EPA ID # 542-G-18-004

Section 1 - Introduction

This technical guide describes the use of "smart scoping" practices during any phase of a Superfund remedial investigation's project life cycle or in accordance with other similar federal, state or tribal regulatory authorities. Use of these practices can support the development of a robust conceptual site model (CSM), which, in turn, helps improve response action development, selection and implementation. Smart scoping integrates adaptive management and site characterization. Adaptive management is an approach the U.S. Environmental Protection Agency (EPA) is expanding to help ensure informed decision-making and the expenditure of limited resources go hand-in-hand throughout the remedial process.

Why is EPA Issuing this Technical Guide?

The U.S. Environmental Protection Agency (EPA) developed this guide to support achievement of the July 2017 Superfund Task Force goals. Two additional companion technical guides should be used in conjunction with this smart scoping technical guide:

- Strategic Sampling Approaches
- Best Practices for Data Management

The scoping process outlined in EPA's 1988 guidance for conducting a remedial investigation and feasibility study (RI/FS) still applies to Superfund sites. Smart scoping targets those parts of the scoping process that can help a site team develop a more robust and realistic CSM; it also highlights new approaches and tools to facilitate that development.

This technical guide's purpose is twofold. First, it broadly highlights the best practices related to scoping an environmental investigation. These best practices have been developed over many years of planning and implementing investigations. Second, it provides technical resources and references to support smart scoping activities.

How is this Technical Guide Organized?

Section 1 – Introduction: introduces smart scoping concepts and provides important definitions.

Section 2 – Focus on the Conceptual Site Model: discusses a robust and realistic CSM's elements and describes CSM development over the life cycle of the project. Section 2 also highlights the various CSM components. Each CSM component is important for the evaluation, selection, and successful implementation of remedial actions.

Section 3 – Focus on Scoping Best Practices: describes a set of EPA-identified best practices and discusses how these best practices can be used during scoping. Each best practice discussion includes a list of resources and references.

This section introduces smart scoping concepts and definitions.

What is Smart Scoping?

With the goal of developing and maintaining a robust CSM, smart scoping encourages both consideration of proven Superfund site strategies; and the upfront commitment of time and resources. It also anticipates the use of best practices or tried-and-true strategies for cleanup of sites with similar contamination profiles. Smart scoping highlights the importance of: (1) participation by and input from Remedial Project Managers (RPMs), technical experts, risk managers and other stakeholders; (2) establishing appropriate current and future land and groundwater resource use assumptions; (3) the appropriate design and use of human health and ecological risk assessments (including collection of appropriate information on natural or anthropogenic "background" and contaminant bioavailability); (4) leveraging in-house expertise (in lieu of contractor support); and (5) the appropriate use of early actions and adaptive management techniques.

What are the Benefits of Smart Scoping?

A robust and realistic CSM helps improve response action development, selection and implementation. Improved technical tools are now available that provide more comprehensive characterization of contamination sources and the environmental media those sources affect. In turn, comprehensive characterization provides greater opportunities for evaluating and selecting more targeted and cost-effective remedies.

Smart scoping can hasten response activity initiation. It calls for strong consideration of the value of shorter- and longer-term actions' ability to achieve risk reduction, and it results in data collection that supports those actions' timely selection and implementation. Smart scoping can facilitate the application of early removal or remedial actions at sites.

Smart scoping also reduces the need for additional characterization after response actions are selected and the comprehensive CSM it produces can reduce the need for more data.

Smart scoping results in strategic sampling designs that incorporate scientific and technical advancements in investigation technologies. These strategic sampling designs are discussed in EPA's companion technical guide "Strategic Sampling Approaches Technical Guide" (EPA 542-F-18-005).

What is a Robust and Realistic Conceptual Site Model?

By "robust," EPA means that the CSM: (1) incorporates all that is known about the site's current and potential future environmental conditions, and (2) evolves and matures over the project's life cycle. By "realistic," EPA means that the CSM is based on adequate data and reflects as closely as possible the true situation on the ground. A realistic CSM accurately portrays critical conditions which affect the success of response actions and at a scale that addresses heterogeneity.

Section 2 – Focus on the Conceptual Site Model

This section focuses on CSM development and describes CSM components. The CSM is a key communication tool for decision-makers, technical teams and stakeholder outreach.

The EPA identified six stages of the project life cycle CSM (see Highlight 1[1]). Each of these stages are representations of the CSM as it evolves through defined states of both maturity and purpose over a project's life cycle. Development of both the preliminary and the baseline CSM requires an initial compilation, synthesis and presentation of the CSM to managers, technical teams and stakeholders. Using existing data is key to developing a preliminary and baseline CSM.

Highlight 1. Project Life Cycle

Six Stages of the Project Life Cycle CSM

Key Points in the Development of a CSM

(1) **Preliminary CSM Stage –** Project milestone or deliverable based on existing data; developed prior to systematic planning to provide fundamental basis for planning effort.

(2) **Baseline CSM Stage –** Project milestone or deliverable used to document stakeholder consensus/divergence, identify data gaps, uncertainties, and needs; an outcome of systematic planning.

Key Points in the Evolution and Refinement of a CSM

(3) **Characterization CSM Stage –** Iterative improvement of CSM as new data become available during investigation efforts; supports technology selection and remedy decision making.

(4) **Design CSM Stage –** Iterative improvement of CSM during design of the remedy; supports development of remedy design basis and technical detail.

(5) **Remediation / Mitigation CSM Stage –** Iterative improvement of CSM during remedy implementation; supports remedy implementation and optimization efforts; provides documentation for attainment of cleanup objectives.

(6) **Post Remedy CSM Stage –** Comprehensive site physical, chemical, geologic, and hydrogeologic information of CSM supports reuse planning; documents institutional controls and waste left on site; and describes other key site attributes.

Develop and Use Project Life Cycle Conceptual Site Model

In July 2011, EPA developed and issued "Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model," to assist environmental professionals in developing realistic CSMs. As stated in the quick reference fact sheet:

The life cycle of a CSM mirrors the common progression of the environmental cleanup process where available information is used, or new information acquired, to support a change in focus for a project. The focus of a CSM may shift from characterization towards remedial technology evaluation and selection, and later, remedy optimization. As a project progresses, decisions, data needs, and personnel shift as well to meet the needs of a particular stage of a project and the associated technical requirements.

Maximize Use of Existing Data

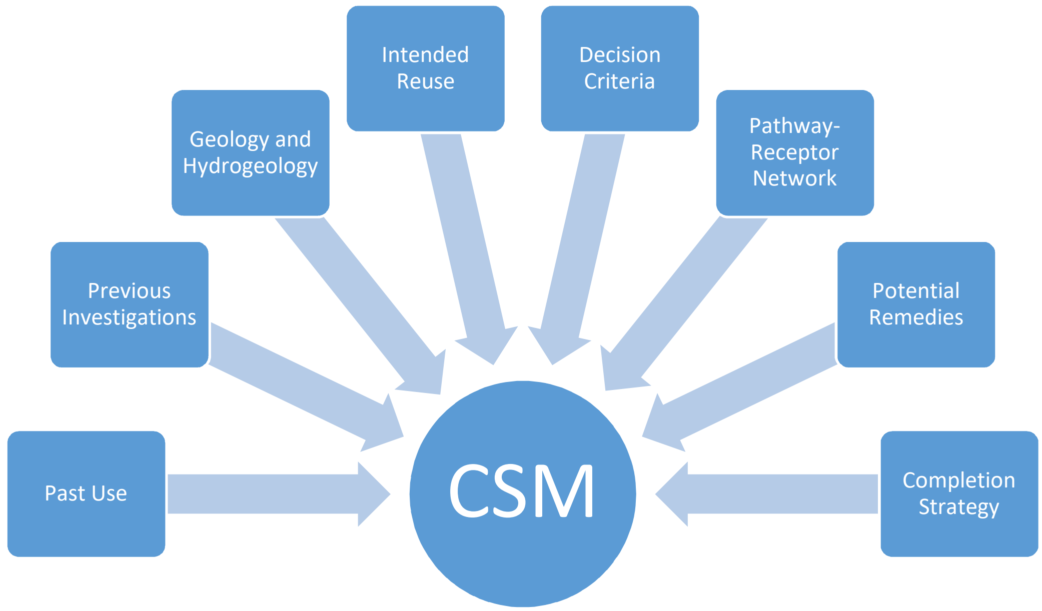
The preliminary CSM considers all existing data, to the extent appropriate, from relevant sources, such as state and tribal partners, other federal agencies, local entities and facility records. The data serve as the planning foundation and are used to provide a comprehensive site overview. The preliminary CSM identifies all that is known about site conditions while also identifying data gaps that must be closed to assess risk and evaluate potential cleanup alternatives. The EPA recognizes there are significant opportunities to leverage existing data to develop more robust and realistic CSMs and to achieve remedial investigation cost savings. New tools for visualizing existing data gaps and to develop efficient data collection efforts to fill those gaps and are discussed in Section 3.

[1] EPA. 2011. Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model. https://www.epa.gov/remedytech/environmental-cleanup-best-management-practices-effective-use-project-life-cycle

Existing data can be leveraged and its usefulness maximized through the following steps:

- Collecting, evaluating, and organizing all existing data;
- Synthesizing existing data into a comprehensive CSM; and
- Visualizing existing data to better comprehend what is known and unknown about important site conditions.

Highlight 2. Components of a Conceptual Site Model



Existing data from past investigations may inform the CSM, for example: (1) associated with the project in question or conducted at nearby sites, (2) at sites with similar contaminant profiles, and (3) at sites with similar environmental conditions, especially in relation to the subsurface geology and surface hydrology. Sufficient time should be given to scoping activities so that existing data can be collected, synthesized, and visualized as part of the planning process.

Address All Conceptual Site Model Components

The EPA has identified physical, historical, programmatic, risk, and remedy data components that constitute a comprehensive CSM as it has gained experience implementing investigation and response activities (see Highlight 2[2]). A comprehensive CSM is not "one" thing, but is comprised of a number of important elements that should be considered to move the project forward to completion. A comprehensive CSM addresses eight components and several sub-elements within each component.

Each of these components can be informed by existing data. One well-known component of a CSM is the pathway-receptor network diagram that helps to identify all pathways by which contaminants may migrate from site sources to human and environmental receptors. While this diagram is likely the CSM's most recognized component, it is just one of several important components informing risk management.

The EPA has found that the most effective investigations use a comprehensive CSM that addresses all elements of the project. Many CSM components are related to and affected by each other. For example, the contaminant mass and distribution is greatly affected by the geology and hydrogeology component and relates to the pathway-receptor network, potential remedies, and decision criteria components.

[2] EPA. 2016. Best Practices for Site Characterization Throughout the Remediation Process course. CERCLA Education Center.

Select Resources: CSM Development

- EPA. 2011. Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model. EPA 542-F-11-011. http://www.brownfieldstsc.org/pdfs/CSM_lifecycle_Fact_Sheet.pdf
- U.S. Army Corps of Engineers. Conceptual Site Models. EM 200-1-12. December 28, 2012. https://www.epa.gov/remedytech/environmental-cleanup-best-management-practices-effective-use-project-life-cycle
- American Society for Testing and Materials (ASTM). 2014. Standard Guide for Developing Conceptual Site Models for Contaminated Sites. E1689-95 (Reapproved 2014). https://www.astm.org/Standards/E1689.htm
- EPA. 2016. Innovations in Site Characterization Case Study: The Role of a Conceptual Site Model for Expedited Site Characterization Using the Triad Approach at the Poudre River Site, Fort Collins, Colorado. EPA 542-R-06-007. https://clu-in.org/download/char/poudre_river_case_study.pdf
- EPA. n.d. Conceptual Site Model Development. http://www.triadcentral.org/mgmt/splan/sitemodel/index.cfm
- EPA. 2006. Systematic Planning Using the Data Quality Objectives Process EPA/240/B-06/001. https://www.epa.gov/sites/production/files/documents/guidance_systematic_planning_dqo_process.pdf
- EPA. 2000. Soil Screening Guidance for Radionuclides, 2.1: Developing a Conceptual Site Model. EPA/540-R-00-007. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100MBXW.PDF?Dockey=P100MBXW.PDF
- EPA. 2016. CLU-IN. Key Optimization Components: Conceptual Site Model. Last Updated September 23, 2016. https://clu-in.org/optimization/components_csm.cfm
- EPA. n.d. Brownfields Road Map. Last Updated January 3, 2018. https://www.epa.gov/brownfields/brownfields-road-map
- EPA. 2008. Triad Issue Paper: Using Geophysical Tools to Develop the Conceptual Site Model. EPA 542-F-08-007. https://www.epa.gov/sites/production/files/2015-08/documents/issue-paper_triad-geophysics.pdf
- New Jersey Department of Environmental Protection, Site Remediation Program. 2011. Technical Guidance for Preparation and Submission of a Conceptual Site Model. http://www.nj.gov/dep/srp/guidance/srra/csm_tech_guidance.pdf

Past Uses

Past uses are evaluated to identify the contaminants of concern/contaminants of potential concern (COCs/COPCs), affected environmental media, potential release mechanisms, probable source area locations, historical releases' timing, the migration pathways, potentially responsible party (PRP) searches, current and former employee interviews, and potential receptors. A critical element is defining the contamination's location and nature of sources that continue to affect various media.

Questions about past uses of the site to be answered might include, but are not limited to:

- What are the contaminants associated with the site?
- Where were the contaminants stored, used, and disposed of?
- How long were the contaminants in use at the site?
- How were these contaminants released?
- When were the contaminants released?
- How many releases have occurred at the site?

Under CERCLA, the identification of contamination sources is important to the listing of sites on the National Priorities List and the investigation and remediation of all types of sites.

Select Resources: Past and Current Uses

- EPA. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. OSWER Directive 9355.3-01. EPA 540/G-89/004. October.
- EPA. 2000. Abandoned Mine Site Characterization and Cleanup Handbook. EPA 910-B-00-001. August.
- EPA. 2005. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. OSWER Directive 9355.0-85. EPA-540-R-05-012. December.

Previous Investigations

Data from previous investigations are evaluated to estimate contaminant distributions in the environment and evaluate potentially complete pathway-receptor networks. Questions to be answered include:

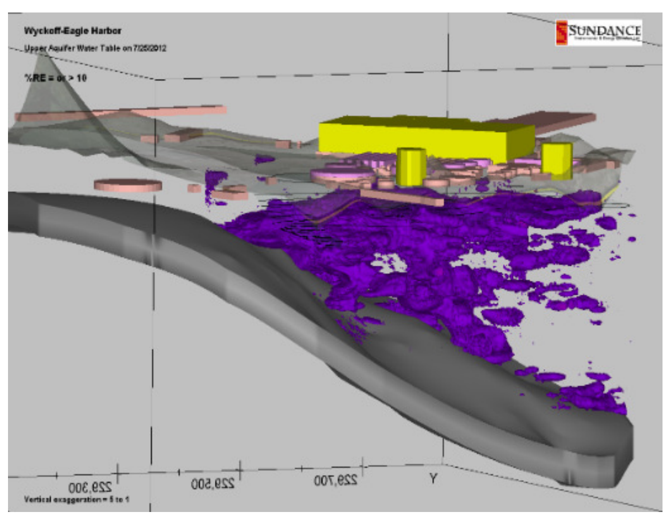
- What are the potential pathways of concern?
- What are the primary pathways for contamination that pose a threat to human health and the environment?
- What is the potential magnitude of the problem?
- What investigative tools and strategies have worked or failed?
- What remedies have been tried and with what success?
- What are potential critical data gaps?
- What are the perceived risks associated with the site?
- What are viable completion strategies?

Every site-related document, regardless of its intended audience or purpose of creation, should be assessed for information that contributes to the CSM. Diligence in gathering and evaluating all data from previous investigations is essential to preparing a thorough CSM.

Select Resources: Previous Investigations

- EPA. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. OSWER Directive 9355.3-01. EPA 540/G-89/004.
- EPA. n.d. Conceptual Site Model Checklist. https://triadcentral.clu-in.org/ref/ref/documents/CSM_Checklist.pdf
- EPA. n.d. Triad Central Web Resources. https://triadcentral.clu-in.org/index.cfm

Highlight 3. Detailed Site Subsurface



Geology and Hydrogeology

Based on investigative experience and other independent research into groundwater contamination, EPA has found that the nature of the geologic structure through which contaminants are moving has profound contaminant fate and transport effects. Highlight 3[3] shows an example of a detailed rendering of the subsurface for a site. Understanding the subsurface heterogeneity at a much higher resolution is critical for designing and implementing more effective and targeted response actions. Scoping activities that: (1) match the scale of the investigation to the scale of geologic heterogeneity expected in the subsurface and (2) define the three-dimensional structure through which groundwater and contaminants are moving can provide data necessary to evaluate and design a remedial strategy, possibly consisting of a combination of technologies. With sufficient resolution, site decisions and responses can be related to source treatment, plume management, and compliance monitoring to efficiently apply and monitor strategic and targeted remedial actions.

Select Resources: Geology and Hydrogeology

- EPA. Technical Support Project. Groundwater Forum. https://www.epa.gov/remedytech/technical-support-project-cleaning-contaminated-sites-ground-water-forum
- EPA. n.d. High-Resolution Characterization for Groundwater. Last Updated on September 23, 2016. https://clu-in.org/characterization/technologies/hrsc/
- EPA. 2017. A Practical Guide for Applying Environmental Sequence Stratigraphy to Improve Conceptual Site Models. EPA/600/R-17/293. https://semspub.epa.gov/work/HQ/100001009.pdf

Decision Criteria

Decision criteria are used to: (1) guide in-field decisions based on the real-time results of field methods, (2) characterize risk, and (3) determine the extent of cleanup. Field-based decision criteria are structured to ensure that the appropriate decision is made, compensating for any analytical method bias or imprecision. Site managers use risk-based screening criteria, such as criteria in EPA's Regional Screening Levels, Regional Removal Management Levels, Vapor Intrusion Screening Levels, and Superfund Chemical Data Matrix, to evaluate the level of contamination in various media. Under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), both potential appropriate or relevant and appropriate requirements and calculated risk-based cleanup levels can be used to define the extent of remediation.

Select Resources: Decision Criteria

- EPA. Triad Central Web Resources. https://triadcentral.clu-in.org/index.cfm
- EPA. Regional Screening Levels (RSLs) – Generic Tables. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
- EPA. Regional Removal Management Levels for Chemicals (RMLs). Tables as of: May 2018. https://www.epa.gov/risk/regional-removal-management-levels-chemicals-rmls
- EPA. Vapor Intrusion Screening Level Calculator. https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator
- EPA. Superfund Chemical Data Matrix (SCDM). https://www.epa.gov/superfund/superfund-chemical-data-matrix-scdm

[3] EPA. Wyckoff Eagle Harbor Superfund Site Information. https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1000612

Pathway-Receptor Network

Pathway-receptor network diagrams depict how contaminants may migrate from sources to receptors. This network diagram influences a CSM by ensuring all actual and potential pathways and receptors are evaluated during the human health and ecological risk assessments. The pathway-receptor network diagram is also used to determine related effects on project design and the sequencing of project activities. The most significant pathways should be addressed first, followed by those that pose less of a concern. Receptor networks can be complex. Chemical and receptor relationships can be less than obvious and drive development of more complex decision criteria. Therefore, it is important to discuss pathway-receptor networks and decision criteria early in the systematic planning process (SPP).

Select Resources: Pathway-Receptor Network

- EPA. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. OSWER Directive 9355.3-01. EPA 540/G-89/004. October.
- EPA. n.d. Conceptual Site Model Checklist. https://triadcentral.clu-in.org/ref/ref/documents/CSM_Checklist.pdf
- EPA. 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final. EPA/540/1-89/002. December. https://www.epa.gov/sites/production/files/2015-09/documents/rags_a.pdf

Intended Reuse

The Superfund Task Force report identifies site reuse as a goal of the Superfund program and includes many recommendations to facilitate redevelopment. EPA's Superfund Redevelopment Initiative has shown the value of early consideration of reuse and facilitation of reuse planning at the local level. Bringing contaminated lands back into productive use is a major objective of all EPA's site cleanup programs. Evaluating and determining reuse of a contaminated site requires a significant lead-time and participation by stakeholder group(s). A site's ultimate reuse (whether open space, recreational, residential, commercial, or industrial or some combination) may be an important factor in determining the level of cleanup that will be required. Both the site type and contamination present may also influence available reuse options. Including reuse as a planning consideration from the beginning of the project life cycle helps ensure appropriate data are collected and developed to inform reuse decisions.

Select Resources: Superfund Redevelopment

- EPA. 1995. Land Use in CERCLA Remedy Selection Process, OSWER 9355.7-04. https://semspub.epa.gov/work/HQ/174935.pdf
- EPA. n.d. Superfund Redevelopment Program. Last Updated on January 9, 2018. https://www.epa.gov/superfund-redevelopment-initiative

Potential Response Alternatives

Scoping activities have traditionally focused on the data needed to conduct the baseline human health and ecological risk assessments and to define the nature and extent of contamination. While these are critical elements of the CSM, additional benefits may be gained by addressing data needed for evaluating and selecting early and long-term actions (see Highlight 4). Identifying and implementing early actions that achieve significant risk reduction and prevent further migration of contaminants (source control and remediation) is a cornerstone of all site remediation programs. Identification of sources of contamination involves several CSM components, including past use, previous investigations, geology and hydrogeology and pathway-receptor network.

Contaminants and mass distribution scenarios may have a limited set of potentially applicable remediation technologies. Once elements of risk and the need for remediation are considered, the data collection focus should be placed on understanding site physical features at appropriate scales and technical or programmatic elements that drive the applicability of these technologies. The EPA's adaptive management approach encourages leveraging experience by identifying potential technologies and ensuring data are collected to adequately evaluate them thus avoiding numerous rounds of data collection.

Highlight 4. Collecting Data to Evaluate Technologies

When planning for likely technology evaluations, parameters like total organic carbon or matrix properties such as hydraulic conductivity, may be collected more cost effectively earlier in the project life cycle.

Select Resources: Potential Remedies

- The EPA's CLU-IN website discusses many potential remedies and technologies. www.clu-in.org
- The Federal Remediation Technology Roundtable (FRTR) provides information on the application of potential technologies. www.frtr.gov
- The Interstate Technology and Regulatory Council (ITRC) provides technical information on the application of technologies. www.itrcweb.org
- The Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ETSCP) provides cutting edge information on data collection techniques.
  https://www.serdp-estcp.org/

Completion Strategy

Scoping efforts often help identify completion strategies for several milestones tracked by EPA: (1) the project phase or a single operable unit, such as RI/FS, (2) completion of an operable unit as defined by the remedial action completion milestone, and (3) completion on a sitewide basis as defined by the construction completion milestone, site close out, and site deletion. Completion strategies for individual phases developed as part of the adaptive management approach should contribute to successful remedial action or risk management designs. While the regulatory program broadly defines requirements for site completion, the site team can develop a more detailed strategy for achieving completion. For example, EPA has issued guidance and a statistical tool for evaluating and documenting completion of groundwater restoration remedial actions. Smart scoping encourages early consideration of the data requirements for evaluating and documenting groundwater completion at sites which may need a groundwater restoration action.

Select Resources: Completion Strategy

- EPA. 2014. Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind. OSWER Directive No. 9200.2-144. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100KM8X.PDF?Dockey=P100KM8X.PDF
- EPA. n.d. Groundwater Remedial Action Completion Webpage. Last Update on June 4, 2018. https://www.epa.gov/superfund/superfund-groundwater-groundwater-response-completion
- EPA. 2011. *Close Out Procedures for National Priorities List Sites*. OSWER Directive No. 9320.2-22. https://semspub.epa.gov/work/HQ/176076.pdf

Section 3 – Focus on Scoping Best Practices

The EPA has identified the following best practices for scoping environmental investigation and remediation programs:

- Project life cycle CSM (discussed in Section 2)
- Comprehensive team formation
- Systematic project planning
- Dynamic work strategies and adaptive management
- High-resolution and real-time measurement technologies
- Use of collaborative data and multiple lines of evidence
- Stakeholder outreach
- Demonstration of method applicability
- Data management and communication
- Three-dimensional visualization and analysis
- Optimization

Section 3 describes all but the first best practice listed above.

Form a Comprehensive Team

Successful investigations use a comprehensive team of multi-disciplinary technical professionals, regulatory staff and site stakeholders. The EPA encourages the use of in-house staff to provide technical support. Each comprehensive site team member should have a defined set of roles and responsibilities. A small group of multi-disciplinary technical staff will usually be responsible for developing and updating the comprehensive CSM. Regulatory staff and stakeholders are usually responsible for reviewing and commenting on approaches developed by the core technical team and data collection results. Regulatory staff and other stakeholders provide important information regarding reuse, decision criteria and site completion strategies. The SPP objective is to obtain site team consensus on the preliminary and baseline CSMs, the data gaps that need to be filled, and the data collection approaches to be used. Systematic project planning is discussed below in more detail. Depending on site-specific needs, a variety of disciplinary skills may potentially be required. Highlight 5 lists the typical types of disciplines that may be needed. The exact make-up of technical and project teams is expected to change over the project's life. For example, regulatory expertise may be critical at the outset, but become less important once key initial decisions are made.

Highlight 5. Typical Disciplines of Multi-Disciplinary Team

Geology – Hydrogeology – Geochemistry - Analytical Chemistry - Risk Assessment – Toxicology – Statistics - Geographical Information Systems (GIS) - Information Management - Soil and Sediment Science - Project Management - Environmental Safety and Health – Engineering – Biology – Ecology – Meteorology - Regulatory Expertise – Contracting – Community Involvement Expertise - Communications

Select Resources: Comprehensive Team Formation

- EPA. 2010. Best Management Practices: Use of Systematic Project Planning Under a Triad Approach for Site Assessment and Cleanup. https://clu-in.org/download/char/epa-542-f-10-010.pdf
- EPA. n.d. Multi-Disciplinary Technical Teams. http://www.triadcentral.org/mgmt/req/techteams/index.cfm

Conduct Systematic Project Planning

Systematic project planning is an efficient method for comprehensive planning, design, and implementation for all stages of hazardous waste site investigation and cleanup projects; it also supports adaptive management. Systematic project planning is a planning process that lays a scientifically defensible foundation for proposed project activities. It usually includes identification of key decisions to be made, the development of a CSM in support of decision-making, and an evaluation of decision uncertainty along with approaches for managing that uncertainty in the context of the CSM[4]. The EPA's *Best Management Practices: Use of Systematic Project Planning under a Triad Approach for Site Assessment and Cleanup*, September 2010, describes the SPP process. Systematic project planning is generally recognized to be common practice for all projects. For example, the data quality objectives process is used as a systematic planning tool for most EPA projects.[5] Such objectives focus on analytical methods and associated data quality, but systematic planning also involves planning for known decisions and identifying contingencies necessary to accommodate changes in project conditions through all key decision-making stages. Highlight 6[6] shows the SPP process. Systematic project planning is important for all types of investigations but is critical for planning and implementing the Triad Approach, which involves SPP, dynamic work strategies and real-time measurement technologies. This project planning approach places a strong emphasis on using a CSM as the basis for the planning of all project life cycle phases, from investigation through remediation (cleanup or mitigation) and site close out (regulatory satisfaction that site risks have been removed

Highlight 6. Systematic Project Planning Process

Preparation activities:

- Organize the project team of stakeholders and technical resources
- Summarize site information in a Preliminary CSM
- Research potential investigation and remedial technologies
- Submit Preliminary CSM and other information to SPP participants in advance of meeting

Meeting activities:

- Introduce and confirm roles and authorities of participants
- Define site reuse goals and project completion strategies
- Identify key site decisions, decision-making processes, tools and rules
- Create a Baseline CSM based on refinement of Preliminary CSM
- Use Baseline CSM to identify key data gaps
- Identify and quantify acceptable levels of uncertainty
- Identify real-time technologies and collaborative data needs
- Plan for real-time data management, assessment, visualization and communication
- Develop detailed dynamic work strategy outline, decision logic diagrams activity sequencing and contingencies plan

[4] Definition of systematic project planning. (https://triadcentral.clu-in.org/gloss/dsp_glossterm.cfm?glossid=223
[5] EPA.2006.Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G4. EPA/240/B-06/001. February. https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf
[6] EPA. 2010. Best Management Practices: Use of Systematic Project Planning Under a Triad Approach for Site Assessment and Cleanup. September. https://clu-in.org/download/char/epa-542-f-10-010.pdf

or mitigated). The CSM is used during SPP to identify data needs, design the data collection approach, and drive the selection of appropriate data collection, analysis, and use methodologies.

Effective SPP has the following benefits:

- Building social capital among project stakeholders.
- Evaluating reuse options and completion strategies.
- Achieving stakeholder consensus on the CSM and data gaps.
- Identifying life cycle project data and resource needs to address all components of the CSM, especially the nature, extent and impact of sources.
- Identifying clear project objectives, timelines and other constraints.
- Developing the data collection strategy's basic elements and establishing performance metrics.
- Evaluating and planning for managing risk-related uncertainties.
- Other integral considerations, such as green remediation, sustainable reuse and environmental justice and community involvement.

Select Resources: Systematic Project Planning

- EPA. 2010. Best Management Practices: Use of Systematic Project Planning Under a Triad Approach for Site Assessment and Cleanup. https://clu-in.org/download/char/epa-542-f-10-010.pdf
- EPA. n.d. Triad Central. Use of Immunoassay Test Kits, Systematic Project Planning, and Dynamic Working Strategies to Facilitate Rapid Cleanup of the Wenatchee Tree Fruit Research and Extension Center Site, Wenatchee, Washington. Last Update on June 29, 2007. http://www.triadcentral.org/user/includes/dsp_profile.cfm?Project_ID=27
- EPA. n.d. Triad Central. Systematic Planning and Conceptual Site Model Case Study Basewide Hydrogeologic Characterization at Naval Air Weapons Station (NAWS) China Lake, Ridgecrest, CA. Last Update on October 22, 2004. http://www.triadcentral.org/user/includes/dsp_profile.cfm?Project_ID=4
- EPA. n.d. Triad Month Session 2: Triad Communications and Systematic Planning Sponsored by: U.S. EPA Technology Innovation and Field Services Division. https://clu-in.org/conf/tio/triad2_080609/
- US Navy. 2004. Triad's Systematic Planning Process. http://www.triadcentral.org/ref/doc/2_Adrianne.pdf
- US Army Corps of Engineers. 2006. Draft Systematic Planning Checklist—Implementing Systematic Project Planning. http://www.triadcentral.org/ref/ref/documents/Triad_Systematic_Planning_Checklist_Oct06_.pdf

Use Dynamic Work Strategies and Adaptive Management

Adaptive management through the design and implementation of dynamic work strategies applies to contaminated site characterization, remediation or monitoring (or a combination thereof) and includes built-in flexibility guided by a pre-approved decision logic.[7] As information is gathered, it is used to adapt the specific activities in real-time so that subsequent activities will best resolve remaining data and decision uncertainties. The goal is to evolve the CSM and complete remedial actions in as few mobilizations as feasible while providing flexibility for field teams and decision-makers to address site realities or unexpected features during these field activities. All planned work activities are described in written work planning documents appropriate to program

[7] EPA. 2017. *Superfund Task Force Recommendation #3: Broaden the Use of Adaptive Management.* Office of Land and Emergency Management directive 9200.3-120. July 25. https://semspub.epa.gov/work/HQ/100001630.pdf

oversight. Dynamic field activities are typically driven by pre-approved decision logic. All scenarios or contingencies cannot be planned for and remaining project decisions are commonly addressed during field activities by remote project team stakeholders and decisions-makers using distance collaboration tools.

Dynamic work strategies are most commonly used in the form of adaptive data collection strategies. Data collection strategies can be "adaptive" in several different ways, one or all of which may be used in an adaptive data collection program. These include:

- Adaptive Location Selection: Refers to data collection programs where sampling location decisions are made in the field in response to real-time data collection results.
- Adaptive Analytics Selection: Refers to data collection programs where sample analysis decisions are made in the field in response to real-time measurement results.

Select Resources: Dynamic Work Strategies

- EPA. n.d. Triad Resource Center, Dynamic Work Strategies. http://www.triadcentral.org/mgmt/dwstrat/index.cfm
- EPA. 2009. CLU-IN. Triad Month Session 7: Dynamic Work Strategies Sponsored by: U.S. EPA Technology Innovation and Field Services Division. https://clu-in.org/conf/tio/triad7_082509/
- EPA. 2005. Use of Dynamic Work Strategies under a Triad Approach for Site Assessment and Cleanup—Technology Bulletin. https://nepis.epa.gov/Exe/ZyPDF.cgi/2000CYTM.PDF?Dockey=2000CYTM.PDF

Use High-Resolution and Real-Time Measurement Technologies

High-resolution site characterization (HRSC) includes investigation tools and strategies appropriate to the scale of heterogeneities in the subsurface that control contaminant distribution, transport and fate. The HRSC techniques provide the degree of detail necessary to understand exposure pathways, processes affecting the fate of contaminants, mass distribution and flux by phase and media, and how remediation or mitigation measures may affect the problem. Many HRSC techniques include real-time measurement technologies which refer to any data generation mechanism that supports real-time decision-making, including rapid turn-around from a fixed laboratory (using either quantitative or qualitative analytical methods) or field-based measurement technologies. Examples of real-time measurement technologies commonly used for HRSC approaches include:

- x-ray fluorescence (XRF)
- membrane interface probe (MIP)
- laser induced fluorescence (LIF)
- electrical conductivity meter
- hydraulic profiling tools
- forward-looking infrared technology
- passive samplers and flux meters
- bioassay and colorimetric test kits
- mobile laboratories
- surface and borehole geophysics

Real-time measurement technologies provide results quickly enough to influence data collection and field activities progress and to indicate where collaborative data collection can provide the greatest benefit.

Select Resources: High Resolution and Real-time Measurement Technologies

- FRTR provides information on the application and cost of measurement technologies. www.frtr.gov
- ITRC provides information on many characterization techniques and technologies. www.itrcweb.org
- The Triad Central website provides information and case studies on the Triad Approach. www.triadcentral.org

- EPA. n.d. High-Resolution Characterization for Groundwater. Last Updated on September 23, 2016. https://clu-in.org/characterization/technologies/hrsc/
- EPA. 2003. Using the Triad Approach to Streamline Brownfields Site Assessment and Cleanup. https://nepis.epa.gov/Exe/ZyPDF.cgi/10002O76.PDF?Dockey=10002O76.PDF

Use Collaborative Data Sets and Multiple Lines of Evidence

The term "collaborative data sets" refers to the use of more than one analytical or measurement technique to inform the contamination status of a site or area of concern. "Collaborative" indicates that the combination of two or more types of investigative results, each with different strengths and weaknesses, produces a better decision-making result than any used separately. The EPA promotes the use of a blend of real-time techniques with fixed-based laboratory methods to produce collaborative data sets. In addition, several field-deployable technologies can be used in combination to provide collaborative data sets.

Using multiple lines of evidence means that data from different measurement techniques provide results that converge and support similar conclusions. If the lines of evidence do not converge, then the site team will evaluate the reason and the original CSM assumptions and adjust to the actual conditions found in the field to resolve the inconsistency. Both convergence and divergence of multiple lines of evidence inform the project team and future investigative efforts. Examples of investigative multiple lines of evidence for determining relative hydraulic conductivity in the subsurface include lithologic logs, cone penetrometer testing, electrical conductivity readings and hydraulic profiling measurements. All four lines of evidence use different methods to give an indication of the relative hydraulic conductivity parameter. The EPA strongly encourages the use of multiple lines of evidence in many of its Superfund technical guides, including those related to vapor intrusion and monitored natural attenuation. Site teams can look for opportunities to develop strategic sampling designs that collect both collaborative data and multiple lines of evidence.

Select Resources: Collaborative Data and Multiple Lines of Evidence

- EPA. 2001. Current Perspectives in Site Remediation and Monitoring: Applying the Concept of Effective Data to Environmental Analyses for Contaminated Sites. https://clu-in.org/download/char/effective_data.pdf
- EPA. 2008. Demonstrations of Method Applicability under a Triad Approach for Site Assessment and Cleanup — Technology Bulletin. http://nepis.epa.gov/Exe/ZyPDF.cgi/P1001FR4.PDF?Dockey=P1001FR4.PDF
- EPA. 2015. Office of Solid Waste and Emergency Response (OSWER) Technical Guide for Assessing and Mitigating The Vapor Intrusion Pathway From Subsurface Vapor Sources To Indoor Air. https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf
- EPA. n.d. Use of a Conceptual Site Model and Collaborative Data Sets Involving ROSTTM and Other Field-based Measurement Technologies to Design and Implement Soil Vapor Extraction and Petroleum Product Extraction Systems at the Hartford Plume Site, Hartford, Illinois. Last Updated on December 31, 2007. http://www.triadcentral.org/user/includes/dsp_profile.cfm?Project_ID=31
- EPA. n.d. Triad Resources Center: Analytical, Data, and Decision Quality: http://www.triadcentral.org/mgmt/meas/key/quality/index.cfm
- ITRC. 2003. Technical and Regulatory Guidance for the Triad Approach: A New Paradigm for Environmental Project Management: http://www.itrcweb.org/Guidance/GetDocument?documentID=90
- ITRC. 2007. Vapor Intrusion Pathway: A Practical Guideline: http://www.itrcweb.org/documents/vi-1.pdf

Conduct Stakeholder Outreach

While stakeholder participation is necessary for all hazardous waste site remediation and closure efforts, stakeholders are key to the SPP process and play a particularly important role when using dynamic work strategies and adaptive site management. This importance is because using dynamic work strategies that are flexible and adaptable often defers significant sampling program decisions to field teams and remote decision makers.

Experience indicates that building “social capital” provides project benefits that flow from the trust, reciprocity, information sharing and cooperation associated with stakeholder networks. All stakeholders are important to project success, however, engaging core technical team’s key stakeholders, such as state, tribal and federal regulators is not only critically important to achieving consensus on the approach, strategies and tools employed but can serve to limit project management costs associated with data interpretation and document review. A collaborative approach to data collection design, execution and interpretation often results in a reduction of identified data gaps or disagreements about CSM elements. This more favorable outcome arises due to key stakeholders’ heavy investment in data collection design and to the majority of data interpretation occurring during dynamic field efforts. In this manner, shorter review times and fewer anticipated technical disagreements can reduce project management costs associated with stakeholder document review, comment and acceptance.

Successful deployment of a dynamic work strategy and an adaptive management approach requires stakeholder participation not just in concurring with work plans, but also potentially with decisions that are made in the field in response to site conditions and real-time results as they are encountered. It is recognized that some stakeholders may face resource challenges (particularly staff time) during dynamic field program planning and implementation; however, it is expected that efficiencies gained from reduced transaction costs during review and comment can help offset these resource expenditures. This participation level can have a positive impact on a characterization or remediation program’s ultimate outcome, since stakeholder data issues can be addressed while field work is underway. Many distance collaboration tools now exist to make engagement in the process easier and more resource friendly, including web portals, websites, file sharing services and video meetings.

Select Resources: Stakeholder Outreach and Engagement

- EPA. 2001. Stakeholder Involvement & Public Participation at the U.S. EPA: Lessons Learned, Barriers, & Innovative Approaches: https://www.epa.gov/sites/production/files/2015-09/documents/stakeholder-involvement-public-participation-at-epa.pdf
- EPA. 2013. Getting in Step: Engaging and Involving Stakeholders in Your Watershed 2nd Edition EPA841-B-11-001. https://cfpub.epa.gov/npstbx/files/stakeholderguide.pdf
- Federal Energy Regulatory Commission. 2001. Federal Energy Regulatory Commission Ideas for Better Stakeholder Involvement in the Interstate Natural Gas Pipeline Planning Pre-Filing Process. https://www.ferc.gov/legal/maj-ord-reg/land-docs/stakeholder.pdf
- Federal Emergency Management Agency. 2016. Guidance for Stakeholder Engagement. https://www.fema.gov/media-library-data/1470349382727-a25897d8ed8adfe0d99989d2b0c9a74c/SE_Discovery_Guidance_May_2016_508.pdf
- ITRC. 2001. Petroleum Vapor Intrusion Guidance- Community Engagement. http://www.itrcweb.org/PetroleumVI-Guidance/Content/7.%20Community%20Engagement.htm

- MDOT. 2009. Michigan Department of Transportation Guidelines for Stakeholder Outreach. https://www.michigan.gov/documents/mdot/MDOT_Guidelines_For_Stakeholder_Engagement_264850_7.pdf

Conduct Demonstrations of Method Applicability

A Demonstration of Method Applicability (DMA) is also called a "methods applicability study" or a "pilot study" to evaluate the investigative approach. The method involves proposed sampling or analytical methods pre-testing to evaluate site-specific performance. Such studies are recommended by EPA prior to finalizing the design of sampling and analyses plans for waste projects [SW-846 Section 2.1]. These studies can be designed to accomplish a variety of goals including:

- Initial evaluation of site-specific heterogeneities that will support further design of the data collection program:
  - Sampling design (how many samples to collect and where to collect them)
  - Sample support (what volume of sample to collect and with what collection tool)
  - Sample processing (also can be related to sample support issues)
  - Communicate heterogeneity issues to regulators and stakeholders
- Evaluation of analytical performance and planned decision logic on site-specific sample matrices:
  - Guides analytical method selection, establishes initial relationships and explores techniques for comparing collaborative data sets (statistical, qualitative, visual observation)
  - Determine whether and how to modify methods to improve performance and/or cost-effectiveness
- Develop initial method performance/QC criteria based on site-specific data needs:
  - During project implementation, both field and analytical QC results will be judged against these criteria to determine whether procedures are "in control" and meet defined project needs
  - Develop list of corrective actions to be taken if QC criteria exceeded
- Decision thresholds ("action levels" to guide decisions about soil or areas, and the routing of materials for final disposal)
- Develop contingency plans for tool or instrument failure
- Refine the data management plan to accommodate field data inputs (high resolution, direct sensing tools, spatial/location tools)
- Provide an initial look at CSM assumptions and elements affecting the sampling design
- Consider logistical issues, such as activity and media sequencing, drilling techniques/contingencies, load balance/staffing, and unitized costs

A DMA can also provide cost and performance information that can be used to optimize collaborative data collection using technologies for generating analytical data (or other information) both in the field and in an offsite location. Additionally, a DMA can offer stakeholders an understanding of a technology's site-specific performance while at the same time providing the basis to optimize deployment standard operating procedures. Demonstration of method applicability efforts are performed easily and affordably before mobilization, or as a field program's early component.

Select Resources: Demonstrations of Method Applicability

- EPA. 2008. Demonstrations of Method Applicability under a Triad Approach for Site Assessment and Cleanup — Technology Bulletin. https://clu-in.org/download/char/demonstrations_of_methods_applicability.pdf
- EPA. 2008. Demystifying the DMA (Demonstration of Method Applicability. https://clu-in.org/conf/tio/dma_072808/

- EPA. 2008. X-ray Fluorescence (XRF) Session 4: Demonstration of Method Applicability (DMA): https://clu-in.org/conf/tio/xrf_081408/
- EPA. 2003. Fort Lewis Agreed Order RI Demonstration of Method Applicability Sampling And Analysis Plan Addendum: http://www.triadcentral.org/user/doc/TPP-FortLewis-DMAMemo.pdf

Plan Carefully for Data Management and Communication

Data management and analysis is an important component of data collection for all environmental investigations. Some of the issues associated with data management are particularly relevant to dynamic work strategies and adaptive site management. They include:

- Timely dissemination of real-time data
- Balancing the needs for data review with the need for rapid data turn-around
- Data archiving requirements and management of direct sensing or other non-traditional data
- Broader uses of data sets

The EPA's new "Best Practices for Data Management Technical Guide," provides additional details on planning and implementing a data management plan. Data management best practices address the following aspects of data management: planning, collecting, analyzing, decision-making, storing, preserving and communicating. Actively planning for and managing data has many project benefits including:

- Quality control at the point of data generation
- Availability of real-time data to dynamically support a robust and realistic CSM
- Data is viewed as a deliverable - it can be reviewed or re-interpreted in response to the CSM rather than forced into a narrow context based on historical reports and interpretation
- Economies of scale for projects, sites, states, regions
- Data warehouse and interoperability - all site data available on demand and in electronic format to stakeholders and project partners

The EPA encourages the use of dynamic work strategies and real-time data collection; however, these approaches require site teams to evaluate and respond to data quickly. For many sites, data collection teams, decision makers, and stakeholders are geographically dispersed and sharing data in a timely manner can be a challenge. Several collaboration tools are available to communicate data among teams. Many of these tools can also be used as portals for teams to store and access information over the project life cycle. The EPA has found these communication tools particularly useful for sharing data visualization and CSM products.

A variety of publicly and commercially available software can assist with statistical data analysis, sampling design, modeling, visualization, risk assessment, optimization and more. Some examples of these tools can be found at https://clu-in.org/software/ and https://frtr.gov/decisionsupport/. Data results, findings and recommendations can be communicated to project team members and stakeholders using dedicated project websites, web meetings and collaboration pages. The EPA teams currently have access to a variety of these tools, such as Adobe Connect and SharePoint. Project teams are encouraged to plan for and utilize appropriate decision support and communication tools to maintain or achieve stakeholder consensus, remotely participate in dynamic field programs and data interpretation, and expedite review of documentation.

Select Resources: Data Management

- EPA. n.d. National Association of Remedial Project Managers - How To Plan Your Data. http://www.slideshare.net/EarthSoft/narpm-data-management-datasearles-pdf

- EPA. 2011. Data Management Plan Remedial Investigation/Feasibility Study Newtown Creek. https://semspub.epa.gov/work/02/162129.pdf
- Department of Energy. n.d. Suggested Elements for a Data Management Plan. Last Modified on: March 5, 2016. http://science.energy.gov/funding-opportunities/digital-data-management/suggested-elements-for-a-dmp/
- ITRC. 2006. Data Management, Analysis, And Visualization Techniques: http://www.itrcweb.org/GuidanceDocuments/RPO-5.pdf

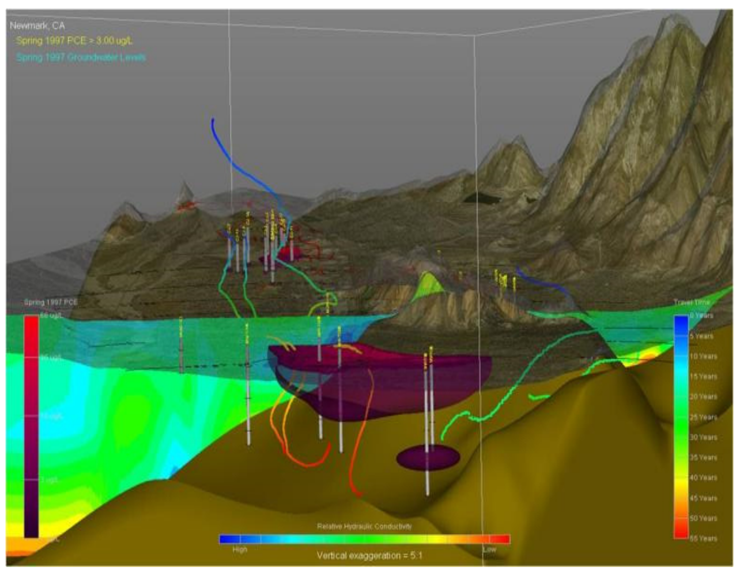
Consider Using Three-Dimensional Visualization and Analysis

The EPA has found that understanding subsurface heterogeneity at a much higher resolution is critical for evaluating contaminant fate and transport, and in designing and implementing more effective and targeted remedial actions. Obtaining a correct geologic interpretation is foundational to depicting the subsurface. Visualization software has been successfully used to perform three-dimensional visualization and analysis (3DVA) that integrates three important subsurface parameters - geology, hydrogeology, and contaminant chemistry - into a single spatially correct format. The EPA has used 3DVA successfully to better understand subsurface structure and characteristics and to reconcile technical CSM discrepancies.

Highlight 7[8] is an example of a three-dimensional visualization of important subsurface parameters. 3DVA provides advantages over two-dimensional data presentation and analyses tools for the following attributes of data analysis:

- Showing data with spatial accuracy
- Showing data at depth
- Showing data over time
- Quantifying mass and volume estimates
- Incorporating outlier data
- Integrating evaluations of collaborative data, maximizing the use of existing information potentially decreasing the need for additional data
- Interpreting and analyzing environmental data geostatistically
- Evaluating potential data gaps
- Quantifying spatial uncertainty and confidence

Highlight 7. Example 3DVA



Select Resources: 3DVA

- EPA. 2011. Use of Geostatistical 3-D Data Visualization/Analysis in Superfund Remedial Action Investigations. https://clu-in.org/conf/tio/3d_092311/
- ITRC. 2006. Data Management, Analysis, And Visualization Techniques. http://www.itrcweb.org/GuidanceDocuments/RPO-5.pdf

[8] EPA. *Newmark Groundwater Contamination Site Information*. Last Updated on August 13, 2018. https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0902439

Optimize Investigations

The EPA has expanded its national optimization activities to include all Superfund remedial process stages. Investigation-stage optimization stresses the concepts this smart scoping technical guide presents and it encourages the use of a life cycle CSM and dynamic approaches that can be adapted in response to site conditions discovered as the investigation is underway. Optimization reviews provide an independent evaluation of site conditions, CSM components, system design, operating remedies, completion strategies and monitoring networks. The reviews result in the presentation of a series of findings and recommendations on technical and policy issues, cost efficiency, system protectiveness and progress towards completion. Project teams are encouraged to plan for the integration of optimization reviews and to take advantage of available technical resources.

Regardless of where a site is in the project life cycle, a team approach utilizing experienced technical staff who can invest time to help project teams update the CSM can result in source and plume management strategy development with measurable timeframes and targets. Armed with an improved understanding of the CSM and specific remediation objectives, project teams should be better positioned to measure progress and meet site goals.

Select Resources: Superfund Optimization

- EPA. Cleanup Optimization at Superfund Sites. Last Updated on June 4, 2018. https://www.epa.gov/superfund/cleanup-optimization-superfund-sites
- EPA. 2012. National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion. OSWER 9200.3-75. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100GI85.PDF?Dockey=P100GI85.PDF
- EPA. n.d. Optimizing Site Cleanups. Last Updated on September 23, 2016. https://clu-in.org/optimization/
- EPA. 2010. Optimizing the Site Investigation Process: https://clu-in.org/consoil/prez/2010/Investigation-Process-Optimization-Slides.pdf
- ITRC. 2004. Remediation Process Optimization: Identifying Opportunities for Enhanced and More Efficient Site Remediation. http://www.itrcweb.org/GuidanceDocuments/RPO-1.pdf

Disclaimer

The use of these best management practices may warrant site-specific decisions to be made with input from state, tribal, and/or local regulators and other oversight bodies. The document is neither a substitute for regulations or policies, nor is it a regulation or EPA guidance. In the event of a conflict between the discussion in this document and any statute, regulation or policy, this document would not be controlling and cannot be relied on to contradict or argue against any EPA position taken administratively or in court. It does not impose legally binding requirements on the EPA or the regulated community and might not apply to a particular situation based on the specific circumstances. This document does not modify or supersede any existing EPA guidance or affect the Agency's enforcement discretion in any way.