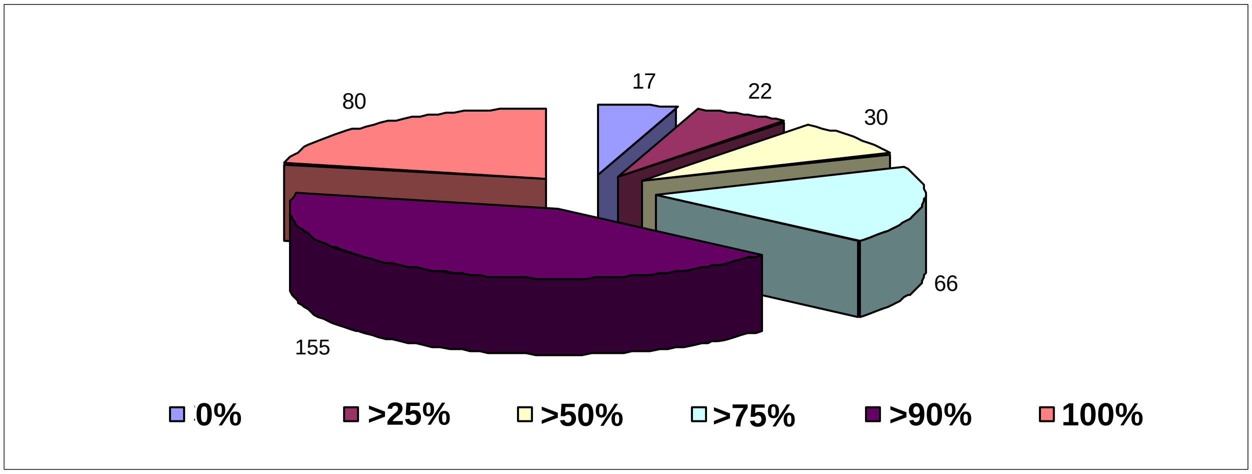


Figure C-1. UST Remediation Progress Towards Cleanup Goals.

Early-Completion Incentives

The South Carolina UST Program incorporated an early-completion incentive program to encourage completion of cleanups and achieving the 100% goals for the ACAs. During the bid solicitation process, based on the risk priority ranking and the size of the plume, an incentive period is set by the South Carolina UST Program. Those contractors who achieve verified completion of cleanup within the established time period would qualify for a bonus equal to 10% of the contract amount.

Project-Specific Implementation of PBCs

In addition to the South Carolina UST Program, PBCs are being executed at several SCDHEC sites in the state. These are in a variety of programs: RCRA, CERCLA, Federal Facility Agreement (FFA), voluntary cleanup programs, brownfields, dry-cleaning, etc. In RCRA and FFA programs, where a federal agency such as DOD or DOE has been the lead agency, PBC cleanups at several sites has been implemented. Some of these sites include the Ft. Jackson Army facility, Charleston Naval Weapons Station, Shaw Air Force Base, sites within Charleston Air Force Base, and sites at the Savannah River Site. At these sites, the PBCs are at various stages of implementation.

Since 2000, several DOD sites in South Carolina have been cleaned up using PBC. One of the larger sites where PBC was successfully applied is the Charleston Naval Complex. It is a BRAC site that was closed in 1996. Consisting of over 1500 acres of prime real estate important for property transfer, an expedited cleanup was necessary, and hence the PBC was chosen for this base. A fixed-price remediation with insurance contract was signed in April 2000. The entire facility consisted of nearly 250 sites (over 170 RCRA and over 70 UST sites) with a variety of COCs: solvents, metals, polychlorinated biphenyls, lead-acid at a variety of fuel/petroleum-oil-lubricant sites, landfills, etc. Some of the reasons that the site considered PBC include the immediate divestment of the property, desire to cap the environmental liabilities associated with the property, and most importantly to fund cleanup liabilities within the current budgets (BRAC and ERN).

Some of the challenges included for the Charleston Naval Weapons Station were that some sites were not fully characterized, an excessive amount of RFI documents were generated and needed to be reviewed in a short period of time, and many sites were far from being ready for remedy selection or remedy in place. Along with the contractor, the Navy had several discussions with the department and developed a strategy using organizational tools and flowcharts to expedite the decision-making process. The concept of high-performance teams was invoked, and a well-planned public relations program was implemented.

A system based on GIS/EVS was developed to specifically manage large volumes of data and enhance visualization capabilities. Some of the innovative technologies that were used in the site investigations include vertical profiling in characterization and use of membrane interface probe. Innovative remediation processes included electrical resistive heating and enhanced bioremediation of solvents using HRC compounds.

Some of the lessons learned for this project include the following:

- Early involvement of the regulators is essential, so that proper planning is done ahead of time.
- Time is built-in for the regulatory processes to be properly conducted.
- Engaging in open discussions with contractors, regulators, and insurers and clarifying the bid solicitations at every step is important.

EPA Information Sheet on Pay for Performance

The EPA Office of the Underground Storage Tanks provides extensive information on pay-for-performance contracting. The information sheet for cleanups at leaking underground storage tanks (www.epa.gov/OUST/pfp/infosheet.pdf) is copied below.

March 2003

Pay for Performance Contracting for Petroleum Site Cleanup
--Information Sheet--

What is Pay for Performance Contracting?

A Pay for Performance (PFP) cleanup agreement sets a firm, fixed price for a cleanup at a leaking underground storage tank (LUST) site (or group of sites). Unlike the traditional "time and materials" approach to LUST cleanup contracting, the cleanup contractor gets paid incrementally based on meeting predetermined contamination reduction goals. The specific price, interim payment milestones, contamination level goals and time for reaching the goals are all agreed to before cleanup begins. Contractors are rewarded for quickly and efficiently reaching cleanup goals, which in turn can result in faster and more cost effective cleanups that protect public health and the environment.

Key Components

- Firm fixed price
- Guaranteed environmental results
- Incremental payments based on attainment of contamination reduction levels specified in the contract
- Less administrative overhead
- Can be used on new releases or existing, stalled "time and materials" cleanups
- Escape clauses to protect the interests of the state, the contractor, and responsible party–specifies conditions under which the contractor may be released from the contract

Benefits

Regulatory Community	• Achieves faster, more efficient cleanups that protect public health and the environment • Minimizes paperwork, administrative costs, and delays • Focuses on contamination reduction, not invoice review • Promotes innovative cleanup strategies
Cleanup Contractors	• Offers prompt payment for environmental results • Results in minimal reimbursement disputes • Produces higher profits for faster cleanups • Allows for less oversight by the regulatory agency as well as more cleanup control • Promotes innovative remediation systems
Responsible Parties	• Encourages faster, more efficient, competitively-priced cleanups

Over 14 states have used PFP. States have reported that their PFP cleanups have resulted in faster and more effective tank cleanups. Some states have even coupled PFP with multi-site cleanup agreements to further increase cleanup efficiencies.

Why Try PFP Now?

- Converts flatlined sites
- Maximizes state budgets
- Expedites cleanup backlogs
- Fosters reuse of Petroleum Brownfields sites

"The results were outstanding. Site costs have come down because the emphasis is on closing the site to make money rather than keeping the site open to make money." *Oklahoma*

"PFP is cleaning sites up faster and saving staff time at the State level." *California*

"We're feeling very positive about going down the PFP road, especially since we discovered two rewards that we weren't anticipating–clearer goals and better remedial systems". *Vermont*

For more information, visit the Office of Underground Storage Tank's ***Pay for Performance Toolbox*** *at www.epa.gov/swerust1/pfp/toolbox.htm*

Appendix D

Example Performance-Based Contract

EXAMPLE PERFORMANCE-BASED CONTRACT

Below is an example PBC contract from the South Carolina Department of Health and Environmental Control. This is one of several contracts that SCDHEC uses for USTs. South Carolina calls this PBC a "Pay for Performance" contract.

SCOPE OF WORK

DEFINITIONS:
For the purposes of this contract the following terms and definitions shall apply:
1. Catastrophic Occurrence: an event (e.g., hurricane) that results in a declared state of emergency and directly and substantially affects the Contractor's operations at a site.
2. Chemicals of Concern: Specific constituents that are identified for monitoring and corrective action.
3. Corrective Action Completion Time: the time in months, estimated by the Contractor, necessary to reduce concentrations of chemicals of concern to site-specific target levels, verify attainment of the goals, and remove or properly abandon assessment and corrective action items (wells, treatment lines, etc.).
4. Corrective Action Plan: A document outlining and detailing proposed corrective actions.
5. Corrective Action System Startup Date: the date on which the Contractor initiates full time treatment operations or initiates injection into or extraction from the subsurface.
6. Site Incentive Period: the period of time in months established by the SCDHEC during which the Contractor must achieve the 100% Concentration Reduction Goal in order to qualify for the Early Completion Incentive.

SOLICITATION STATEMENT

The Underground Storage Tank (UST) Program of the South Carolina Department of Health and Environmental Control (SCDHEC) is seeking services to perform active corrective action of petroleum releases at regulated underground storage tank sites in accordance with defined remediation goals. The *objective is to prevent significant further migration and reduce the levels of free phase product (FPP) and chemicals of concern (COC) in the soil and groundwater to or below defined site-specific target levels (SSTLs).* All offerors must be South Carolina Certified Class I Site Rehabilitation Contractors.

SCHEDULE OF DELIVERABLES

The following table summarizes the deadlines for deliverables associated with this contract:

Deliverable Due	Deadline
Questions	By 5:00 p.m. ET FILL IN DATE
Sealed Bids	By 2:30 p.m. ET FILL IN DATE
Corrective Action Plan	30 days from date of award
Performance Bond	30 days from date of award
Initial Monitoring Report	45 days from date of award
CAP Implementation	30 days from Notice to Proceed

Deliverable Due	Deadline
System Start Up	15 days from receipt of Permit to Operate and CAP Notice to Proceed
Notify Project Manager of Sampling	At least two (2) weeks prior to the event
Corrective Action Monitoring Report	Quarterly from date of start up
Abandon Monitoring Wells and Corrective Action System	Within 60 days from notice by SCDHEC

SITE-SPECIFIC INFORMATION

The scope of work defined in this solicitation is to be implemented at:

UST Permit #	Facility Name	Site Address	Date Release Reported	Appendix #
«Permit_1»	«Facility_1»	«Address_1», «City_1»	«Rel_Date_1»	«Appendix_1»
«Permit_2»	«Facility_2»	«Address_2», «City_2»	«Rel_Date_2»	«Appendix_2»
«Permit_3»	«Facility_3»	«Address_3», «City_3»	«Rel_Date_3»	«Appendix_3»
«Permit_4»	«Facility_4»	«Address_4», «City_4»	«Rel_Date_4»	«Appendix_4»
«Permit_5»	«Facility_5»	«Address_5», «City_5»	«Rel_Date_5»	«Appendix_5»
«Permit_6»	«Facility_6»	«Address_6», «City_6»	«Rel_Date_6»	«Appendix_6»

CONTRACTUAL REQUIREMENTS

GENERAL REQUIREMENTS

1. CONTRACT PERIOD: The contract will be effective from date of award until the corrective actions are complete as described in this contract.

2. EQUAL OPPORTUNITY EMPLOYMENT: Contractor must agree to make positive efforts to employ women, other minorities, and minority-owned businesses.

3. AMENDMENTS: All amendments to this solicitation shall be in writing from the SCDHEC Procurement Officer indicated on page one of this solicitation. SCDHEC shall not be legally bound by any amendment, interpretation or settlement that is not in writing.

4. RESTRICTION . . . THE ONLY OFFICIAL CONTACT PERSON AT SCDHEC DURING THE SOLICITATION AND AWARD OF THIS CONTRACT IS THE PROCUREMENT OFFICER INDICATED ON PAGE 1 OF THIS SOLICITATION. OFFERORS ARE NOT TO CONTACT ANY OTHER SCDHEC PERSONNEL LOCATED OUTSIDE THE BUREAU OF BUSINESS MANAGEMENT.

5. AWARD: Award will be made to a South Carolina Certified UST Site Rehabilitation Contractor based on the Grand Total cost, method(s), and Corrective Action Completion Times for all sites listed. For a bid to be considered responsive, the proposed implementation schedule(s) and the proposed remediation technology(ies) or method(s) for active corrective action to achieve the remediation goals must be protective of public health and the environment and be eligible for permitting by SCDHEC. The total cost, methods, and time to

complete the contract must be advantageous to the State of South Carolina.

a. The Corrective Action Completion Times shall be determined by the offeror and entered into the Corrective Action Solicitation Response in Contract Item IV.C.
   i. Time is of the essence in completing the site work to restore the aquifers and protect human health and the environment. Therefore, offerors are encouraged to strive for efficient remediation methods and to propose the shortest practical times for the completion of these sites.
   ii. Award of the contract, if made, will be made to the responsible and qualified offeror who submits the lowest Grand Total amount. The Grand Total amount will be the sum of the Site Total Amounts provided for each site in the Corrective Action Solicitation Response. In the event that two or more bidders submit the lowest Grand Total amount, the award, if made, will be decided in accordance with the Tie Bids procedure in Section B.(6) of the Underground Storage Tank Environmental Remediation Procedures. Submittal of a "No Bid" for an individual site in this solicitation will be considered non-responsive and will result in rejection of the overall bid.
   iii. The contractor shall enter the number of months in the space provided for each site in Section IV.B and in the Summary Table of the Corrective Action Solicitation Response.

6. REASONABLE COST: SCDHEC reserves the right to reject any and all bids that appear to be above the customary and reasonable cost for the same scope of work in a similar geologic setting, that propose technologies that cannot be permitted in South Carolina, or that propose time frames for cleanup that are not protective of human health or the environment.

7. SITE WORK VERIFICATION: The contractor will be required to treat the area where measurable FPP is present and petroleum chemicals of concern (COC) are above site-specific target levels for each site in Appendices A through @%& of this solicitation. Verification that interim corrective action goals have been met will be based upon direct measurements and groundwater quality samples collected from the monitoring wells indicated for each site in the appendices. Verification that final corrective action goals have been met will be based upon direct measurements and groundwater quality samples for each site from all existing monitoring wells and additional verification wells to be installed at locations and depths designated by SCDHEC (See Contract Item III.B.10 for more details). It is understood that seasonal fluctuations in FPP thickness and COC concentrations will occur over time. It is the intent of this corrective action to prevent further degradation of the aquifer(s) by continued migration of FPP or COC into areas not previously impacted. If the corrective action allows FPP or COC to migrate and impact areas beyond the assessed areas of concern established for any of the sites in this solicitation, the Contractor will be responsible for completing assessment activities necessary to re-define the area of concern and for providing amendments to their Corrective Action Plan addressing the additional impacted areas.

8. REPORTS: Deliver one copy of each plan or report to: SCDHEC, Bureau of Land and Waste Management, UST Program, 2600 Bull Street, Columbia, SC 29201. A minimum of one (1) copy of each plan and one (1) copy of each report for each site in the appendices must be

delivered to the parties listed on the Distribution List included in the appendix for each site. Based on permitting and other requirements, additional copies of plans or reports may be required by the SCDHEC. The SCDHEC will notify the Contractor of the exact number of copies of each document to be submitted.

9. INVOICING: Invoices will be submitted to: SCDHEC, Bureau of Land and Waste Management, UST Program, ATTN: Financial Section, 2600 Bull Street, Columbia, SC 29201, using the SCDHEC's Corrective Action (CA) Invoice form. The initial invoice for each site must be received at the above address within four months of CAP approval or funds will be uncommitted as required by the Section 44-2-40(B) of the SUPERB Act. If funds are uncommitted the submitted invoice will be held until funding is available. **Payment will only be made for achieving the corrective action goals as specified. No partial payments will be made once corrective action is initiated, except as outlined in Contract Item III.B.3.** Payment to the contractor will be a pay for performance system as follows:

    A. Payment of forty percent (40%) of the total corrective action price for each site will be made within 90 days following receipt of an invoice and documentation that the contractor has completed the Corrective Action System Startup. All corrective action activities must be as described in the CAP and are subject to the limitations of Section 44-2-40 of the SUPERB Act. The implementation should be documented in the first corrective action system evaluation (CASE) report for each site. The first CASE report for each site must include the construction logs for all treatment/recovery wells installed in accordance with the CAP.

    B. Payment of forty percent (40%) of the total corrective action price for each site will be made based on achieving interim COC concentration reduction goals at the site as verified in the monitoring wells listed in the appendix for each site. Payments will be made upon receipt of invoices and documentation that the contractor has achieved interim goals of FPP removal followed by 60, 90 and 100 percent reduction of total COC concentration above the SSTLs for each site by the implementation of active corrective action. The COC concentrations and SSTLs for each site are listed in the respective appendices.

        1. The first concentration reduction goal will be achieved upon verification that FPP thickness does not exceed 0.01 foot in the wells defined in the appendix for each site and at any point in the area of concern for that site. Verification that the reductions have been achieved will be based upon gauging of all existing monitoring wells. Payment of ten percent (10%) of the total bid price will be made upon verification (see Contract Item III.B.10 for the method of verification) that the total FPP thickness above 0.01 foot is removed.

        2. The second concentration reduction goal will be achieved when sixty percent (60%) of the COC concentration above the SSTLs is removed from the monitoring wells specified in the appendix for each site. The initial COC concentration above the SSTLs will be established from the first sampling event following completion of FPP removal. The following formula will be used to calculate the percent total

concentration reduction: total concentration above SSTLs from the first sampling event following completion of FPP removal less total concentration above SSTLs from subsequent sampling divided by total concentration above SSTLs from the first sampling event following completion of FPP removal. Payment of ten percent (10%) of the total bid price will be made upon verification (see Contract Item III.B.10 for the method of verification) that at least sixty percent (60%)of the total COC concentration above SSTLs is removed.

The following is an example to demonstrate the COC Concentration Reduction Calculation:

Well		Benzene	Toluene	Ethylbenzene	Xylene	MTBE	Naphthalene	Conc>SSTL
MW-1	Initial [A]	7,500	4,000	2,000	15,000	3,000	1,000	[A]
	SSTL [B]	10	2,000	1,400	10,000	80	50	[B]
	Initial > SSTL [C]	7,490	2,000	600	5,000	2,920	950	18,960 [C]
	Subsequent [D]	3,000	1,000	900	13,000	2,000	5	[D]
	SSTL [E]	10	2,000	1,400	10,000	80	50	[E]
	Subsequent > SSTL [F]	2,990	0	0	3,000	1,920	0	7,910 [F]
MW-4	Initial [G]	150	400	50	250	300	25	[G]
	SSTL [H]	5	400	50	250	40	25	[H]
	Initial > SSTL [I]	145	0	0	0	260	0	405 [I]
	Subsequent [J]	100	100	1	1	100	1	[J]
	SSTL [K]	5	400	50	250	40	25	[K]
	Subsequent> SSTL [L]	95	0	0	0	60	0	155 [L]
Totals	Initial > SSTL [M]	(sum of initial concentration above SSTL for all wells) (C+I)						19,365 [M]
	Subsequent> SSTL [N]	(sum of subsequent concentration above SSTL for all wells) (F+L)						8,065 [N]

Notes:

- If subsequent sampling indicates a COC concentration at or below the SSTL and/or a COC concentration at BDL but the reporting limit is at/or below the SSTL value for any constituent, the value for the concentration reduction will be 0 (no negative numbers).
- If subsequent sampling indicates a COC concentration at BDL but the reporting limit is above the SSTL, the value for any constituent will be the analytical reporting limit.
- Concentration Reduction Calculation

$$\text{COC Concentration Reduction} = \frac{(M-N)}{(M)} = \frac{(19{,}365 - 8{,}065)}{19{,}365} = 0.5835 * 100 = 58.35\% \text{ COC Reduction}$$

3. The third concentration reduction goal will be achieved when ninety percent (90%) of the COC concentration above the SSTLs from the monitoring wells specified in the appendix for each site is removed. The formula outlined in Contract Item II.A.9.B.2 will be used. Payment of ten percent (10%) of the total corrective action price will be made upon verification (see Contract Item III.B.10 for the method of verification) that at least ninety percent (90%) of the total COC concentration above SSTLs has been removed.

4. The fourth concentration reduction goal will be achieved when one hundred percent (100%) of the COC concentration above the SSTLs from the monitoring wells

specified in the appendix for each site is removed. The formula outlined in Contract Item II.A.9.B.2 will be used. Payment of ten percent (10%) of the total corrective action price will be made upon verification (see Contract Item III.B.10 for the method of verification) that one hundred percent (100%) of the total COC concentration above SSTLs has been removed. **Achievement of this goal must be verified by split sampling with the SCDHEC**.

C. The final twenty percent (20%) of the total corrective action price will be paid upon receipt of an invoice and verification that FPP thickness does not exceed 0.01 foot and COC concentrations do not exceed the SSTLs defined in the appendix for each site and SSTLs calculated for any point in the area of concern for that site. Verification that the SSTLs have been achieved will be based upon groundwater quality samples collected from all existing monitoring wells and additional verification wells to be installed at locations and depths designated by SCDHEC (see Contract Item III.B.10 for more details); and 2) all remediation and assessment items (e.g., wells [including pre-existing wells], trenches, etc.) are removed from the site or properly abandoned. The SSTLs for each site are given in the appendices.

10. NOTIFICATION FOR FAILURE TO PERFORM: If the contractor fails during the course of this contract to make reasonable progress toward the cleanup goals or to meet any condition or specification of corrective action as outlined in this document without prior notification to the project manager of circumstances legitimately beyond the control of the contractor, SCDHEC will, on the first occurrence, notify the contractor by certified letter and meet with them to establish a remedy for the deficiency(ies). If the contractor corrects the deficiency(ies) within an agreed to period of time, the corrective action award will continue. If the contractor does not correct the deficiency(ies) within the agreed to period of time, the contractor will be in breach of contract and the corrective action award may be voided by SCDHEC. On the second occurrence, SCDHEC will notify the contractor and their bonding agent or creditor by certified letter and meet with them to establish a remedy for the deficiency(ies). If the contractor corrects the deficiency(ies) within an agreed to period of time, the corrective action award will continue. If the contractor does not correct the deficiency(ies) within the agreed to period of time, the contractor will be in breach of contract and the corrective action award may be voided by SCDHEC. **If the contractor fails on a third occasion during the course of this contract to meet any condition or specification established in this document, the contractor will be in breach of contract and the corrective action award will be voided by SCDHEC.** SCDHEC will notify the contractor and their bonding agent or creditor by certified letter that the corrective action award has been voided and will initiate appropriate actions with the bonding agent. **In the event that the corrective action award is voided due to a breach of contract as outlined above, no further payment of any invoices will be made.** If the corrective action award is voided under the conditions listed above, the contractor will incur a six-month suspension from bidding on any UST-related solicitations in South Carolina and may be subject to suspension or decertification in accordance with the SUPERB Site Rehabilitation and Fund Access Regulations, R.61-98. Any voiding of a corrective action award due to breach of contract will apply only to the site where the deficiency(ies) occurred and will not directly affect other sites awarded in conjunction with this solicitation.

11. CANCELLATION: <u>The accepted corrective action cost will be final and will not be increased or cancelled for any reason (e.g., unanticipated iron fouling of a system, wells clogging because of biological activity or sediments, damage by lightning, increased subcontractor costs, loss of utilities, modification to the system to meet the remediation goals, etc.) with the exception of unforeseen subsurface conditions as determined solely at the discretion of the SCDHEC or identification of additional COC from a release occurring after the award of this contract that adversely impacts the corrective action</u>. Contractor-owned items used on-site for the contract that are damaged or destroyed by common acts of nature, improper maintenance or handling, theft or vandalism will not be replaced or reimbursed by the SUPERB Account. **Payment will only be made for achieving the corrective action goals as specified in this contract. No interim or partial payments will be made once corrective action is initiated, except as outlined in Contract Item III.B.3. Once site rehabilitation has been initiated under this contract, in the event of a cancellation due to the circumstances prescribed in this condition, final payment will be a percentage of the contract amount equal to the actual percent reduction of the COC concentration as calculated based on the last sampling results from all wells listed in the Appendix for each site less the amount previously paid.** Any action taken by the SCDHEC under this condition that might result in the cancellation of a corrective action award due to circumstances described in this condition will apply only to the affected site and will not directly affect other sites awarded in conjunction with this solicitation.

12. PERFORMANCE BOND: A performance bond, equal to fifty percent (50%) of the award price, will be required by SCDHEC for each site and should be submitted with the CAP. **Bonds must be obtained from a surety that is on the Secretary of the Treasury's list of acceptable sureties for Federal bonds.** The original performance bonds will be submitted to the Bureau of Land and Waste Management, UST Program, Attn: Financial Section, within 30 days of award. The performance bonds will specify that the SUPERB Account will be the recipient of any forfeiture. **The performance bonds must bear the SCDHEC Permit ID Number and the Bid Number.** Since SCDHEC is responsible for disbursement of funds from the SUPERB Account, the bonds will be held by the Bureau of Land and Waste Management, UST Program until the work is successfully completed at each of the awarded sites. **The performance bond for each site must be kept current for the duration of the corrective action. Failure to maintain the performance bonds may result in the corrective action award being voided by SCDHEC in accordance with Contract Item II.A.10.**

SPECIFIC REQUIREMENTS

1. CONTRACT SCOPE: This contract is for active corrective action at <u>##</u> sites in South Carolina.

2. INQUIRIES: Questions or requests for information must be submitted in writing and received by 5:00 P.M. on the date specified in Section I.C of this solicitation. After this date, no further questions will be addressed. A written response will be provided to all requestors of the solicitation. The questions may be faxed to E. Madison Winslow in the SCDHEC

Bureau of Business Management at (803) 898-3505.

3. PROVISION FOR EARLY COMPLETION INCENTIVE: The SCDHEC will pay the Contractor an incentive of ten percent (10%) of the Cleanup Cost for early completion, subject to the conditions set forth in this provision. Payment will be made if the remediation goals on a given site have been met in accordance with the terms and conditions of this contract prior to the end of the Site Incentive Period, as established by the SCDHEC, and verified in accordance with Contract Item III.B.10.

   The Site Incentive Period will commence on the Corrective Action System Startup Date. A month starts at 12:00 Midnight on the same day of the month as the Corrective Action System Startup Date and ends at Midnight preceding the same day of the following month. Months will be consecutively counted from the corrective action system startup date. Following system startup at a site, the SCDHEC will provide the Contractor notice in writing of the closing date of the Site Incentive Period for that site.

   The Site Incentive Period will not be adjusted for any reason, cause or circumstance whatsoever, regardless of fault, save and except in the instance of a catastrophic occurrence directly and substantially affecting the Contractor's operations and resulting in unavoidable delay of the cleanup. In the event of a catastrophic occurrence on a specific site, the SCDHEC shall determine the number of months reasonably necessary and due solely to such catastrophic occurrence to extend the Site Incentive Period. Any amendments to the Site Incentive Period will be provided to the Contractor in writing.

   The parties anticipate that routine delays may be caused by or arise from any number of events during the course of site rehabilitation, including, but not limited to, work performed, work deleted, supplemental agreements, delays, disruptions, differing site conditions, utility conflicts, design changes or defects, extra work, right of way issues, permitting issues, actions of suppliers, subcontractors or other contractors, actions by third parties, expansion of the scopes of the projects by the Contractor to make them functional, weather, weekends, holidays, suspensions of the Contractor's operations, or other such events, forces or factors experienced in environmental work. Such delays or events and their potential impacts on performance by the Contractor are specifically contemplated and acknowledged by the Contractor in entering into this Contract, and shall not affect the Site Incentive Periods or incentives set forth above. Further, any and all costs or impacts whatsoever incurred by the Contractor in accelerating the Contractor's work to overcome or absorb such delays or events in an effort to complete the sites within the Site Incentive Periods, regardless of whether the Contractor successfully does so or not, shall be the sole responsibility of the Contractor in every instance.

   The Contractor shall have no rights under the Contract to make any claim arising out of this incentive provision except as is expressly set forth in this provision. The Site Incentive Periods for these projects are as follows:

Permit #	Site Name	Appendix	Site Incentive Period
«Permit_1»	«Facility_1»	«Appendix_1»	«Incentive_1»
«Permit_2»	«Facility_2»	«Appendix_2»	«Incentive_2»
«Permit_3»	«Facility_3»	«Appendix_3»	«Incentive_3»
«Permit_4»	«Facility_4»	«Appendix_4»	«Incentive_4»
«Permit_5»	«Facility_5»	«Appendix_5»	«Incentive_5»
«Permit_6»	«Facility_6»	«Appendix_6»	«Incentive_6»

4. SITE SPECIFIC DETAILS: Brief technical summaries of the releases, including location map and specifics of existing wells for each site are attached in Appendices A - @%&. The complete technical file for each site will be available for review through the Freedom of Information (FOI) Office located at the Stern Building, 8911 Farrow Road, Columbia, SC. **Offerors are strongly encouraged to review the files to ensure a complete understanding of the project requirements. The successful offeror will be responsible for all information in the technical files.** Appointments to view the technical files may be scheduled on weekdays between the hours of 8:30 A.M. to 5:00 P.M. by calling the SCDHEC Freedom of Information Office at (803) 898-3882. **NOTE: Free-phase product is present at these sites. The application of corrective action technologies or natural fluctuations in the water table can result in the mobilization or possible appearance of additional free-phase product or elevated COC concentrations in the monitoring wells.**

SPECIFICATIONS for CORRECTIVE ACTION

GENERAL SPECIFICATIONS

1. SUBMITTALS**:** All offerors must meet the following specifications for **each site** as required by the proposed treatment method(s) or corrective action technology(ies). Submit the Corrective Action Solicitation Response. The response will outline in general terms an approach to achieve the remediation goals (e.g., reduction of each COC to SSTL). The proposal must outline the following:
   a) A description of the proposed treatment method(s) or technology(ies) for corrective action.
   b) The amount of time in months to complete site rehabilitation to meet the remediation goals, install verification wells, and remove or abandon all assessment and remediation items.
   c) The total cost (in U.S. dollars) to complete site rehabilitation to meet the remediation goals and to remove or abandon all assessment and remediation items.

2. MINIMUM REQUIREMENTS: Corrective action will be considered complete at each site once the FPP thickness does not exceed 0.01 foot and levels of COC are verified to be at or below the SSTLs listed in the Appendix for that site and SSTLs calculated for any point in the area of concern, and all remediation and assessment items installed by the contractor (e.g., wells [including pre-existing wells], trenches, etc.) are removed or abandoned. See Contract Item III.B.10 for the method of verification. All rehabilitation activities associated with a UST release must be performed by a SCDHEC certified Class I Site Rehabilitation

Contractor as required by R.61-98. All corrective action plans and reports must be sealed by a Professional Engineer or Professional Geologist registered in the State of South Carolina. All engineering reports, drawings and plans must be sealed by a Professional Engineer registered in the State of South Carolina. All laboratory analysis for COC must be performed by a SC certified laboratory. All monitoring, verification, injection, or recovery wells must be installed and abandoned by a SC certified well driller. The corrective action methods or technologies will be designed to prevent vapors from entering onsite or adjacent structures. All applicable certification, training, permits, applications, and fees associated with well installation; injection, discharge, treatment, or transportation of groundwater, air, or soil; construction or operation of a remediation system; and any other action requiring a permit are the responsibility of the contractor. Any required business or occupation license and occupational safety and health training (e.g., OSHA) as defined by the laws and regulations of the United States of America, the State of South Carolina, the county or city is also the responsibility of the contractor. The terms and conditions of all applicable permits will be met. Any FPP, contaminated groundwater, soil, or construction material must be properly transported and disposed of, or treated at an approved facility with prior approval from SCDHEC. Any costs for utilities construction and service (electric, telephone, sewer, etc.) required by the corrective action are the responsibility of the contractor.

PERFORMANCE REQUIREMENTS

- CORRECTIVE ACTION PLAN: The successful contractor must complete and submit a detailed Corrective Action Plan for each site in the Appendices within 30 days from the date the Purchase Order is issued by the Bureau of Business Management. Copies of the CAP must be distributed in accordance with Section II.A.8. **NOTE: Use of monitoring well(s) for injection, extraction, or free-phase product recovery purposes is not allowed.** A condition of the CAP may include installation of additional recovery, sparge, compliance, or injection wells. The CAP must define all active (pump and treat, sparge, vapor extraction, excavation of impacted soils, bioremediation, etc.) and passive (intrinsic remediation, monitoring, etc.) corrective action method(s) proposed to reduce COC to SSTLs. It must be shown, by use of scientific models, computations, or discussion, how each COC will be reduced to the SSTL for each remediation method proposed for the release. Any assumptions used in a model will be listed or shown, as well as appropriate references. All corrective action will require monitoring to verify remediation. General construction details will be included (e.g., install four additional recovery wells, construct a compliance point, install four air injection wells, excavate 3,000 cubic yards of impacted soils, etc.) as well as details of well abandonment and equipment removal. **The corrective action method(s) or technology(ies) will be designed to prevent vapors from entering onsite or adjacent structures.** A remediation timetable including abandonment of wells and removal of equipment will be included with each CAP. The Bureau of Land and Waste Management, UST Program will review each CAP and initiate a public notice period for a maximum of 30 days. The names and addresses of the owners of all impacted properties and all properties located adjacent to the impacted properties are provided in the appendix for each site. The contractor may be required to attend and provide input at one or more public meetings upon request by SCDHEC. Any CAP amendments and modifications arising from public notice must be submitted within 15 days of notification by SCDHEC. The CAPs and any amendments or modifications must be sealed by a qualified Professional Geologist or Engineer registered in the State of South Carolina. The owner/operator of each site and any other affected property owners will be consulted and will approve the location of the corrective action systems. Permanent systems must be enclosed in fenced areas or small buildings.

- PERMIT APPLICATIONS: Complete and submit all applications for permits (injection, NPDES, BAQC modeling form, thermal treatment, construction, etc.) with the CAP for each site. All submitted applications must comply with the requirements of the respective permitting program. Any required permit changes or corrections will be submitted within 15 days of notification by SCDHEC.

- INITIAL MONITORING REPORT: An initial monitoring report for each site documenting FPP thicknesses or COC concentrations in all wells and potentiometric conditions prior to start up must be submitted to the Bureau of Land and Waste Management, UST Program **within 45 days** after award. Copies of the initial monitoring report must be distributed in accordance with Section II.A.8.

  Based on naturally occurring conditions, the FPP thickness or dissolved concentration of petroleum chemicals of concern (COC) will increase or decrease. For the purposes of this contract, the total FPP thickness and COC concentration for the wells included in the bid package may reasonably increase up to 150 percent or decrease as much as 50 percent. If the total FPP thickness or COC concentration in all wells for any included site increases more than 150 percent based on this initial sampling or if measurable free-phase product that has not been previously documented in any report is detected during the initial sampling event, the contractor may request in writing that the award for that site be canceled. **If either of these conditions occurs, the contractor will contact the UST project manager within two days of problem identification and will submit written documentation within five days of notification.** The contractor will be reimbursed based on the following rate schedule:

Subcontract Costs*	Invoice + 15%
Personnel Mobilization	$ 125.00
Equipment Mobilization	$ 250.00
Groundwater Sample Collection	$ 35.00 each
Gauging Free-Phase Product	$ 30.00 per well
Wastewater Disposal	$ 90.00 per drum
CAP Preparation and Assoc. Costs	$6,000.00

* Includes laboratory, drilling, electrical, etc.

The rate schedule above does not apply in the event that the corrective action award is voided due to a breach of contract in accordance with Contract Item II.A.10. The contract will be amended to remove the site in question and the performance bond for that site will be returned to the contractor. If the total FPP thickness or COC concentration in all wells for any included site decreases more than 50 percent based on this initial sampling the SCDHEC may amend the award to remove the site in question. If the contract is amended by SCDHEC to remove a site, the contractor will be notified by certified letter and an invoice for the above outlined items for that site shall be submitted within 20 days from the date of the certified letter. If the corrective action system is started or treatment is performed, the contractor will be required to complete the contract unless circumstances as outlined in Contract Item II.A.11 are encountered. **Once CAP implementation has been initiated under this contract, in the event of a cancellation due to the prescribed circumstances and before any concentration reduction has been achieved, final payment will not exceed 40 percent of the award price under any circumstances as no reduction of COC concentration has been accomplished.**

- CORRECTIVE ACTION PLAN IMPLEMENTATION: After completing review of the CAP and all permit applications submitted for each site, the Bureau of Land and Waste Management, UST Program will issue a notice to proceed with CAP implementation. The contractor will implement the CAP within 30 days of receipt of the notice to proceed and any required permit to construct. Disruption to the normal business at the sites will be kept to a minimum. The contractor will repair each site to the condition that existed prior to installation of the corrective action system (e.g., asphalt paved areas will be repaved with asphalt, concrete areas replaced with concrete, grass area will have soil replaced to the original grade and reseeded or sodded with grass, etc.). Upon completion of any required construction, SCDHEC will inspect the system and issue a permit to operate. The contractor will, at all times, keep the sites free from waste materials and rubbish related to the corrective action. Until completion of the corrective action, the contractor will keep the premises in a clean, neat and workmanlike condition satisfactory to SCDHEC. All soil and wastewater generated on site will be removed from the each site promptly. Manifests documenting the proper disposal of the soil and wastewater must be included in the appropriate report.

  Implementation of the CAPs is not authorized until the contractor receives correspondence from the UST Program indicating that the required public notice period has been successfully completed and all permits have been issued. If premature implementation occurs, the UST Program will not reimburse those costs from the SUPERB Account, and the bid award will be reduced by that amount. If the SCDHEC agrees with early implementation to better protect human health in an emergency and provides approval in writing, early implementation without any reduction to the corrective action amount will be authorized.

- PROPERTY ACCESS: Gain access to the adjacent properties to sample monitoring wells and to install any corrective action equipment, as required. The contractor will repair the adjacent properties to the conditions that existed prior to installation of the corrective action system (e.g., asphalt paved areas will be repaved with asphalt, concrete areas will be replaced with concrete, grass areas will have soil replaced to the original grade and reseeded or sodded with grass, etc.). The Contractor will be responsible for any equipment/wells installed on adjacent properties. Costs to repair/replace components of the remediation system damaged due to the actions of adjacent property owners cannot be paid by the SUPERB Account.

- SYSTEM START-UP: The Contractor will initiate system startup within 15 days of receipt of the Permit to Operate, if required. Remediation as defined in the CAP for each site will begin upon system startup. **If any problem with CAP implementation occurs, the contractor will contact the UST project manager for the site within 24 hours of problem**

identification and will submit written documentation within five days of notification. ***NOTE: Free-phase product is present at these sites. The application of corrective action technologies or natural fluctuations in the water table can result in the mobilization or possible appearance of additional free-phase product or elevated COC concentrations in the monitoring wells***

- REPORTING: Complete and submit a corrective action system evaluation (CASE) report on a quarterly basis. Deliver one copy of each report to: SCDHEC, Bureau of Land and Waste Management, UST Program, 2600 Bull Street, Columbia, SC 29201. A copy of each report for each site in the appendices must be delivered to the parties listed on the Distribution List included in the appendix for each site. The first quarter CASE report for each site is due within 90 days of the permit to operate. The CASE reports must include:

A. A narrative portion that documents current site conditions, verification of system operation or CAP implementation, and system effectiveness in achieving the remediation goals (e.g., removal of FPP, reducing COC to the SSTLs) as outlined in the CAP. Any system down time and the associated reason(s) will be included in the report.

B. Conclusions and recommendations based on the reported data.

C. Groundwater laboratory analytical data for all monitoring wells in the following format (additional parameters such as dissolved oxygen may be required):

Analytical Data (µg/l)

Monitoring Well	Date	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	Naphthalene
MW-1	7/15/97 10/15/97	145 140	200 190	146 140	1,000 900	170 50	47 165
MW-2	7/15/97 10/15/97	580 480	800 90	300 257	1,000 912	60 50	20 19

D. Groundwater potentiometric data for all monitoring wells in the following format:

Groundwater Data (feet)

Monitoring Well	Date	TOC Elevation	TOC to GW	TOC to FP	FP Thickness	GW Elevation
MW-1	7/15/97 10/15/97	98.0 98.0	17.54 17.90			80.46 80.10
MW-2	7/15/97 10/15/97	100.0 100.0	20.50 21.50	20.47 21.48	0.03 0.02	79.50 78.50

E. A groundwater elevation contour map of the site based on current groundwater potentiometric data.

F. A COC map based upon current groundwater laboratory analytical data. The groundwater data should be adjacent to the relevant monitoring well using the following format (additional parameters such as dissolved oxygen may be required):

   MW (number)
   Benzene (µg/l)
   Toluene (µg/l)
   Ethylbenzene (µg/l)
   Xylenes (µg/l)
   MTBE (µg/l)
   Naphthalene (µg/l)

G. Calculation of COC concentration reduction as outlined in Contract Item II.A.9.

H. A copy of the SCDHEC approval letter and manifests for any contaminated soil and groundwater removed from the site for treatment and/or disposal.

I. Additional data required by permits (e.g., air analyses, wastewater effluent analyses and amounts, etc.). The data should be reported on a form or in a format specified in the permits, and attached to the monitoring report as an addendum.

   All rehabilitation activities associated with the UST releases must be performed by a SCDHEC Certified Class I Site Rehabilitation Contractor. All air, soil, and groundwater analyses must be performed by a South Carolina certified laboratory. The corrective action monitoring reports must be sealed by a Professional Engineer or Geologist registered in the State of South Carolina. All monitoring wells, water supply wells, and surface water locations associated with each release will be sampled on a quarterly basis for the first year following implementation/system start-up. CASE reports must be submitted in accordance with the established monitoring schedule regardless of the operational status of the corrective action system. Thereafter, the number of monitoring wells sampled may be reduced or the interval between CASE reports may be lengthened upon clear demonstration of COC reduction, unless restricted by permit requirements. Approval of any reduction in the number of wells to be sampled or change in the interval between submittal of CASE reports is at the sole discretion of SCDHEC. Any approval to reduce the number of wells sampled or the frequency of sampling must be in writing from the UST Program. SCDHEC may require data to be reported on a form or in a specific format. The contractor will be provided with the proper report forms and format prior to system startup. The contractor will be notified of any revisions to the report forms or format 90 days prior to the due date for the next CASE report.

- GROUNDWATER & ADDITIONAL SAMPLING: Collect one (1) water sample per monitoring event for all monitoring wells, water supply wells, and surface water locations associated with the release for each site (see Appendices). If free-phase product appears that was not documented in the baseline data, the thickness of product and depth to groundwater must be recorded to the nearest 0.01 foot. If required, the well shall be purged prior to sampling and pH, temperature, dissolved oxygen, and specific conductance recorded. For those monitoring wells where the water level is within the screened interval, groundwater samples should be collected without purging. For those monitoring wells where the water level is not within the screened interval, purging must be conducted. All water supply wells must be purged prior to sampling. Purging is considered complete once three well volumes have been removed or the pH, temperature, dissolved oxygen, and specific conductance have equilibrated, yielding two consecutive readings with all parameters within ±10 percent, whichever comes first. Sampling logs should note all field measurements, as well as the location and type of each sample submitted for laboratory analysis. Each groundwater sample will be collected in accordance with established QA/QC protocol and submitted to a certified laboratory for analysis. The samples must be analyzed for the parameters listed in the appendix for each site.

Additional samples (air, groundwater, effluent, soil) required by permits must be collected in accordance with established QA/QC protocol and submitted to a certified laboratory for analysis. The samples will be analyzed for parameters stipulated in the permits. Sampling and analytical data for each sample (e.g., field sampling logs, chain of custody forms, certificates of analysis, and the lab certification number) will be included in the CASE report.

- DISPOSAL: Properly dispose of all contaminated soil and groundwater generated during the implementation of the CAP and installation of verification wells for each site. The disposal facility selected for treatment and disposal of any contaminated soil and groundwater must be a SCDHEC-approved facility. The owner/operator of the UST facility is considered the generator for any contaminated soil and groundwater. The contractor must document disposal of contaminated soil and groundwater in the CASE reports.

- QUALITY ASSURANCE: If the remediation technology is in-situ (e.g., pump and treat, air sparging, vapor extraction): suspend operation of the system once the remediation goals for FPP and all COC have been maintained for a period of 30 days. Samples are to be taken one (1) quarter after the date established by the SCDHEC as the start of the post-remediation verification period and again after a second quarter. Along with the parameters listed in the appendix for each site, the groundwater samples should also be analyzed for the following parameters:

Analyte	Analytical Method*	Reporting Limit (μg/l)
Dissolved oxygen	SM4500-O G	500
Ferrous iron	SM3500-Fe D	30
Methane	Kerr	1000
Nitrate	9056/9210	100
Sulfate	9038/9056	1000

*or EPA equivalent method that can achieve the same reporting level

If sample results indicate that the remediation goals are not sustained, the contractor must submit a corrective action status report (3 copies) that outlines the deficiency(ies) and offers recommendations for achieving the remediation goals with a revised timetable. Modifying and restarting of the system may be necessary. All remediation goals must be again maintained for a minimum of 30 days. Corrective action will then be suspended again and samples taken to verify that remediation goals are sustained. This cycle of activity, including status reports, will be repeated until all COC levels remain below SSTLs for all wells listed in the appendix for each site for two (2) consecutive quarters. Verification wells may be installed at locations and depths designated by SCDHEC (See Appendices for number of verification wells for each site). Costs for verification well installation are considered part of the Cleanup Cost. Each well will be sampled in accordance with Contract Item III.B.8 and the analyses compared to the calculated SSTLs for the COC at that well location. If the laboratory analyses are at or below the SSTLs, corrective action will be considered complete. If any analyte is above the SSTL, the corrective action will not be considered complete, and the activity cycle described above must be repeated until all COC levels remain below SSTLs for those wells listed in the appendix for that site. Split or duplicate samples may be collected by SCDHEC (or its subcontractors) to verify achievement of remediation goals. In addition to the groundwater collected from the monitoring wells, the UST Program may provide up to three standards or prepared blanks for the contractor's laboratory to analyze. The laboratory analysis from the contractor's and the UST Program's laboratory will be compared. In the event of substantial variance (more than 15%), a second sampling event with field and trip blanks will be sent to a SC certified laboratory by the UST Program for analysis. The contractor will be notified when the wells will be resampled, can observe this second sampling event, and will be provided analytical results for comment. SCDHEC Laboratory Certification will be provided copies of all sample data sets with all relevant quality assurance/quality control data to assist the UST program in determining the cause of a laboratory variation. The Director of the Assessment and Corrective Action Division will make the final decision on which analytical values will be the basis for payment or closure with input from the site rehabilitation contractor, SCDHEC Laboratory Certification, the UST Section Manager, and the UST Project Manager. The site rehabilitation contractor will be provided a written record of any decision. **At least two weeks notice will be provided to the UST Project Manager prior to mobilizing to the site for sampling to verify attainment of remediation goals.** Costs for transportation and analysis of split or duplicate samples will be paid by SCDHEC.

- DEMOBILIZATION: Disassemble and remove the remediation system and all associated remediation items including utilities from each site within 60 days of notification by SCDHEC that the remediation goal for the release associated with the UST(s) at each site has been achieved. Disruption to the site's normal business will be kept to a minimum.

- SITE RESTORATION: Properly abandon all monitoring, recovery, and/or injection wells (including pre-existing wells), borings, trenches, and piping/utility runs installed by the contractor as part of corrective action within 60 days of notification by SCDHEC that the remediation goal for the release associated with the UST(s) at the site has been achieved. The abandonment will be in accordance with South Carolina Well Standards and Regulations R. 61-71 and accepted industry standards for abandonment of trenches and piping/utility runs. Disruption to the property owner's normal business will be kept to a minimum. The contractor must notify SCDHEC of the method of well abandonment and final disposal of any contaminated soil or groundwater. The contractor will return the site to the condition prior to corrective action (e.g., asphalt paved areas will be repaved with asphalt, concrete areas will be replaced with concrete, grass areas will have soil replaced to the original grade and reseeded or sodded with grass, etc.).

- COMPLETION NOTICE: The Contractor shall provide the SCDHEC with written notice at least two weeks prior to Completion. This will allow the Project Manager and Contractor time to jointly inspect the project and, if necessary, make a Completion Punch List of work to be finished. Items on the Punch List may include, but are not limited to well abandonment, pavement repair, debris removal, etc. The date of Completion will be determined by the Project Manager when all Punch List work is completed.

BID AWARD

ACCEPTANCE and DELIVERY STATEMENT

In compliance with the solicitation and subject to all conditions thereof, the offeror agrees, if this bid is accepted within ___________ days from date of opening, to complete the corrective action as specified at the prices set forth for all sites as stated below.

For the purpose of this submittal and acceptance of financial approval should it occur, I certify that this company understands the nature of the releases and the geologic conditions at these sites as documented in the technical files and this solicitation. **Any quantities listed in the corrective action method(s) below are estimates and changes to those quantities or to the listed method(s) will not affect the bid price.** Additionally, I certify that this company understands that acceptance is based on total cost to treat the areas of concern.

___________________________________ Certification No. _______________________
Contractor (Print)

_______________________________________ _______________________________________
Authorized Representative (Print) Signature

CORRECTIVE ACTION SOLICITATION RESPONSE

Please respond to the following questions:

SITE A –«Facility_1», (UST Permit #«Permit_1»), «Address_1», «City_1», South Carolina.

1. The corrective action method(s) or technology(ies) that will be proposed in the CAP will be:
____
____
____

2. The Corrective Action Completion Time, in months, to complete the corrective action from the date of corrective action system startup until corrective action goals are met is _______________ months.

3. The Corrective Action Cost, in whole dollars, regardless of the type, quantity, or duration of the permitted technology applied, to treat the area of concern (see Attachment A, Figure #«Figure_1») such that the thickness of free-phase product does not exceed .01 foot and the levels of COC do not exceed the site-specific target levels (SSTLs) defined in Contract Item II.A.9.C at any point, complete all associated monitoring and post-remediation verification, prepare all plans, reports, and correspondence; obtain and meet all terms and conditions of all required permits and licenses; design, install, monitor, operate, maintain, and when completed, properly abandon or remove all assessment and remediation items installed as part of corrective action; provide evidence of performance bond; and other items outlined in this solicitation is: $______________________

SITE B – «Facility_2», (UST Permit #«Permit_2»), «Address_2», «City_2», South Carolina

1. The corrective action method(s) or technology(ies) that will be proposed in the CAP will be:
   ____
   ____
   ____

2. The Corrective Action Completion Time, in months, to complete the corrective action from the date of corrective action system startup until corrective action goals are met is _____________ months.

3. The Corrective Action Cost, in whole dollars, regardless of the type, quantity, or duration of the permitted technology applied, to treat the area of concern (see Attachment B, Figure #«Figure_2») such that the thickness of free-phase product does not exceed .01 foot and the levels of COC do not exceed the site-specific target levels (SSTLs) defined in Contract Item II.A.9.C at any point, complete all associated monitoring and post-remediation verification, prepare all plans, reports, and correspondence; obtain and meet all terms and conditions of all required permits and licenses; design, install, monitor, operate, maintain, and when completed, properly abandon or remove all assessment and remediation items installed as part of corrective action; provide evidence of performance bond; and other items outlined in this solicitation is: $______________________

SITE C- «Facility_3», (UST Permit #«Permit_3»), «Address_3», «City_3», South Carolina

1. The corrective action method(s) or technology(ies) that will be proposed in the CAP will be:
   ____
   ____
   ____

2. The Corrective Action Completion Time, in months, to complete the corrective action from the date of corrective action system startup until corrective action goals are met is _____________ months.

3. The Corrective Action Cost, in whole dollars, regardless of the type, quantity, or duration of the permitted technology applied, to treat the area of concern (see Attachment C, Figure

#«Figure_3») such that the thickness of free-phase product does not exceed .01 foot and the levels of COC do not exceed the site-specific target levels (SSTLs) defined in Contract Item II.A.9.C. at any point, complete all associated monitoring and post-remediation verification, prepare all plans, reports, and correspondence; obtain and meet all terms and conditions of all required permits and licenses; design, install, monitor, operate, maintain, and when completed, properly abandon or remove all assessment and remediation items installed as part of corrective action; provide evidence of performance bond; and other items outlined in this solicitation is: $_________________

SITE D – «Facility_4», (UST Permit #«Permit_4»), «Address_4», «City_4», South Carolina

1. The corrective action method(s) or technology(ies) that will be proposed in the CAP will be: ____ ____ ____

2. The Corrective Action Completion Time, in months, to complete the corrective action from the date of corrective action system startup until corrective action goals are met is ______________ months.

3. The Corrective Action Cost, in whole dollars, regardless of the type, quantity, or duration of the permitted technology applied, to treat the area of concern (see Attachment D, Figure #«Figure_4») such that the thickness of free-phase product does not exceed .01 foot and the levels of COC do not exceed the site-specific target levels (SSTLs) defined in Contract Item II.A.9.C at any point, complete all associated monitoring and post-remediation verification, prepare all plans, reports, and correspondence; obtain and meet all terms and conditions of all required permits and licenses; design, install, monitor, operate, maintain, and when completed, properly abandon or remove all assessment and remediation items installed as part of corrective action; provide evidence of performance bond; and other items outlined in this solicitation is: $_______________________

SITE E – «Facility_5», (UST Permit #«Permit_5»), «Address_5», «City_5», South Carolina

1. The corrective action method(s) or technology(ies) that will be proposed in the CAP will be: ____ ____ ____

2. The Corrective Action Completion Time, in months, to complete the corrective action from the date of corrective action system startup until corrective action goals are met is ______________ months.

3. The Corrective Action Cost, in whole dollars, regardless of the type, quantity, or duration of the permitted technology applied, to treat the area of concern (see Attachment E, Figure #«Figure_5») such that the thickness of free-phase product does not exceed .01 foot and the levels of COC do not exceed the site-specific target levels (SSTLs) defined in Contract Item

II.A.9.C at any point, complete all associated monitoring and post-remediation verification, prepare all plans, reports, and correspondence; obtain and meet all terms and conditions of all required permits and licenses; design, install, monitor, operate, maintain, and when completed, properly abandon or remove all assessment and remediation items installed as part of corrective action; provide evidence of performance bond; and other items outlined in this solicitation is: $______________________

SITE F- «Facility_6», (UST Permit #«Permit_6»), «Address_6», «City_6», South Carolina

1. The corrective action method(s) or technology(ies) that will be proposed in the CAP will be:
   ____
   ____
   ____

2. The Corrective Action Completion Time, in months, to complete the corrective action from the date of corrective action system startup until corrective action goals are met is ______________ months.

3. The Corrective Action Cost, in whole dollars, regardless of the type, quantity, or duration of the permitted technology applied, to treat the area of concern (see Attachment F, Figure #«Figure_6») such that the thickness of free-phase product does not exceed .01 foot and the levels of COC do not exceed the site-specific target levels (SSTLs) defined in Contract Item II.A.9.C. at any point, complete all associated monitoring and post-remediation verification, prepare all plans, reports, and correspondence; obtain and meet all terms and conditions of all required permits and licenses; design, install, monitor, operate, maintain, and when completed, properly abandon or remove all assessment and remediation items installed as part of corrective action; provide evidence of performance bond; and other items outlined in this solicitation is: $________________

BID SCHEDULE SUMMARY TABLE

Site (ID #)	Facility Name	Corrective Action Completion Time (months)	Corrective Action Cost
A. «Permit_1»	«Facility_1»		
B. «Permit_2»	«Facility_2»		
C. «Permit_3»	«Facility_3»		
D. «Permit_4»	«Facility_4»		
E. «Permit_5»	«Facility_5»		
F. «Permit_6»	«Facility_6»		
		GRAND TOTAL	

NOTE: SCDHEC bid “boilerplate” information was deleted from this example to conserve space.

Appendix E

Optimization Toolbox

OPTIMIZATION TOOLBOX

Multiagency

www.frtr.gov/optimization.htm
Sponsor: Federal Remediation Technologies Roundtable
Description: Provides a wide variety of information and links on the topic of optimization. The Federal Remediation Roundtable has prepared a comprehensive directory of long-term management and optimization case studies.

Air Force

www.hqafcee.brooks.af.mil/products/rpo/default.asp
Sponsor: Air Force Center for Environmental Excellence
Description: Contains the latest Air Force RPO guidance. Includes the AFCEE RPO Handbook.

Army Corps of Engineers

www.environmental.usace.army.mil/ltm_rse.htm
Sponsor: United States Army Corps of Engineers
Description: Home page for the Army Corps "optimization area of interest."

Department of Energy

www.doe.gov/engine/content.do?BT_CODE=ENVIRONMENT
Site Owner: Department of Energy
Description: DOE's home page for environmental information. Search on "optimization" for various related topics.

Environmental Protection Agency

www.clu-in.org/optimization/
Sponsor: U.S. Environmental Protection Agency
Description: Part of the Technology Innovation Program's initiative to promote optimization of site remediation activity, the Clu-In optimization page provides a wealth of information on the topic of optimization.

www.epa.gov/superfund/action/postconstruction/optimize.htm
Sponsor: U.S. Environmental Protection Agency
Description: Located within the Superfund area of the EPA Web site, this page contains many of the EPA source documents on optimization, as well as links to other optimization Web pages.

www.epa.gov/oswer/iwg/about.htm
Sponsor: U.S. Environmental Protection Agency
Description: Provides information about and contact information for the Innovations Work Group. RPO frequently relies on innovative answers to remediation problems. The Innovation Workgroup provides a wide range of expertise in the area of innovative remediation technology.

http://envinfo.com/dec2000/implementation.pdf
Sponsor: U.S. Environmental Protection Agency
Description: Superfund Reform Strategy, Implementation Memorandum: Optimization of Fund-Lead Ground Water Pump and Treat (P&T) Systems, December 2000.

www.epa.gov/superfund/resources/5year/index.htm
Sponsor: U.S. Environmental Protection Agency
Description: A Superfund resources site for five-year review guidance.

Navy

http://enviro.nfesc.navy.mil/erb/
Sponsor: Navy, Naval Facilities Engineering Service Center
Description: Home page for NFESC's environmental information. Look for RPO links here.

http://enviro.nfesc.navy.mil/erb/support/work_grp/raoltm/main.htm#top
Sponsor: Navy and Marine Corps Working Group
Description: Optimizing remedial action operations and long-term monitoring.

http://enviro.nfesc.navy.mil/erb/erb_a/support/wrk_grp/raoltm/case_studies/tds_2066.pdf
Sponsor: Navy, Naval Facilities Engineering Service Center
Description: NAVFAC Tech Data Sheet SMART SITE—Cost-Efficiencies in Remedial Action Operations and Long-Term Monitoring.

State Agencies

www.nj.gov/dep/srp/training/sessions/rpo200304/
Sponsor: New Jersey Department of Environmental Protection
Description: Link to NJDEP's presentation on RPO.

Educational and Stakeholder

//www.earthdrx.org/
Sponsor: Private
Description: Provides environmental information in a format directed at the general public. Unique approaches to groundwater remediation and subsurface gas migration are presented.

TOPIC AREA TOOLS

1. **Environmental Multicritical Decision Making (e-MCDA)**
   Multicritical decision making is a field of thinking that combines sociopolitical, environmental, ecological and economic factors into practical methods for applying scientific decision processes in complex decision making. Kiker, Bridges, Varghese, Seager, and Linkov, "Application of Multicritical Decision Analysis in Environmental Decision Making," *Integrated Environmental Assessment and Management* **1**(2), 2005, presents a review of the available literature on the topic. www.setacjournals.org/perlserv/?request=get-toc&issn=1551-3793&volume=1&issue=2

2. **MAROS and GTS**
   a. **MAROS** (Monitoring and Remediation Optimization System) is a database application that helps users with groundwater data trend analysis and long term monitoring optimization. www.frtr.gov/decisionsupport/DST_Tools/MAROS.htm
   b. **GTS (**more formally, Geostatistical Long-Term Monitoring Optimization Algorithm) was developed by AFCEE as a temporal and spatial algorithm for optimizing monitoring networks using geostatistical methods. GTS can be used to manage both passive sampling networks and those that monitor performance or effectiveness of remedial systems. www.hqafcee.brooks.af.mil/products/rpo/ltm.asp

3. **Analysis Using the Performance Tracking Tool (PTT)**
   PTT is a tool for analysis of remediation system performance that correlates treatment performance with cost performance, allows analysis by installation staff with basic chemistry, and promote regular review of remediation performance. PTT addresses two key questions:

   - Is contaminant mass being reduced at the anticipated rate?
   - Is the O&M cost consistent with projections?

   Tracking performance of systems and processes throughout their lives using all available data is essential to construct a true picture of their status. To facilitate this task, Air Force Center for Environmental Excellence, Technical Directorate - Environmental Science Division (AFCEE/TDE) developed a Performance Tracking Tool version 1 (PTTv1) and is available upon request from AFCEE/TDE. PTTv1 is based on Microsoft Excel and can track recommendations and their implementation. Version 2 of the PTT (i.e., PPTv2) is currently being developed as a Web-based tool and will incorporate additional features.

   Watch the AFCEE RPO and PBC pages for information:
   www.afcee.brooks.af.mil/products/rpo/default.asp
   www.afcee.brooks.af.mil/products/pbc/default.asp

4. **Exit Strategy Tools**

A number of tools are available to aid in planning and reviewing an exit strategy.

Exit Strategy Checklist, for evaluating installation-wide and site-specific exit strategies, has been prepared jointly by the Air Force and USACE. Copies are available from the USACE Web site: www.environmental.usace.army.mil/rse_checklist.htm

Appendix F

Remediation Process Optimization Team Contacts

REMEDIATION PROCESS OPTIMIZATION TEAM CONTACTS

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Appendix G

Acronyms

ACRONYMS

ACA	active corrective action
AFCEE	Air Force Center for Engineering and the Environment
ARAR	applicable or relevant and appropriate requirement
ASTSWMO	Association of States and Territories Solid Waste Management Officials
BIC	Business Initiative Council
BRAC	Base Realignment and Closure
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	corrective measures study
COC	chemical of concern
CSM	conceptual site model
CTC	cost-to-complete
DERP	Defense Environmental Restoration Program
DL	decision logic
DLA	Defense Logistics Agency
DOD	Department of Defense
DOE	Department of Energy
DQO	data quality objective
EM	Environmental Management
EPA	(U.S.) Environmental Protection Agency
ER	Environmental Restoration
FAR	Federal Acquisition Regulation
FFA	Federal Facilities Agreement
FS	feasibility study
FSO	Field Site Office
FUDS	formerly used defense sites
FY	fiscal year
GPRA	Government Performance and Results Act
HTRW	hazardous, toxic, and radioactive waste
IC	institutional control
IRP	Installation Restoration Program
ITRC	Interstate Technology & Regulatory Council
LTM	long-term management
LUC	land-use control
M&O	management and operating
MAROS	Monitoring and Remedy Optimization System
MCL	maximum contaminant level
MMRP	Military Munitions Response Program
NAVFAC	Naval Facilities Engineering Command
NPL	National Priorities List
OA	objective assessment
O&M	operations and maintenance
OE	ordnance and explosive
OSWER	Office of Solid Waste and Emergency Response

OU	operable unit
PACAF	Pacific Air Forces
PBA	performance-based acquisition
PBC	performance-based contract/contracting
PBEM	performance-based environmental management
PBM	Performance-Based Management
PFP	pay-for-performance
PGDP	Paducah Gaseous Diffusion Plant
POC	point of contact
PRP	potentially responsible party
QA	quality assurance
QC	quality control
RA	remedial action
RAO	remedial action objective
RBCA	risk-based corrective action
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFI	RCRA Facility Investigation
RI	remedial investigation
RIPS	RPO Inventory and Performance Software
ROD	record of decision
RP	responsible party
RPM	remedial project manager
RPO	remediation process optimization
RSE	Remediation System Evaluation
SCDHEC	South Carolina Department of Health and Environmental Control
SIR	self-insured retention
SMARTe	Sustainable Management Approaches and Revitalization Tools electronic
SPP	Systematic Planning Process
SSTL	site-specific target levels
TBC	to-be-considered material
TPP	technical project planning
USACE	U.S. Army Corps of Engineers
UXO	unexploded ordnance
UST	underground storage tank
VE	value engineering