

**Remediation Process Optimization:  
Identifying Opportunities for Enhanced  
and More Efficient Site Remediation**

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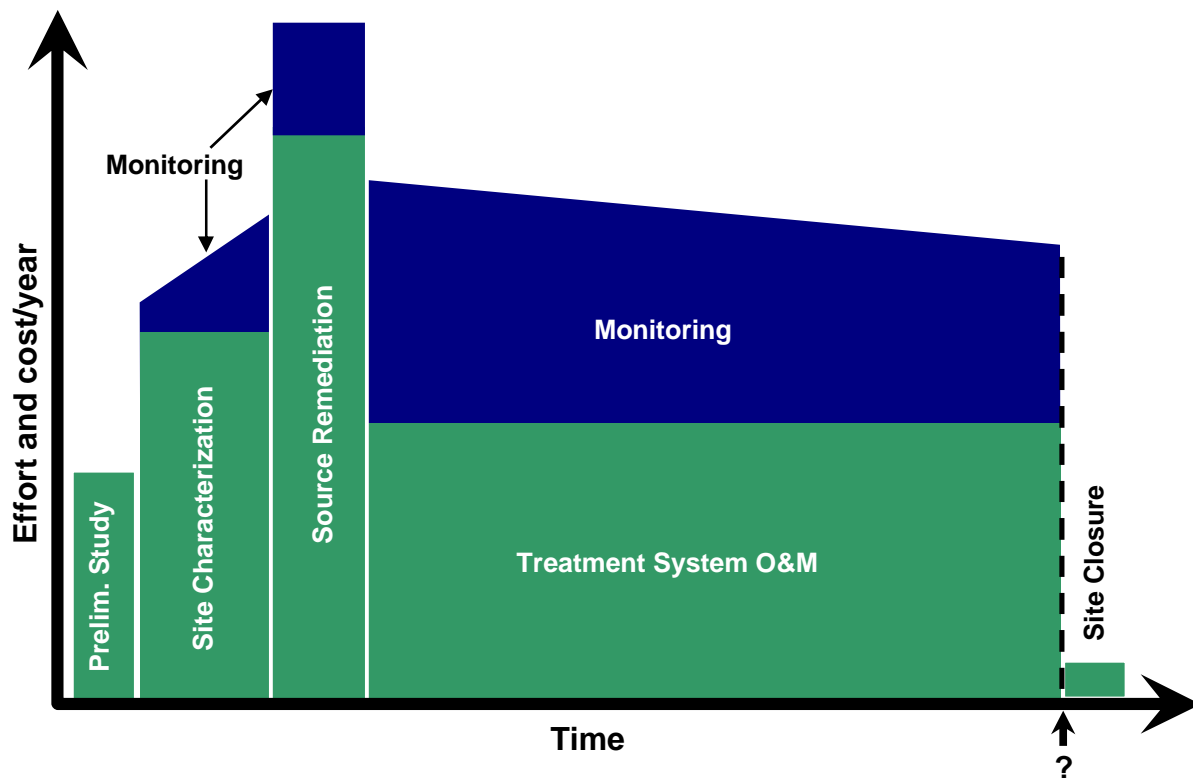
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## EXECUTIVE SUMMARY

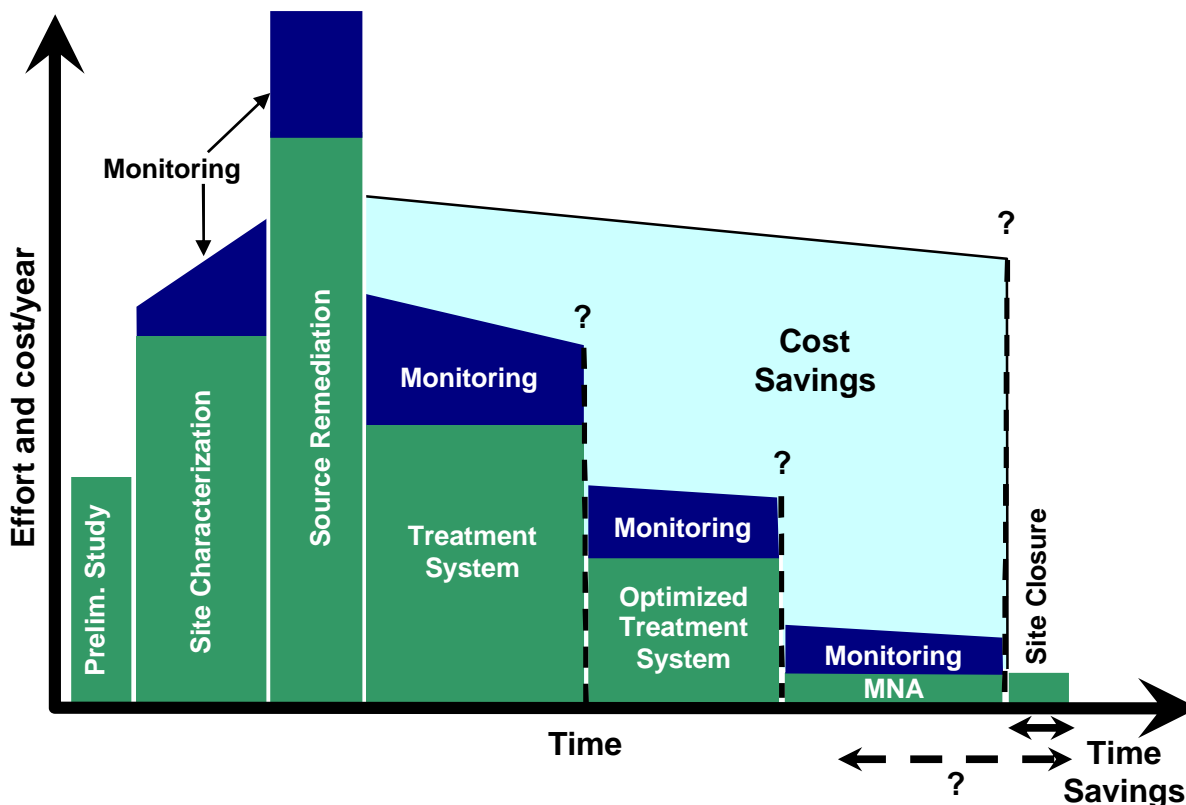
For the foreseeable future, federal, state, and private-sector organizations will continue to spend billions of dollars on the characterization and assessment of contaminated environmental media and on the selection, construction, operation, maintenance, and monitoring of environmental remediation systems. As the various environmental cleanup statutes and their implementing regulations evolved, the initial assumption was that these programs could follow a basic “study, design, build” linear paradigm. However, years of experience has 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 “remediation process optimization” (RPO). The Interstate Technology & Regulatory Council RPO Team developed this guide to respond to that realization. With schedules for projects in the operating and maintenance or long-term remedial action phase frequently being measured not merely in years, but in decades, RPO is not an just option, but a necessity.

In the initial stages of a remediation action, much of the effort is on characterization and source remediation; limited effort is spent on monitoring. As the project matures, most of the resources are spent for monitoring and operations and maintenance (O&M). Figure ES-1 depicts effort and cost vs. time for a typical conventional remediation action at a contaminated site. As shown by the dashed line, at most sites we cannot be sure how long it will take to reach closure.



**Figure ES-1. Effort vs. time in typical remediation actions.**  
(Modified from U.S. Navy 2003.)

An RPO review is a way to evaluate the status of remediation process and get an idea of when to expect closure. Instead of continuing with a long-term O&M, we can actually—through the process of optimization—reduce the cost as well as time to completion, as shown in Figure ES-2. Depending on site-specific conditions, such an RPO review could result in substantial savings.



**Figure ES-2. Effort vs. time in remediation actions with RPO.**  
(Modified from U.S. Navy 2003.)

This document provides interested parties—regardless of role (responsible parties, regulators, stakeholders)—with practical information and guidance on how to systematically evaluate and manage uncertainty associated with the remediation process by using RPO as a tool. Its primary goal is to provide information and tools to help ensure that the remediation process is progressing toward site cleanup objectives that are both acceptable and feasible and that selected remediation approaches attain those objectives and remain protective of human health and the environment. This document provides guidance on what could and should be included in an effective RPO proposal or program, including what RPO is, the regulatory framework that RPO must operate within, and references that provide examples of successful RPOs and resources for further examination of RPO.

The guidance describes the general regulatory and technical framework for evaluating remediation processes, regardless of the type or complexity of the remedy. Until recently, RPO has been associated with the “how” of remediation, such as the technologies in place. This document looks not just at the “how” of site cleanup, but also at the “why,” which can be described as the conceptual site model (CSM). The CSM considers all factors involved with the

site remediation, such as the environmental and (current and future) land-use plans, site-specific chemical and geologic conditions, and the regulatory environment.

The regulatory environment establishes the need to review and possibly revise cleanup goals to ensure their continuous applicability. 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 a comprehensive RPO review. Therefore, consideration is given to the reevaluation of remediation goals and 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. It also lays out key considerations when planning, designing, and implementing an optimization review.