



# **REVIEW OF THE SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION (SITE) PROGRAM**

**PREPARED BY THE SITE  
SUBCOMMITTEE OF THE  
ENVIRONMENTAL ENGINEERING  
COMMITTEE (EEC)**

July 15, 1997

EPA-SAB-EEC-97-005

Honorable Carol M. Browner  
Administrator  
U.S. Environmental Protection Agency  
401 M Street, SW  
Washington, DC 20460

Subject: Review of the Superfund Innovative Technology Evaluation (SITE)  
Program

Dear Ms. Browner:

At the request of the Office of Research and Development (ORD), the Superfund Innovative Technology Evaluation (SITE) Subcommittee of the Environmental Engineering Committee (EEC) of the Science Advisory Board (SAB) reviewed the Agency's SITE program. The Subcommittee met June 11-13, 1996 at the National Risk Management Research Laboratory (NRMRL) in Cincinnati, Ohio. The EEC approved the Subcommittee's report April 2, 1997 and the SAB's Executive Committee approved this report April 25, 1997.

EPA developed the SITE program in response to the Superfund Amendments and Reauthorization Act of 1986 (SARA). Participation of technology developers in SITE is voluntary and since its inception SITE's primary mission has been the evaluation of innovative treatment technologies for contaminated site remediation. It is anticipated that these evaluations will result in commercialization of promising technologies.

The Risk Reduction Research Laboratory (now part of the National Risk Management Research Laboratory) and the Environmental Monitoring Systems Laboratory (now the National Exposure Research Laboratory) directed the SITE program. ORD requested that the EEC review the technical aspects of the program including:

- a) Establish the extent to which the stated program objectives have been met;

- b) Review the scientific and technical aspects of the SITE program and its implementation on all levels (bench, pilot, and full), including the preparation of test, quality assurance (QA), and quality control (QC) plans, sample collections, and field activities, and procedures for evaluation and interpretation of results leading to conclusions and recommendations;
- c) Identify impacts and provide recommendations for potential improvements; and
- d) Determine how well the approach taken has supported technology commercialization.

The Subcommittee was also asked to recommend program improvements and highlight strengths.

The Subcommittee recognized that decision-makers must consider many factors in addition to science when determining the existence, size, or form of a program. The legislative language as well as the legislative history provide the policy directives to the Agencies in the Executive branch of the federal government. The Subcommittee restricted its review of the SITE program to the science and engineering context and to SITE's impact on the commercialization of innovative technologies. Therefore, its comments should be understood in that same context.

The Subcommittee found the accomplishments of the SITE program to be impressive. Stated program objectives have been generally met or exceeded, and the program has provided credible information on mostly innovative technologies, many of which are in use today at Superfund or RCRA Corrective Action sites. EPA personnel have done a good job of conducting self reviews and adjusting the program to improve its operations.

The need for improved technology to prevent, reduce or remediate environmental contamination remains a national priority. The Subcommittee believes that in order to meet this need, the Agency should build upon the success of SITE either by continuing the existing program with some improvements or by creating a new technology evaluation program built upon the precepts of the current program.

To help select the most appropriate course of action, the Agency should define the desired products, the customer base, and plan how best to bring the two together.

Better product definition and improved marketing--including a clear portrayal of the successes and benefits of the program--will make the program better understood by and even more valuable to the user community. Interpretive documents summarizing and comparing the results of the individual technology evaluations would help practitioners choose wisely from a variety of potentially useful technologies.

The Subcommittee recommends two technical improvements to the evaluations. Cost information should be collected in a more consistent and complete manner, because, often times, cost is the pivotal decision criterion. Also, the level of rigor applied to material balances must be increased to more fully address the Agency's stated concerns about trans-media migration of hazardous constituents and resultant concentration data that could be used in future RCRA Risk-Based Cleanup Actions at actual field sites. SITE should strive for material balances in demonstration projects providing a high level of closure for hazardous constituents.

The Subcommittee appreciates the opportunity to review this program, and looks forward to a written response to its recommendations for the SITE program.

Sincerely,

*/signed/*

Dr. Genevieve M. Matanoski, Chair  
Executive Committee

*/signed/*

Dr. Ishwar P. Murarka, Chair  
Environmental Engineering Committee

*/signed/*

Dr. Wayne M. Kachel, Chair  
SITE Subcommittee

## **NOTICE**

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## ABSTRACT

The Superfund Innovative Technology Evaluation (SITE) Subcommittee reviewed the technical aspects of EPA's SITE program including: a) whether the stated program objectives have been met; b) scientific aspects of the program, including the preparation of test, quality assurance, and quality control plans, sample collections, and field activities, and procedures for evaluation and interpretation of results leading to conclusions and recommendations; c) impacts and improvements; and d) whether the approach taken has supported technology commercialization.

The Subcommittee found the accomplishments of SITE to be impressive because they generally met or exceeded stated program objectives and because SITE provided credible information on mostly innovative technologies, many of which are in use today. The annual Reports to Congress and Associated Technical Profiles have recorded the growth and development of SITE to a multi-faceted program which included 77 emerging technologies, 124 demonstrations, 30 monitoring and measurement methods, and an extensive technology transfer effort. An analysis of cost savings using innovative technologies for 17 sites in four EPA regions, indicates that the innovative technologies saved five to two hundred million dollars per region.

Because of the continued need for and the contributions made by the SITE program, the Subcommittee advises that the Agency build upon the successes of SITE and continue with either a refinement of SITE or a "SITE Like" program for evaluation of innovative technologies. The Agency should define the desired products and the customer base, then develop a plan for how best to provide the product to the customer. SITE should clearly portray the successes and benefits of the program, and provide interpretive analyses to facilitate decisions about which technologies are best suited to their situations.

The Subcommittee also recommends that more complete and consistent cost data be developed in future demonstration projects and that the rigor of materials balances be increased to better account for the fate of hazardous constituents.

**Keywords:** technology, development, demonstration, evaluation, Superfund

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# 1. EXECUTIVE SUMMARY

EPA developed the Superfund Innovative Technology Evaluation (SITE) program in response to the provisions of the Superfund Amendments and Reauthorization Act of 1986 (SARA). Its primary mission has been to develop, implement, and commercialize innovative treatment technologies for contaminated hazardous waste site remediation.

From June 11 through 13, 1996, the SITE Subcommittee met at the National Risk Management Research Laboratory's (NRMRL) to review the SITE program. The charge was to review the technical aspects of the program including:

- a) Establish to what extent the stated program objectives have been met;
- b) Review the scientific and technical aspects of the SITE program and its implementation on all levels (bench, pilot, and full), including the preparation of test, QA, and QC plans, sample collections, and field activities, and procedures for evaluation and interpretation of results leading to conclusions and recommendations;
- c) Identify impacts and provide recommendations for potential improvements; and
- d) Determine how well the approach taken has supported technology commercialization.

The Subcommittee was also asked to recommend Program improvements and highlight strengths.

The Subcommittee found the accomplishments of the SITE program to be impressive. Stated program objectives have been generally met or exceeded, and the program has provided credible information on innovative technologies, many of which are in use today at Superfund or Resource Conservation and Recover Act (RCRA) Corrective Action sites. An analysis of cost savings using innovative technologies for 17 sites in four EPA regions, indicates that the innovative technologies saved five to two hundred million dollars per region (USEPA, 1996b). EPA personnel have done a good job of conducting self reviews and adjusting the program to improve its effectiveness.

The need for improved technology to prevent, reduce or remediate environmental contamination has not disappeared. Because that need remains, and because the SITE program has been relatively successful, the Subcommittee--speaking from a science and engineering viewpoint--strongly recommends that the Agency build upon the successes of SITE either by continuing the existing program or by creating a new technology evaluation program built upon the precepts of the current program.

To help select the most appropriate course of action, the Agency should define the desired products, the customer base, and plan how best to bring the two together. Better product definition and improved marketing--including a clear portrayal of the successes and benefits of the program--will make the program better understood by and even more valuable to the user community. Interpretive documents summarizing and comparing the results of the individual technology evaluations would be easily referenced sources of credible information. Such easy-to-use documents would help practitioners choose among the variety of potentially applicable technologies.

It is now time for the program to develop more substantive objectives with which to measure the progress of the program. Metrics are needed for the various objectives to evaluate the program's very real contribution to remediation and technical cultivation. For purposes of illustration, additional metrics might include: a tabulation of the technologies that have participated in SITE, the subsequent use of those SITE technologies in remediation (or elsewhere) and the number of locations where they were used; some measures of reduced costs for remediation, restoration, measurement and monitoring; and documentation of cleanups that are cheaper, faster, and better because of SITE.

The Subcommittee recommends two technical improvements to the evaluations. Cost information should be collected in a more consistent and complete manner, because, often times, cost is the pivotal decision criterion in selecting a technology at a site. Also, the level of rigor applied to material balances must be increased in response to the Agency's stated concerns about trans-media migration of hazardous constituents. SITE should strive for material balances that provide a high degree of certainty as to the fate of hazardous constituents.

## 2. INTRODUCTION

### 2.1 Background

EPA developed the Superfund Innovative Technology Evaluation program (SITE) in response to the provisions of the Superfund Amendments and Reauthorization Act of 1986 (SARA). Its primary mission has been to evaluate innovative treatment technologies for contaminated site remediation. The mission is accomplished through four sub-programs.

- a) Demonstration Program (DP) - Conducts and evaluates demonstrations of promising innovative site cleanup technologies to provide reliable performance and cost information.
- b) Emerging Technology Program (ETP) - Provides funding to developers to continue research efforts at the bench and pilot-scale levels for the development of innovative technologies.
- c) Monitoring and Measurement Technologies Program (MMTP) - Develops technologies that detect, monitor, and measure hazardous and toxic substances to provide better, faster, and more cost-effective methods for producing real-time data during site characterization and remediation.
- d) Technology Transfer Program (TTP) - Disseminates technical information on innovative technologies obtained via DP, ETP, and TTP.

In 1985, even before the SITE program was established, the Environmental Engineering Committee (EEC) of the Science Advisory (SAB) sent a resolution to the EPA Administrator expressing concern, "that enormous expenditures were being made under Superfund without an adequate technological data base to support rehabilitation of . . . sites" (SAB, 1985). In response, the SAB's EEC was asked to review plans for the SITE program and "found the draft Strategy and Program Plan to be well done, and a good basis for proceeding." (SAB, 1986). The following year, the SITE Emerging Technology Program began to foster and accelerate the research and development of innovative technologies.

At a June 28, 1990 public meeting, the EEC expressed interest in reviewing the SITE program. A variety of reviews subsequently sharpened the EEC's interest in

innovative environmental technologies and in how to encourage further technology development. In FY95, agreement was reached with the Office of Research and Development (ORD) and the Office of Solid Waste and Emergency Response (OSWER) for the EEC to undertake this review of the SITE program.

## **2.2 Context**

The Subcommittee recognizes that decision-makers must consider many factors in addition to science when determining the existence, size, or form of a program. Public values, government policy, various current events, the economy, and competing needs are part of this larger context. The Subcommittee restricted its review of the SITE program to the science and engineering context and to SITE's impact on the commercialization of innovative technologies. Therefore, its comments should be understood in that limited context.

The Subcommittee assumes that technology development and evaluation should and will continue at EPA. Thus, the recommendations herein are intended to improve that undertaking. Consideration of non-science factors could lead a decision-maker to alter or end EPA programs that assist with technology development and evaluation. However, from a science and engineering viewpoint, knowing that the annual market for remediation in the U.S. alone approaches \$10 billion and that decades will be needed to clean up those locations already identified--and having seen research and improved technology lower costs, improve performance, and speed clean-up (NETAC, 1995)--the Subcommittee finds a compelling need for continued existence and improvement of SITE.

An independent technical review of an ongoing program can result in significant beneficial improvements to the program. In choosing to conduct the SITE review even during the uncertain budget decisions for FY96-97, the Subcommittee has acknowledged the fundamental importance of technology development and evaluation programs in the public sector. Because of SITE's uniqueness as a prototype for government/private sector technology innovation programs, documenting the benefits and shortcomings of SITE could be useful to other programs (particularly for programs such as the Environmental Technology Verification Centers currently being planned).

## **2.3 The Review and Charge**

On June 11-13, 1996, the SITE Subcommittee of the EEC met at the National Risk Management Research Laboratory (NRMRL) to review the SITE program. The

Subcommittee was charged to review the technical aspects of the SITE program methodology, and to:

- a) Establish the extent to which the stated program objectives have been met;
- b) Evaluate the scientific and technical aspects of the SITE program and its implementation on all levels (bench, pilot, and full), including the preparation of test quality assurance (QA) and quality control (QC) plans, sample collections, and field activities, and procedures for evaluation and interpretation of results leading to conclusions and recommendations;
- c) Identify impacts and provide recommendations for potential improvements; and
- d) Determine how well the approach taken has supported technology commercialization.

During the June 11-13, 1996, meeting, the Subcommittee was also asked to recommend potential future program directions.

A full listing of the review documents provided prior to and during the meeting can be found in Appendix B.

### **3. RESPONSE TO THE CHARGE**

The Subcommittee finds itself in the unusual position of pointing out that the SITE program has not received full recognition for its contributions. The SITE program has met the objectives set for it, has become a model for at least one other technology evaluation program, EnTICE, and has played a substantial role in joint technology evaluations with the Departments of Energy and Defense. Because the need for technology that reduces or remediates environmental contamination remains, the SITE program should be continued, with some modifications. The Subcommittee's cross-cutting findings follow immediately. The detailed response to the charge appears in Sections 3.1 through 3.5.

First, the Subcommittee commends the SITE staff for their careful preparation for the review, their responsiveness to requests for additional information before and during the review, and for being forthright in discussions. This enabled the Subcommittee to reach informed conclusions about the various aspects of the SITE program. The quality of the interaction indicates that the SITE program is staffed with professionals who understand the scientific and engineering requirements of technology evaluation.

Indeed, SITE program staff have recognized the importance and value of using good science and technology from the inception of the program. The quality assurance, quality control, and auditing aspects of the program are now well organized and have resulted in systematic improvements to the implementation of demonstration projects under SITE. EPA personnel have done a good job of conducting self-reviews and using the results to improve the SITE program as warranted. As a result, the program has been very productive.

Second, the SITE program is generating credible, objective evaluations of individual technologies selected for demonstrations, however, the scientific rigor of the program--coupled with a natural reluctance to appear to favor any technology or vendor--has constrained the conclusions which SITE has drawn. The SITE program staff appear to have a more comprehensive understanding of the limitations and the applicability of the evaluated technologies than that indicated by the Innovative Technology Evaluation Reports (ITER) for the Demonstration Program. There appear to be both data and expertise to support interpretive analyses that could help developers by guiding future development and could help potential users select the most appropriate technologies. Such analyses are not currently conducted.



The Subcommittee understands that developers, consulting engineers, local, state and federal officials making decisions on site remediation, investors, the media and the lay public all can benefit from the SITE results. The Subcommittee finds that SITE results are currently reported in a manner suitable for the professional peers of the researchers and in a manner useful to engineers experienced in location remediation. Some of the consumers of SITE information may have conflicting needs. Some developers may not wish their technology to appear with descriptions of other technologies in an interpretive document where comparisons can more easily be drawn about which technology is most useful for a particular application. Such documents are well within the technical capability of the staff and are potentially of great use to less experienced engineers, decision-makers and the lay public.

Speaking from the research science standpoint, the creation of such interpretive documents would be a valuable advancement. In the context of regulatory science, it would appear that such documents should make SITE more accessible and accountable to a broader range of its potential users.

Third, the program could benefit from an updated strategy developed, in part, from an improved understanding of SITE's customer base, the products needed, and how best to deliver those products to the customers. The updated strategy should identify metrics for measuring the success of the program as a whole, not just for the success of individual projects. Examples of such metrics might include: documenting to what extent SITE has helped commercialization of demonstrated technologies or documenting reduced remediation costs; follow-up on technologies evaluated to assure that recommended improvements are widely implemented; and documenting the use of investigation and monitoring techniques evaluated by SITE.

### **3.1 Meeting Objectives**

Many objectives have been set for SITE. Section 3.1.1 summarizes the stated objectives and Section 3.1.2 summarizes the Subcommittee's findings in relation to those objectives. Section 3.1.3 presents the Subcommittee's findings as they relate to unstated objectives. Section 3.1.4 recommends development of more demanding objectives.

#### **3.1.1 Summary of Stated Objectives**

After more than a decade of operation, the SITE program is well-defined, with established objectives and implementing tactics. While few of these objectives were originally stated in terms of measures of quality or quantity, the Subcommittee finds

substantial quantitative and qualitative evidence that the SITE program has met or exceeded the objectives as stated in SARA, in the mission statement, and in review materials.

The Superfund Amendments and Reauthorization Act of 1986 (SARA) required EPA, “to establish a comprehensive and coordinated Federal program of research . . . evaluation, testing, development, and demonstration of alternative or innovative treatment technologies . . . which may be utilized in response actions to achieve more permanent protection of human health and welfare and the environment.” SARA also required an annual solicitation, demonstration plans, ten demonstrations per year, and annual reports to Congress.

The SITE program’s mission statement reads, “to conduct technology development and demonstration projects, technology transfer activities, and technical assistance to increase commercialization of innovative hazardous waste clean-up technologies” (USEPA, 1996a).

In presentations to the Subcommittee, the following Program objectives were stated; “facilitate acceptance by regulators, provide a sound scientific basis for evaluating technology, provide reliable performance information, support the use of ‘verified’ technologies, pool resources of Federal and private sectors, and reduce the time it takes to get new technologies into routine use” (USEPA, 1996b).

### **3.1.2 Subcommittee Findings as They Relate to the Objectives**

With respect to Congressional requirements, the SITE program has matured in response to its broadly defined mission, as directed in SARA, into an operationally productive and impressive activity. SITE collaborates with and conducts research on a variety of technologies with other agencies, including the Departments of Commerce, Defense, Energy, and Interior, various states (including Arizona, Florida, and New York), and the private sector (USEPA, 1996b). From 1987 to 1994, SITE co-funded 21 emerging technology projects with DOE and 8 with DOD, conducted three demonstrations with New York State, and developed 72 cooperative agreements with the private sector (USEPA, 1995a and USEPA, 1996b). SITE has an annual solicitation for projects and reports annually to Congress as required by SARA (USEPA, 1995a).

SITE’s Demonstration Program prepares demonstration plans, and conducts and evaluates demonstrations for ten innovative location cleanup technologies each year. Subcommittee members are aware from their professional experience that technologies

demonstrated in the SITE program are being utilized in response actions to remediate contaminated locations. Based on these findings, the Subcommittee concludes that the SITE program has been responsive to the objectives set for it by Congress.

With respect to achieving the objectives of SITE's mission statement, the Emerging Technology Program funds research efforts at the bench and pilot-scale levels for the development of innovative technologies. Of participants in the emerging technology program, 60% are pursuing commercialization and almost a quarter had buyers for the technology under development (USEPA, 1995a). The Demonstration Program conducts and evaluates demonstration of innovative technologies; 117 technologies had been accepted into the program by the end of FY94 (USEPA, 1995a). The Monitoring and Measurement Technologies Program (MMTP) addresses methods for detection and monitoring of contaminants and the geophysical characteristics of Superfund locations. It provides developers with the opportunity for a rigorous evaluation of their technology's performance; evaluations or demonstrations for 27 technologies have been completed (USEPA, 1994). The Technology Transfer Program (TTP) undertakes technology transfer activities and provides technical assistance to increase commercialization of innovative hazardous waste clean-up technologies. Not all of its work is written; the TTP holds on-location Visitor's Days for local communities and prepares demonstration videotapes. The TTP made available databases on treatment technology, treatability studies, underground storage tanks, and spills of chemicals or oil. In addition to the Annual Report to Congress, the TTP produces SITE Technology Profiles, Demonstration Bulletins, and Success Stories (Superfund at Work). SITE personnel have also published in the peer reviewed literature and provided statistics on the ETP, DP, MMTP, and TT achievements. In FY94, the TTP distributed almost 325,000 copies of publications to requesters (USEPA, 1995a).

The use of SITE demonstrated technologies for remediation, coupled with positive statements by developers, implies a positive effect of the program on commercialization. Three successful developers are quoted in The Annual Report to Congress 1994 (USEPA, 1995a).

SITE has generally been successful in achieving its mission, "to increase commercialization." To achieve commercialization of an innovative technology, three items must exist: a) a market for the technology, b) scientific data verifying the technology, and c) successful case studies from actual technology applications. However, some elements of the SITE program create barriers to commercialization in some situations. Other barriers or needed improvements include: improved timeliness of reports, better cost estimates, improved performance data interpretation, simplicity

and clarity in summarizing results, and evaluations that aid potential technology users in determining whether or not a technology is cost-effective in their situation.

Through the SITE program, the Agency has enabled technology innovators to test and demonstrate technologies under strict protocols and QA/QC requirements, thereby providing objective performance information. The SITE program has collected extensive performance data on numerous promising innovative technologies.

The resulting SITE reports have generally delivered reliable scientific information but limited cost information on the performance of technologies. Most of the technical reports well describe the technologies and information generated during testing. In the Subcommittee's experience, successful demonstration of a remediation technology does facilitate acceptance by regulators, because they tend to support use of demonstrated technologies.

The Subcommittee found that SITE does make use of the best attributes of both the Federal and private sector. The government provides credibility, experience in the evaluation of remediation technologies, access to test locations, visibility, and technology transfer. The private sector provides creativity, funding, equipment and related operations. In some sense, SITE is to the user community as Consumer Reports is to the ordinary consumer. This is a very valuable service to the private sector.

To measure how much SITE has reduced the time to get new technologies on line, one would need to know how long it would take similar technologies without SITE. This is not known. The Subcommittee cannot quantify how much SITE has accelerated the commercialization process.

However, there are several good reasons to infer that SITE has reduced the time it takes to get new technologies on line. First, because SITE program projects are exempt from permits, the SITE program removes the delays associated with obtaining permits. Second, SITE's ET program "feeds the pipeline" by encouraging new ideas for technology to make their way through the "Valley of Death." "The "Valley of Death" for environmental technology development occurs when the federal funding program considers a technology 'too applied' for additional funding and industry considers the technology 'too embryonic' to adopt" (NETAC, 1995). Third, participants have stated that SITE had assisted them in commercialization--and speed is a critical issue in commercialization (USEPA, 1995a). Fourth, the SITE program has helped create high interest in new or practical technologies by users and vendors. Staff within state agencies as well as within EPA are aware of the technologies being tested in SITE and

the results; this may reduce the time and difficulty in getting a technology approved at a different location.

### **3.1.3 Findings Relating to Unstated Objectives**

In terms of the scientific foundations, the SITE program has appropriately identified the critical phases of technology development from research to market penetration and commercialization. These are:

- a) Technology research,
- b) Pilot development,
- c) Field demonstration,
- d) Information and Technology Transfer, and
- e) Market Penetration/Commercialization (USEPA, 1995a).

The program's research quality is attested to by both the QA/QC documentation and the acceptance of papers in the peer-reviewed literature (USEPA, 1995a). The latter is also one of many indicators of relevance. SITE has already been used on at least one occasion, by the EnTICE program, as a model for other organizations attempting to evaluate and demonstrate innovative technologies.

With respect to communicating the results and benefits of the SITE program, there is room for further improvement. Such communication is important for two reasons. In the Subcommittee's view, SITE is regulatory science--and regulatory science must be communicated clearly not only to the professional community, but to other users as well. Also, in the Subcommittee's view, SITE is a relevant and quality research program worthy of continuation; it is worrisome that some decision makers do not appear to be aware of SITE's achievements.

The annual Reports to Congress and Associated Technical Profiles have recorded the growth and development of SITE to a multi-faceted program which included 77 emerging technologies, 124 demonstrations, 30 monitoring and measurement methods, and an extensive technology transfer effort. Almost 325,000 copies of documents were distributed in FY94 alone (USEPA, 1996a; 1995b). Despite the variety, quantity, and wide distribution of technology transfer products (from on-location Visitor's Days and videos to a dozen different types of written products), the

Subcommittee perceives the availability of such disclosures as somewhat random, mechanically delivered, and without a concerted effort to highlight those feedback mechanisms that would serve to sustain and elevate the program to even greater levels of achievements.

Despite SITE's communication efforts, it is unfortunately true that SITE's accomplishments over this 10-year period have not been as vividly and universally acknowledged as they may have merited. Indeed, some of the criticism of SITE during this period may result from the failure to communicate in a clear but scientifically sound and technically decisive manner, with metrics that indelibly quantify successes as well as failures. Hence, some skepticism has arisen which brings to question the overall effectiveness of the program in terms of impact and return on investment.

A more effective mechanism to highlight accomplishments in targeted user groups could include a more vivid identification of the stakeholder constituencies, their needs, and how value is tangibly added by the SITE program. Networking with these beneficiaries should ensure vitality consistent with needs and offer opportunities for restructuring and refining goals and strategies as the next evolution of SITE unfolds.

#### **3.1.4 Developing More Demanding Objectives**

The SITE program has met the original objectives and has developed methods for evaluating individual projects. Hence, the Subcommittee generally views the program as a success with an opportunity to grow into an even more productive entity. It is now time for the program to develop more substantive objectives with which to measure the progress of the program. Metrics are needed for the various objectives to evaluate the program's very real contribution to remediation and technology cultivation. Discussions between SITE program staff and customers could better define the products needed and the methods of delivery. The Subcommittee believes that such discussions will identify interpretive analyses as highly useful to the customers.

The SITE program staff already counts the number and variety of technologies addressed in the subprograms, the progress of technologies to commercialization in the United States and abroad, the projects co-funded with others, and the distribution of technology transfer products. For purposes of illustration, additional metrics might include: a tabulation of the technologies that have participated in SITE, the subsequent use of those SITE technologies in remediation (or elsewhere) and the number of locations where they were used; some measures of reduced costs for remediation, restoration, measurement and monitoring; and documentation of cleanups that are cheaper, faster, and better because of SITE.

Because SITE has generally met the past objectives set for it, the Subcommittee finds it appropriate to “raise the bar” and hold the program to higher standards. From this new perspective, the Subcommittee views the lack of such objectives (and metrics) as an overall program weakness that jeopardizes the desired stability and growth of the program. Because the SITE program staff have made steady improvements to the program over the last decade, the Subcommittee is confident that they can strengthen the program by developing better objectives and metrics in cooperation with their customers.

The Subcommittee suggests that individual technology evaluations could be improved by the inclusion of consistent cost information, use of a success matrix, and more rigorous mass balances.

### **3.2 Scientific/Technical Aspects and Implementation**

In its review of the SITE component programs, the Subcommittee gave the greatest attention to the Demonstration Program and less attention to the lower-funded Emerging Technology Program and the Monitoring and Measurement Technology Program. The proportional funding for DP, ETP and MMTP is, respectively, 28:3:1, when NRMRL staffing costs are excluded. (The funding for Technology Transfer which is responsible for dissemination of information regarding DP, ETP and MMTP, is incorporated into the funding of the other component programs).

#### **3.2.1 Project Planning**

SARA requires the Agency to supervise demonstrations and provide quality assurance for associated data. The SITE planning process includes the developers, support contractors, Agency personnel, and other stakeholders as participants. To meet its responsibilities, the Agency employs a Data Quality Objective planning process that defines critical elements of the planning process and documents them in a Project Objective Agreement (POA). Planning details are further described in Implementation Agreements and Quality Assurance Project Plans (QAPP). All stakeholders, including the Agency or their contractors and those responsible for data production, sign these plans and agreements .

The Subcommittee reviewed examples of recent planning documents and noted a level of detail that displays an understanding of the innovative technologies and proper technology evaluation (USDOE, 1995; USEPA, 1995b; PRC, 1994). The plans recognize the potential impact of soil, waste, and residual heterogeneity upon precision and levels of uncertainty. Implementation of these plans should result in data of known

quality suitable for technology evaluation. The reviewed documents confirmed the general consensus of the Subcommittee that SITE addresses most of the technical and scientific aspects that are key to the evaluation of innovative technology.

NETAC has identified several technical barriers to environmental technology commercialization. They are inter-related and include: lack of acceptable demonstration locations; difficulties associated with technical performance and engineering for scale-up; lack of real performance and cost data, lack of methods to measure success, lack of site characterization data; and the complexity of both wastes and contaminated sites (NETAC, 1995). With the exception of the difficulties associated with technical performance and engineering for scale-up, these barriers to commercialization are also barriers to evaluation.

The Subcommittee has made suggestions regarding mass balance, cost comparability and interpretative analysis; if SITE is continued, then planning of future SITE evaluations and demonstrations should be expanded to accommodate these features.

### **3.2.2 Quality Assurance and Quality Control**

The Agency's planning process assigns the level of quality assurance according to the end use of the scientific and technical data. A series of Agency publications document this structured project planning process (USEPA, 1991a-d). The Agency employed Level II quality assurance planning for Demonstration Program projects because data generated by these projects are of high visibility and could be used for making policy decisions. The Agency implemented a slightly less demanding planning process (Level III) for Emerging Technology Program projects because the associated data are used to determine the feasibility of emerging technologies. MMTP projects are planned according to Agency guidance (USEPA, 1995c).

The Subcommittee reviewed examples of DP, ETP and MMTP Quality Assurance Project Plans (QAPP), field and laboratory audit reports and corrective actions. The audit reports, which are referred to as Technical System Reviews, detail compliance with the QAPP and identify concerns and technical comments. Technical system reviews are scheduled at the beginning of sampling and analytical efforts to ensure that concerns are identified and corrected early in the project. The QAPPs describe the types and frequency of quality control samples, the quality assurance organization, quality indicators, data handling, management oversight as well as the appropriate sampling and analytical protocols.



In response to an independent management assessment, more recent projects identify and document their objectives in project POAs. POAs detail quantitative goals and acceptable levels of decision error. The SITE program recognizes QAPPS and the issues addressed in POAs are key to project QA/QC and that these planning documents are in great part responsible for the high quality of sampling and analytical data now associated with the SITE program.

### **3.2.3 Interpretative Analysis**

Writing from the perspective of science and engineering, the Subcommittee finds that the usefulness of the SITE program could be improved by the addition of interpretive analyses, either to the Innovative Technology Evaluation Reports (ITER) or as stand-alone summary reports. While decision-makers must consider many factors in addition to science when making decisions about programs and their products, the Subcommittee believes that such analyses would be very useful to consumers and the scientific community.

Over the last decade the SITE program has generated significant quantities of data from DP, ETP and MMTP evaluations. Due to time and costs constraints, these data cannot capture the effect that all environmental, waste or operating conditions may have on a technology's efficacy. However, the Subcommittee infers from the depth, breadth, and quality of its discussions with the SITE program staff at the public meeting that the program staff have a more comprehensive understanding of the limitations and the applicability of the evaluated technologies than that which is routinely documented in Demonstration Program ITERs.

Section 311.(b)(5)(A)(v) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requires the Agency to establish a demonstration program that includes "The evaluation of the results of the alternative innovative technology demonstration projects and the determination of whether or not the technologies used are effective and feasible." A discussion of the limitations and potential applications of a technology including a discussion of the applicable and non-applicable matrices, wastes, contaminants and operational conditions appears to fall within this mandate. The Subcommittee believes the Agency can comply with this aspect of the law within the limitations of the data, and balance this need for interpretation without displaying bias for a technology. These interpretations and the bases for these interpretations should be subjected to the Agency's quality assurance review. While the interpretive analyses may not be a measure of absolute success, they would at least provide a comparative measure. This interpretive analysis can be

of significant help to developers by guiding future development, and to the potential users who are searching for an appropriate technology.

### **3.2.4 Mass Balances**

Evaluation of innovative technologies requires that destruction or removal efficiencies be calculated for the contaminants of concern. It is often difficult to accurately balance inputs and outputs. Heterogeneity of influent, pre-treatment, post-treatment and in-situ materials are impediments to accurate mass balances, as are the complexity of the treatment system and the potential presence of sinks and leaks in treatment equipment. Testing the system for a longer time reduces these difficulties, but may also add to the cost of the evaluation.

Notwithstanding these limitations, mass balances providing a high degree of closure are generally expected to determine a technology's performance. During the public meeting, the Agency made the point that mass balances of 80% or greater are not always achieved. This problem is not unique to the SITE program. Because staff understand the difficulties involved and possible solutions, more deliberately sharing their experiences might benefit the wider technical community. This could be achieved through publications, a workshop, or some other means.

### **3.2.5 Coordination of MMTP Activities**

Because of the relative expense of evaluating innovative treatment technologies, the Monitoring and Measurements Technology Program (MMTP) has been funded at a lower level than the DP and ETP programs. Nonetheless, MMTP is an important part of the SITE program because characterization and monitoring costs are often a substantial percentage of remediation costs.

The MMTP is implemented by the National Exposure Research Laboratory's (NERL), Characterization Research Division located in Las Vegas, NV. Due to its expertise in monitoring and measurement technology, NERL has also attracted funding from the Environmental Technology Initiative (ETI) and the Strategic Environmental Research and Development Program (SERDP). NERL has field-tested characterization and monitoring technologies and has assessed their applicability and limitations.

The Subcommittee encourages SITE staff to continue to identify those characterization and monitoring needs important to the Superfund program, and to work closely with NERL to maintain its integration within the SITE program while

leveraging the MMTP to meet the needs of Superfund and other related multi-agency efforts.

### **3.3 Impacts and Improvements**

First, SITE has developed and tested technologies which have resulted in a positive impact on the nation's location remediation efforts. SITE has facilitated the scale-up of some technologies to field trials or demonstrations--a major hurdle in any development effort. The SITE program has subjected many of the evaluated technologies to more extensive and rigorous testing and review than is often conducted by a developer. This permits better decision-making by consumers.

Second, SITE has interested users and vendors in new, improved, or more practical technologies. By participating in SITE, a new technology or improvement gains credibility and exposure. Staff within EPA and state agencies are aware of what technologies SITE is funding, and technical consultants learn from their government contacts. SITE circulates reports and bulletins to a wide audience, and most of the technologies that received SITE support are in use. In 1992, more than half of Superfund Records of Decision (RODs) used innovative technologies versus conventional technologies (USEPA, 1996b).

Third, an analysis of cost savings using innovative technologies for 17 sites in four EPA regions, indicates that the innovative technologies saved five to two hundred million dollars per region (USEPA, 1996b). While data are not available on enough locations to quantify the total cost savings due to SITE, SITE has reduced technology costs for site characterization and remediation and has the opportunity to have further positive impact. SITE financial support, during development and scale-up, reduces the financial burden on the technology developer. This saving reduces pass-on costs to first practical applications. When cost reporting for a demonstration project is complete and credible, then potential technology users will be able to examine base rate financial data and costs will become less susceptible to vendor manipulation. This, too, should lead to cost reductions.

It is the Subcommittee's understanding that by reducing barriers to commercialization of new technologies, collecting and reporting credible and complete cost and performance data, and including interpretive analyses easily understood by those who select technologies for location characterization and remediation, the SITE program will reduce government expenditures at Superfund locations and, in so doing, reduce costs to the taxpayers.

The Subcommittee wishes to emphasize that one of the most critical expectations of the SITE program is provision of a fair and consistent basis for evaluation of results and the comparison of competing technologies--to be a "Consumer Reports" for site remediation. Therefore, one of the most valuable advancements SITE could make is to improve the consistency and completeness of the objective measures for evaluation and inter-comparison. Although, SITE has developed some criteria for comparison, the program currently refrains from making comparative statements regarding technology success, problems, or failure. And, of course, not all technologies participate in SITE. As a result, the potential user is still somewhat vulnerable to marketing claims when making a decision whether or not to employ a particular technology or to choose between technologies.

### **3.4 Technology Commercialization**

The SITE program mission includes facilitating the commercialization of innovative technologies. Commercialization can be defined two ways, with most views on commercialization falling somewhere between the two. Industry usually defines commercialization as turning a profit, but the term can also be defined in the environmental arena as commercial scale. Commercial-scale efforts provide reliable performance, cost, and applicability information to technology developers, industry, and the public. These data become crucial in enabling industry to market technologies. Thus, the two definitions are actually integrated and form the basis of the term "commercialization" in this report.

#### **3.4.1 Factors Affecting Commercialization**

To achieve commercialization of an innovative technology, three items must exist: a) a market for the technology; b) scientific data verifying the technology performance; and c) successful case studies from actual technology applications. While SITE generally facilitates commercialization, some elements of the SITE program create barriers to commercialization. Other needed improvements include: improved timeliness of reports, better cost estimates, improved performance data interpretation, simplicity and clarity in summarizing results, and evaluations that aid potential technology users in determining whether or not a technology is cost-effective in their situation.

Of the barriers, the biggest, and most important is time. Because of the numerous and complex barriers associated with environmental technology development, investors often lack confidence that they will receive an adequate and timely return on their investment (NETAC, 1995). Often developers rely on the SITE

report as a marketing tool. Unfortunately, at times SITE has experienced significant delays in the review and publishing of reports. Without significant internal financial resources or outside investors, a small firm may perish in the time it takes the SITE program to produce a report.

Four problems can limit the ability of the SITE program to gather cost data and develop useful projections for demonstrated technologies, which are critical in technology commercialization (Evans, 1990).

- a) Each field demonstration represents a mix of unique factors. Location-specific conditions such as type of media and location geology largely determine the cost of applying a particular technology at a given location. Such variability often makes it difficult to translate costs to other locations having different conditions.
- b) The research and development aspects of each demonstration impacts observed costs. Specifically, this problem relates to the one-time costs that occur when first demonstrating a technology (e.g., unplanned equipment modifications, shakedown problems).
- c) Each developer is a profit maximizer operating within a competitive marketplace. By law, all data collected during a demonstration shall be made available to the public except trade secrets or other proprietary information. The confidentiality assigned to proprietary information protects the vendor from having to share information that may affect their marketing and price competitiveness, but it also makes it more difficult to develop cost projections.
- d) The SITE program creates unique interactions, such as exemptions from permits, between the public and private sectors. The unique nature of these interactions may result in a cost under- or overestimate, which dramatically impacts the market and all stakeholders.

To address these concerns, the SITE program developed the following five rules to govern each SITE cost analysis (Evans, 1990).

- a) Provide full disclosure of all assumptions and calculations used in the base-case analysis.
- b) Place each base-case cost analysis within a common framework of 12 cost categories listed in Table 1.
- c) Present each base-case cost projection as "order of magnitude" estimates (+50% and -30%).
- d) Identify key operating parameters that are likely to have significant cost implications beyond the base-case.
- e) Offer developers the opportunity to present their own cost analysis.

<b>Table 1</b> <b>Cost Categories for SITE Base-Case Analyses</b>	
1.	Site preparation
2.	Permitting and regulatory requirements
3.	Capital equipment
4.	Startup
5.	Labor
6.	Consumables and supplies
7.	Utilities
8.	Effluent treatment and disposal
9.	Residuals/waste shipping and handling
10.	Analytical services
11.	Maintenance and modifications
12.	Demobilization

(Adapted from Evans, 1990)

The SITE program has assembled vendor supplied cost data for technologies to aid in commercialization. However, no rigorous evaluation is conducted to investigate

how the vendors generated the cost data. To support technology commercialization, cost data must be presented in a consistent and defensible manner.

### **3.4.2 Timeline**

Long periods for evaluation and reporting are a barrier to commercialization. The time the SITE program takes for an evaluation varies from one technology to another, and the time taken to document and report the results also varies. In an extreme case, a lag time of one year occurred between when the ITER report was final and when it was published. Smaller companies cannot financially survive the average three years that it takes to participate in the SITE program.

### **3.4.3 Technology Transfer**

The SITE program has made a conscious effort to provide a variety of users with information about the program and the technologies evaluated by it. The Agency's Center for Environmental Research Information (CERI) has distributed almost 325,000 copies of reports documenting innovative technologies in the SITE program (EPA, 1995a). Users include consultants, state and local governments, the Agency, other federal organizations, universities, industries, and private citizens groups. This distribution of knowledge provides an informed basis for discussion among users and technology developers, which, in turn, can mean potential commercialization at other locations. SITE participants have found the SITE program to be a good marketing tool that increases visibility. Several stated that SITE was the single most important aspect of commercializing their technology. In fact, one stated that the technology would not have become commercial if it had not been for the SITE program.

However, the transfer of knowledge from the SITE program to potential users outside of the Superfund arena and other government agencies can be improved. Disagreements between agencies regarding evaluation protocols sometimes result in lack of commercialization of the technology, despite a favorable report from the SITE program. If the SITE program proves the technology is effective (through results), then other government agencies (e.g., DOD) should readily accept these results as valid. This approach would not only promote commercialization of the technology, it would save other agencies time and money in testing the technology. A report expected from the National Research Council's Committee on Innovative Remediation Technologies in 1997 may be helpful. (National Research Council, in preparation) The report is expected to address evaluation of protocols for commercializing innovative remediation technologies for ground-water clean-up and to suggest standard protocols for testing, evaluating, and verifying these technologies.

#### **3.4.4 Market Determination**

In the view of private sector environmental firms and potential investors, the development and demonstration of innovative technology is secondary to the development of actual markets for these technologies (Commercialization Roundtable, 1993). The NETAC report makes the same point, (p vii)

“ . . . the investment community seeks opportunities for high-growth businesses, not in technologies. As a result, ‘seasoned’ entrepreneurial management which can offer critical business or marketing skills is essential to the successful development of environmental technologies. Typically, the developer’s emphasis on research is too great, with too little emphasis on commercialization or technology applications “ (NETAC, 1995).

Therefore, to ensure that each demonstration has a purpose, the SITE program may wish to require that applicants demonstrate in writing the existence of a potential market prior to selection or it may prove to be just a waste of effort and financial resources of the involved parties including the Agency.

#### **3.4.5 Permitting**

SITE program projects enjoy certain advantages. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 311 (b) exempts SITE program projects from permits. Also, the projects are covered under CERCLA Section 107 (b) for liability. Thus, the SITE program inherently removes many of the barriers associated with obtaining permits (e.g., lengthy delays before beginning work and costly insurance premiums).

#### **3.4.6 Conclusions About Commercialization**

The SITE program has helped a number of technologies become commercialized. However, the time needed to implement SITE’s procedures and restrictions has also hindered others from being successful in the commercial market. Other barriers or needed improvements include: improved timeliness of reports, better cost estimates, improved performance data interpretation, simplicity and clarity in summarizing results, and evaluations that aid potential technology users in determining whether or not a technology is cost-effective in their situation.



The SITE program's success in developing and demonstrating innovative technologies is partly due to the focused strategies and approaches EPA developed to achieve those ends. However, commercialization brings with it some inherent difficulties, and EPA's role in the commercialization aspect of the SITE program mission is unclear. It may be that SITE's role is simply to provide a unique opportunity to generate scientifically defensible cost and performance data that allows industry to simplify its commercialization efforts. In any case, without a clear strategy and systematic approach, it will be difficult for EPA to focus on commercialization or to measure success in this area.

### **3.5 Future Direction**

Remediation is a big, expensive problem that won't be solved quickly. The annual market for remediation in the U.S. alone approaches \$10 billion, and decades will be needed to clean up those locations already identified (NETAC, 1995). Improved technology lowers costs, improves performance, and speeds results. Therefore, the Subcommittee finds the need for continuing the SITE program-- and for continuing to improve it--compelling.

SITE can be even bigger and better if the totality of its experiences are objectively reviewed and measured not only in terms of numbers of "success stories," but in terms of a prospective assessment of the needs, directions, and implementing tactics of today and tomorrow. Mission and objectives should be rethought within a contemporary perspective, including the possibility of eventually including a verification/certification element as does the EnTICE program (SAB, 1995).

SITE should embrace the contributions of other complementary activities. Some examples are: the upcoming report of the National Research Council's Committee on Innovative Remediation Technologies (NRC, in preparation), the Advanced Applied Technology Demonstration Facility for Environmental Technology Development at Rice University, and the DOD Matrix (USEPA/USAF, 1993).

Such an exercise should help to enlist support outside the Agency, and provide a more convincing argument why SITE should be continued as an EPA-directed program.

## 4. RECOMMENDATIONS

These recommendations are made from the perspective of scientists and engineers familiar with environmental problems and methods used to reduce or eliminate them. Economic, policy, or other considerations could lead a decision-maker to other conclusions.

Continue SITE: The need for improved technology to prevent, reduce or remediate environmental contamination has not disappeared. Because that need remains, and because the SITE program has been successful, the Subcommittee recommends that the Agency build upon that success either by continuing the existing program or by creating a different technology development and demonstration program built upon the precepts of the current program.

Develop a plan: To aid in selecting the most appropriate course of action, the Agency should develop a plan that defines the desired products (including the adequacy of the reportable data), the customer base, and how the two will be best brought together. Better product definition and improved marketing--including the clear portrayal of the successes and benefits of SITE--will make the program better understood by and more valuable to the user community. The EEC's "Strategic Research Planning Commentary" discusses the benefits of such planning and some approaches to it (SAB, 1994).

The Subcommittee recommends that SITE retain not only the Demonstration Program, but also the other three subprograms. The Emerging Technology portion of the program helps to supply the next generation of demonstrations and a primary means to identify or open new horizons or technical areas. The program should follow-up on technologies tested to assure improvements recommended get built into technologies thereby leading to their wider use and the collection of data on their subsequent performance at additional locations or conditions and associated costs. Some attention should also be given to minimizing the appearance of conflict of interest when emerging technologies developed by EPA are evaluated by EPA.

The MMTP should be continued, with SITE management identifying characterization and monitoring needs important to Superfund and by working closely with NERL to maintain its integration within the SITE program.

Develop Metrics: Once the plan has been developed, the Subcommittee recommends that additional program-wide quality metrics be identified. The purpose of

such measures may to quantify to what extent SITE has helped commercialization of demonstrated technologies; document reduced remediation costs; follow-up on technologies evaluated to assure that recommended improvements are widely implemented; and document the use of investigation and monitoring techniques evaluated by SITE.

The measures should be tracked from year to year, and a formal mechanism for identifying and documenting common problems and successful corrective actions should be implemented. For example, the proceedings of the April 6, 1995 SITE QA meeting, contain valuable information regarding program quality (USEPA, 1995d). Formalization of these types of meetings, their proceedings and documentation of follow-up actions and quality metrics would allow for the identification of trends while chronicling and documenting quality for the overall SITE program.

For purposes of illustration, such metrics might be: a tabulation of the technologies that have been evaluated through SITE, the subsequent use of those SITE technologies in remediation (or elsewhere) and the number of locations where used; more complete measures of reduced costs for remediation, restoration, measurement and monitoring; documentation of cleanups that are cheaper, faster, and better because of SITE.

Increase Marketing: The Subcommittee recommends increased attention to three aspects of marketing; selection of technologies for demonstrations, improved support to SITE customers, and developing support for SITE.

In selecting technologies for demonstration, SITE should require that the vendor provide evidence of a potential market to ensure that the demonstration will be useful and the technology will have a market.

In the course of planning improvements to SITE, the staff should develop a better understanding of who uses the SITE program and its products, sharpen product definition, and consider how each product may best be delivered to its customers. The Subcommittee expects that timeliness will be of special importance to developers who plan to use the SITE report in marketing, and that interpretive analyses will be important to those who select technologies for location remediation.

Finally, in spite of unstable financial support in recent years, the SITE program has managed to achieve much more than is recognized by many in the user community. Clearly stating the program's contribution to commercialization of demonstrated technologies and to reduced costs of remediation and restoration should

help SITE gain the recognition it deserves. Funding stability for the program and additional opportunities for leveraging resources with other organizations may result.

Develop Success Matrix: The Subcommittee suggests that the concept of collecting comparative cost data be expanded into a success matrix which reports on both technical parameters and cost. For example, success in meeting treatment or capacity goals, reports on the operation history or maintenance needs, identification of optimal operating ranges or conditions, identification of inappropriate applications or conditions, reports of problems encountered, or other performance criteria would help in making a decision to apply a technology.

The Federal Remediation Technologies Roundtable has published a Guide to Documenting Cost and Performance for Remediation Projects (US Federal Roundtable, 1995). The Guide was written to encourage the use of consistent procedures to document cost and performance information for projects involving treatment of contaminated media. While this is not the same task as research to evaluate innovative technologies, it may be useful in structuring a success matrix for SITE.

Provide interpretive analyses and develop data for intercomparison: Inter-comparison of evaluations is critical. The SITE program funded many often competitive projects (for example several thermal desorption technologies and a few luminescence field investigation techniques), but insufficient objective information was presented to provide a basis for comparison. Nonetheless, report documents are used to make technology selection decisions at contaminated sites. The data and information reported by the program needs to be sufficient to help support these decisions. The Subcommittee therefore recommends that the program also prepare interpretive documents that summarize, compare, extend, and extrapolate the results of the individual evaluations.

Increase the rigor of cost analyses and improve consistency and completeness of cost data: SITE must improve the collection of cost data. A rigorous evaluation of cost data should be conducted, and cost data should be presented in a way to evaluate the technology's engineering value.

The development of the twelve categories for cost reporting was good in concept but weakly supported or filled out inconsistently thus limiting its value as a tool for evaluation or inter-comparison. The data need to be reported on some consistent basis not just total or absolute cost so that inter-comparisons are possible. The data support calculations and their bases should also be provided.

Improve Mass Balances: The ITERS should address the issue of mass balances, when appropriate, in an interpretive section. If the Agency believes it is not always possible to achieve mass balances under the constraints of the SITE program, the rationale for this shortcoming, such as abbreviated test runs or limited sampling of heterogeneous materials, should be explored and discussed to educate the technical community. Given the Agency's stated concerns about trans-media migration of hazardous constituents, SITE should strive for material balances providing a high degree of closure for hazardous constituents.

Improve Report Clarity: In the reports, vendor claims should be separated from the reporting of project results and include an Agency or third party reviewer analysis of technology effectiveness. Reports should provide all the information gathered to help the user community in decision making.

Decrease Final Report Production Times: Document production should be accelerated to provide timely information to the marketplace.

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## APPENDIX A - ACRONYMS AND ABBREVIATIONS

<b>CERCLA</b>	Comprehensive Environmental Response, Compensation and Liability Act
<b>CERI</b>	Center for Environmental Research Information
<b>DOD</b>	Department of Defense
<b>DOE</b>	Department of Energy
<b>DP</b>	Demonstration Program
<b>EEC</b>	Environmental Engineering Committee
<b>EnTICE</b>	EPA's Environmental Technology Innovation and Commercialization Enhancement Program
<b>ETI</b>	Environmental Technology Initiative
<b>ETP</b>	Emerging Technologies Program
<b>ITER</b>	Innovative Technology Evaluation Report
<b>MMTP</b>	Monitoring and Measurements Technologies Program
<b>NERL</b>	National Exposure Research Laboratory
<b>NRMRL</b>	National Risk Management Research Laboratory
<b>ORD</b>	Office of Research and Development
<b>OSW</b>	Office of Solid Waste
<b>OSWER</b>	Office of Solid Waste and Emergency Response
<b>POA</b>	Project Objective Agreement
<b>QA</b>	Quality Assurance
<b>QAPP</b>	Quality Assurance Program Plans
<b>QC</b>	Quality Control
<b>RCRA</b>	Resource Conservation and Recovery Act
<b>SAB</b>	Science Advisory Board
<b>SARA</b>	Superfund Amendments and Reauthorization Act
<b>SERDP</b>	Strategic Environmental Research and Development Program
<b>SITE</b>	Superfund Innovative Technology Evaluation
<b>TTP</b>	Technology Transfer Program

## APPENDIX B - DOCUMENTS REVIEWED

The Following Review and Background/Briefing Materials Were Provided to the Subcommittee and are listed in the Federal Advisory Committee Act file for this review.

- I. May 3, 1996 letter from SAB staff Re: Site Review
- II. May 3, 1996 letter from SAB staff Re: Practicalities of SITE Meeting June 11-13, 1996, including:
  - A. A project description which includes the charge for the review.
  - B. A draft agenda for the meeting
  - C. A detailed roster with phones and faxes
  - D. An "affiliation" roster for use in the final report
  - E. A copy of the Science Advisory Board's 1986 report on the draft strategy and program plan for the SITE review.
  - F. A copy of the Agency's response to that report
- III. Materials mailed from the laboratory in advance of the meeting:
  - A. USEPA 1995, "The Superfund Innovative Technology Evaluation Program, Annual report to Congress, FY1994," EPA/540/R-95/522
  - B. "Superfund Innovative Technology Evaluation Program, Technology Profiles, Seventh Edition." EPA/540/R-94/526, November 1994.
  - C. "EPA's Process for Technology Demonstration" (This unpublished document explains what SITE does).
  - D. Alissa, Robert A., Letter about "RAP SITE-010, Risk Reduction Engineering Laboratory, U.S. Environmental Protection Agency," January 10, 1995.

- E. Request for Proposals (RFP) SITE-E09 The Emerging Technology Program (ETP) of the Superfund Innovative Technology Evaluation (SITE) Program," Ninth Solicitation, Emerging Technology Program, September 6, 1995.
  - F. Draft overheads and agenda for the SAB meeting June 1995
- IV. Materials from Subcommittee Member John Maney
- A. May 20, 1996 Survey of Site Developers
  - B. May 21, 1996 Request for Information
- V. Materials distributed at the meeting:
- A. Science Advisory Board Review Meeting for SITE Program, June 11-13, 1996, Cincinnati, Ohio. This is a bound volume including the annotated agenda
  - B. "Estimating Innovative Technology Costs for the SITE Program" by Gordon M. Evans. J. Air Waste Management Assoc., July 1990
- VI. The following materials were distributed to individual members based on expertise and interest
- A. Overview Materials for SITE
    - 1. USEPA 1995, Office of Research and Development National Exposure Research Laboratory, "A Guidance Manual for the Preparation of Site Characterization Technology Demonstration Plans." Interim Final
    - 2. USEPA, 1994, SITE Program: An Engineering Analysis of the Demonstration Program. EPA/540/R-94/530.
    - 3. OSWER Directive 9380.0-25 Elliot P. Laws, "Initiatives to Promote Innovative Technology in Waste Management Programs," April 29, 1996
  - B. Materials relating primarily to QA

1. USEPA 1991, Office of Research and Development, "Preparation Aids for the Development of Category I Quality Assurance Project Plans." EPA/600/8-91/003
2. USEPA 1991, Office of Research and Development, "Preparation Aids for the Development of Category II Quality Assurance Project Plans." EPA/600/8-91/004
3. USEPA 1991, Office of Research and Development, "Preparation Aids for the Development of Category III Quality Assurance Project Plans." EPA/600/8-91/005
4. USEPA 1991, Office of Research and Development, "Preparation Aids for the Development of Category IV Quality Assurance Project Plans." EPA/600/8-91/006
5. Site QA Meeting Summary, February 10, 1993
6. Site QA Meeting Executive Summary, February 11, 1993
7. USEPA 1995, "Record of Meeting for the SITE QA Meeting of April 6, 1995"
8. Technical System Review of the Laboratory Analysis Associated with the SITE Demonstration of North America Technologies Group, Inc. SFC 0.5 Oleofication System, June 1994
9. U.S. Department of Energy 1995, "Matrix Photocatalytic Oxidation Technology Demonstration, Final Quality Assurance Project Plan," Oak Ridge Reservation, Oak Ridge, TN.
10. USEPA 1995, Quality Management Plan for the National Risk Management Research Laboratory, December 1994

C. Project Specific Materials

1. PRC Environmental Management Inc., 1994, "Draft Demonstration Plan for the Evaluation of Field Portable X-Ray Fluorescence Technologies," prepared for USEPA/EMSL in partial fulfillment of Contract No. 68-CO-0047, Work Assignment No. 0-65.

2. USEPA 1993, SITE Demonstration Bulletin: X\*Trax Model 200 Thermal Desorption System, Chemical Waste Management, Inc., EPA/540/MR-93/502, February 1993
3. USEPA 1994, "SITE Emerging Technology Summary, Acid Extraction Treatment System for Treatment of Metal Contaminated Soils," EPA/540/SR-94/513
4. USEPA 1994, "SITE Emerging Technology Summary, Handbook for Constructed Wetlands Receiving Acid Mine Drainage," EPA/540/SR-93/523
5. USEPA 1994, "SITE Emerging Technology Summary, Acid Extraction Treatment System for Treatment of Metal Contaminated Soils," EPA/540/SR-94/513
6. USEPA 1994, "SITE Emerging Technology Summary, Handbook for Constructed Wetlands Receiving Acid Mine Drainage," EPA/540/SR-93/523
7. USEPA 1995, "Colloid Polishing Filter Method - Filter Flow Technology, Inc., Innovative Technology Evaluation Report," EPA/540/R-94/501, May 1995
8. USEPA 1995, Office of Research and Development Risk Reduction Engineering Laboratory (RREL) "Project Objective Agreement for General Environmental Corporation, CURE Electrocoagulation Technology at the Rocky Flats Technology Site"
9. USEPA 1995, "J.R. Simplot Ex-Situ Anaerobic Bioremediation Technology: TNT" EPA 540/R-95/529a, Site Technology Capsule, September 1995
10. USEPA 1995, "Ex-Situ Anaerobic Bioremediation Technology-TNT" EPA 540/MR-95 Demonstration Bulletin, August 1995
11. USEPA 1995, "Electrokinetics, Soil Processing," EPA/540/F-95/504, Emerging Technology Bulletin, March 1995

12. USEPA 1993, "Metals Treatment at Superfund Sites by Adsorptive Filtration," EPA/540/SR-93/515, Emerging Technology Summary, September 1995
13. USEPA 1993, "Low Temperature Thermal Aeration (LTTA) Process Canonic Environmental Services, Inc." EPA/540/AR-93/504, Application Analysis Report, July 1995
14. Theoretical and Experimental Modeling of Multi-Species Transport in Soils Under Electric Fields. Cooperative Agreement No. CR 816828-01-1

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