



Brownfields Technology Primer: Requesting and Evaluating Proposals That Encourage Innovative Technologies for Investigation and Cleanup



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Encourage Innovative Technologies for
Investigation and Cleanup**

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office
Washington, DC 20460

NOTICE

This document has been funded by the United States Environmental Protection Agency (EPA) under Contracts 68-W-99-003 and 68-W-99-020 to Tetra Tech EM Inc. The document was subjected to the Agency's administrative and expert review and was approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ACKNOWLEDGEMENTS

The Technology Innovation Office would like to acknowledge and thank the individuals who reviewed and provided comments on draft documents. The reviewers included representatives of business and community organizations, legal institutions, EPA Headquarters and regional offices, local government and city planning offices, and remediation contractors.

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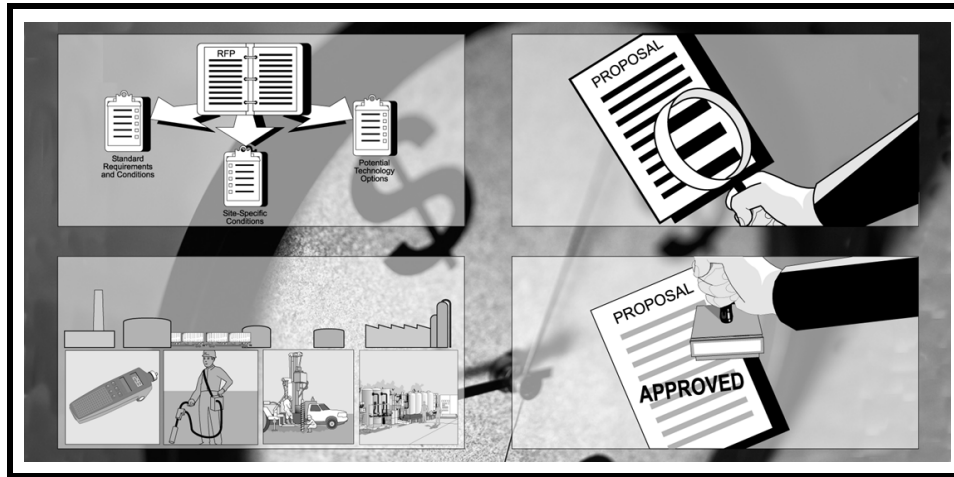
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Sources of Innovative Technology Information

1.0 INTRODUCTION



1.1 Purpose

Innovative technologies and streamlined strategies for assessing, characterizing, monitoring, and remediating contamination have potential to minimize the cost and time required to clean up brownfields sites. With proper planning and consideration of the options available for using innovative technologies and streamlined strategies, many of those sites will move faster to the redevelopment phase than could be achieved by using more traditional cleanup approaches. By carefully selecting technologies and approaches for conducting site investigations, and then analyzing and using the data gathered as a basis for evaluating all reasonable remediation options, decision makers will be in a strong position to select technologies that will achieve the cleanup objectives at the site in timely manner, while assuring the required protection of human health and the environment.

The Brownfields Technology Support Center (BTSC) (see box on the next page) prepared this primer to assist site owners, project managers, and others preparing requests for proposals (RFP) to solicit support in conducting activities to investigate and clean up contaminated sites. The primer is not a general guidance document on preparing RFPs for the investigation and cleanup of sites. Rather, it is specifically intended to assist those individuals in writing specifications that encourage contractors and technology vendors

(both referred to as contractors in this document) to propose options for using innovative characterization and remediation technologies at brownfields sites. The primer also provides information, from a technology perspective, to guide review teams in their evaluations of proposals and the selection of qualified contractors.

The BTSC previously issued a document titled *Assessing Contractor Capabilities for Streamlined Site Investigations* [EPA 542-R-00-001]. That document provides information useful to brownfields decision makers as they interview contractors to determine each contractor's qualifications to provide streamlined and innovative strategies for conducting site investigations. A number of Brownfields Pilot Coordinators and others requested that the BTSC supplement that document by developing this primer. It is hoped that the use of the information in this primer by the brownfields community will encourage contractors to consider the use of innovative technologies earlier in the proposal "pipeline," preferably at the time the contractors are preparing their proposals, and will create a more receptive atmosphere for contractors that do so. RFPs that clearly define the requirements and expectations for contractors to use innovative technologies will encourage contractors to "think outside of the box" and consider non-traditional approaches as they prepare their proposals.

When developing this primer, the BTSC reviewed a number of RFPs prepared by brownfields communities. Many of those communities recognized the advantages of innovative technologies and required their inclusion in proposals. Although that trend is encouraging, the use of innovative technologies could be much more widespread at brownfields sites. Individuals who prepare RFPs and evaluate proposals should be aggressive in identifying the many contractors across the nation that offer innovative technologies.

The BTSC produced this primer to serve as a resource for general information; localities, states, and federal brownfields staff can turn to the BTSC for further assistance addressing site-specific issues. The BTSC can assist localities in scoping potential technology options for their sites and using the information obtained in the RFP process. The BTSC also can identify other sources of information to assist individuals who prepare RFPs and contractors who submit proposals in conducting research to identify appropriate technology options for the site under review.

1.2 Background

The U.S. Environmental Protection Agency (EPA) has defined brownfields sites as “abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is






complicated by real or perceived environmental contamination.” Numerous technology options are available to assist those involved in the cleanup of brownfields sites. EPA’s Technology Innovation Office (TIO) encourages the use of innovative, cost-effective technologies to characterize and clean up contaminated sites. An innovative technology is a technology that has been field-tested and applied to a hazardous waste

problem at a site, but lacks a long history of full-scale use. Although readily available information about its cost and how well it works may be insufficient to encourage use under a wide variety of operating conditions, an innovative technology has potential to significantly minimize the cost and time required to redevelop brownfields sites.

The process of redeveloping brownfields sites provides an excellent framework for using innovative technologies because: (1) state and federal

regulators tend to be flexible in approving cleanup plans for brownfields sites, particularly those sites for which voluntary cleanup plans have been submitted; (2) most of the current brownfields sites are not encumbered by a history of litigation or enforcement actions for which traditional technologies may already have been specified; and (3) redevelopment plans have been prepared for many brownfields sites and are used to establish site-specific cleanup targets and the time frames

Brownfields Technology Support Center



EPA established the Brownfields Technology Support Center to ensure that brownfields decision makers are aware of the full range of technologies available for conducting site assessments and cleanup, and can make informed decisions for their sites. The center can help **government** decision makers evaluate strategies to streamline the site assessment and cleanup process, identify and review information about complex technology options, evaluate contractor capabilities and recommendations, explain complex technologies to communities, and plan technology demonstrations. The center is coordinated through EPA’s Technology Innovation Office and works through EPA’s Office of Research and Development laboratories. Localities can submit requests for assistance:

- Directly through their EPA Regional Brownfields Coordinators
- Online at <http://brownfieldstsc.org>
- By calling 1 (877) 838-7220 (toll free).

For more information about the program, the central point of contact is Dan Powell of the EPA Technology Innovation Office at (703) 603-7196 or powell.dan@epa.gov.

for cleanup – this information provides an excellent basis for tailoring innovative approaches to the investigation and cleanup of individual sites.

1.3 Approach

Although the structure of RFPs will vary, the criteria listed below are those typically used to evaluate and select contractors for individual projects. Many RFPs specify how the criteria will be used to evaluate individual proposals. Contractors typically structure their proposals according to the criteria to ensure they respond to each item. The criteria are:

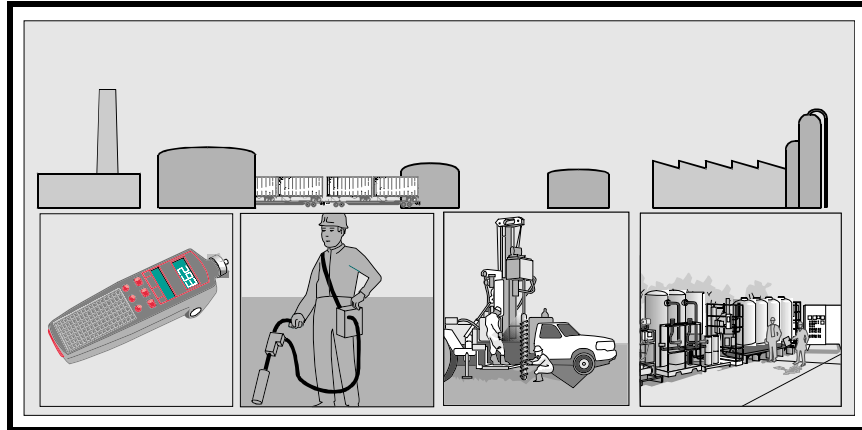
- Proposed technical methodology based on site requirements and the schedule for performing the work
- Qualifications of the contractor’s proposed project management team and other key staff
- Corporate experience in performing similar work
- Proposed quality assurance and quality control procedures
- Proposed price to complete the project

Individuals preparing RFPs should define site-specific conditions and potential challenges clearly so that bidders can respond adequately to each criterion. This primer provides information on how to apply each criterion in preparing RFPs.

The primer illustrates the importance of providing prospective bidders with as much site information as possible. Individuals preparing RFPs should ensure all relevant information is communicated effectively to all prospective bidders. Contractors then have the basis to fully understand the conditions of the site and can provide proposals that offer sound and viable approaches for assessing and cleaning up the site. The selection officials also should review all available information to ensure they understand the site requirements and will select a contractor with qualified and experienced staff to perform the work correctly.

In all cases, selection officials and contractors should make every effort to tailor the RFPs and the responses to those RFPs to the specific redevelopment and regulatory goals for the site under review. The use of generic objectives, such as “define the nature and extent of contamination” without the context of the ultimate site goals can lead to costly, time-consuming site investigations and cleanup activities.

2.0 ADVANTAGES AND USES OF INNOVATIVE TECHNOLOGIES



2.1 Advancements in Innovative Technologies

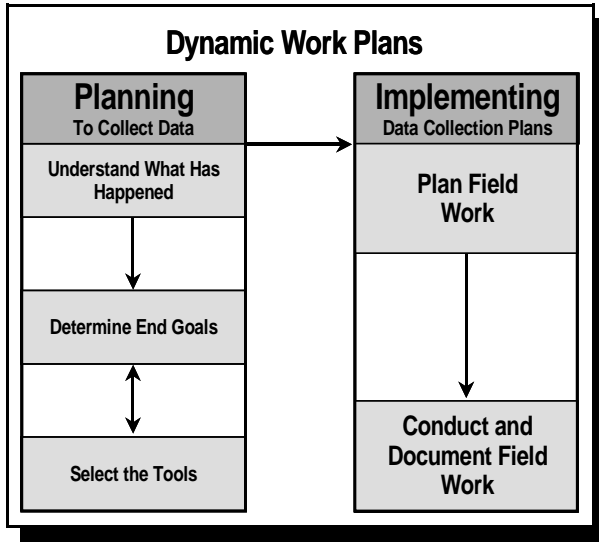
The discussion below illustrates the uses and advantages of innovative technologies for characterization and remediation. Over the past decade there have been significant advancements in the development and use of innovative technologies. Over the next decade, technology advancements are expected to continue to increase significantly as thousands of brownfields sites across the nation, as well as outside the U.S., are cleaned up.

2.2 Characterization and Monitoring Technologies

In the past, characterizing a contaminated site typically included: (1) reviewing past records of the site, (2) drilling one well upgradient of the contaminated area to obtain background information, (3) drilling three wells downgradient to locate and characterize the contamination, (4) sending the samples to an off-site Contract Laboratory Program (CLP) laboratory and waiting several weeks or months for the results, and (5) sometimes conducting a geophysical survey to better understand the underground flow patterns of contamination. This approach, which often required several sampling events and mobilizations to gather sufficient information to accurately characterize the site and design valid cleanup options, may not be efficient enough to support brownfields redevelopment. New

technologies and approaches, developed and optimized over the past 5 to 10 years, are now emerging on the market. Such approaches are designed to gather information in greater detail and more frequently, with immediate or real-time data output. Examples of new technologies and approaches for characterization activities include: (1) hand-held chemical screening tools that take readings and display results immediately; (2) direct-push drilling techniques rigged with detection devices that collect samples as the probe is penetrating the subsurface; and (3) on-site mobile laboratories that provide results in 24 hours or less.

New, innovative characterization strategies also include flexible or dynamic work plans, which provide the basis for a continuous and efficient characterization process. Under these strategies, a work plan is designed to conduct sampling at locations at which contamination is suspected. If the locations investigated are not contaminated, the sampling plan can be revised on site and the sampling can continue, with the new information obtained used to guide the additional sampling. Through such an approach, repeated mobilizations to the same site can be avoided. Since the amount of funds available often determines the extent of characterization work done at a site, effective coupling of inexpensive field techniques with limited off-site analyses can provide a more complete picture of site conditions, thereby reducing uncertainty.



Comprehensive, up-front planning is essential to effectively use innovative strategies for characterizing sites. Proper planning will ensure that the only data that will be collected are data that will lead to decisions about the site and that the data collection process is efficient. If known at the time of characterization, the end use and ultimate cleanup goals for the site should be used as the basis for developing a sampling plan that will ensure that the correct data are collected the first time and will provide sufficient information to support the design of remediation options. If the reuse plan for the site is not fully defined at characterization, those designing the sampling plan should take advantage of the best information available on the basis of zoning or other general reuse plans for the area. In addition to providing as accurate a picture as possible of the site, a well-planned approach can help avoid delays and expenses associated with unnecessary collection of data.

In designing site characterization plans, every effort should be made to collect the first time the information needed to support future decisions about remediation alternatives. Because the data required for making decisions about remediation technologies vary from technology to technology, and from site to site, it is essential that contractors carefully define the data that will be needed to assess remediation options and include those data points in their characterization plans.

Some sites require the use of more intricate innovative methods than other sites. For example, sites that are relatively uncontaminated with simple and homogeneous geology and hydrology typically lend themselves to a simpler collection and analysis process than sites at which complexities such as fractured rock are present. For such sites, extensive data typically are needed to identify accurately the vertical and lateral extent of contamination.

The planning phase also should include early coordination with the state regulatory authority to ensure that the state is aware of the work that will be performed. Although state approval generally is not necessary for characterization activities, state "buy-in" at this point will facilitate any concurrences or approvals that may be necessary as the project moves forward to redevelopment. It may be beneficial to request the state's comments on quality assurance and quality control plans or other critical activities and take advantage of the expertise and experience members of the state staff have with similar sites.

2.3 Remediation Technologies

For remediation technologies, traditional approaches of simple containment or "digging and hauling" off-site can be replaced or augmented by treatment technologies that use biological, physical and chemical, and thermal processes. Advances have been made in using containment to eliminate the migration of contaminants on site. New technologies and containment strategies can be used for soil, sediments, sludges, groundwater, surface water, and leachate. A key consideration in selecting technologies at individual sites is control of sources of contamination (hot spots). In some cases, the sources can be removed; in other cases, they can be contained, with or without further treatment. Innovative technologies can be used very effectively as a source control option.

The evaluation of remediation options requires detailed information about the site, including the past, current, and planned uses of the site. In evaluating remediation options, consideration of potential impacts on nearby neighborhoods and potential long-term liabilities from remediation

activities must be factored into the decision-making process. Decision makers also should weigh the costs and benefits of treating contaminants against the cost and benefits of leaving them in place, untreated. Containment options or the use of institutional controls, such as deed restrictions, easements, zoning restrictions, or prohibitions against drilling in the area of contamination, may be considerably quicker and cheaper than treatment alternatives. However, decision makers should weigh the full costs of such options, including capital costs, long-term sampling and analysis costs, and replacement costs for equipment, as well as concerns about potential long-term risks associated with contaminants left in place, against the cost options that would permanently remove or destroy the contaminants.

Decision makers also should consider special construction needs during the remediation process. Innovative technologies provide excellent alternatives for remediating brownfields sites where existing buildings and other structures are to be preserved and not damaged. For example, steam injection has been used successfully at sites where excavation of contaminated soils under structures was not feasible. Section 3 of the primer provides more detailed information about considerations for brownfields sites

2.4 Examples

The following examples illustrate how innovative characterization and remediation technologies expedited cleanup time frames, resulted in significant cost savings, and achieved a better result than traditional approaches that were proposed or previously used at the sites.

Example 1

The city of Newark, New Jersey successfully used innovative characterization technologies to support the redevelopment of a brownfields site that consists of approximately 700 acres of public and private property. The project was administered by the city of Newark under an EPA pilot grant. By using innovative characterization approaches, assessments were completed for portions of the site in only 20 days, instead of 120 days, as originally was anticipated. Cost savings were realized by using a one-time mobilization and minimizing the cost of analysis required. Additional information about this project and the names of individuals to contact can be found at <http://www.epa.gov/r02earth/superfnd/brownfld/newrkcv.htm>.

Reasons for Considering Innovative Treatment Options Include:

- Cost (both capital and long-term maintenance costs)
- Time (when other alternatives require long-term stewardship)
- Permanent destruction (nondestructive options often entail residual risk)
- Neighborhood concerns (community and nearby businesses)
- Logistical considerations (applicability with existing structures and space requirement for equipment)

Example 2

The use of innovative characterization approaches, such as immunoassay kits, resulted in a faster and cheaper cleanup than originally was anticipated at the Wenatchee Tree Fruit Facility in the state of Washington. The site was contaminated with pesticides. Originally, it was estimated that it would be necessary to evacuate

780 tons of soil and transport the soil to an off-site incinerator, at a cost of \$1 million. The U.S. Army Corps of Engineers (USACE) proposed the use of immunoassay kits to guide sampling, removal, and disposal decisions, in one mobilization effort under a dynamic work plan. Using the USACE approach, 334 tons of soil were landfilled and 56 tons incinerated. The total project cost was approximately \$589,000, far less than the estimate. Additional information about this project can be found in the EPA publication *Innovations in Site Characterization Case Study: Site Cleanup of the Wenatchee Tree Fruit Test Pilot Site Using a Dynamic Work Plan* (EPA 542-R-00-009). The publication can be viewed online at <http://www.clu-in.org/pub1.htm>.

Example 3

In 1998, six-phase heating (SPH) technology was implemented to remediate pools of dense non-aqueous phase liquid (DNAPL) at a former manufacturing facility near Chicago, Illinois. The site was contaminated with trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA) and is located in a tight, heterogeneous silty-clay formation. Three sources of contamination (hot spots) were identified, each having pools of DNAPL. Before SPH, a combination of steam injection and conventional groundwater and soil vapor extraction (SVE) technologies had been in operation since 1991. During the seven years of

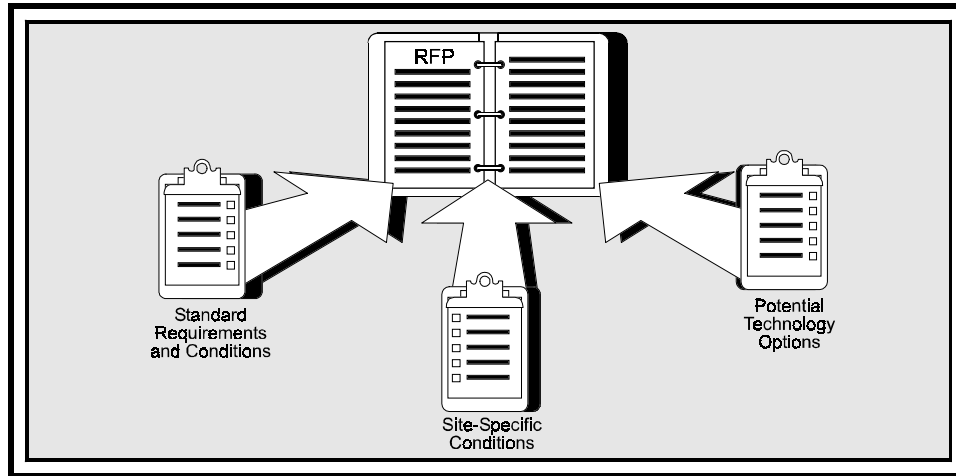
operation, the groundwater extraction and SVE removed 30,000 pounds of TCE and TCA; and reduced the groundwater concentration to below site-specific risk-based closure levels, but were not successful in reducing the hot spots to acceptable levels. SPH successfully removed free phase of DNAPL present in approximately 24,000 cubic yards of subsurface materials in 130 days. The hot spot concentrations were reduced to below site-specific risk-based closure levels. A case study on this project can be found on the Federal Remediation Technologies Roundtable (FRTR) case study data base at <http://www.frtr.gov>.

The Brownfields Technology Support Center Can Help!!!

The BTSC can provide assistance to local, state, and federal government brownfields staff during the RFP process on:

- Preliminary scoping of innovative approaches for site-specific needs
- Identification of sources of information
- Description(s) of a technology (or technologies)

3.0 INCORPORATING INNOVATIVE APPROACHES INTO YOUR RFP



3.1 Types of Information Contained in Requests for Proposals

An RFP serves as the mechanism through which a site owner or operator procures the contractor that offers the best approach, qualifications, and cost estimate for the requested services. The components that typically are found in RFPs for cleaning up hazardous waste sites are:

Purpose: This section provides a concise statement of the work the contractor is being asked to perform, for example:

“The City of Pleasantville is soliciting proposals to select a qualified consulting firm to perform a Phase II/III Environmental Assessment”

Background and Project Information: This section provides relevant site information that contractors should use to develop their approaches and cost estimates. (Section 3.2.1 presents a detailed description of such information.)

Scope of Work: The scope of work presents the key information bidders use to prepare their proposed methodologies. It provides detailed information about each task the contractor is being asked to perform and clearly identifies the interim and final deliverables for each task. The requirements in the scope of work also are used

as the basis for comparing the proposals received for technical adequacy.

Inquiries: This section provides the name, telephone number, and address of a contact person(s) who can answer questions from bidders and provide copies of reports or other site information that is available to bidders. It also specifies the procedure and deadline for submitting inquiries.

Proposal Format and Submittal: This section describes the information that must be included in the written proposal, as well as the format to be used. At a minimum, the required information includes:

- *Corporate experience* – Presents a description of the contractor’s experience in performing similar projects over a certain period of years (typically the past three to five years) and the firm’s familiarity with applicable regulations and provides references for the projects listed
- *Qualifications of key personnel, including subcontractors* – Presents a table of staff that lists the project management team and other key personnel assigned to the project, including titles, functions, locations, and availability for the project, and resumes that demonstrate the

experience and qualifications of each key staff member

- *Organizational chart* – Shows the responsibilities and lines of authority for the project management team and support staff
- *Technical methodology, implementation plans, and schedule* – Demonstrates the contractor’s understanding of the scope of work and includes measurable performance objectives and specific tasks, descriptions of deliverables, descriptions of the proposed methodology for each task, and milestones and schedules for completing tasks
- *Cost proposal* – Identifies the components and format for the cost proposal, for example, as a lump sum or a time-and-materials estimate
- *Quality assurance project plan (QAPP)* – Describes the quality assurance (QA) and quality control (QC) requirements for conducting the work
- *Insurance coverage* – Presents the information required to verify the insurance program the contractor has in place to guarantee successful completion of the project

Terms and Conditions: This section identifies the terms and conditions to which the contractor must adhere. Examples of terms and conditions are:

- *Conflict of interest* – The RFP shall specify the contractor must not create a situation designed to influence activities or decisions under the project in ways that could lead to personal gain for the contractor or give an improper advantage to third parties in their dealings with the site owner or operator
- *Compliance with relevant laws and regulations* – The RFP shall clearly identify by reference the laws and regulations that apply to the project

- *Termination of contract* – The RFP shall clearly identify conditions that will result in termination of the contract
- *Validity of the proposal* – The RFP shall specify the time period for which the proposal is to remain valid from the date of submittal

Schedule of Events: This section identifies deadlines for such events as the submittal of questions and responses to questions and the bid opening date.

Evaluation Criteria: The criteria that will be used to evaluate proposals are discussed in this section. A common evaluation method is to assign points to each of the dominant criteria, such as corporate qualifications to provide the required services, the contractor’s reputation for competence in performing similar work, the professional and educational experience of key personnel to be assigned to the project, the proposed cost to complete the project, and the contractor’s technical approach for completing the project. A weighting factor is applied to the points assigned to each of the criteria, typically based upon the importance of that criterion to each project.

For all RFPs for site cleanups, the technical approach must be evaluated on the extent to which the approach is based upon sound science and logical strategies. For proposals involving innovative approaches and technologies, the contractor’s proposed strategies must include specific components to ensure the success of the project. Those components should be defined in the evaluation criteria and presented in the RFP so that prospective bidders will understand the importance of the components to the success of the project. Those components include:

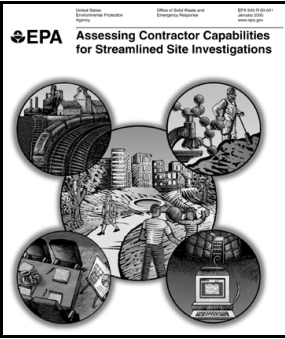
- A direct and clear correlation between the proposed analytical methods and the decisions to be made and the data quality required
- Maximization of the use and capabilities of field analytical tools to support decisions

- Minimization of the number of field mobilizations
- Thorough evaluation and consideration of the use of treatment options that treat waste in place
- Minimization of long-term maintenance and monitoring requirements
- Minimization of restrictions on future site use

Those considerations are key to the success of many brownfields projects for which an efficient and expeditious cleanup is required and the site must be made available for a specific reuse.

Oral Presentations: It is becoming more common to require contractors to make oral presentations in conjunction with the submittal of their written proposals. For example, a screening of written proposals for such key elements as corporate or personnel qualifications may be conducted. Those bidders who qualify would then make oral presentations to the selection officials about their technical methodology. Oral presentations provide a more interactive framework than written proposals and can expedite the selection process.

In conducting oral presentations, selection officials should prepare in advance a standard list of questions to ask each contractor to ensure that officials are asking appropriate questions and will obtain the information they need. Using a standard list of questions also ensure that all contractors are treated fairly and equitably during the oral presentations. The document *Assessing Contractor Capabilities for Streamlined Site Investigations* provides a series of questions that selection officials can use when interviewing contractors. The box above provides additional information about the document.



Assessing Contractor Capabilities for Streamlined Site Investigations (EPA 542-R-00-001)

This document familiarizes and encourages brownfields decision makers to investigate and employ innovative methods for characterizing their sites and to assist decision makers in assessing contractors' capabilities and familiarity with those methods, as well as to suggest additional items that contractors should consider in conducting their activities. The document can be viewed online at <http://brownfieldstsc.org> or ordered through the National Service Center for Environmental Publications (NSCEP) at 1 (800) 490-9198.

3.2 Incorporating Innovative Technologies into the RFP

Currently, many RFPs for characterization and remediation work: (1) allow bidders to include in their proposals options for innovative approaches, in addition to traditional approaches; (2) encourage bidders to submit alternative approaches, including separate cost proposals for the innovative approaches; or (3) require bidders to provide such information. Although such scenarios encourage contractors to consider innovative approaches, the responsibility for the thought process of considering and selecting technology options rests solely with the prospective bidders.

Individuals preparing RFPs should identify opportunities to encourage contractors to use innovative technologies by: (1) ensuring that all available, non-confidential, relevant site-specific information, including the goals for cleanup and redevelopment, is included in the RFP so that bidders can identify appropriate technology options and (2) specifying potential options for innovative technologies that must be considered on the basis of use of those technologies at similar sites. The two steps are discussed in more detail in sections 3.2.1 and 3.2.2.

Providing comprehensive site-specific information and taking advantage of experiences at other sites reduces the likelihood that arbitrary decisions will be made about technologies and increases the chances of success in cleaning up sites correctly the first time. Those preparing RFPs and prospective contractors must understand the redevelopment goals for the site, if they have been established, and how the goals affect the selection of characterization and remediation technologies. If the redevelopment goals have not been established, the proposed zoning and potential general uses of the site (residential, commercial, or industrial) should be used as a guide for selecting technologies. In all cases, presenting site-specific goals, rather than using generic boilerplate language in the discussion of cleanup objectives, will better guide the selection of technologies.

3.2.1 Site-Specific Information to be Included

Studies and reports completed for many brownfields sites, typically referred to as Phase I, II, or III site assessments or site remediation plans, are an excellent source of information for crafting RFPs for characterization and remediation work. The information provided in such documents should be included in the RFP. As a cleanup progresses through the characterization, monitoring, and remediation phases, the level of detail available about the site increases significantly, enhancing the ability to make decisions about technologies.

Site-Specific Drivers
<input type="checkbox"/> Redevelopment objectives
<input type="checkbox"/> Past use
<input type="checkbox"/> Geology
<input type="checkbox"/> Climate
<input type="checkbox"/> Structures
<input type="checkbox"/> Water bodies

Listed below are the types of information typically found in site reports and studies:

Phase I Reports – Environmental Assessments

- Physical information about the site, including location, size, prominent features, geology, physiography, and environmental setting
- Historical information about the site and its adjacent properties, including chronology of ownership, past and present operations and processes, inventory of products and wastes handled at the site, locations of product and waste storage and disposal areas, transcripts of interviews with knowledgeable individuals, and reviews of past environmental investigations and cleanups
- Results of physical reconnaissance of the site
- Recommendations for the Phase II work
- Development of cleanup levels in accordance with federal, state, or local regulations in light of future land use
- Development of corrective action alternatives and detailed evaluations of each alternative, using such criteria as effectiveness, efficiency, implementability, and cost
- Presentation of preferred remediation alternatives

Phase II Reports – Environmental Assessments

- Site maps that indicate all areas of concern identified in the Phase I environmental assessment
- Locations of sampling grids for each environmental medium
- Results of analysis of samples from each sampling location
- Rationale for selecting sampling locations and analytical parameters
- Description of sampling protocol and analytical methods
- Description of QA/QC procedures

*Phase III Reports –
 Environmental
 Assessments and
 Corrective Action and
 Remediation Plans*

- Information about the nature, effects, and magnitude of contamination

In addition to the Phase I, II, and III reports, other sources of publicly available information about the site or the area in the vicinity of the site may provide useful information for the RFP. For example, many states require studies to identify leaks from underground storage tanks. Individuals preparing an RFP should research thoroughly information about the site, checking with the engineering department of the city, state regulatory officials, and others who have knowledge of the site or who may be able to provide past reports and studies. Table 3-1

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- Help to identify qualifications to implement innovative approaches
- Help to determine the QA and QC requirements to support streamlined approaches for the project
- Help in the selection of site-specific evaluation criteria and weighting factors to determine the success of innovative approaches
- Help to define the site-specific information that can be included in the RFP to encourage innovative approaches

provides additional examples of publicly available documents and reports that contain site-specific information or information about the area adjacent to or near a site that could enhance the quality of an RFP. Commonly available documents, such as utility records, can provide useful information in

a variety of ways. For example, older records will show the names of businesses that were located at the site, which may indicate the types of activities conducted and the contaminants potentially generated. Utility records also can show the layout of water supply lines and service structures, potential pathways for exposure at the site. The Internet and other electronic means of dissemination give potential bidders easy access to such documents.

**TABLE 3-1
 PUBLICLY AVAILABLE DOCUMENTS AND REPORTS THAT PROVIDE SITE
 INFORMATION**

Documents/Reports	Type of Information Provided					Source of the Document/Report
	Site History and Past Uses	Assessment of Potential Contaminants of Concern (COC)	Assessment of COCs Migration	Assessment of Sensitive Environments in the Vicinity of the Site	Assessment of Potential Characterization or Remediation Options	
Superfund Records of Decision (RODs) for target sites or for nearby or adjacent properties	✓	✓	✓	✓	✓	Abstract: http://www.epa.gov/superfund Hard copy: National Technical Information Service Springfield, Virginia 22161 (703) 605-6000 or < http://www.ntis.gov >
USGS Reports			✓		✓	http://usgs.gov
Utility Records	✓		✓			Local Utility Company
Tax Records	✓	✓				State or Local Government Office
Administrative and Enforcement Orders	✓	✓			✓	EPA or State Public Record Office
Soil Conservation Studies			✓		✓	http://usda.gov

3.2.2 Technologies Used At Similar Sites

In addition to including site-specific information, individuals preparing RFPs also should take the initiative to provide suggestions for the use of innovative technologies at their site. Taking that extra step will: (1) demonstrate to prospective bidders that the decision makers for the contract are committed to the use of innovative technologies and (2) facilitate the process of reviewing proposals and selecting the most qualified contractor. However, identifying innovative technologies during the preparation of an RFP is a challenging step, particularly for individuals who have little or no technical experience in site cleanup activities, a common situation in the case of brownfields sites, at which the economic development staff or other staff who traditionally do not prepare RFPs for site cleanup work frequently are responsible for soliciting proposals. Fortunately, a number of excellent resources are available that provide information about innovative technologies and their application at sites.

Those resources, including the Brownfields Technology Support Center, EPA Regional Brownfields Coordinators, the EPA National Center for Environmental Research Information, USACE, and the hazardous substance research centers including the Technical Assistance to Brownfields (TAB) program, are available to discuss potential technology options for individual sites and to provide assistance in sorting through the large amounts of published information.

The *Directory of Technology Support Services to Brownfields Localities* (EPA 542-B-99-005) provides information about EPA offices, non-government organizations funded by EPA, and other federal agencies that may be able to provide expertise to assist in the selection of technologies for characterizing and cleaning up brownfields properties. The directory is available online at <http://brownfieldstsc.org>. The box above provides additional information about the TAB Program.

Reports and many online databases list new technologies and discuss how they are used, whether they have been demonstrated and proven effective and reliable, the types of conditions

**Technical Assistance to
Brownfields (TAB) Program**
<<http://www.toscprogram.org/tab-overview.html>>

The TAB program has been established to help communities cleanup and redevelop properties that have been damaged by or undervalued because of environmental contamination through workshops, such as those on leadership training, risk assessment, brownfields processes, site assessment, and cleanup alternatives.

Center Program Contacts:

Great Lakes/Mid-Atlantic:

Lisa Szymecko
1 (800) 490-3890
szymecko@egr.msu.edu

Great Plains/Rocky Mountains:

Blase Leven Terrie Boguski
(785) 532-0780 (913) 780-3328
baleven@ksu.edu mboguski@tfs.net

Northeast:

William Librizzi
(873) 596-5846
librizzi@admin.njit.edu

South & Southwest:

Bob Schmitter
(404) 894-8064
bob.schmitter@gtri.gatech.edu

Western:

Michael Fernandez
(541) 737-4023
Michael.Fernandez@orst.edu

National Program Contact:

Nigel Fields, Program Assistant
U.S. EPA (MC 8703)
1200 Pennsylvania Ave., NW
Washington, DC 20460
(202) 564-6936
fields.nigel@epa.gov

under which they have been the most effective, and their performance specifications. One of those resources is EPA's *Treatment Technologies for Site Cleanup: Annual Status Report (ASR) (ninth edition)*, April 1999 (EPA 542-R-99-001). The report also is available online at <http://clu-in.org/pub1.htm>.

Listed below are examples of site characterization and remediation technology databases:

- EPA REmediation And CHaracterization Innovative Technologies (EPA REACH IT) at <http://www.epareachit.org>

- Federal Remediation Technologies Roundtable (FRTR) Field Sampling and Analysis Technologies Matrix and Reference Guide at <http://www.frtr.gov/site>
- FRTR Screening Matrix and Reference Guide at http://www.frtr.gov/matrix2/top_page.html
- FRTR Cost and Performance Reports and Internet site at <http://www.frtr.gov/cost>
- U.S. Department of Energy (DOE) Preferred Alternatives Matrix at <http://www.em.doe.gov/define>
- DOE Vendor Database for Environmental Applications at <http://www.cmst.org/vendor/>

Other resources include the EPA Internet Technology Seminar Series and the *Road Map to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup*. The Internet Technology Seminar Series provides online seminar sessions to discuss innovative remediation approaches. Each topic is packaged in a 2- to 2 ½-hour session. Participants can listen to presenters over the Internet or telephone and view presentation slides online. See the boxes to the right and below for additional information about the Internet seminars and the road map.

Table 3-2 provides a comprehensive list of information resources and the types of information each provides. Appendix A presents more information about these and other resources.



Internet Technology Seminars

EPA's Technology Innovation Office offers an **Internet Technology Seminar Series** as an efficient and cost effective alternative to traditional conferences and classroom training. The seminars are open to the public. Between the initiation of the series in the fall of 1998 and January 2001, EPA offered 28 Internet seminars. Topics include:

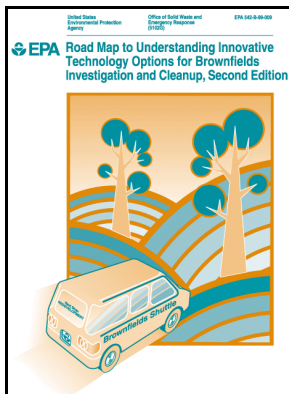
- Dynamic Data Collection Strategy; Systematic Planning for Field-Based Measurements
- Specific Field Analytical Technologies (Monitoring VOCs in Groundwater, Immunoassay for PCBs)
- Cleanup Approaches (Permeable Reactive Walls; *In-Situ* Bioremediation; Natural Attenuation)

More than 4,500 persons in both public and private sectors have participated in the seminars. Participants have joined from over 350 municipalities in 49 states and over 20 countries on six continents. EPA's Office of Research and Development, EPA's Office of Solid Waste, the U.S. Army Corps of Engineers, and the Interstate Technology and Regulatory Cooperative Workgroup have co-sponsored and contributed to the seminars.

The schedule and descriptions of upcoming seminars, as well as information about and descriptions of past seminars (which have been archived), are available online at:

<http://clu-in.org/studio>

For more information about the seminars, the central point of contact is Jeff Heimerman of the EPA Technology Innovation Office at (703) 603-7191 or heimerman.jeff@epa.gov.



Road Map to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup, Second Edition (EPA 542-B-99-009)

The Road Map to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup is a companion document to the Tool Kit of Information Resources for Brownfields Investigation and Cleanup. Used together, the resources link technology options to the general steps involved in the characterization and cleanup of a brownfields site. The road map is intended for the various individuals involved in or affected by the redevelopment of brownfields sites, whether public projects, private developments, or projects pursued under public-private partnerships. The second edition has been expanded significantly to include new and updated resources. The document can be viewed online at <http://brownfieldstsc.org> or ordered through the National Service Center for Environmental Publications (NSCEP) at 1 (800) 490-9198.

TABLE 3-2
EXAMPLES OF PUBLICLY AVAILABLE INFORMATION RESOURCES
 (Page 1 of 3)

Resource	TYPES OF INFORMATION								
	Remedial Evaluation	Characterization Strategies/Plans	Characterization Technologies (Monitoring, Health, and Safety Analytical)	Remediation Technologies	Site Types Addressed	Contaminants Addressed	Cost Information	Performance Information	General Information on Characterization and Remediation Technologies
EPA REACH IT <i>http://www.epareachit.org</i>			✓	✓	✓	✓	✓	✓	
FRTR Case Studies <i>http://www.frtr.gov/cost/</i>				✓	✓	✓	✓	✓	
FRTR Remediation Technologies Screening Matrix <i>http://www.frtr.gov/matrix2/top_page.html</i>				✓	✓	✓	✓	✓	
FRTR Characterization Technologies Matrix <i>http://www.frtr.gov/site</i>			✓		✓	✓	✓	✓	
CLU-IN <i>http://clu-in.org</i>									✓
Citizens' Guides to Innovative Treatment Technologies <i>http://clu-in.org/pub1.htm</i>	✓			✓					
A Guideline for Dynamic Workplans and Field Analytics: The Keys to Cost-Effective Site Characterization and Cleanup <i>http://clu-in.org/pub1.htm</i>		✓							
A Dynamic Site Investigation: Adaptive Sampling and Analysis Program for Operable Unit 1 at Hanscom Air Force Base, Bedford, Massachusetts <i>http://clu-in.org/pub1.htm</i>		✓							
Application of Field-Based Characterization Tools in the Waterfront Voluntary Setting <i>http://clu-in.org/pub1.htm</i>			✓						

TABLE 3-2
EXAMPLES OF PUBLICLY AVAILABLE INFORMATION RESOURCES
(Page 2 of 3)

Resource	TYPES OF INFORMATION								
	Remedial Evaluation	Characterization Strategies/Plans	Characterization Technologies (Monitoring, Health, and Safety Analytical)	Remediation Technologies	Site Types Addressed	Contaminants Addressed	Cost Information	Performance Information	General Information on Characterization and Remediation Technologies
Assessing Contractor Capabilities for Streamlined Site Investigations EPA 542-R-00-001 http://brownfieldstsc.org		✓	✓						
Assessment of Phytoremediation as an In Situ Technique for Cleaning Oil-Contaminated Sites http://clu-in.org/pub1.htm				✓		✓			
Directory of Technology Support Services to Brownfields Localities EPA 542-B-99-005 http://brownfieldstsc.org									✓
Field Analytical and Site Characterization Technologies - Summary of Applications EPA 542-R-97-011 http://clu-in.org/pub1.htm			✓		✓	✓		✓	
Phytoremediation Decision Tree http://clu-in.org/pub1.htm	✓			✓					
Quality Assurance Guidance for Conducting Brownfields Site Assessments EPA 540-R-98-038 http://clu-in.org/pub1.htm		✓							
Road Map to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup, Second Edition EPA 542-B-99-009 http://brownfieldstsc.org	✓		✓	✓	✓	✓			
Tool Kit of Information Resources for Brownfields Investigation and Cleanup EPA 542-B-99-009 http://clu-in.org/pub1.htm									✓

TABLE 3-2
EXAMPLES OF PUBLICLY AVAILABLE INFORMATION RESOURCES
(Page 3 of 3)

Resource	TYPES OF INFORMATION								
	Remedial Evaluation	Characterization Strategies/Plans	Characterization Technologies (Monitoring, Health, and Safety Analytical)	Remediation Technologies	Site Types Addressed	Contaminants Addressed	Cost Information	Performance Information	General Information on Characterization and Remediation Technologies
Field Analytic Technologies Encyclopedia (FATE) <i>http://fate.clu-in.org</i>			✓						
DOE Vendor Database for Environmental Applications <i>http://www.cmst.org/vendor</i>			✓						
Hazardous Waste Site Characterization (on CD-ROM) <i>http://www.epa.gov/ncepihom</i>		✓							
Ames Laboratory's Environmental Protection Sciences <i>http://www.epsci.ameslab.gov</i>		✓							
Evaluation of Selected Environmental Decision Support Software <i>http://clu-in.org/pub1.htm</i>	✓	✓							
Uncertainty Management: Expediting Cleanup Through Contingency Planning <i>http://clu-in.org/pub1.htm</i>	✓								
Environmental Technology Verification Reports, Site Characterization and Monitoring Technologies (43 verified as of 9/1/00) <i>http://www.epa.gov/etv/02/02_main.htm</i>			✓		✓	✓	✓	✓	
Treatment Technologies for Site Cleanup: Annual Status Report (ninth edition) EPA 542-R-99-001 <i>http://clu-in.org/products/asr/index2.html</i>				✓	✓	✓			

Notes:

See Appendix A for details on how to access the resources.

3.2.3 Special Considerations for Brownfields Sites

For many brownfields sites, special considerations must be factored into the selection of characterization and remediation technologies. Typically, such considerations affect brownfields sites that are located in residential or business areas, that contain buildings and structures that will remain in place, and that are targeted for a specific reuse. Among the special considerations that could significantly influence the selection of characterization or remediation technologies:

- The characterization and or remediation process must be completed within a defined time frame for redevelopment
- Community concerns about the potential risks posed by cleanup activities must be addressed
- Noise and traffic during cleanup must be minimized in residential neighborhoods
- Access to the contamination present is difficult because the contamination is adjacent to or

under a building or other structure that will remain in place

- Site activities must not cause damage to historic buildings located on site or near the site
- The impact of site activities on on-going businesses must be minimized
- The proposed location of new buildings, structures, and parking lots limits the feasibility of some characterization and remediation options
- The effects of long-term monitoring and remediation activities must be considered relative to the proposed site design

Table 3-3 provides a general overview of contaminants and media at five common types of brownfields sites. Tables 3-4.a, 3-4.b, and 3-4.c present special considerations related to commonly used characterization technologies that may influence the selection of those technologies for individual sites. Table 3-5 provides similar information for remediation technologies.

**TABLE 3-3
SELECTED TYPICAL BROWNFIELDS SITES, CONTAMINANTS, AND MEDIA**

No.	Site Type	Contaminants	Media
1	Dry Cleaning Operation	Solvent containing halogenated VOCs and SVOCs, such as PCE	Soil, groundwater, surface water, and sediment
2	Wood Treating Operation	TPH, PAHs, PCP, creosote, and metals, such as chromated copper arsenate (CCA)	Soil, sludge, groundwater, surface water, and sediment
3	Gas Station and Tank Farm	TPH, BTEX, VOCs, and SVOCs	Soil, groundwater, surface water, and sediment
4	Railroad Yard	TPH, phthalates, carbazole, dibenzofurans, dieldrin, PAHs, metals (lead, copper, zinc, nickel, antimony, and mercury), and chlorinated and non-chlorinated solvents.	Soil, sediment, sludge, groundwater, and surface water
5	Manufactured Gas Plant (MGP)	Non-halogenated VOCs and non-halogenated SVOCs, such as PAHs and carcinogenic PAHs, including naphthalene, phenanthrene and anthracene chrysene and benzo(a)pyrene.	Soil, sediment, sludge, groundwater, and surface water

Notes:

- | | |
|--------------------------------------|--|
| VOC = Volatile organic compound | PAH = Polyaromatic hydrocarbons |
| SVOC = Semivolatile organic compound | PCP = Pentachlorophenol |
| PCE = Perchloroethylene | BTEX = Benzene, toluene, ethylbenzene, and xylenes |
| TPH = Total petroleum hydrocarbon | |

BROWNFIELDS TECHNOLOGY PRIMER:
REQUESTING AND EVALUATING PROPOSALS THAT ENCOURAGE
INNOVATIVE TECHNOLOGIES FOR INVESTIGATION AND CLEANUP

TABLE 3-4.a¹
SPECIAL CONSIDERATIONS AT BROWNFIELDS SITES
FOR SELECTING INNOVATIVE CHARACTERIZATION TECHNOLOGIES –
Examples of Sample Access, Collection, and Extraction Tools

Technology	CONSIDERATIONS						
	Potential Impact on Buildings and Other Structures	Impact to Nearby Businesses or Community	Media	Range of Nominal Working Depth	Sample Acquisition Time ²	Status of Technology	Relative Cost per Sample or per Analysis
Hollow-Stem Auger	Yes (when it is performed in close proximity to buildings or structures, it may cause formation and foundation fractures)	Yes (potential disruption resulting from vibration, noise, and foundation fractures)	Soil and Groundwater (for unconsolidated formations)	Up to 200 feet	Immediate	Commercially available and routinely used field technology	Average
Directional Drilling	No	No	Soil and Groundwater (for unconsolidated formations)	Up to 100 feet	Rapid	Commercially available and routinely used field technology	Expensive
Cable Tool	No	Yes (potential disruption from noises)	Soil and Groundwater (for consolidated formations)	Less than 5,000 feet	Rapid	Commercially available and routinely used field technology	Expensive
Cone Penetrometer (CPT)	No	No	Soil, Groundwater	Up to 100 feet	Immediate	Commercially available and routinely used field technology	Average
Direct Push Sampler	No	No	Soil, Soil Gas, and Groundwater	Up to 100 feet	Immediate	Commercially available and routinely used field technology	Least expensive

Notes:

- Adapted from the *Field-Based Site Characterization Technologies Course, Participant Manual*, USEPA, CERCLA Education Center, TIO, September 1999, and from the *Field Sampling and Analysis Technologies Matrix* by the FRTR (<http://www.frtr.gov/site>). All techniques are site-specific.
- Immediate = generally less than 10 minutes; rapid = generally less than 1 hour

BROWNFIELDS TECHNOLOGY PRIMER:
REQUESTING AND EVALUATING PROPOSALS THAT ENCOURAGE
INNOVATIVE TECHNOLOGIES FOR INVESTIGATION AND CLEANUP

TABLE 3-4.b
SPECIAL CONSIDERATIONS AT BROWNFIELDS SITES
FOR SELECTING INNOVATIVE CHARACTERIZATION TECHNOLOGIES –
Examples of Sample Analysis Tools for VOCs, SVOCs, and Pesticides
(Page 1 of 2)

TECHNOLOGY	CONSIDERATIONS							
	Media	Throughput	Status of Technology	Advantages	Limitations	In Situ or Ex Situ Technology	Unit Cost	Data Application
Laser-Induced Fluorescence (LIF)	Soil and Groundwater	Average of 300 feet per day, continuous reading	Commercially available and routinely used field technology	<ul style="list-style-type: none"> • Continuous, real-time data • No soil cuttings • Quick decontamination 	<ul style="list-style-type: none"> • Expensive on small projects • Large equipment • Difficult mobilization for rough terrain 	In situ	Rental: \$2,000 to \$3,000 per day, including operators	Delineation of gross contamination, monitor well placement, source identification, and geological data/profile.
Gas Chromatography/Mass Spectrometry (GC/MS)	Soil, Groundwater, and Gas (extraction required except for gas)	30 - 50 samples per day	Commercially available and routinely used field technology	<ul style="list-style-type: none"> • Definitive compound identification • Identify components that cannot be detected by PID and FID • Available in portable units 	<ul style="list-style-type: none"> • Expensive • High degree of experience needed to operate instrumentation 	Ex situ	Purchase: \$50,000 - \$100,000 per unit Rental: \$5,000 per month	Site assessments, site investigations, site characterizations, and cleanup monitoring
Gas Chromatography - Photo-Ionization Detector (GC - PID)	Soil, Groundwater, and Gas (extraction required except for gas)	30 - 50 samples per day	Commercially available and routinely used field technology	<ul style="list-style-type: none"> • Produce definitive data with proper QA/QC • Proven technique • No solvents needed for VOC analysis 	<ul style="list-style-type: none"> • Need experienced operator • Sensitive to moisture • Dual columns are required for positive identification of analytes 	Ex situ	Purchase: \$10,000 to \$50,000 Rental: \$1,000 to \$3,000 per month	Site assessments, site investigations, site characterization, cleanup monitoring, and removal monitoring
Gas Chromatography - Flame-Ionization Detector (GC - FID)	Soil, Groundwater, and Gas (extraction required except for gas)	30 - 50 samples per day	Commercially available and routinely used field technology	<ul style="list-style-type: none"> • Produce definitive data with proper QA/QC • Proven technique • No solvents needed for VOC analysis • FID is stable, low-maintenance detector 	<ul style="list-style-type: none"> • Need experienced operator • Dual columns are required for positive identification of analytes 	Ex situ	Purchase: \$10,000 to \$50,000 Rental: \$1,000 to \$3,000 per month	Site assessments, site investigations, site characterization, cleanup monitoring, and removal monitoring

TABLE 3-4.b
SPECIAL CONSIDERATIONS AT BROWNFIELDS SITES
FOR SELECTING INNOVATIVE CHARACTERIZATION TECHNOLOGIES –
Examples of Sample Analysis Tools for VOCs, SVOCs, and Pesticides
(Page 2 of 2)

TECHNOLOGY	CONSIDERATIONS							
	Media	Throughput	Status of Technology	Advantages	Limitations	In Situ or Ex Situ Technology	Unit Cost	Data Application
Detector Tubes (Colorimetric Indicator Tubes)	Soil, Groundwater, and Gas (extraction required except for gas)	> 100 measurements per day	Commercially available and routinely used field technology	<ul style="list-style-type: none"> • Small size • Easy to use • Rapid analysis • Cost effective 	<ul style="list-style-type: none"> • Semiquantitative (subjective) results 	Ex situ	Purchase: Tube: \$3 - \$10 per tube Pump: \$300 - \$400	Health and safety monitoring
Immunoassay	Soil and Groundwater	up to 50 samples per day	Commercially available technology with moderate field experience	<ul style="list-style-type: none"> • Small size • Easy to use • Rapid analysis • Cost effective 	<ul style="list-style-type: none"> • Interference from similar compounds • Matrix-dependent results (soil) 	Ex situ	\$10 - \$50 per sample (supplies and reagents only)	Site assessments, site investigations, site characterization, and cleanup monitoring

Notes:

Adapted from the *Field-Based Site Characterization Technologies Course, Participant Manual*, USEPA, CERCLA Education Center, TIO, September 1999, and from the *Field Sampling and Analysis Technologies Matrix* by the FRTR (<http://www.frtr.gov/site>).

BROWNFIELDS TECHNOLOGY PRIMER:
REQUESTING AND EVALUATING PROPOSALS THAT ENCOURAGE
INNOVATIVE TECHNOLOGIES FOR INVESTIGATION AND CLEANUP

TABLE 3-4.c
SPECIAL CONSIDERATIONS AT BROWNFIELDS SITES
FOR SELECTING INNOVATIVE CHARACTERIZATION TECHNOLOGIES –
Examples of Sample Analysis Tools for Inorganics and Metals

TECHNOLOGY	CONSIDERATIONS							
	Media	Throughput	Status of Technology	Advantages	Limitations	In situ/ Ex situ Technology	Unit Cost	Data Application
Inductively-Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES)	Soil, Groundwater, and Gas (extraction required except for gas)	25 to 50 samples per day	Commercially available technology with limited field experience	<ul style="list-style-type: none"> • Multielement technique • Low detection limit • Definitive data with appropriate QA/QC 	<ul style="list-style-type: none"> • Expensive • Interference from iron and uranium 	Ex situ	Expensive	Site assessment, site characterization, and long-term monitoring
X-Ray Fluorescence	Soil, Groundwater, and Gas (extraction required for gas)	<ul style="list-style-type: none"> • 50 to 100 samples per day (ex situ) • > 100 samples per day (in situ) 	Commercially available and routinely used field technology	<ul style="list-style-type: none"> • Portable • Relatively easy to use • Fast and multielement analysis • Non-destructive technique • Definitive results with appropriate QA/QC 	<ul style="list-style-type: none"> • High detection limit (tens to thousands of parts per million) • Involves the use of radioactive sources • Matrix-variable results 	In situ and Ex situ	Purchase: \$20,000 - \$60,000 Rental: \$1,000 to \$2,000 per week	Site characterizations, site assessments, and monitoring of remedial activities
Mercury Vapor Analyzers	Soil and Gas	Hundreds of measurements per day	Commercially available technology with moderate field experience	<ul style="list-style-type: none"> • Portable • Easy to use • Rapid response 	<ul style="list-style-type: none"> • Potential interference from sulfur 	Ex situ	Purchase: \$5,000 - \$7,000 Rental: \$400 to \$700 per week	Health and safety monitoring, identifying hot spots or sources, and identifying locations for confirmatory samples

Notes:

Adapted from the *Field-Based Site Characterization Technologies Course, Participant Manual*, USEPA, CERCLA Education Center, TIO, September 1999, and from the *Field Sampling and Analysis Technologies Matrix* by the FRTR (<http://www.frtr.gov/site>).

BROWNFIELDS TECHNOLOGY PRIMER:
REQUESTING AND EVALUATING PROPOSALS THAT ENCOURAGE
INNOVATIVE TECHNOLOGIES FOR INVESTIGATION AND CLEANUP

TABLE 3-5
SPECIAL CONSIDERATIONS AT BROWNFIELD SITES –
Examples of Remediation Technologies
(Page 1 of 3)

TECHNOLOGY	CONSIDERATIONS										
	In situ/ Ex situ Technology	Space Requirement for Treatment	Potential Impact to Buildings and Structures ¹	Impact to Nearby Businesses ² or Community ³	Remediation Time Frame ⁴	Cost Range ⁵	Frequency of Use/ Status of Technology	Targeted Contaminant (Organics/ Metals)	Targeted Media (Groundwater, Soil, Sludge)	Management of Residues	Reuse Limitation ⁶
SVE	In situ	Treatment areas will be the same size as the contamination area. Designated area is required to house the aboveground treatment unit (e.g. compressor and emission control unit).	No	Yes (Potential vapor buildup in basements within the radius influence of air injection wells)	Contaminant specific	\$10 - \$40 /cy	Full Scale	Semivolatile and volatile organics	Soil	Yes (Emission control unit is required.)	Maybe restricted for residential use during remediation
Bioventing	In situ	Treatment area will be the same size as the contamination area. Designated area is required to house the aboveground treatment unit (e.g. blower).	No	Yes (Potential vapor buildup in basements within the radius influence of air injection wells)	Contaminant specific	\$10 - \$50 /cy	Full Scale	Semivolatile and volatile organics	Soil	None (No additional process is required to treat air emission.)	Maybe restricted for residential use during remediation
Phytoremediation	In situ	Treatment area will be the same size as the contamination area.	Yes (Potential foundation fracture caused by root penetrations)	No	Long	\$60,000 - \$100,000 per acre (50 cm deep)	Emerging	Organics	Soil and Sludge	Yes (Treatment is required for destruction of concentrated contaminants stored in the plants.)	
Natural Attenuation	In situ	No treatment area is required.	No	No	Long	Site specific	Full Scale	Organics and inorganics	Groundwater, Soil, and Sludge	None. (Natural attenuation is a passive technology; no action in terms of treatment.)	
Chemical Oxidation	In situ	Treatment area will be the same size as the contamination area. Designated area is required to house the aboveground treatment unit such as pumps and chemical injection unit.	Yes (Potential formation and foundation fractures caused by pressure buildup from chemical reaction and injection)	Yes (Potential pressure buildup from chemical reaction and high-pressure injection system)	Short	Site-specific	Full Scale	Organics and Metals	Groundwater	None (Contaminants are converted into non-hazardous products.)	

BROWNFIELDS TECHNOLOGY PRIMER:
REQUESTING AND EVALUATING PROPOSALS THAT ENCOURAGE
INNOVATIVE TECHNOLOGIES FOR INVESTIGATION AND CLEANUP

TABLE 3-5
SPECIAL CONSIDERATIONS AT BROWNFIELD SITES –
Examples of Remediation Technologies
(Page 2 of 3)

TECHNOLOGY	CONSIDERATIONS										
	In situ/ Ex situ Technology	Space Requirement for Treatment	Potential Impact to Buildings and Structures ¹	Impact to Nearby Businesses ² or Community ³	Remediation Time Frame ⁴	Cost Range ⁵	Frequency of Use/ Status of Technology	Targeted Contaminant (Organics/ Metals)	Targeted Media (Groundwater, Soil, Sludge)	Management of Residues	Reuse Limitation ⁶
Solidification / Stabilization	In situ	Treatment area will be the same size as the contamination area.	No	Yes (Traffic congestion from heavy equipment)	Short	\$40 - \$60 / cy - shallow \$150 - \$250 / cy - deep	Full Scale	Metals	Soil and Sludge	None (Contaminants are immobilized and left in place.)	
Landfarming	Ex situ	Landfarming requires a vast footprint because soil or sludge will be spread out in one 18-inch lift.	No	Yes (Traffic congestion during earth-moving operation and air quality issues; potential volatile air emissions)	Average	< \$75/cy (Only includes costs of excavation, placement of soil on a prepared liner, and ex situ treatment)	Full Scale	Organics	Soil and Sludge	Yes (Emission control may be required.)	
Low Temperature Thermal Desorption	Ex situ	Staging and treatment area outside of the contaminated zone is required.	No	Yes (Potential noise, vibration, and traffic congestion; potential volatile air emissions)	Short	\$40 - \$300 /ton (excluding excavation, transport, and utilities)	Full Scale	Organics	Soil and Sludge	Yes (Emission control may be required.)	
Air Sparging	In situ	Treatment area will be the same size as the contamination area. Designated area is required to house the aboveground treatment unit.	No	No	Average	\$150,000 - \$350,000 per acre (only 1 estimate)	Full Scale	Organics	Groundwater	Yes (Emission control may be required.)	
Dual Phase Extraction	In situ	Treatment area will be the same size as the contamination area. Designated area is required to house the aboveground treatment unit.	No	No	Average	\$2,500 - \$4,000 per month for dual pumping system	Full Scale	Organics	Groundwater	Yes (Additional treatment may be required for the air emissions and produced water.)	Directional extraction wells might be necessary for recreational-related and residential area reuse

BROWNFIELDS TECHNOLOGY PRIMER:
REQUESTING AND EVALUATING PROPOSALS THAT ENCOURAGE
INNOVATIVE TECHNOLOGIES FOR INVESTIGATION AND CLEANUP

TABLE 3-5
SPECIAL CONSIDERATIONS AT BROWNFIELD SITES –
Examples of Remediation Technologies
(Page 3 of 3)

TECHNOLOGY	CONSIDERATIONS										
	In situ/ Ex situ Technology	Space Requirement for Treatment	Potential Impact to Buildings and Structures ¹	Impact to Nearby Businesses ² or Community ³	Remediation Time Frame ⁴	Cost Range ⁵	Frequency of Use/ Status of Technology	Targeted Contaminant (Organics/ Metals)	Targeted Media (Groundwater, Soil, Sludge)	Management of Residues	Reuse Limitation ⁶
Thermally Enhanced SVE	In situ	Treatment area will be the same size as the contamination area. Designated area is required to house the aboveground treatment unit.	Yes (Potential formation and foundation fracture from high-pressure injection system - if steam is used. In addition, the use of steam on clay formation may cause settling)	Yes (Potential disruption due to potential damage to buildings and structures; potential vapor build-up in basements within the radius of influence; and air emissions)	Short	\$43/cy for VOCs \$80 - \$100/cy for SVOCs	Full Scale	Organics	Soil and Sludge	Yes (Additional treatment may be required for the air emissions and produced water.)	
Landfill	Ex situ	Treatment area will be the same as the contamination area.	No	Yes (Traffic congestion during landfill construction; noise, vibration, and potential air emissions from earth-moving activities)	Short	\$175,000 per acre (RCRA D) \$225,000 per acre (RCRA C)	Full Scale	Organics and metals	Soil and Sludge	Yes (Additional treatment may be required for the leachate and air emissions.)	Reuse is limited to activities that will not disturb the integrity of the cap, such as a parking lot or a golf course
Bioreactor	Ex situ	Treatment area will be the same size as the contamination area. Designated area is required to house the aboveground treatment unit.	No	Yes (Traffic congestion, air emissions, noise, and vibration during earth-moving operations)	Average	Site-specific	Full Scale	Organics	Groundwater	None. (Contaminants are converted into non-hazardous products.)	

Notes:

¹ Potential damage might be in the form of foundation fracture.

² Disruptions might be in the form of noise, vibration, traffic from heavy equipment, and air emissions during remediation stages.

³ Risk to the community, such as air emissions, potential vapor buildup in basements, noise, vibrations, and ingestion and inhalation of contaminated materials, may occur during and after remediation.

⁴ Long = more than 3 years for in situ soil; more than 1 year for ex situ soil; and more than 10 years for water
Average = 1 - 3 years for in situ soil; 0.5 - 1 year for ex situ soil; and 3 - 10 years for groundwater
Short = less than 1 year for in situ soil; less than 0.5 year for ex situ soil; and less than 3 years for groundwater.

⁵ Adapted from the *Technologies Screening Matrix* of the FRTR (<http://www.frtr.gov/site>)

⁶ The reuse limitation applies to the period after remediation, unless otherwise noted. Examples of site reuse include use as an industrial park, a commercial parking lot, a soccer field, a golf course, a stadium, a public park, or a residential area.

3.2.4 Examples of RFP Formats for Brownfields Sites

This section presents examples of two RFP formats for brownfields sites that illustrate how innovative approaches are incorporated into RFPs. Only portions of the language in the RFPs are included.

A national brownfields site assessment pilot city issued an RFP to solicit services to perform a Phase II/III environmental assessment for a 1,200-acre site in the city. The site is designated for reuse as an agribusiness park because it has extensive infrastructure suitable to serve agribusiness needs. The language used in the RFP was:

- “Option A: Provide costs for each boring and/or test for an estimated 50 temporary boring wells.
- Temporary Well: The cost to construct and install a temporary well shall be quoted on a per linear foot basis. ...
 - Soil Sampling: BTEX using Method OA-1 ...
 - Groundwater Sampling: BTEX using Method OA-1, base neutral and acid extractables in water using USEPA Method 8270, ...”

“Option B: Cost for each boring and/or test described above in Option A shall be provided by using a direct push method with a mobile lab for an estimated 50 temporary boring wells. Describe whom the lab is certified by or the time frame for obtaining certification. In addition, indicate if more stringent standards will be applied to ensure quality assurance/quality control and explain them. State the level of expertise that the project operator has with this equipment. Describe the cost savings advantages of this approach.”

The RFP encouraged potential bidders to use an innovative approach by specifying a technology, in this case direct-push technology. The RFP prompted contractors to provide two optional approaches, traditional drilling with off-site laboratory analysis and the direct-push method with on-site mobile laboratory analysis. The RFP

requested the total cost for each option and a description of the cost savings anticipated through the use of the innovative technology. In this RFP, the city established the requirements for the cost format using the traditional approach, in this case auger drilling, while leaving flexibility for the cost format for the innovative approach. Defining the innovative technology in the RFP makes it easier for decision makers who have only limited understanding of innovative approaches to review proposals.

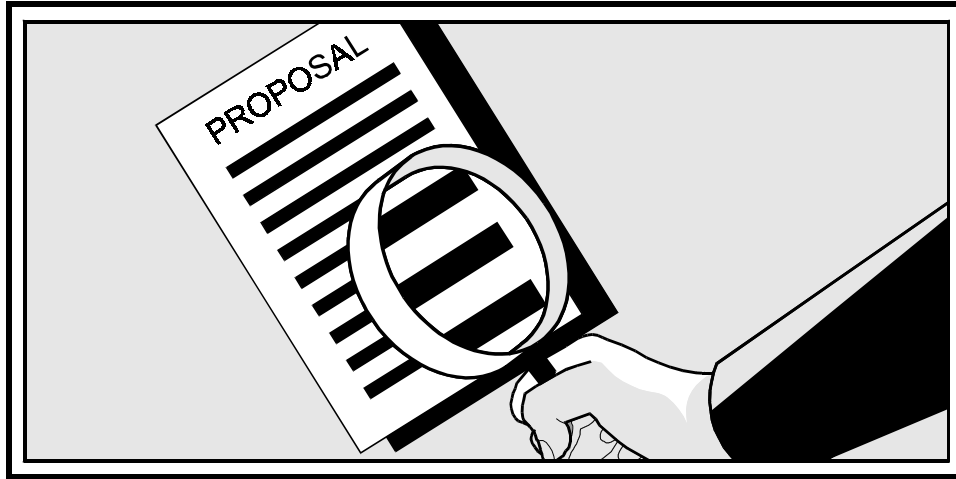
On the other hand, the reference to specific methods may discourage contractors from proposing alternative approaches. By adding the phrase “or equivalent” to the language, brownfields communities can encourage contractors to propose solutions that provide data of a sufficient quality to support decision-making needs. Communities should avoid absolute language and instead ensure that analyses and cleanup techniques are relevant to the decisions to be made and, if known, the ultimate or proposed site use.

A second pilot city issued its RFP for site investigations that were being conducted in its efforts to redevelop a 214-acre area along a creek. The planned future use is commercial redevelopment. The proposal encouraged the use of innovative characterization approaches, but did not define specific options. The language in the RFP stated:

“The contractor shall test for the presence of various contaminants, using field screening sampling techniques and innovative technologies where appropriate”

The “open-ended” or general style of language allows a wide range of responses by the contractors. The disadvantage of the approach is that it is difficult for decision makers who are not familiar with the proposed options to compare and evaluate proposals.

4.0 EVALUATING CONTRACTORS' PROPOSALS



4.1 Evaluating the Proposed Methodology

When evaluating proposals, decision makers should carefully assess the reasonableness and completeness of the information submitted for each technical task. Decision makers also should be confident that the methodology in the selected proposal is appropriate for the site and that the contractor's proposed work activities will not cause damage or pollution problems. Proposals for site cleanup activities typically present information that requires an understanding of the technical concepts of site characterization and remediation. Discussed below are technical activities typically addressed in proposals for innovative (and traditional) approaches for cleaning up sites. Some of the information presented may include more technical detail than decision makers typically see in proposals. When in-house expertise is not available, and for those who seek assistance to better understand the technical concepts, a number of resources are available, as noted in Section 3.2.2. The assistance of the resources listed there is free and usually provided on a quick-turnaround basis.

4.1.1 Characterization Technologies

Contractors that propose innovative sampling and cleanup technologies may include field-based site characterization technologies to supplement traditional approaches to sampling and analysis. Field-based technologies span a broad spectrum of

analytical techniques, ranging from indicator tubes to field laboratories that provide gas chromatography/mass spectrometry (GC/MS) analysis. Because innovative technologies are used to expedite characterization and cleanup processes and reduce the costs of those activities, the contractor should demonstrate how innovative site characterization technologies would achieve that goal for the site.

In evaluating proposals, the decision makers must carefully evaluate the contractor's proposed approach for developing a QA plan and sampling plan for the site. The contractor must clearly lay out the decision logic that will be followed in determining data needs and describe how the proposed approach for collecting and analyzing samples will support the decision logic. A clear delineation of the logic also will assist in presenting information to and obtaining concurrence from regulatory officials for the use of innovative options. The logic used and plans prepared are essential in defending any decisions about the selection of remediation approaches at the site.

Field-based site characterization technologies expedite the cleanup process in several ways. For example, field-based techniques can provide data in hours instead of days, weeks, or even months. Such rapid turnaround reduces the characterization time by eliminating the time spent waiting for analytical results from an off-site laboratory. In addition, rapid analytical

turnaround may allow project managers to modify the sampling plan during the characterization process and more accurately characterize the site, in less time than traditional methods take. When a site is rapidly and, more important, accurately characterized during the first mobilization, subsequent mobilizations are eliminated, saving time and money.

Expediting the site characterization process also can reduce on-site labor costs and analytical expenses. Further, field analytical techniques can produce data for a fraction of the cost of fixed laboratory analysis. For example, immunoassay test kits can produce quantitative data for as little as \$20 to \$40 per sample, compared with \$500 per sample for fixed laboratory data. Again, the appropriate use of data from both field and fixed laboratories must be judged in accordance with the level of data quality required to support the decisions to be made.

Because innovative technologies are not as widely used as more traditional approaches, a contractor that proposes innovative approaches should be able to explain why it believes its proposed approach is feasible and specify its potential advantages for the site. Whether proposing an innovative or a traditional approach, the contractor should demonstrate a thorough knowledge of potential limitations and problems with proposed technologies and describe contingencies for adjusting the approach should it be necessary. As with any analytical approach, such knowledge is crucial in presenting plans to regulators and addressing their concerns about limitations of the chosen field methods. A qualified contractor must be able to explain why data are being collected and how the data will advance decision making at a site, regardless of the technique or technology that is proposed.

In cases in which innovative site characterization techniques may not be a substitute for traditional

sampling and fixed laboratory analysis, they still may be very effective as a supplement.

Proposals that include the use of dynamic work plans should describe the contractor's plan for ensuring effective communication and facilitating on-site decision making among the members of the project team. The plan should describe: (1) the procedures for managing and interpreting (potentially large quantities of) field data daily or more quickly; (2) roles and responsibilities among contractor staff for making decisions about the need to obtain additional field data; and (3) communication of those decisions in a timely manner to the site owner and regulatory staff, if so required.

Discussed below is the evaluation of key aspects of methodologies proposed by contractors. Because each methodology must be tailored to the site under review, not every item may be applicable to every proposal.

The Brownfields Technology Support Center Can Help!!!

The BTSC also can provide assistance in evaluating technical aspects of the contractors' proposals for site-specific needs, including:

- Identification of characterization technologies on the basis of the characteristics of the site, such as selection of drilling methods, and sampling instruments and methods
- Identification of remediation technologies that provide the most innovative approaches that save time and money

4.1.1.1 Selection of Locations for Sampling Points

The geology of a site controls the migration of contaminants. Once the geology at a site has been defined, predictions of the direction of migration become more reliable. Higher detection rates then can be achieved by selecting locations at which the pattern of migration indicates contamination is present. The contractor's proposed methodology can describe:

- Data or other considerations that will influence the contractor's selection of borehole or sampling locations other than upgradient or downgradient locations
- Statistical methods or modeling programs the contractor will use to assist in the selection of sampling locations

- Geophysical methods the contractor will use to gain a better understanding of the geology at the site
- Geophysical methods the contractor will use to determine the locations of subsurface utilities or underground structures
- Geological information that will influence the contractor's selection of sampling locations
- Additional geological information the contractor will seek and its significance

4.1.1.2 Hydrogeologic Conditions

Hydrological information typically is obtained from regional groundwater flow maps or from potentiometric plots derived from groundwater levels taken from existing wells. New groundwater flow meters are available that attach to drilling equipment, such as cone penetrometry technology (CPT) probes that can place flow meters at any particular saturated layer. Another option is to use pore information from CPT or geoprobe technologies to obtain detailed information about flow patterns at a particular site. The contractor's proposed methodology can describe:

- The proposed method for determining detailed groundwater flow patterns at the site
- The proposed method of using the flow pattern information in selecting sampling locations
- The contractor's capability to obtain information about groundwater flow patterns by means other than the use of published potentiometric surfaces

4.1.1.3 Boreholes and Drilling Methods

With today's technologies, soil depth profiles may be obtained quickly (within minutes to hours) with direct-push techniques, providing geological information continuously as the probe penetrates the subsurface. The probe can be withdrawn while exuding grouting material so that the borehole is sealed and no well remains to be maintained. The information obtained can be used

to prepare a complete record of the site. The contractor's proposed methodology can describe:

- Factors that influence the contractor's decision to use direct-push methods rather than standard drilling procedures
- The contractor's rationale for the determination of the number of samples required
- Information about how subsurface soil depth profiles will be used in determining what soil samples are to be taken
- The method to be used to collect soil samples for analysis

4.1.1.4 Soil and Water Samples

Many test kits and hand-held instruments for analyzing soil and water in the field are available. Such techniques often are used to quickly gather information about contamination that then is used as a guide to determine whether more detailed laboratory analysis is warranted. Generally, site managers and regulators will stipulate the percentage of duplicate analyses that must be run by standardized methods to ensure the quality of the field analysis methods. That percentage should be based on site-specific conditions. A proper QC protocol must be constructed to support specific aspects of data quality that are important in defending site-specific decisions. A QA protocol must describe the process that will be followed to ensure that matrix interferences, equipment malfunction, and other issues will not cause data to be ambiguous or misleading. Many field methods have been verified for their accuracy, precision, and reliability through formal verification programs, but site-specific performance always should be assessed. Using a mix of field methods and standard analysis methods expedites the field program and increases the quality of the data and their usefulness in supporting conclusions about the site's condition.

An understanding of the analyte[s] (specific chemical[s] or contaminant[s]) that the technology targets and the principles upon which the technology is based is essential to the selection of the correct technology for a site. No single technology is effective for every contaminant, and

each has various advantages and limitations. For example, a test kit may be marketed as a technology for detecting polychlorinated biphenyls (PCB). However, the kit may respond to any organochloride (chlorinated hydrocarbon pesticide such as DDT) because of the chemical reaction the kit uses. In such a case, the kit would, in fact, be effective in identifying most organochlorides but would not distinguish between chlorinated pesticides and PCBs. Therefore, if the goal is to establish the presence of organochlorides, the test kit would be effective. However, if the goal is to quantitate PCBs in the presence of chlorinated organics, the test kit would not be effective.

Cross-reactivity is another potential concern associated with test kits used during site characterization. Cross-reactivity is the degree to which a test kit responds to compounds other than the target analyte. For example, organic immunoassay test kits designed for PCBs usually are calibrated with a specific Aroclor (trade name of PCBs), but the kits will respond to other congeners (compounds within the same class) on the basis of degree of chlorination. When a contractor proposes technologies that do not produce definitive data, the contractor should demonstrate an understanding of cross-reactivity and interferences. Further, the contractor should demonstrate an understanding of how those issues affect data quality and the overall site characterization project.

Field-based site characterization technologies produce data quality ranging from qualitative to

definitive. The type of data generated by field-based technologies depends on the degree of sophistication of the technology and the QA/QC measures implemented. Some methods produce only qualitative information, with no quantitative information. Others provide quantitative information that is above or below a designated level and is referred to as semi-quantitative data. That term can describe data showing a range of concentrations. Quantitative data provide an analyte concentration for a sample, and definitive

data, usually produced by GC/MS, confirm the presence of the analyte and its concentration. The use to which the field analytical data will be put usually determines the degree of QA/QC required. Data used to confirm the presence or absence of a contaminant, thereby allowing the project manager to more accurately direct further sampling and analysis, usually require less stringent QA/QC. Qualitative or semi-quantitative data may be sufficient for such requirements. However, if the field analytical data are used to confirm the presence or absence of a contaminant and must withstand legal scrutiny, the data must

be definitive, and a sophisticated technique, such as GC/MS, must be employed.

The contractor's proposed methodology can describe:

- Field analytical methods for identification of volatile contaminants, such as benzene or trichloroethylene (TCE), particular semivolatile contaminants, or metals

Factors That May Necessitate Innovative Cleanup Approaches

- Stakeholders prefer that contamination be treated in place rather than disturbed and moved off site.
- Site owners may prefer fully treating contaminants over containment remedies or long-term institutional controls to offset long-term risk, residual liability, and long-term operations and maintenance costs.
- The excavation of contaminated soils under existing buildings and structures is not feasible because of potential damage to those buildings or structures or disruption of ongoing businesses.
- Cleanup must be accomplished within a specified time frame to meet milestones for redevelopment of the site. Time factors also may favor the use of an innovative approach over a traditional response that involves a long-term remedy.
- Full reuse plans have not been developed for the site, and interim treatment activities, such as phytoremediation, allow treatment to proceed while final decisions are being made.
- The budget for cleanup is limited, and innovative approaches offer less expensive options than traditional approaches.
- Innovative approaches can be designed and configured to blend in with the proposed reuses of the site.

- The selection of field test kits for the project
- The method of determining the locations and number of samples
- The strategy or justification for the mix of field analytical methods and laboratory analysis that is proposed
- The procedure for confirming the accuracy of the measurements

4.1.2 Remediation Technologies

When evaluating remediation options, a number of factors should be considered to identify the most technically feasible and cost-effective technology for a specific site. The general considerations for all sites are applicability, implementability, effectiveness, remediation time frame, cost, and regulatory compliance. Specific factors may include current or future use of the site, remediation objectives, proximity to neighbors or businesses, proximity to historic buildings, potential long-term liability and risk, future reuse, and regulatory considerations, as well as evaluation of treatment options compared with containment and institutional controls. For individual sites, one or more factors may be dominant. RFPs should clearly state extenuating circumstances that may require innovative cleanup approaches rather than traditional containment or removal.

Because the performance of each technology depends heavily on site-specific conditions and characteristics, a treatability study should be conducted before full-scale implementation of any technology, innovative or traditional. The following sections present information for use in evaluating such proposed activities.

4.1.2.1 Treatability Studies

Before the final remediation technology is selected, a treatability study should be conducted to demonstrate that the treatment technology will work at that site. To avoid problems and delays that may occur if a technology fails to perform as intended, the treatability study should be performed as early as possible in the study phases of the project. The requirements for a treatability

study that are set forth in an RFP should be tailored to the complexity of the site. At a minimum, the RFP should specify that the contractor must demonstrate that the technology will work before the contractor proceeds with remediation activities. The expenses of the treatability study are paid in various manners. In some cases, the contractor performing the treatability study may assume such expenses because the study is an opportunity to further test the technology and obtain performance data for it. In other cases, the RFP may stipulate that the contractor will be reimbursed for the cost of the treatability study upon successful completion of that study.

Many treatment technologies are patented, and the patent owner may be reluctant to sell patent rights or licensing agreements to another vendor or contractor. An RFP for remediation work must define clearly the process by which the patent holder will allow another vendor or contractor to use the technology, if the patent holder is not to perform the work. On the other hand, many companies may be reluctant to participate in a treatability study if their participation would preclude them from later bidding on the remediation contract. Local conflict of interest procedures should be checked carefully to ensure that contractors are not precluded from future work in such situations.

4.1.2.2 Full-Scale Remediation Technology

It first must be determined whether the proposed technology is applicable and implementable for the site, in light of the contaminant(s) of concern (COC) and the site characteristics. For example, phytoremediation is not appropriate if the concentrations of contaminants are toxic to plants, nor is it implementable if the contamination is located in the deep strata of a geological formation beyond the root zones of plants that could be used at the site. Soil vapor extraction (SVE) alone is not applicable for treating a site at which a tight clay formation is present because the SVE process depends on the ability of the subsurface area to exchange air. SVE also is not applicable for a site contaminated with non-volatile COCs, inorganic compounds, or metals because volatilization is the prime removal mechanism in SVE.

The proposed methodology then must be evaluated for short-term and long-term effectiveness. Short-term effectiveness is related to potential risks to the community and construction workers during remediation, while long-term effectiveness is related to risks to the community that remain after remediation work has been completed. For example, a proposed innovative technology that uses a cap consisting of a shallow layer of compacted soil for a site in a proposed residential area that is contaminated with friable asbestos may be an effective approach for the short term. Risk to construction workers during remediation can be mitigated by providing workers with appropriate personal protective equipment (PPE). However, such a cap may not be an effective solution for the long term because the contaminant remains in place and any number of potential residential activities could disturb the structure of the cap and expose the contaminants.

Third, the time frame of the proposed remediation technology must be consistent with the future use of the site. Brownfields sites for which commercial or residential use or redevelopment as industrial parks has been designated typically are on a fast-track schedule for transfer. A technology such as phytoremediation would not be an acceptable option for fast-track sites because it may take a number of years to completely remediate the site by such an approach.

Fourth, the proposed remediation must be cost-effective. For a project for which the budget is limited, cost can be a determining factor in the selection of a technology. However, since the least costly approach may not bring about the most expeditious site remediation, a balance between potential cost savings and time frames may be necessary. Similarly, both short-term construction costs and long-term operation and maintenance costs must be considered. For example, a cap for soil and a pump-and-treat remedy for groundwater initially may be considered preferred options because those options would move a site quickly to redevelopment and would appear to be cost-effective, as well. However, in assessing the cost of such an option, the cost of maintaining a cap over a long period of time, 30 years or more, as well as construction costs, must be considered. For pump-and-treat systems and other long-term

remedies that require operating equipment, site owners should consider replacement costs as well as maintenance costs because pumps and other equipment eventually may need to be replaced.

Finally, the proposed methodology must comply with state regulations governing cleanups. In all cases, localities should work with state and federal regulators to ensure that regulatory requirements are addressed appropriately in the RFP. Depending upon the complexity of the site, the past history of the site, and the procedures regulators require for cleanups at brownfields sites, compliance may require full review and approval by the state or less formal concurrence. In some cases, application of the risk-based corrective action (RBCA) standards may affect the selection of technologies. Approval of the state may be required for specific remediation activities, such as air emissions, groundwater re-injection, or health and safety procedures. The various ways in which states regulate or limit the use of some technologies could affect the use of those technologies at particular sites. For example, although land farming is an established technology for remediating sites contaminated with fuel or petroleum, some states limit the use of land farming as a remediation technology. (Land farming relies on biological and chemical reactions in soil to degrade, transform, or immobilize hazardous constituents.) Similarly, design and operating requirements may differ according to the location of the land-farming site. For a site in an urban area, the state may require an enclosure and off-gas treatment unit control for emissions of VOCs, but such requirements might not be applicable in a rural setting.

Table 3-5, which presents an overview of a number of innovative technologies, can be used as a reference when evaluating the contractor's proposed remediation technologies.

4.2 Evaluating Qualifications of Personnel

To effectively implement innovative technologies, the contractor staff must be fully qualified and experienced in the proposed work. To ensure that the contractor selected has the appropriate qualified staff to perform the work, RFPs should require that bidders provide information that demonstrates:

- The experience of each key staff member in using innovative technologies under site conditions covered by the RFP
- The availability of the full range of technical disciplines needed

Care should be taken to ensure that the contractor's personnel have expertise in the specialized disciplines needed to support innovative technologies.

Various factors determine the disciplines required to support the cleanup of a specific site. The types of contaminants at the site may require a chemist who has highly specialized experience, the physical characteristics of the site might require an in-depth understanding of local geology or hydrogeology, or implementation of a technology might require an understanding of specialized modeling software. Similarly, analytical quality control protocols must be designed by a qualified analytical chemist who can ensure that analytical methods will produce data of a quality adequate to support the decisions to be made or to maximize the efficiency of in-field analyses. In addition, trained scientists or engineers must be on site to interpret the data as they are generated.

Staff who have the appropriate background in chemistry can predict the mobility of contaminants. For example, if metals were released at the site, the mobility of the metals is dependent on the speciation of the metals, which in turn is dependent on the reduction oxidation (redox) conditions at the site. For example, metals such as chromium (commonly used in industry) exist in various states. However, chromium is mobile only in the CrVI state. Therefore, a chemist can predict whether chromium will migrate to the groundwater and determine where to sample. On the other hand, if the contaminant is a solvent, it very likely will migrate with the groundwater and break down to other chemical species.

Resumes of key staff members must describe their experience in using field analytical methods, test kits, and field screening methods or in designing site-specific remediation plans. Information about the technical experience of the staff must establish a direct correlation between that experience and the needs of the project. Further, the capabilities

of the contractor's proposed management and coordination teams must be assessed carefully against the requirements of the project. For example, individuals who demonstrate experience in managing characterizations of large, complex sites and the ability to meet short deadlines may be needed to complete a specific project.

Another consideration is the experience of the contractor's staff in working in the state in which the site is located. It is advantageous for the staff to be familiar with that state's regulations and procedures for characterizing and remediating contaminated sites and policies related to the cleanup and redevelopment of brownfields sites, including familiarity with state voluntary cleanup programs and procedures for obtaining "no further action" letters. The contractor's team also should include a registered professional engineer and a licensed geologist, ideally with registry and licensing in the state in which the site is located. Individuals who have such credentials can facilitate the processes of obtaining operating permits and approvals of technical designs.

In summary, the contractor must have access to a multidisciplinary team that can address all aspects of the project. In general, teams should include individuals who have expertise in chemistry, geochemistry, geology, hydrogeology, biology, toxicology, civil engineering, and soil sciences. Depending upon site-specific conditions and proposed remediation options, other expertise also may be required. Specialized expertise may be required to conduct environmental and public health risk assessments, operate models, or perform complicated statistical analyses.

4.3 Evaluating Corporate Experience

Bidders must demonstrate the corporate experience that will enable them to complete the proposed project successfully. They should describe their experience in completing similar projects and provide references for those projects.

4.3.1 Experience in Performing Similar Projects

Depending upon the specifications for the project, bidders must be able to demonstrate their experience in selecting and using specialized field

equipment, designing remediation plans, and performing remediation activities in similar settings. In their proposals, contractors should identify problems that might affect the project and describe how they would resolve such problems. Their recommendations could be based on “lessons learned” from similar projects. A contractor’s ability to clearly define potential problems and provide sound resolutions is a good indication that the contractor understands the details of the project and the issues that might affect it. The use of dynamic work plans and other innovative strategies includes an inherent element of uncertainty. The contractor might encounter problems that may require creative, sound thinking to resolve the problems and keep the project moving forward. As an alternative, the contractor’s ability to respond to problems could be tested by including in the RFP a list of potential problems and requiring contractors to submit resolutions in their proposals.

4.3.2 Past Performance

As is the case in selecting a contractor for any type of work, a good, reliable contractor should be able to provide references for past performance. RFPs should require a minimum number of references for projects similar to the proposed project. The RFP should require specific information about each project used as a reference, including: (1) the name and location of the project; (2) a brief description of the project; (3) the period of performance; and (4) the name, address, and telephone number of a contact person. The RFP should specify how far into the past the contractor can reach in selecting recent reference projects. Because innovative technologies and streamlined strategies evolve quickly, shorter time periods, such as one to two years, may be appropriate for projects that involve such options.

4.4 Evaluating the Contractor’s Quality Assurance and Quality Control Procedures

Contractors must understand the importance of using sound quality assurance and quality control procedures in completing their work, and they must be prepared to fully implement those

procedures, as well. In general terms, QA is an integrated system of management activities carried out to ensure that the work performed and the products provided are of the type and quality needed and expected. QC is the system of technical activities that measure and control quality to ensure that data meet the needs of users. In characterizing and monitoring brownfields sites, errors can occur in the field or laboratory; therefore, QA/QC procedures must be built into all key activities. Contractors must be prepared to implement QA/QC procedures for all aspects of the project, including planning, sample collection, laboratory analysis, data review, and data assessment.

RFPs for any type of technical activity usually include specific procedures that contractors must implement to ensure that federal, state, or local QA/QC requirements are met. A contractor must establish and carry out a sound QA/QC program to ensure that all data the contractor provides is defensible and that officials can have a high level of confidence in using the data to support decisions about the potential reuse of the site. Depending on the site-specific situation, the types of decisions to be made about the site, and the entity that will make those decisions, it may be necessary that data be defensible on a regulatory or a scientific basis, or both.

A major challenge associated with the redevelopment of brownfields sites is uncertainty about potential environmental risks and liability related to contamination that has not been characterized properly. Requiring contractors to explain their proposed QA/QC procedures for individual sites and ensuring that those procedures meet established requirements for collecting and analyzing environmental data will reduce that uncertainty. All RFPs that include site investigation activities and monitoring should require that each bidder include a detailed quality assurance project plan (QAPP) in its proposal. The objectives of the QAPP are to ensure the accuracy, precision, comparability, representativeness, and completeness of the data generated.

Streamlined investigation and monitoring strategies rely heavily on comprehensive, up-front planning designed to collect only data that will support the decisions to be made about the site,

while simultaneously gathering all the data necessary to support a defensible decision. That planning process is done through the development of a conceptual site model and the establishment of data quality objectives (DQO). Contractors must be able to demonstrate relevant experience in conducting the DQO process and be prepared to participate in that process. Further, contractors must be able to demonstrate how they will maintain QA/QC as they implement their site assessment work plan. Because site characteristics, the decisions to be made, and data quality needs vary from site to site, the contractor's qualifications should be evaluated against the particular requirements for the site covered by the RFP.

Additional information about the QA process is available in the *Quality Assurance Guidance for Conducting Brownfields Site Assessments*, EPA 540-R-98-038, September 1998. Another source of information is the EPA waste methods guidance *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846). SW-846 is a compendium of sampling and analytical methods that have been evaluated and approved for use in complying with regulations under RCRA. Although a number of states have ratified SW-846 methods formally, the methods, as stated by EPA, are intended as a guide. In many cases the use of other methods is permitted if it can be demonstrated they are sufficiently sensitive, adequate, and precise to support the decisions to be made. Again, the site-specific data quality requirements that support decisions about a site should be the principal consideration for the technology selection.

4.5 Evaluating the Contractor's Cost Proposal

A variety of factors could influence the selection of the appropriate type of pricing mechanism(s) for a particular site. Generally, site characterization work entails more uncertainties than cleanup work. Contractors commonly propose different pricing mechanisms for different types of activities – for example, time-and-materials or a combination of time-and-materials and fixed-price contracting mechanisms for characterization projects and fixed-price or fixed-unit-price mechanism for cleanup projects.

Fixed-price contracting may be appropriate when activities are defined clearly. Contracts that incorporate performance specifications or a combination of lump-sum payments and fixed unit prices for work that cannot be defined clearly at the time of the bid add flexibility to the fixed-price procurement process, while adding a level of protection against cost overruns. Unit pricing is appropriate for potentially high-volume or unpredictable items, such as clearing, backfilling, installation of wells, and treatment of contaminated media. If the actual quantity of a given item varies significantly from the estimated quantity set forth in the contract, it may be beneficial to negotiate a reduction in the unit price for that item.

Contracting for innovative treatment technologies may require the examination of special considerations in soliciting bids, evaluating cost proposals, and preparing contracts, particularly when the entity soliciting the bid has little or no experience in purchasing such services or when the conditions at the site are complex or undefined. In many cases, actual costs of treatment have varied significantly from budget estimates and bids because the extent and types of contamination were not characterized adequately or the quantities of waste, soil, or groundwater to be treated were estimated poorly. Further, some treatment technologies, because they are not typical construction projects, are better scoped out and priced under a service contract.

RFPs may specify innovative contracting approaches as one of the requirements for the proposal. For example, pay-for-performance cleanup agreements might be established; under such agreements, preestablished payments are made to the contractor as the project reaches measurable environmental goals. Paying for cleanups through such agreements rewards contractors for reaching cleanup goals quickly and efficiently.

4.6 Evaluating the Contractor's Insurance

Insurance coverage of several types is appropriate for protection against potential damages and liabilities associated with characterization and remediation activities at contaminated sites. Some

coverage may be standard requirements in any contract issued by a brownfields community, private company, or other entity. Other specialized coverage may be required for a particular site or project. Typically, those entities that issue contracts take the prime responsibility for determining their insurance needs for the project because they could be ultimately responsible for any damages, both environmental and business. For brownfields sites, banks and other lending institutions will specify the insurance coverage that must be in place to protect their loans. Before any contract is signed, it is incumbent upon all parties to understand their potential risks and to be assured that all appropriate coverage is in place. Table 4-1 lists information about six types of environmental insurance products that should be considered.

At any contaminated site, there is potential risk that site investigation and remediation activities could disturb the contaminants and cause pollution damage. The types of insurance necessary and the limits of coverage will vary from site to site. Such factors as the potential types of contaminants present, proximity to groundwater, the degree to which the site has been properly characterized, and proximity to ongoing businesses and population centers must be considered in determining the types and level of insurance necessary. Questions about the availability and selection of insurance products for a specific site should be directed to insurance companies and underwriters that specialize in environmental insurance products.

**TABLE 4-1
 ENVIRONMENTAL INSURANCE
 PRODUCTS**

Type of Coverage	Key Features of Coverage
Bodily injury and property damage	Provides compensation for bodily injury and property damage caused by a pollution condition, such as a release of hazardous or toxic materials. Covers injuries to others that occur on site or off site.
Contract damages	Provides compensation when pollution impairs the insured's ability to perform under a contract.
Environmental cleanup costs	Pays for the costs the insured must incur to address its pollution problems and comply with government standards established to protect human health and the environment. Covered costs include those for site investigation and for the removal, treatment, or disposal of wastes.
Remediation cost overruns (also called cleanup cost cap or stop-loss insurance)	Pays for cleanup costs, including remediation costs, that substantially exceed the budget. The insurer pays only if the project cost exceeds the estimated project cost, plus an agreed-upon buffer amount over the estimated cost.
Business interruption	Pays for internal costs, such as loss of income or salary to employees, that the insured suffers as a result of pollution.
Legal defense expenses	Coverage pays for the insured's legal costs incurred to defend or settle a dispute about liability for pollution.



Appendix

Sources of Innovative Technology Information

BULLETINS, FACT SHEETS, JOURNALS, AND NEWSLETTERS

Bibliography for Innovative Site Clean-Up Technologies, August 1999 Update

<http://clu-in.org/pub1.htm>

The bibliography is a comprehensive list of information resources related to innovative site cleanup technologies that includes titles and document numbers. The bibliography lists resources by categories, including: technology survey reports; information about programs of the U.S. Environmental Protection Agency (EPA); groundwater (in situ) treatment; thermal treatment; bioremediation; soil vapor extraction (SVE) and enhancements of that technology; physical and chemical treatment; conferences and international surveys; technical support; community relations; bulletin board systems, databases, software, and the Internet; technology newsletters; and innovative site remediation engineering technology monographs. Information on how to order individual documents also is provided.

Citizen's Guides to Understanding Innovative Treatment Technologies

<http://clu-in.org/pub1.htm>

The Citizen's Guides to Understanding Innovative Treatment Technologies fact sheets are four-page guides prepared by the U.S. Environmental Protection Agency (EPA) to provide site managers with non-technical outreach materials. The guides, which are available in English and Spanish, are intended to be shared with communities in the vicinity of a cleanup site at which innovative treatment technologies are in use or under consideration. The guides present information about innovative treatment technologies that have been selected or applied at some cleanup sites, provide overviews of innovative treatment technologies, and present success stories about sites at which innovative treatment technologies have been applied. The second document number listed after each title is the document number of the guide in Spanish.

Ground Water Currents

<http://clu-in.org/products/newsltrs/tt&gwc.htm>

Ground Water Currents is a leading source of information about recent developments in innovative groundwater treatment, characterization, sampling, and monitoring technologies. The newsletter provides information about developments and demonstrations, new regulations, conferences, and publications. For example, the June 1999 issue features topics related to the flushing of dense non-aqueous phase liquids (DNAPL) with alcohol, cost-effective sampling of groundwater monitoring wells, in situ chemical oxidation through recirculation, and a new remediation group for dry-cleaner sites convened in April 1999.

Tech Trends

<http://clu-in.org/products/newltrs/tt&gwc.htm>

Tech Trends focuses on recent applications of innovative technologies for site characterization and remediation. The newsletter includes descriptions of and performance data for innovative source control and site characterization technologies that have been applied in the field. The newsletter, which is updated quarterly, is a valuable tool for keeping abreast of the most recent developments in innovative technologies and can be subscribed at the web address provided above.

U.S. Environmental Protection Agency (EPA) Region 3 Industry Profile Fact Sheets

<http://www.epa.gov/reg3hwmd/brownfld/industry.htm>

Developed by EPA Region 3, the fact sheets are designed to assist in the initial planning and evaluation of sites that are under consideration for remediation, redevelopment, or reuse. The fact sheets provide general descriptions of site conditions and contaminants commonly found at selected industrial sites. Each fact sheet provides information about the processes conducted in the industry; raw materials characteristic of the industry; environmental media that could be affected; sampling strategies; and suggested parameters for analysis.

DATABASES AND SOFTWARE

Completed North America Innovative Remediation Technology Demonstration Projects Database

<http://clu-in.org/pub1.htm>

The searchable database contains information about more than 300 completed innovative technology field demonstration projects conducted in North America. The database consolidates key information from innovative demonstration projects in a single source. Information is presented in a format that enables the user to easily identify innovative technologies that may be appropriate to the user's particular site remediation needs. The database, which is limited to completed demonstration projects and a small number of full-scale cleanup efforts, does not include emerging technologies or laboratory-scale projects.

Evaluation of Selected Environmental Decision Support Software

<http://clu-in.org/pub1.htm>

Developed by DOE's Office of Environmental Management, the report evaluates decision support software (DSS), computer-based systems that facilitate the use of data, models, and structured decision processes in making decisions related to environmental management. The report evaluates 19 such systems through the application of a rating system that favors software that simulates a wide range of environmental problems. It includes a glossary of terms and a statement of the rationale for the selection of various aspects of the performance of the DSS for evaluation.

Tank RACER 99

<http://www.epa.gov/swerust1/tnkracr1.htm>

Tank RACER 99 is a Windows™-based PC software that provides fast, accurate, and comprehensive cost estimates for cleanups at leaking underground storage tank (UST) sites. The software estimates costs for UST cleanups on a site-specific basis for all phases of remediation, including site assessment, remedial design, remedial action, operations and maintenance, closure of tanks, and site work and utilities, as well as the costs of using alternative technologies, such as air sparging, bioremediation, bioventing, groundwater extraction wells, land farming, natural attenuation, soil vapor extraction (SVE), and thermal desorption. The web site also provides information about training workshops that are available.

ONLINE REFERENCES AND RESOURCES

Field Analytic Technologies Encyclopedia (FATE)

<http://fate.clu-in.org>

EPA's Technology Innovation Office, in collaboration with the U.S. Army Corps of Engineers, developed a new online encyclopedia of field analytic technologies. This encyclopedia is intended to provide information about technologies that can be used in the field to characterize contaminated soil and groundwater, monitor the progress of remedial efforts, and in some cases, for confirmation sampling and analysis for site close out. The encyclopedia posted on the web provides information on ten classes of technologies, but EPA intends to expand the encyclopedia with additional field analytical technology classes in the future.

Field Sampling and Analysis Technologies Matrix, Version 1.0

<http://www.frtr.gov/site>

The Field Sampling and Analysis Technologies Matrix Version 1.0 is an online tool that can be used to conduct initial screening of site characterization and monitoring technologies. The matrix, developed by member agencies of the Federal Remediation Technologies Roundtable (FRTR), is a quick-reference chart that provides consumer-response-style ratings in several categories for various site characterization, monitoring, and sampling technologies. Each technology is rated in a number of performance categories, such as detection limits, applicable media, selectivity, and turnaround time. Other useful information provided includes technology descriptions; data on commercial status, cost, and certification; and evaluation reports. The matrix is extremely helpful to users who are not familiar with specific characterization, monitoring, or sampling technologies, but who know baseline information about a site, such as contaminants and media; for such users, the matrix can identify and screen technologies for potential use at a site.

Innovative Remediation and Site Characterization Technologies Resources CD-ROM

<http://www.epa.gov/ncepihom>

The U.S. Environmental Protection Agency's (EPA) Office of Solid Waste and Emergency Response (OSWER) Technology Innovation Office (TIO) Innovative Remediation and Site Characterization Technologies Resources CD-ROM contains resources that provide information to help federal, state, and private-sector site managers evaluate site assessment and cleanup alternatives. The ability to gain access to resources that provide information about innovative site characterization and remediation technologies will increase understanding of those technologies and of the cost and performance factors related to them. Such understanding is essential to the consideration of those technologies for use in addressing contamination at hazardous waste sites. The CD-ROM can be ordered by calling the National Service Center for Environmental Publications at (800) 490-9198 or (513) 489-8190 or by faxing a request to (513) 489-8695. The order number for the CD-ROM is EPA 542-C-99-001.

National Exposure Research Laboratory (NERL) Hazardous Waste Site Characterization CD-ROM

<http://www.epa.gov/ncepihom>

The U.S. Environmental Protection Agency's (EPA) National Exposure Research Laboratory (NERL) Hazardous Waste Site Characterization CD-ROM, developed by NERL's Environmental Sciences Division - Las Vegas (ESD-LV), contains guidance documents and related software designed to aid environmental professionals in the characterization of hazardous waste sites. The CD-ROM is a

compilation of computer programs developed by EPA and publications related to EPA's Resource Conservation and Recovery Act (RCRA) and Superfund programs that can be printed, as well as searched by key word. The CD-ROM requires a 386 IBM-compatible computer with DOS Version 3.0 or higher, 640 K RAM, and 3 MB of hard-disk space. A math co-processor is recommended but not required. The CD-ROM can be ordered by calling the National Service Center for Environmental Publications at (800) 490-9198 or (513) 489-8190 or by faxing your request to (513) 891-8695. The order number for the CD-ROM is EPA-600-C-96-001.

Remediation Technologies Screening Matrix and Reference Guide

http://www.frtr.gov/matrix2/top_page.html

The Remediation Technologies Screening Matrix and Reference Guide, prepared for federal agencies that participate in the Federal Remediation Technologies Roundtable (FRTR), provides information about remediation technologies. The on-line searchable guide is intended to assist remedial project managers (RPM) in screening and evaluating candidate cleanup technologies and selecting the best remedial alternative(s). The guide includes available cost and performance data and focuses primarily on demonstrated technologies. Information about emerging technologies also is included in the guide. This guide is continuously updated.

Site Characterization Library, Volume 1, Release 2.0, April 1998

<http://www.epa.gov/ncepihom>

The Site Characterization Library, Volume 1, Release 2.0 (October 1998) CD-ROM, developed by the U.S. Environmental Protection Agency's (EPA) National Exposure Research Laboratory (NERL), contains a variety of guidance documents, standard operating procedures (SOP), and risk assessment guidelines, as well as a large collection of software tools, including groundwater flow and transport models and statistical packages. The CD-ROM can be ordered from the National Service Center for Environmental Publications at (800) 490-9198 or (513) 489-8190 or by fax at (513) 891-8695. The order number for the CD-ROM is EPA-600-C-98-001.

The Hazardous Waste Clean-up Information (CLU-IN) Web Site

<http://clu-in.org>

This web site is searchable and provides information about innovative treatment and site characterization technologies to the hazardous waste remediation community. It contains information, publications, and software, many of which can be downloaded or viewed online from the site; remediation and site characterization technology selection tools; recently published articles; and information about partnerships and consortia and vendor support, as well as links to related web sites.

U.S. Department of Energy (DOE) Preferred Alternatives Matrices (PAMs)

<http://www.em.doe.gov/define>

PAMs provides the user access to evaluations of site characterization and remediation technologies preferred by DOE on the basis of the types of contaminants and contaminated media selected. PAMs was developed by DOE's Office of Environmental Restoration (EM-40) to assist decision makers in selecting the most appropriate cleanup alternatives for remediation, waste processing, and decommissioning of sites. It provides a tool for field personnel to use in focusing remedy selection; expediting implementation of preferred alternatives; eliminating the cost of excessive or redundant treatability studies; and allowing preselection of effective, low-cost remediation alternatives.

U.S. Department of Energy (DOE) Vendor Database for Environmental Applications

<http://www.cmst.org/vendor>

This DOE web site is devoted to supporting the chemical and physical property measurements of environmental samples. The Characterization, Monitoring & Sensor Technology - Cross Cutting Program (CMST-CP) of DOE maintains this vendor database as a focal point for environmental measurement technologies. The database contains information about 200 vendors that provide equipment related to the analysis of environmental samples.

U.S. Environmental Protection Agency (EPA) REmediation And CHaracterization Innovative Technologies (REACH IT)

<http://www.epareachit.org>

The U.S. Environmental Protection Agency (EPA) REmediation And CHaracterization Innovative Technologies (REACH IT) online searchable database, developed by EPA's Technology Innovation Office (TIO), provides users with comprehensive, up-to-date information about more than 150 characterization technologies and 1,300 remediation technologies offered by more than 750 service providers. Information provided by service providers is matched with comprehensive information submitted by project managers for EPA, the U.S. Department of Defense (DoD), and the U.S. Department of Energy (DOE) about treatment technology projects at Superfund, DoD, and DOE sites. EPA REACH IT is accessible through the Internet; the guided and advanced search capabilities allow users to develop custom searches based on such criteria as media, contaminant type, site type, and technology type to gather information about innovative technology solutions and service providers that meet their needs.

PUBLICATIONS

A Guideline for Dynamic Workplans and Field Analytics: The Keys to Cost-Effective Site Characterization and Cleanup

<http://clu-in.org/pub1.htm>

This guideline provides users with information about the many factors that are to be considered in incorporating field analytical instruments and methods into an adaptive sampling and analysis program for expediting the site investigation process. One of the primary goals of the expedited site characterization process is to minimize the collection and analysis of uninformative samples, thereby saving time and money. The guideline was developed by Tufts University, Massachusetts, in cooperation with the U.S. Environmental Protection Agency (EPA), and was funded under President Clinton's Environmental Technology Initiative (ETI). The guideline is intended to help federal and state regulators, site owners, consulting engineers, and remediation companies understand how to develop, maintain, and update a dynamic work plan.

Application of Field-Based Characterization Tools in the Waterfront Voluntary Setting

<http://clu-in.org/pub1.htm>

Voluntary action to redevelop potentially contaminated property operates under vastly different market constraints than mandated corrective action programs. Pressures affect the time scale, cost-to-benefit ratio, priorities, and resources that allow the action to take place. non-market pressures, usually in the form of regulation, also affect decisions over the course of redevelopment. Together, those forces also determine the technologies and methods used to characterize the property, as well as the media sampled. This report investigates the reasons behind the use of and details the current level

of application of field-based characterization tools at 115 waterfront brownfield and voluntary cleanup program (VCP) sites.

Assessing Contractor Capabilities for Streamlined Site Investigations

<http://brownfieldstsc.org>

Innovative technologies are having a significant effect on the cost, schedule, and effectiveness of environmental cleanup projects. The impact of these technologies has been demonstrated during CERCLA and RCRA investigations, and such technologies should be incorporated into brownfields projects, as well. The purpose of this document is: (1) to familiarize brownfields decision makers with innovative methods for characterizing their sites and encourage them to investigate and employ such methods; (2) to assist brownfields decision makers in assessing contractors' capabilities and familiarity with such methods; and (3) to suggest additional factors for contractors to consider in conducting their activities.

Assessment of Phytoremediation as an In Situ Technique for Cleaning Oil-Contaminated Sites

<http://clu-in.org/pub1.htm>

Drawing on a review of the relevant literature, this document provides examples of the phytoremediation of petroleum hydrocarbons and discusses the key mechanisms, as well as the special considerations, involved in phytoremediation of petrochemicals. The benefits, limitations, and costs of phytoremediation, compared with those of alternative approaches – including natural attenuation, engineering and bioremediation – also are discussed.

Brownfields Technology Primer: Selecting and Using Phytoremediation for Site Cleanup

<http://brownfieldstsc.org>

The Brownfields Technology Support Center developed this document to provide an educational tool for site owners, project managers, and regulators to help evaluate the applicability of the phytoremediation process at brownfields sites. The primer explains the types of biological processes involved in phytoremediation; provides examples of the sites and contaminants where phytoremediation has been applied; and discusses technical considerations in selecting and designing phytoremediation systems, activities necessary to operate and maintain phytoremediation systems, and examples of estimated potential cost savings from using phytoremediation versus more conventional treatment processes. The primer also provides a comprehensive list of other resources that are available to assist decision makers in evaluating phytoremediation as an option for cleaning up contaminated sites.

Characterization, Monitoring, and Sensor Technology Crosscutting Program (CMST-CP) Rainbow Book

<http://em-52.em.doe.gov/ifd/RbBooks/cmst/cmstrb.htm>

The CMST-CP Rainbow Book developed in August 1996, under the CMST-CP program provides the user information about specific technologies and detailed descriptions of how each technology works. The book provides information about characterization, monitoring, and sensor technology for DOE's Office of Waste Management (EM-30), Office of Environmental Restoration (EM-40), and Office of Nuclear Material and Facility Stabilization (EM-60). The book is designed to ensure that technology development is cost-effective and appropriate, and recommends that the technology development effort be concentrated on the following focus areas: subsurface contaminants; high-level waste tank remediation; mixed waste characterization, treatment, and disposal; and decommissioning and final disposition of facilities.

Directory of Technology Support Services to Brownfields Localities

<http://brownfieldstsc.org>

This directory provides information about EPA offices, non-government organizations funded by EPA, and other federal agencies, that may be able to provide expertise to assist in the selection of technologies to characterize and cleanup brownfields properties.

EPA Office of Enforcement and Compliance Assurance (OECA) Sector Notebooks

<http://es.epa.gov/oeca/sector>

EPA's OECA has developed a series of profiles or notebooks that provide information about selected major industries that focus on key indicators that holistically present air, water, and land pollutant release data and have been reviewed thoroughly by experts from both inside and outside EPA. The notebooks provide a comprehensive environmental profile and information about industrial processes, pollution prevention techniques, pollutant release data, regulatory requirements, compliance and enforcement history, government and industry partnerships, innovative programs, contact names, bibliographic references, and descriptions of research methodology for such industries as iron and steel, metal mining, oil and gas extraction, and more.

Environmental Technology Verification (ETV) Site Characterization and Monitoring Technologies Pilot (SCMT): Technology Verification Statements and Reports

http://www.epa.gov/etv/02/02_main.htm

The Environmental Technology Verification (ETV) Site Characterization and Monitoring Technologies Pilot (SCMT) web site provides access to ETV technology verification statements and reports about site characterization technologies. To date, verification statements and reports are available for the following technologies: cone penetrometer-deployed sensor; field-portable gas chromatograph/mass spectrometer; field-portable x-ray fluorescence analyzer; technologies for analysis for polychlorinated biphenyls (PCB); technologies for well-head monitoring for volatile organic compounds (VOC); and soil sampling technologies. The SCMT pilot was established as one of 12 pilots currently implemented by the U.S. Environmental Protection Agency's (EPA) ETV Program. The pilot is a partnership program of EPA, the U.S. Department of Defense (DoD), and the U.S. Department of Energy (DOE) and is responsible for evaluating and verifying the performance of innovative and alternative monitoring, measurement, and site characterization technologies. The pilot provides support for technology developers, evaluates and verifies data generated during technology demonstrations, and develops and disseminates information about the performance of site characterization technologies.

Federal Facilities Forum Issue: Field Sampling and Selecting On-Site Analytical Methods for Explosives in Soil, November 1996

<http://www.epa.gov/clarit/on/clhtml/pubtitle.html>

Federal Facilities Forum Issue: Field Sampling and Selecting On-Site Analytical Methods for Explosives in Soil was produced by the U.S. Environmental Agency's (EPA) Federal Facilities Forum, a group of EPA scientists and engineers who represent federal facility remediation interests. The document identifies screening procedures for characterizing soils contaminated with explosive and propellant compounds. (To find this document using the URL listed above, use the Find in Page feature of your browser and type in 540R97501.)

Federal Remediation Technologies Roundtable (FRTR) Case Studies

<http://www.frtr.gov/cost>

The Federal Remediation Technologies Roundtable (FRTR) case studies contain detailed information about specific remedial technology applications. FRTR case studies are developed by the U.S. Department of Defense (DoD), the U.S. Army Corps of Engineers (USACE), the U.S. Navy, the U.S. Air Force (USAF), the U.S. Department of Energy (DOE), the U.S. Department of the Interior (DOI), and the U.S. Environmental Protection Agency (EPA). As of September 1998, FRTR published and made available on its Internet site 140 cost and performance case studies. The case studies focus on full-scale and large field demonstration projects and include background information about the site, a description of the technology, cost and performance data for the technology application, and a discussion of lessons learned. Both innovative and conventional treatment technologies for contaminated soil, groundwater, and solid media are included. A search function on the web site allows a user to search the case studies using key words for media, contaminant, and primary and supplemental technologies.

Field Analytical and Site Characterization Technologies - Summary of Applications, November 1997

<http://clu-in.org/pub1.htm>

Field Analytical and Site Characterization Technologies - Summary of Applications lists more than 200 sites at which 23 different field analytical and site characterization technologies have been used. The information about the application of each technology was obtained from federal and state program managers and provides insights into their experiences with the technology. The information presented for each technology includes the types of pollutants and media for which the technology has been used; reported advantages and limitations of the technology; and cost data for the technology, when available.

Ground-Water Remediation Technologies Analysis Center (GWRTAC) Technology Overview Reports

http://www.gwrtac.org/html/tech_over.html

These reports provide general overviews and introductions to specific groundwater remediation technologies. Information for the reports is gathered from a range of sources, including project documents, reports, periodicals, Internet searches, and personal communications with parties involved in the use of the technologies.

Innovations in Site Characterization Case Study: Hanscom Air Force Base, Operable Unit 1, September 1998

<http://clu-in.org/pub1.htm>

Innovations in Site Characterization Case Study: Hanscom Air Force Base, Operable Unit 1 presents a case study of a dynamic site investigation. The case study describes a 10-day adaptive sampling and analysis program (SAP) under which six technologies were used to take more than 600 soil samples and conduct quantitative analysis for volatile organic compounds (VOC), polychlorinated biphenyls (PCB), polynuclear aromatic hydrocarbons (PAH), and metals. The report documents cost savings and discusses the other advantages of the use of the adaptive SAP.

Phytoremediation Decision Tree

<http://clu-in.org/pub1.htm>

This document, produced by the Interstate Technology Regulatory Cooperation (ITRC) workgroup, provides a tool that can be used to determine whether phytoremediation can be effective at a given site. It is designed to complement existing phytoremediation documents. It allows the user to use basic information about a specific site, through a flow chart layout, to decide whether phytoremediation is feasible at that site.

Quality Assurance Guidance for Conducting Brownfields Site Assessments, September 1998

<http://clu-in.org/pub1.htm>

Quality Assurance Guidance for Conducting Brownfields Site Assessments provides information for brownfields site managers about concepts and issues related to quality assurance and provides step-by-step instructions for identifying the type and quality of environmental data needed to present a clear picture of environmental conditions at a given site.

Remediation Technologies Development Forum Reports

<http://www.rtdf.org>

The series of documents, prepared by the U.S. Environmental Protection Agency's (EPA) Office of Research and Development (ORD), summarizes the activities of the Remediation Technologies Development Forum (RTDF). The RTDF is a consortium of partners who represent industry, government agencies, and academia and who work together to develop more effective, less costly hazardous waste characterization and treatment technologies. It is designed to foster partnerships between public-sector and private-sector entities to conduct laboratory and field research to develop, test, and evaluate innovative technologies. Five action teams have been formed to address priority research areas in the development, testing, and evaluation of in situ remediation technologies. Each document in the series describes the purpose and activities of one of the action teams, identifies the members of that team, and provides contact information.

Road Map to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup

<http://brownfieldstsc.org>

and

Tool Kit of Information Resources for Brownfields Investigation and Cleanup

<http://clu-in.org/pub1.htm>

The Road Map to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup focuses on the site characterization and cleanup phase of brownfields redevelopment. It provides a logical framework of steps involved in the characterization and cleanup of a brownfields site to link technology options and resources to each of those steps. In addition, the road map is linked to an accompanying document, the Tool Kit of Information Resources for Brownfields Investigation and Cleanup, which describes information resources developed by the U.S. Environmental Protection Agency (EPA) to support innovative characterization and cleanup technologies. It is intended to be used by local citizens and community groups that are not familiar with available environmental cleanup resources. The tool kit provides abstracts of and access information about a variety of resources, including electronic databases, newsletters, regulatory and policy guidance, and technical reports.

Site Remediation Technology InfoBase: A Guide to Federal Programs, Information Resources, and Publications on Contaminated Site Cleanup Technologies, First Edition, August 1998

<http://clu-in.org/pub1.htm>

This guide was prepared by the member agencies of the Federal Remediation Technologies Roundtable (FRTR). The guide identifies programs, resources, and publications of the federal government related to technologies for the cleanup of contaminated sites. It presents information about federal cleanup programs, federal site remediation technology development assistance programs, federal site remediation technology development electronic databases, federal electronic resources for site remediation technologies, and other electronic resources for site remediation technology information. In addition, it provides a selected bibliography of federal publications on alternative and innovative site remediation technologies, and technology program contacts at federal agencies.

Superfund Innovative Technology Evaluation (SITE) Innovative Technology Evaluation Reports (ITER)

<http://epa.gov.ORD/SITE/reports.html>

SITE ITERs provide the user information about independent data evaluation information about specific site characterization technologies and how they work. SITE ITERs developed by the U.S. Environmental Protection Agency's (EPA) National Environmental Research Laboratory (NERL), Las Vegas, are designed to assist decision makers in reviewing technology options and assessing a technology's applicability to a particular site. The reports include an evaluation of available information about a technology; provide an analysis of its overall applicability to site characteristics, waste types, and waste matrices; and present testing procedures, performance and cost data, and quality assurance/quality control (QA/QC) standards. The ITERs provide information about the following technologies: the clor-n-soil polychlorinated biphenyl (PCB) test kit, Dexsil Corp.; envirogard PCB test kit, Millipore, Inc.; field analytical screening program: pentachlorophenol (PCP) method; HNU-Hanby environmental test kit for PCP; and PCP immunoassay technologies.

Superfund Innovative Technology Evaluation (SITE) Technology Profiles - Tenth Edition, February 1999

<http://www.epa.gov/ORD/SITE/profiles3.html>

SITE Technology Profiles - Tenth Edition provides the user information about specific site characterization technologies and how they work. The document, prepared between July 1998 and October 1999, is intended as a reference guide for those interested in technologies included in the Site Demonstration Program (Volume I); the Emerging Technology Program (Volume II); and the Monitoring and Measurement Technologies (MMT) Program (Volume III). The two-page profiles are organized into two sections for each program (except the MMT program) for completed and ongoing projects, and are presented in alphabetical order by name of the developer. Reference tables for SITE program participants precede the sections and provide contact information for representatives of both EPA and the developer. Each technology profile includes: (1) a technology developer and process name; (2) a technology description, including a schematic diagram or photograph of the process, if available; (3) a discussion of applicability to wastes; (4) a project status report; and (5) contact information for the EPA project manager and the technology developer.

Test Methods for Evaluating Waste, Physical/Chemical Methods (SW-846)

<http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm>

The SW-846 Internet site provides the user access to the third edition of the SW-846 base manual, as well as finalized updates I, II, IIA, IIB, III, and IIIA; the fully integrated manual contains approximately 3,500 pages. Developed by the U.S. Environmental Protection Agency's (EPA) Office of Solid Waste (OSW), SW-846 is a compendium of analytical and sampling methods that have been evaluated and approved for use in complying with the Resource Conservation and Recovery Act (RCRA) regulations. Advances in analytical instrumentation and techniques are continually reviewed by OSW and incorporated into periodic updates to SW-846 to support changes in the regulatory program and to improve method performance and cost effectiveness. The Methods Team of OSW has also published Draft Update IVA for public use and is currently working on Draft Update IVB.

Treatment Technologies for Site Cleanup: Annual Status Report, Ninth Edition, April 1999

<http://clu-in.org/products/asr/index2.html>

The report documents, as of the summer of 1998, the status of treatment technology applications at more than 900 soil and groundwater cleanup projects in the Superfund program, selected Resource Conservation and Recovery Act (RCRA) corrective action sites, and U.S. Department of Energy (DOE) and U.S. Department of Defense (DoD) sites. It also includes information about 217 incineration and solidification and stabilization projects not previously covered. For the most frequently selected technologies, the report analyzes selection trends over time, contaminant groups addressed, quantities of soil treated, and the status of the project. For each technology application, information about specific sites has been incorporated into the U.S. Environmental Protection Agency (EPA) REmediation And CHaracterization Innovative Technologies (REACH IT) on-line database. Information included in previous editions of this report is included in this edition.

Uncertainty Management: Expediting Cleanup Through Contingency Planning

<http://clu-in.org/pub1.htm>

This guide describes techniques for managing project uncertainty through decision rules and contingency planning. This document was issued jointly by DOE and EPA.

U.S. Army Corps of Engineers (USACE) Technical Project Planning (TPP) Process

<http://www.usace.army.mil/inet/usace-docs/eng-manuals/em200-1-2>

The USACE's engineering manual published in August 1998 that describes the four-phase TPP process can help project managers, technical personnel, customers, regulators, and stakeholders identify project objectives and design data collection programs for hazardous, toxic, and radioactive waste (HTRW) sites. The TPP process helps ensure that the requisite type, quality, and quantity of data are obtained to satisfy project objectives that lead to informed decisions and site closeout.

U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) Brownfields Guides

<http://www.epa.gov/ncepihom>

The series of publications are designed to assist communities, states, municipalities, and the private sector to address brownfields sites more effectively. The guides provide decision makers, such as city planners, private sector developers, and others who are involved in redeveloping brownfields, with a better understanding of the technical issues involved in assessing and cleaning up automotive repair sites, iron and steel mill sites, and metal finishing sites. After reading the guides, the user will have a better understanding of activities commonly carried out at such sites and how those activities might

cause the release of contaminants into the environment. The guides also provide information about the types of contaminants often found at such sites; a discussion of site assessment, screening and cleanup levels, and cleanup technologies; a conceptual framework for identifying potential contaminants; information about developing a cleanup plan; and a discussion of issues and special factors that should be considered when developing plans and selecting technologies. The following guides are available:

- Technical Approaches to Characterizing and Cleaning Up Automotive Repair Sites Under the Brownfields Initiative (EPA 625-R-98-008)
- Technical Approaches to Characterizing and Cleaning Up Iron and Steel Mill Sites Under the Brownfields Initiative (EPA 625-R-98-007)
- Technical Approaches to Characterizing and Cleaning Up Metal Finishing Sites Under the Brownfields Initiative (EPA 625-R-98-006)

Writing a Request for Proposals: A Primer for Brownfield Pilots

<http://www.engg.ksu.edu/HSRC/Tosc/toschome.html>

This document was prepared by the Great Plains/Rocky Mountain Hazardous Substance Research Center at Kansas State University. The purpose of the primer is to guide those who need to solicit proposals for environmental assessments of brownfields. Communities that receive a Brownfields Pilot Grant typically need to hire a contractor to conduct an environmental assessment of the property.

PROGRAMS

Ames Laboratory's Environmental Technology Development Program

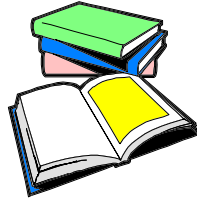
<http://www.epsci.ameslab.gov>

Ames Laboratory, located in Ames, Iowa, was initiated by DOE through its Environmental Management Division. A DOE Headquarters and Ames Lab work together to speed development and transfer of technologies for faster, safer, better, and cheaper characterization, monitoring, and sensing work. One such approach is Expedited Site Characterization (ESC). ESC is a team effort between DOE's Environmental Restoration Program, U.S. EPA, state regulators, and Westinghouse Savannah River Corporation.

California Environmental Technology Certification Program — California Certified Technologies List

<http://www.calepa.ca.gov/calcert/certified.htm>

The California Environmental Protection Agency's (Cal/EPA) Environmental Technology Certification program Internet site provides the user access to the California Certified Technologies List. The document, last updated on August 19, 1998, provides a list of technologies and their respective vendors that have been certified by the state of California. Certification is granted to technologies on the basis of an independent, third-party verification of the technology's performance and ability to meet regulatory specifications and requirements. Developers and manufacturers define quantitative performance claims for their technologies and provide supporting documentation. Cal/EPA reviews that information and, when necessary, conducts additional testing to verify the claims. Technologies, equipment, and products that are proven to work as claimed receive official state certification.



For additional information, please see these other publications issued by the Brownfields Technology Support Center:

- ***Road Map to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup, Second Edition***
EPA 542-B-99-009
 - ***Directory of Technology Support Services to Brownfields Localities***
EPA 542-B-99-005
 - ***Assessing Contractor Capabilities for Streamlined Site Investigations***
EPA 542-R-00-001
 - ***Brownfields Technology Primer: Selecting and Using Phytoremediation for Site Cleanup***
EPA 542-R-01-006
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These publications are available online at:
<http://www.brownfieldstsc.org>

or can be ordered by contacting:

U.S. Environmental Protection Agency
National Service Center for Environmental Publications
(NSCEP)
P.O. Box 42419
Cincinnati, OH 45242-2419
1 (800) 490-9198
FAX (513) 489-8695

Brownfields Technology Primer:

Requesting and Evaluating Proposals That Encourage Innovative Technologies for Investigation and Cleanup



Visit the Brownfields Technology Support Center Web Site at:

<http://www.brownfieldstsc.org>