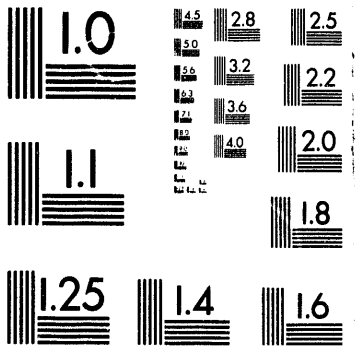
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EXPEDITED SITE CHARACTERIZATION FOR REMEDIAL INVESTIGATIONS AT FEDERAL FACILITIES

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Argonne National Laboratory has developed a unique, cost- and time-effective, technically innovative process for preremedial site characterization, referred to as Expedited Site Characterization (ESC). This process is flexible and neither site nor contaminant dependent; it has been successfully tested and applied at numerous federal facilities. Examples include remedial site investigations for the Department of the Interior's Bureau of Land Management and the Department of Agriculture's Commodity Credit Corporation. Argonne's ESC is scheduled for implementation at a Department of Energy facility and in the Department of Defense base closure program, to meet accelerated schedules for remedial actions by these departments.

The most critical component of the Argonne ESC is the formation of a dedicated team of scientists with diverse expertise and experience. A technical manager with a broad base of scientific and field experience heads the team. The entire team works together throughout the process, including planning, field implementation, data evaluation, and final reporting. Another important component of the process is the *dynamic* work plan, which is developed after a critical review of existing background data, the formulation of initial working hypotheses, and an initial site visit, in which the team selects a suite of noninvasive and minimally intrusive technologies that are appropriate to local conditions and evaluates the multiple working hypotheses. The work plan is viewed as a guide, subject to modification, rather than an absolute, unchangeable document. The final critical function of the manager and team is to participate in the simultaneous activities of the technical field program. Data from the various activities are reduced and interpreted each day by the technical staff, and then the team and manager meet, review results, and modify the program daily to optimize field data gathering activities. This daily modification benefits regulators by allowing them early access to data and early participation in decision making.

The result of the Argonne ESC process and the basis for its success is optimization of the field activity to produce a high-quality technical product that is both cost and time effective. Argonne has achieved technically sound site characterizations that are acceptable to regulatory agencies and provide extensive cost and time savings for the sponsors.

Federal agencies and regulators alike are experiencing increased pressure to accelerate remedial activities and the final cleanup of entire federal facilities rather than just individual sites or units within a facility. The Argonne ESC approach helps to achieve this goal by establishing a geologic/hydrogeologic framework for rapid sitewide implementation of the ESC.

Once the framework is in place, the facility/site is subdivided into a small number of *characterization domains* that are investigated concurrently. Each characterization domain may include numerous sites or waste units that normally would be investigated independently. Taking this fundamental and comprehensive approach to site characterization as an initial step can drastically reduce the time and cost of remedial site investigations for the entire facility.

The current cost of the Argonne ESC field process at a single site ranges from 1/10 to 1/5 of the cost of traditional site characterization. The time required for field activities is approximately 1/30 of that for current methods. Implementing the Argonne ESC with the characterization domain approach at large federal facilities will allow years and millions of dollars to be cut from remedial programs, while the accelerated timetables established by Congress are met.

INTRODUCTION

Argonne National Laboratory's Expedited Site Characterization (ESC) methodology gives federal agencies a process for producing high-quality CERCLA and RCRA site characterizations and remedial investigations in a cost- and time-efficient manner. The ESC process has been successfully tested and applied at numerous federal facilities. Examples include expanded site investigations for the Department of Interior's Bureau of Land Management and remedial investigations for the Commodity Credit Corporation/U.S. Department of Agriculture (CCC/USDA). In particular, the CCC/USDA has been the major sponsor in the development of the ESC process at Argonne. The technical successes and the cost and time savings of the ESC process for these programs have been detailed in previous papers (1, 2). The Argonne ESC is currently being implemented at a Department of Energy facility (Pantex) and is scheduled for implementation in the Department of Defense base closure program in order to meet accelerated schedules for remedial actions by these agencies.

Quality is the driving force in the Argonne ESC process. *The Argonne ESC process is abbreviated only in time and cost and never in terms of quality.* More usable data are produced through the Argonne ESC process than traditional site characterization methods based on statistical grid sampling and multiple monitoring wells. The purpose of this paper is to discuss the Argonne ESC methodology in greater detail with an emphasis on the activities necessary to ensure quality throughout the process. This discussion will also address the Argonne ESC concept in terms of what it is and is not. For example, the Argonne ESC is not a single piece of equipment, field laboratory, or analytical method.

Barriers to the successful implementation of the Argonne ESC are also addressed in this paper. Argonne's experience indicates that one major barrier is the hesitancy of some companies to provide staff of sufficient expertise and experience to conduct an ESC successfully. However, the shorter time frame of the ESC can make such staffing cost effective because more sites can be completed each year than with traditional methods. The regulatory agencies approached by Argonne have been receptive to the ESC process because they realize that it offers them a more comprehensive database than traditional approaches while giving them early access to both data and decision making.

A new feature of the Argonne ESC discussed here is the use of a geologic/hydrogeologic framework for rapid facility-wide or sitewide implementation of the ESC. Once the framework is in place, a facility/site is subdivided into a small number of *characterization domains* that are investigated concurrently. Characterization domains are selected on the basis of similar geologic/hydrogeologic features such as vadose zone similarities and the presence or absence of aquitards, soil source terms, or multiple aquifers. Each characterization domain may include numerous sites or waste units that normally would be investigated independently. Taking this fundamental and comprehensive approach to

site characterization as an initial step can drastically reduce the time and cost of remedial site investigations for an entire facility. In the case of the CCC/USDA, which is faced with characterization of multiple geographically separated sites in Nebraska and Kansas, this approach of placing like sites in characterization domains is allowing us to project completion of five sites per year in concurrent Argonne ESC investigations.

THE ARGONNE ESC PROCESS

The Argonne ESC process can be used to dramatically streamline site characterization investigations at hazardous waste sites. The ESC as developed by Argonne carries a very specific meaning as a methodology for implementing a technically correct site characterization or remedial investigation in a cost- and time-efficient manner. Before we discuss the basic steps in implementing the process, it is important to note exactly what the Argonne ESC actually is and is not.

The Argonne ESC is a process and not a single or specific technology or tool. The Argonne ESC represents the marriage of good science and both existing and emerging technologies to answer important questions on site features. The Argonne ESC is not a single technology such as a geophysical instrument, a field analytical facility, a field analytical screening tool, a sampling device, or drilling or other equipment; the ESC should never be confused with these. The Argonne ESC process relies on the interaction of a number of different disciplines to completely and accurately characterize a site. Several different types of technologies may be used in the Argonne ESC program, and the types of equipment and technologies may vary widely from site to site, because the unique features of a site are factored into technology selection.

The Argonne ESC is flexible and neither site nor contaminant dependent. The process is broadly based and was built on scientific principles that apply to all geologic regimes and contaminant types. Multiply contaminated sites with complex geology are as amenable to the process as sites with simple geology and a single contaminant.

The Argonne ESC demands the highest levels of accuracy for correct implementation. Traditional field screening tools that generate qualitative or approximate data are not appropriate for incorporation in the Argonne ESC. The process is built on careful and correct delineation of features and contaminant distribution very early in the characterization. Field analytical facilities capable of generating these levels of accuracy can be incorporated.

The Argonne ESC is scientifically driven within a regulatory framework; regulatory guidance does not drive the program without science. Regulatory guidance documents frequently give only the broadest outlines for conducting a site characterization program. This is natural, because a guidance document cannot address all the unique problems and features encountered in individual sites. Unfortunately, too often these guidance documents are treated as complete instructions for site investigations with no consideration for specific constraints or features of individual sites. The Argonne ESC incorporates regulatory requirements for analytical quality within a tailored, scientifically based program for each facility, to prove the existence of site features such as source areas, migration pathways, and migration inhibitors. Multiple techniques are used to demonstrate the scientific validity of a conclusion. Thus, staff with a high level of scientific competence are required for both design and implementation of the Argonne ESC.

The Argonne ESC requires that all field activities potentially affecting the quality of results be addressed in a quality assurance/quality control (QA/QC) plan. This aspect of the Argonne ESC is unique in that it goes beyond the normal sampling and analysis activities for which QA/QC regulatory guidance exists. The Argonne ESC also addresses QA/QC for such tasks as geologic logging, hydrogeologic investigations, geophysical investigations,

surveying, and management and storage of computer files. This QA/QC is not a paper exercise but a true effort to ensure accurate tracking, transfer, and integration of data in a dynamic, multidisciplinary program.

IMPLEMENTING THE ARGONNE ESC PROCESS

The basic features and steps in successful implementation of the Argonne ESC process are illustrated in Figure 1 and are described below.

- An experienced technical manager with a broad base of expertise and a team of scientists with diverse expertise and strong field experience are required to make the process work. The Argonne team is composed of geologists, geochemists, geophysicists, hydrogeologists, chemists, biologists, computer scientists, health and safety personnel, and regulatory staff as well as technical support staff. Of the geoscience staff, seven scientists are at the Ph.D. level, two are at the master's level, and one is at the bachelor level. These individuals have a combined total of 170 years of experience in various aspects of the geosciences. The distribution of degrees and experience within the team is similar for other disciplines. The technical manager and team work together throughout the process. In other words, the team that plans the program also implements the program in the field and writes the reports. The more experienced scientist does not remain in the office while individuals with lesser degrees or experience carry out the field work.

- The technical team first *critically* reviews and interprets existing data for the site and contaminants to determine which data sets are technically valid and can be used in initially designing the field program. One of the most basic mistakes in the site characterization process is failure to use technically sound available data to form working hypotheses on hydrogeology, contaminant distribution, etc. for initial testing.

- After assembling and interpreting existing data for the site, the entire technical team visits the site to identify as a group the site characteristics that may prohibit or enhance any particular technological approach. Logistic and community constraints are also identified at this point.

- After the field visit, the team selects a suite of technologies appropriate to the problem and completes the design of the field program. No one technique works well at all sites, and a suite of techniques is necessary to fully delineate site features. In addition, multiple technologies are employed to give greater confidence to conclusions about site features. Noninvasive and minimally invasive technologies are emphasized to minimize risk to the environment, the community, and the staff. *In no case is the traditional approach of installing a massive number of monitoring wells followed.* High levels of accuracy are required in selecting technologies as well as analytical programs.

  A *dynamic* work plan that outlines the program is produced for the sponsoring and regulatory agencies. The word dynamic is emphasized because the work plan is viewed as a guide, subject to modification, for the site characterization activity rather than a document that is absolute and unchangeable. Therefore, the health and safety plan and the QA/QC plan must be broad and encompass all possible alterations. The cooperation of the regulating agency and the support of the sponsoring agency are essential in successful implementation of this approach.

- The entire team participates in the technical field program. Several technical activities

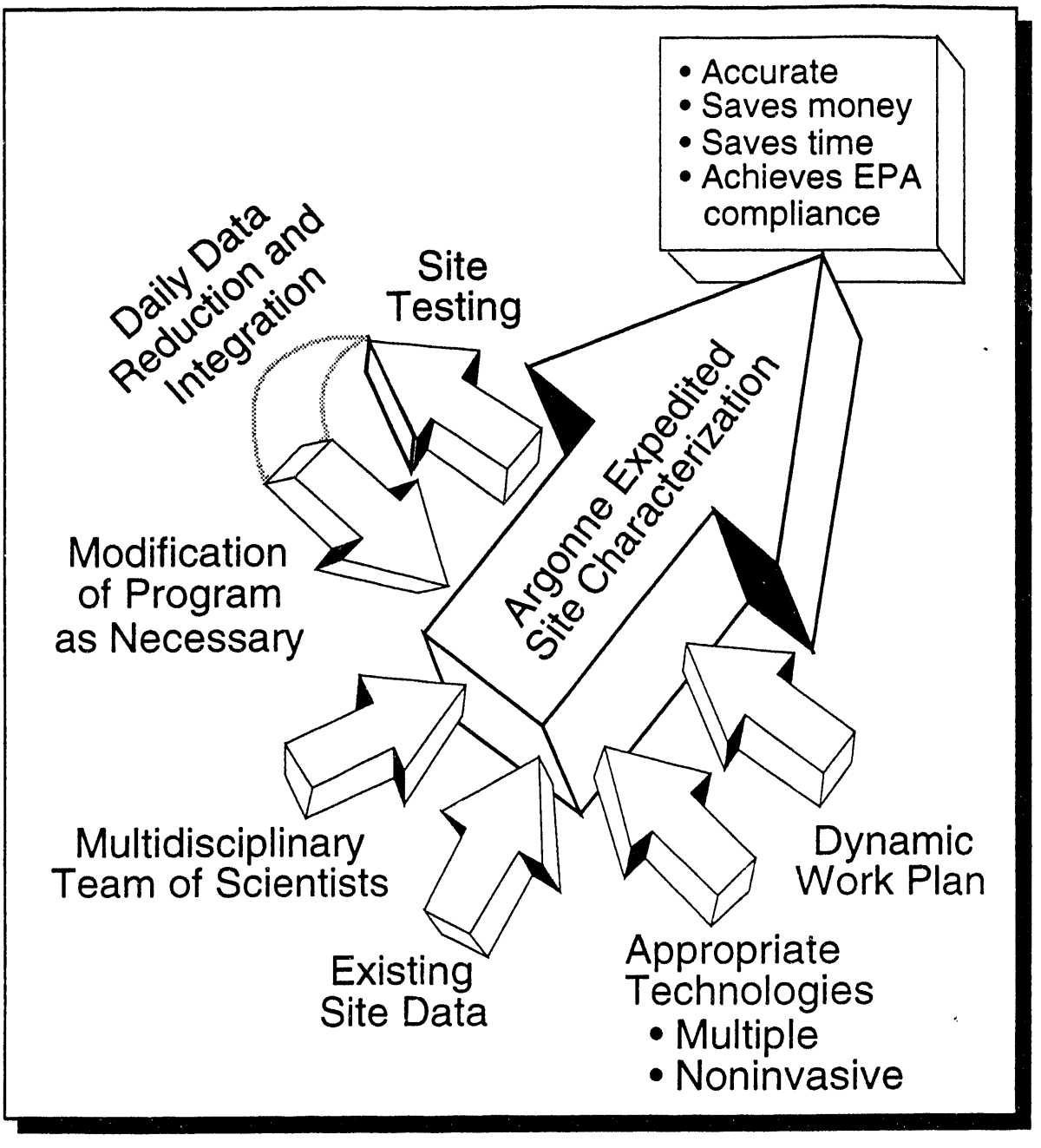

Figure 1. The Argonne ESC process integrates multiple components to facilitate decision making.

are undertaken simultaneously. These may range from different surface geophysics investigations to vegetation sampling. Data from the various activities are reduced and interpreted each day by the technical staff. Various computer programs are used to visualize and integrate the data. However, *the scientists* do the data interpretation and integration, not the computers, which are just one more tool at the site.

At the end of the day, the staff members meet, review results, and modify the next day's program as necessary to optimize activities that are generating overlapping or confirming site details. Data are not arbitrarily discarded — each finding must

be explained and understood. Anomalous readings may be due to equipment malfunctions, laboratory error, and/or the inability of a technique to work in a given setting even though theoretically it should.

- The daily results and modifications can easily be transmitted to the sponsor and regulator, allowing both to participate in early data review and decision making for the site. This early transmittal of data can be extremely advantageous to both sponsor and regulator because it allows them to digest information required for decision making in small doses, rather than waiting several months for a large document.

- The end result of this iterative process is the optimization of the field activity to produce a high-quality technical product that is cost and time effective.

BARRIERS TO BROAD IMPLEMENTATION OF THE ARGONNE ESC PROCESS

Argonne has found both regulators and federal agencies to be receptive to the Argonne ESC process. However, if the process is to be implemented on a broad scale, both regulators and agencies must require a strong technical approach and technical team from private-sector contractors.

An argument offered against the broad implementation of the Argonne ESC by the private sector is that the cost of supplying experienced, qualified personnel full time will be prohibitively expensive. What is not being factored into such thinking is the decreased time required to conduct an Argonne ESC.

Figure 2 shows projected schedules for a remedial investigation/feasibility study program into which Argonne has been asked to incorporate its ESC concept. The primary purpose of adopting the ESC in this particular case is to meet accelerated cleanup schedules for transfer of property. As Figure 2 shows, adopting the Argonne ESC approach decreases the time substantially from the original contractor-generated agency estimates. The original contractor estimate for completion was 4.5 years from project onset to the Record of Decision. This original estimate is reduced to 2.5 years with the Argonne ESC process.

The two schedules in Figure 2 can be used to demonstrate that staffing costs for the ESC with senior professionals are less than those for the traditional approach, in which more junior staff dominate. To quantify staff cost for each approach, the following assumptions are made: (1) The traditional (agency estimate) program will employ four junior and one senior staff members full time for 4.5 years. (2) The ESC program will employ five senior staff for 2.5 years. (3) Estimated costs for junior staff are $65/hr; those for senior staff are $120/hr.

On the basis of the above assumptions, the estimated staffing costs for the two approaches are as follows:

- For the *traditional (agency estimate) program*, the cost of junior staff will be (4.5 years) × (12 months/year) × (160 hours/month) × ($65/hour) × (4 individuals) = $2,246,400. The cost of senior staff will be (4.5 years) × (12 months/year) × (160 hours/month) × ($120/hour) × (1 individual) = $1,036,800. Thus, the total cost of staff for the traditional program will be *$3,283,200.*

- For the *ESC program*, the cost of senior staff will be (2.5 years) × (12 months/year) × (160 hours/month) × ($120/hour) × (5 individuals) = *$2,880,000.*

  As this calculation shows, staff costs for the Argonne ESC approach are lower, even though the team is composed of senior staff. The Argonne team has never exceeded eight senior-level staff members for a single site; comparable savings are generated with a team this size. Even larger savings have been reported from the entire Argonne ESC approach (2). However, the purpose of this example is to

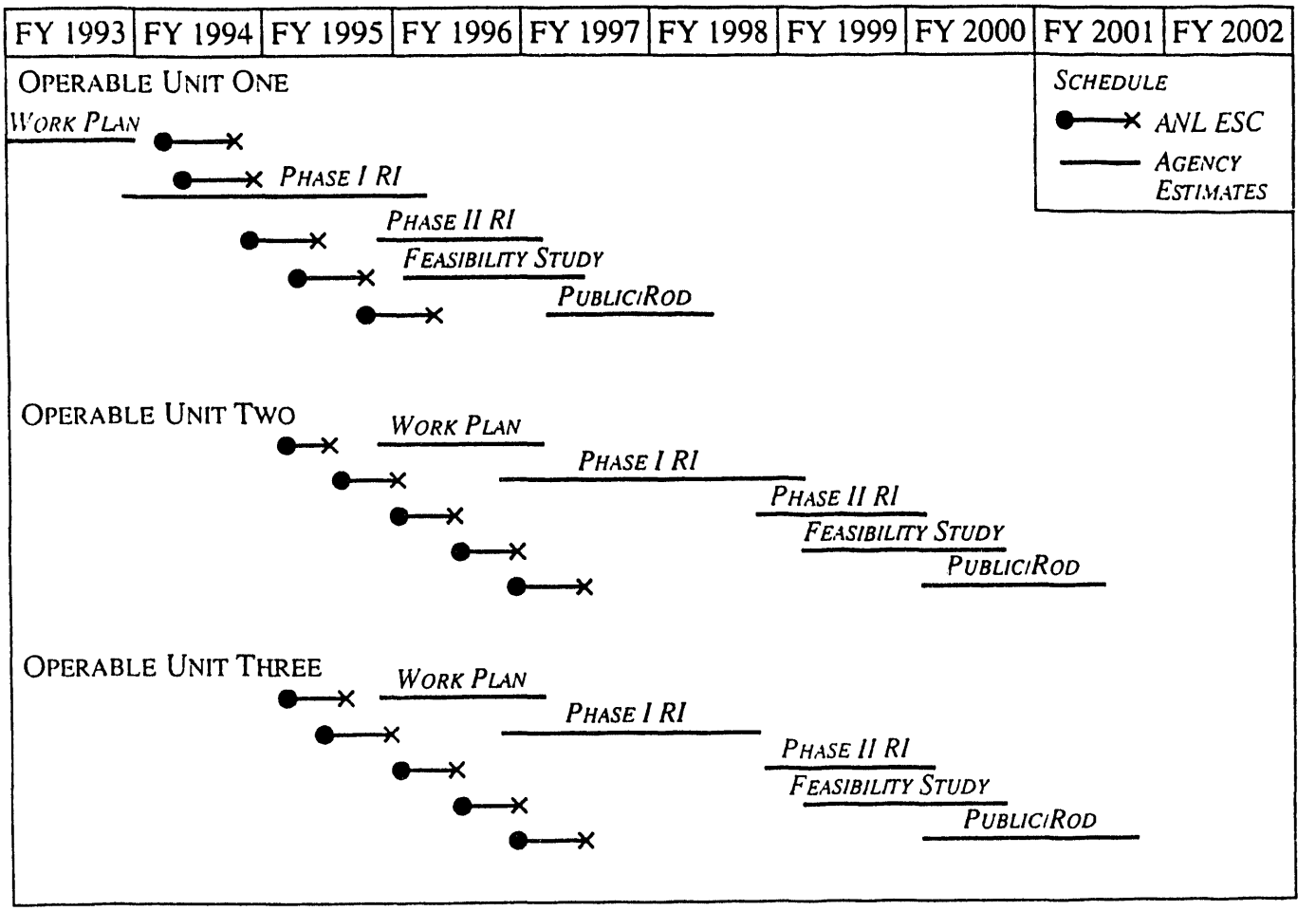

Figure 2. Impact of the Argonne ESC process on remedial investigation programs of federal agencies.

illustrate that the cost of supplying senior-level personnel need not be considered a barrier to successful implementation of the Argonne ESC by the private sector.

CHARACTERIZATION DOMAINS

Federal agencies and regulators alike are experiencing increased pressure to accelerate remedial activities and the final cleanup of entire federal facilities rather than just individual sites or units within a facility. The Argonne ESC approach helps to achieve this goal by establishing a geologic/hydrogeologic framework for rapid sitewide implementation of the ESC. When the framework is in place, the facility/site is subdivided into a small number of characterization domains that are investigated concurrently. Characterization domains are selected on the basis of similar geologic/ hydrogeologic features. Each characterization domain may include numerous sites or waste units that normally would be investigated independently. Taking this fundamental and comprehensive approach to site characterization as an initial step can drastically reduce the time and cost of remedial site investigations for an entire facility. In the case of the CCC/USDA, which is faced with characterization of multiple geographically separated sites in Nebraska and Kansas, this approach of placing like sites in characterization domains is allowing us to project completion of five sites per year in concurrent Argonne ESC investigations.

The CCC/USDA maintained grain storage facilities in the Midwest from the 1950s through the 1970s. At several of these facilities, the grain was fumigated with carbon tetrachloride before it was classified as a hazardous chemical by the Environmental Protection Agency. The carbon

tetrachloride subsequently leached into soils and groundwater at some of these former grain storage sites. For example, at approximately 40 sites in Nebraska carbon tetrachloride has been documented in groundwater (Figure 3). All of these sites may require some type of remedial action by the CCC/USDA to restore drinking water supplies to the affected communities.

The CCC/USDA has been the major sponsor for the development of the ESC approach by Argonne in order to accelerate the remedial investigation process. The goal of the CCC/USDA is to initiate remedial actions expeditiously for the affected communities. However, as is the case for many governmental agencies, funding is limited for this program. Even though the Argonne ESC process has accelerated investigations appreciably for the CCC/USDA at reduced costs (2), the challenge is always to accomplish more at less cost while maintaining quality. Therefore, Argonne has recently integrated the characterization domain approach into its ESC program in Nebraska, to investigate more sites at a reduced cost per site.

Figure 3 illustrates how some of the potential CCC/USDA sites in Nebraska have been grouped into characterization domains for concurrent study on the basis of similar geologic/hydrogeologic features such as vadose zone similarities and the presence or absence of aquitards, soil source terms, and multiple aquifers. Sites within a given domain lend themselves to similar investigative techniques, such as use of the electronic cone penetrometer, surface geophysical measurements, and drilling procedures. Therefore, equipment is mobilized once for two or three sites, and the team works simultaneously on these sites. Equipment is moved between sites as needed. A central base station accessible from all sites is established for the field analytical work and computer operations. Argonne is currently implementing this approach for field activities in Nebraska.

In developing the characterization domain approach, Argonne has written a *Master Work Plan* for each state. Each document presents all materials common to all sites in that state, including a health and safety plan, a QA/QC plan, applicable or relevant and appropriate requirements, a community relations plan, common investigative procedures such as geophysical techniques, sampling and analytical protocols, guidelines for computer operations, drilling procedures, well construction details, and ECPT operations. The work plan for each site is then greatly reduced in size and does not repeat these common materials. Each site-specific work plan covers only the specific technical program for that site, along with the site setting and history and site-specific geologic/hydrogeologic features. This design significantly reduces the time required to prepare site work plans and reports.

A similar approach using characterization domains is currently under development for the Department of Defense base closure program.

SUMMARY

The Argonne ESC process produces a high-quality technical product that is both cost and time effective. Argonne has produced technically sound remedial investigations and expanded site investigations for a variety of sponsors by following the ESC methodology. All of these programs have been acceptable to regulatory agencies and have provided extensive cost and time savings for the sponsors.

The Argonne ESC process carries a very specific meaning and is classified as a methodology for implementing technically correct site characterizations. The Argonne ESC is not a single technology or tool but represents the marriage of good science with multiple technologies appropriate for investigating the unique features of any site. The Argonne ESC is flexible and neither site nor contaminant dependent. The Argonne ESC process is scientifically driven within a regulatory framework; regulatory guidance does not drive the program without science.

The current cost of the Argonne ESC field process at a single site ranges from 1/10 to 1/5 of

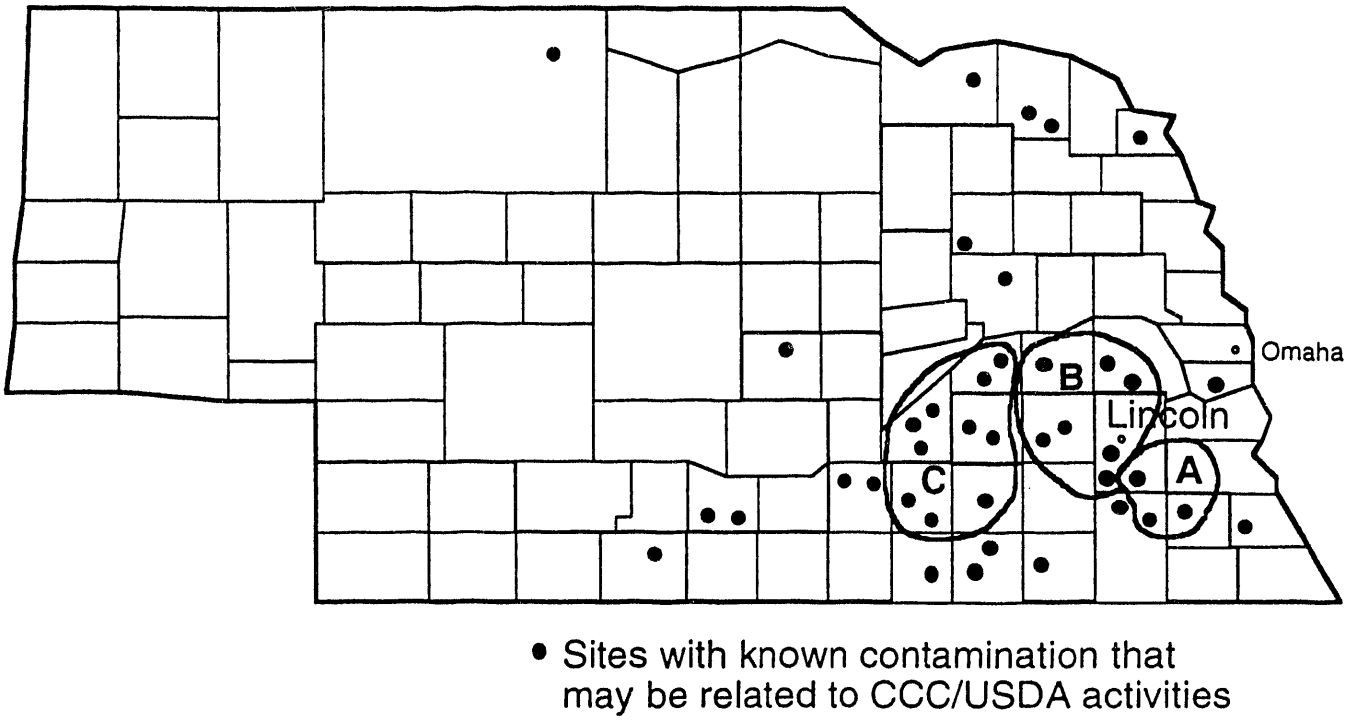

Figure 3. Expedited Site Characterization domains based on geologic and geographic criteria.

the cost of traditional site characterization. The time required for field activities is approximately 1/30 of that for current methods. Implementing the Argonne ESC with the characterization domain approach at large federal facilities will allow years and millions of dollars to be cut from remedial programs, while the accelerated timetables established by Congress are met.

ACKNOWLEDGMENT

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REFERENCES

1. Burton, J.C., Prioritization to Limit Sampling and Drilling in Site Investigations, Proceedings of the 1992 Federal Environmental Restoration Conference and Exhibition, pp. 242-251, Hazardous Materials Control Resources Institute, Rockville, Maryland, 1992.

2. Burton, J.C., J.L. Walker, T.V. Jennings, P.K. Aggarwal, B. Hastings, W.T. Meyer, C.M. Rose, and C.L. Rosignolo, Expedited Site Characterization: A Rapid, Cost-Effective Process for Preremedial Site Characterization, Proceedings of SUPERFUND XIV Conference and Exhibition, Vol. II, pp. 809-826, Hazardous Materials Control Resources Institute, Rockville, Maryland, 1994.

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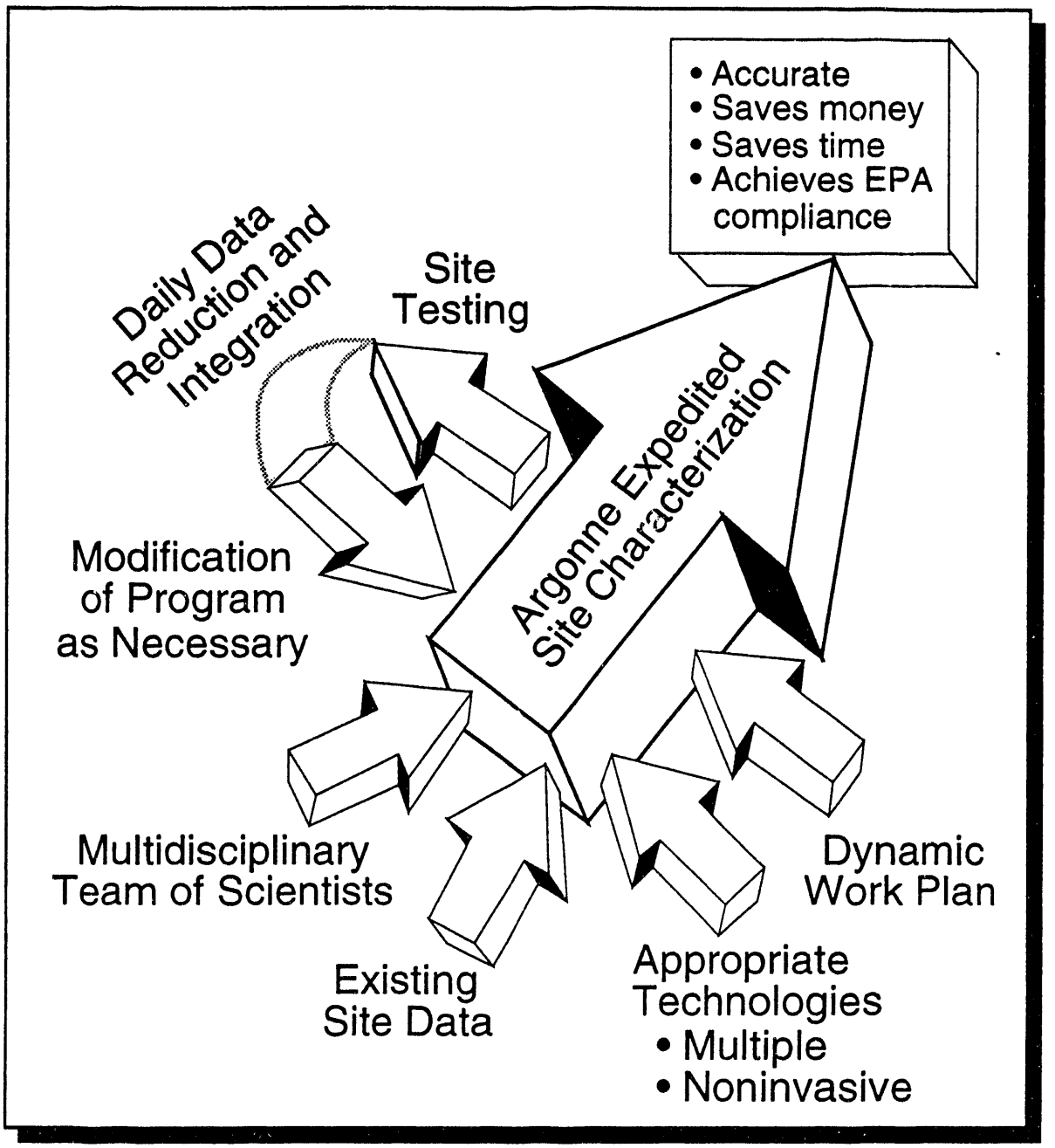
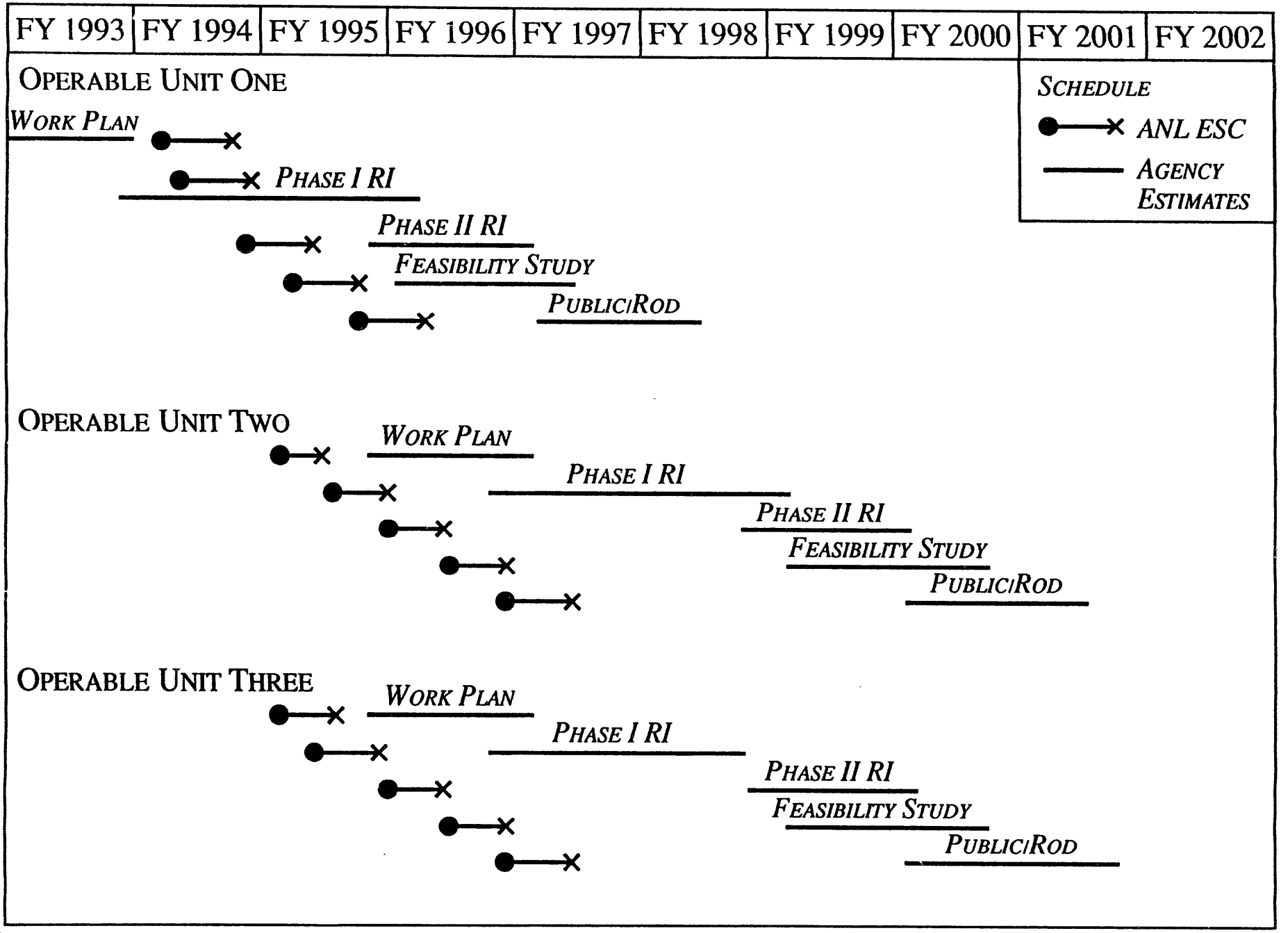
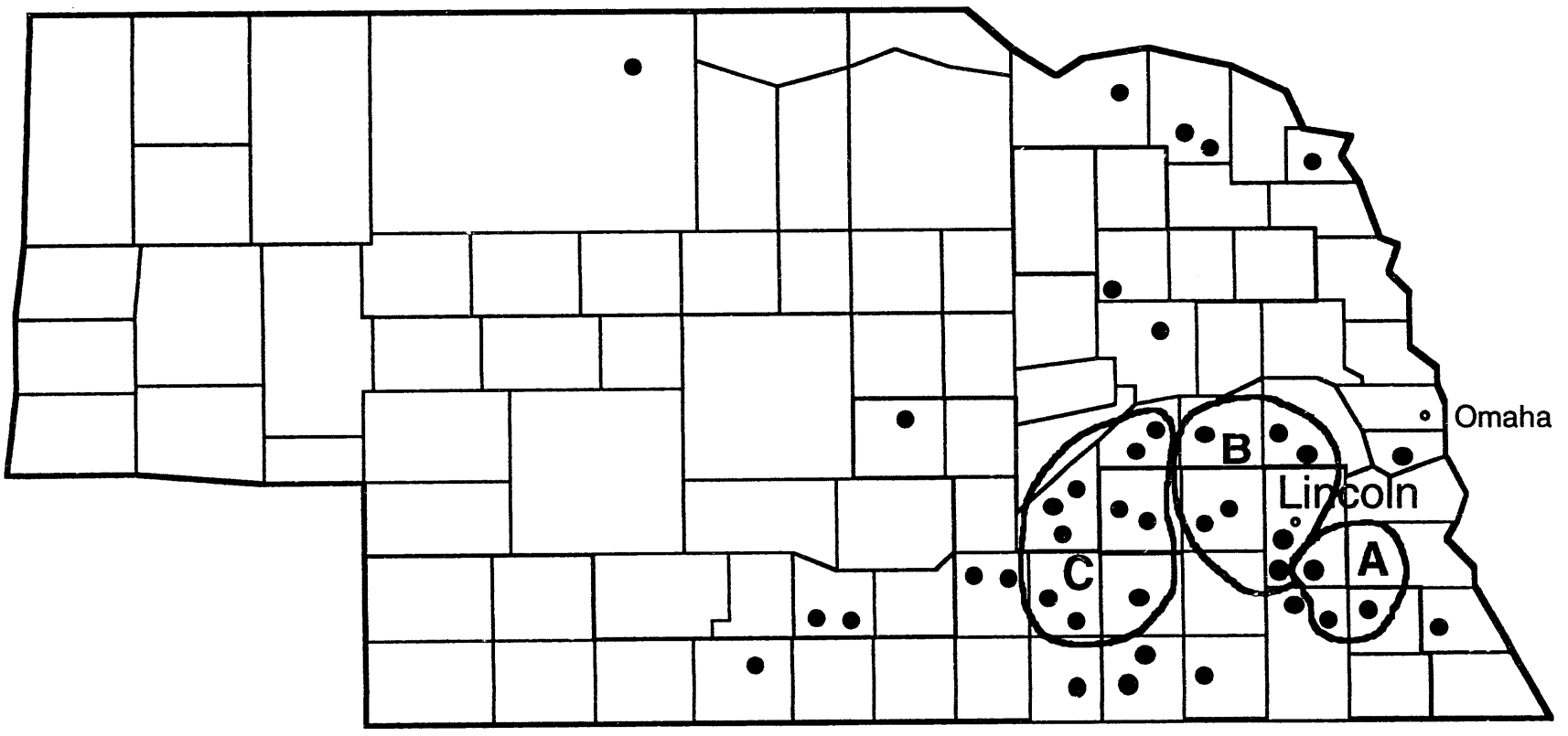

• Accurate
• Saves money
• Saves time
• Achieves EPA compliance
Daily Data Reduction and Integration
Site Testing
Argonne Expedited Site Characterization
Modification of Program as Necessary
Multidisciplinary Team of Scientists
Dynamic Work Plan
Existing Site Data
Appropriate Technologies
• Multiple
• Noninvasive

IMPACT OF ESC ON FEDERAL AGENCY RI/FS PROGRAM





- Sites with known contamination that may be related to CCC/USDA activities

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