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Strategic Plan for Hanford Site Environmental Restoration Information Management

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Preface

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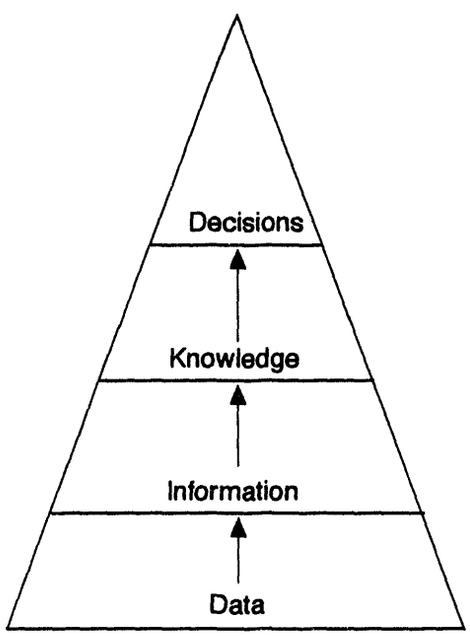
Environmental Restoration Information Management Vision

The vision of this strategic plan is to ***ensure that quality information is available to the people who need it, when they need it, at a convenient location, in a usable form, and at an acceptable cost.*** This can be accomplished by providing the infrastructure and program support for gathering and maintaining the information required for achieving the Hanford Site's Environmental Restoration mission and by integrating the U.S. Department of Energy's information needs with its internal and external stakeholders.



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The vision for information management can be achieved by implementing this plan's strategies to eliminate the common problem of drowning in data while starving for knowledge. The vision is to manage all forms of information so well that it can be actively used in making cleanup decisions, as technical backup for those decisions, and for regulatory compliance purposes.

The pyramid at the left illustrates the hierarchial relationship between data, information, knowledge, and decisions. The process begins with the collection of raw data, facts associated with some type of measurement or observation. The original **data** could be analytical results from environmental samples from the waste site. The results are combined and analyzed to provide, for example, an inventory of contaminants at the waste site and a description of the environmental setting. That becomes useful **information**. That information is combined with other information sources (e.g., technology performance) to provide the **knowledge** necessary to develop and compare cleanup approaches. This involves analyzing more data (e.g., comparing cost, risk, schedules) associated with the individual approaches to understand their inherent strengths and weaknesses. Conclusions of these analyses give rise to well-informed, defensible **decisions**. In this plan, no attempt is made to differentiate between data and information since the distinction is not relevant to the discussions that follow, and what is information to one user may be data to another.

Executive Summary

This strategic plan addresses information management for the Environmental Restoration (ER) Program at the Hanford Site. This Program leads the cleanup of the Hanford Site's soil, groundwater, buried waste, and the decontamination and decommissioning of facilities. The vision that drives this strategic plan is

> ***to ensure that quality information is available to the people who need it, when they need it, at a convenient location, in a usable form, and at an acceptable cost.***

Although investments are being made in managing the vast amounts of information, which include data, records and documents associated with the Hanford Site's production history and new cleanup mission, it is widely recognized that efforts to date have not accomplished the vision. Effective information management involves more than the compilation of massive amounts of electronic and non-electronic information. It also involves integrating information management into business processes that support user's needs and decisionmaking. Only then can information management complement and enable environmental restoration priorities and practices, help identify environmental restoration requirements, and enable communication within the Environmental Restoration Program and between the Program and its stakeholders. Successfully accomplishing the Hanford Site mission requires an integrated approach to information management that crosses organizational boundaries, streamlines existing systems, and builds new systems that support the needs of the future. This plan outlines that approach.

This ER strategic plan also supports and is integrated with the Hanford Site's overall approach to information management, which is outlined in the Strategic Plan for Hanford Site Information Management. Each program at the Hanford Site is developing implementation plans that are integrated and consistent with the Site's overall strategic plan for managing its information resources.

This plan was written during 1993 and 1994 by a 15-member core planning team comprised of the U.S. Department of Energy, Richland Operations Office; the Hanford Site contractors; and the U.S. Army Corps of Engineers. Additionally, a total of 130 stakeholders (individuals representing Hanford Site contractors, government organizations, and groups with a vested interest and need to access Hanford Site information) were interviewed to provide the essential input used throughout this plan's construction. Their input identified key information management needs and helped develop the plan's strategies through a stakeholder-focused interactive planning process. The following five strategies form the vehicle for change needed to accomplish the Environmental Restoration Program's information management vision:

1. **Enhance and refine the data collection process.** The Environmental Restoration data collection process has been improving but increased effectiveness is needed. If ER is to meet the demands for effective data capture by those who generate information and for more timely access by data users, more data must be initially collected electronically. Currently, the volume of data that needs to be processed exceeds our ability to effectively handle it manually and that data volume will continue to grow. Many data flow problems

originate at the interfaces between organizations and companies. Data should be collected once, at the source. It should be used by other systems, where appropriate, to eliminate multiple data entry.

2. **Develop an information architecture that will support current and future environmental restoration needs.** The "information architecture" is a descriptive conceptual framework for information systems implementation and the associated underlying computer-based infrastructure. The architecture requires the integration of a heterogeneous and distributed set of computer systems. An accepted, Sitewide set of data standards is required to establish an effective information architecture. A phased implementation is needed to allow new systems to be built using the architecture, to incorporate existing systems into the architecture where feasible, and to allow other existing systems to be modified or reimplemented so they can be integrated into the evolving information architecture.

3. **Structure a management and control process for environmental restoration information management.** A structured management and control process establishes a basis for strong understanding, involvement, and accountability by managers, which is essential to achieving the vision of integrated information management. This creates an environment with well established rules and expectations that allows the integration of widely distributed responsibilities and accountabilities into a consolidated whole.

4. **Develop data access and delivery mechanisms and associated processes that ensure information is available to authorized internal and external stakeholders.** Today, stakeholders need timely access to information generated by the Environmental Restoration Program as well as information generated by other programs. Current Hanford Site information resources are fragmented and incomplete, access to existing resources is limited, complex, and time-consuming, and user-friendly ER processes for data delivery do not exist. At this point, it is difficult for stakeholders to even determine who should be contacted to obtain needed information. Access mechanisms, both administrative and technical, must be in place, provide connectivity for internal and external users, provide high quality service, and provide protection of information and systems from unauthorized access and use. Standard, integrated processes for the retrieval and delivery of environmental information must be provided so information can be effectively collected, maintained, electronically accessed, and meaningfully interpreted. Since users need open access to information, the Site needs to reexamine current policies on computer security that restrict information access. The Environmental Restoration Program needs to examine issues related to the recovery and accessibility of historic data and records to ensure that the cost is justified by the value realized. The Program also needs to provide both internal and external stakeholders with easy electronic access to agreed-upon levels of environmental restoration information.

5. **Ensure that environmental restoration information management meets users' needs in the most effective and efficient ways possible.** Although the job of addressing the needs of data trustees responsible for data content and form has improved significantly, too little attention has been paid to the needs of end users, people who are not intimately

familiar with the data but who need to use it. User needs will be met **effectively** when the users have an adequate information infrastructure, user support facilities, reliable standards, and user-friendly access to the information resources they require to perform the tasks they set out to do. These needs will be met **efficiently** when users can perform these tasks productively without duplication of effort, using streamlined processes, and without wasting time or effort.

The strategies contained in this plan are each presented with a summary of current status, near-and long-term initiatives, and criteria for judging the success of the strategy. They represent a first step in improving environmental restoration information management. The next logical step is the development of an implementation plan supported with the specifics of workscope, budgets, organizations, and schedules. Such specifics are beyond the scope of this document, but work on the implementation planning needs to begin soon so there will be a context for current and future information management work.

Even though the regulators provided a major influence for an increased focus on information management within the Environmental Restoration Program, the entire Environmental Restoration Program needs an improved information management focus. Internal staff and external stakeholders need an integrated approach to information management to make effective use of the information being collected and to provide technical backup for cleanup decisions. This plan represents significant progress in identifying and planning for meeting the information management needs of the Environmental Restoration Program. Creating the plan helped focus interest and awareness of the importance of information management. The plan has already had an impact on information management planning for the entire Hanford Site since it has been used as a foundation for the Strategic Plan for Hanford Site Information Management. The teams responsible for the ER and Sitewide plans are striving for compatibility between the two plans since they recognize the need for information management integration across all Site programs.

Acknowledgments

This information management strategic plan was promulgated as one part of the planning process for the U.S. Department of Energy, Richland Operations Office (DOE-RL), Environmental Restoration (ER) Program. A core planning team was chosen from DOE-RL, the Hanford contractors, and the U.S. Army Corps of Engineers (USACE) to produce and document the strategic plan.

Core Planning Team

The following individuals were involved in the planning and production of this strategic plan:

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Core Advising Team Members: Judy Black, Westinghouse Hanford Company (WHC); Merrick Blancq, USACE; Jim Brown, PNL; Dick Fox, WHC; Roy Gephart, PNL; Lois Holmes, PNL; Jerri Main, Boeing Computer Services, Richland (BCSR); Susan McCargar, WHC; Gary Morgan, PNL; Allen Pomraning, USACE; Robert Richardson, BCSR; PJ Walker, MACTEC; Nancy Werdel, DOE-RL.

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1.0 Introduction

The goals of this strategic plan are to (1) develop a Hanford Sitewide approach for managing environmental restoration (ER) information that meets users' current and future needs, and (2) provide timely information of known and defensible quality to data users. To support technical analyses and make informed decisions, it is critical to ensure that quality information is available to the people who need it, when they need it, at a convenient location, in a usable form, and at an acceptable cost. This strategic plan provides an approach to achieve these goals.

ER information is defined as all administrative, programmatic, and technical data used to carry out the ER Program. This includes the information to perform technical analyses, support decision-making, enhance communication, and comply with regulatory requirements. This information is found in databases, documents, maps, images, and videotapes. If any one of them meets the appropriate criteria, it can be a record, regardless of its physical form or characteristics. Effective information management is not simply the compilation of massive amounts of electronic information. It also involves integrating information management into ER business processes to complement and enable ER priorities and practices, identify ER requirements, and enable communication within the ER and between the ER and its stakeholders.

This strategic plan was written by a core planning team from the U.S. Department of Energy (DOE); Westinghouse Hanford Company (WHC); Boeing Computer Services, Richland; the Pacific Northwest Laboratory (PNL); and the U.S. Army Corps of Engineers. The team interviewed over 130 stakeholders (individuals from onsite technical and management organizations, DOE Headquarters, U.S. Environmental Protection Agency [Region X], Washington State Department of Ecology, and tribal governments) who have a need and vested interest in accessing Hanford Site information. A common theme heard is that timely access to the Hanford Site's knowledge base is essential to cleanup success, improved communications, and increased trust between Hanford Site operators and external stakeholders. The findings from the interview process have been reflected throughout the plan.

After this strategic plan has been accepted and issued, an implementation plan that is supported with the specifics of workscope, budgets, organizations, and schedules, must be developed. The implementation plan will ensure that (1) specific information requirements supporting the ER Program are identified; (2) information sources are established; (3) processes are established to collect and validate that information; (4) effective methods are defined to support information collection and access; (5) information is maintained and preserved to accurately reflect completed work; and (6) the roles and responsibilities of organizations are identified and integrated. When this plan is implemented, the information to support ER's analyses and decisions will be readily available and traceable.

Although the scope of the plan is limited to the ER Program, the Program needs access to information resources funded outside the ER Program. For example, data from other sources such as RCRA (*Resource Conservation and Recovery Act of 1976*) efforts and Sitewide environmental monitoring efforts are of great value to the ER Program. At the same time, other programs at the Site, such as waste management and the Tank Waste Remediation System, need access to the ER Program information resources. Most of the issues and strategies in this plan apply to other Site programs.

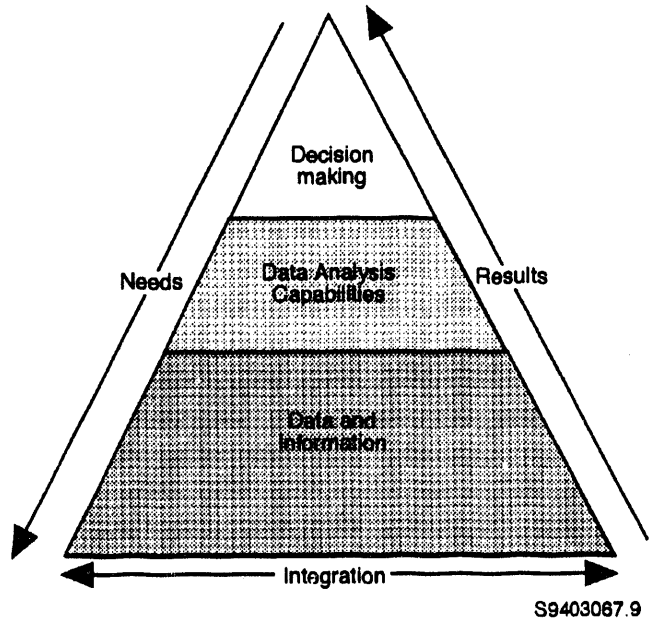
This is to be expected since information management is a cross-cutting function driven by common needs to access, store, preserve, and use information.

1.1 Background

The ER Program includes the cleanup of the Hanford Site's soils, groundwater, buried waste, and the decontamination and decommissioning of facilities. ER is one of several Sitewide missions being undertaken. Other missions include restoration of high-level radioactive waste tanks, solid waste cleanup, liquid effluent cleanup, and nuclear material management.

At the Hanford Site, the primary information users are the scientists, engineers, managers, and regulators as well as associated support staff. Each mission needs to shape and control its information management approach to meet its unique needs within established requirements because the success of each organization depends on using existing and new information to conduct business activities. However, because of the interrelationship of the missions, each mission must proceed with ties to a Site perspective. The regulators, other interested parties, and eventually the public are also users of Hanford Site information, but the shaping and control must proceed with ties to the Site perspective.

The timely access to information and the ability to easily analyze and compare this information are critical to planning and decisionmaking processes. The figure below illustrates that decisionmaking is the key driver to knowing which data are required as well as which data analysis capabilities must be available. Data and information must be supported by data analysis processes that enable the examination, comparison, and integration of multiple data sets to support decisionmaking.

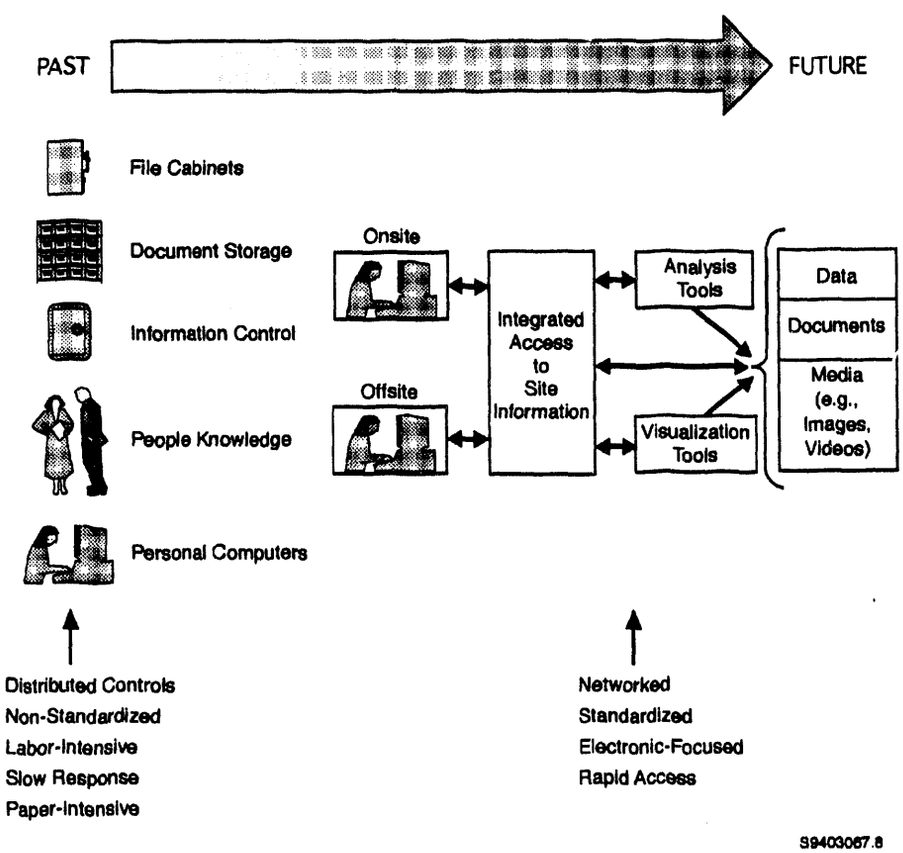


Relationship Between Information and Decisionmaking

Decisionmaking has many levels. To a scientist, it might entail selecting models to accurately simulate natural phenomena. To a regulator, it could involve ensuring compliance with cleanup standards. ER managers must make decisions on resource allocations for achieving maximum cleanup benefit with available resources. External stakeholders make recommendations on the acceptance of future Hanford Site land use and waste forms. Increasingly, alternative cleanup approaches must be evaluated for effects on potential human health (for both workers and the public) and the environment. The results of these evaluations must be factored into decisionmaking. Each level of decisionmaking has its own information requirements and analysis needs. Information products generated by one decision maker may be data input to another decision maker.

1.1.1 Hanford's Past Information Culture

For nearly 50 years, the Hanford Site's business of nuclear material production was conducted in an atmosphere of secrecy. The information management culture during this era was inward-focused and based on the "need to know." The left side of the figure below shows the Hanford Site's past information culture. Data flow was limited by organizations that exercised control and contained the technical experts. Information was commonly managed on a project-by-project, short-term basis. The long-term technical knowledge base was frequently contained in file cabinets, in paper report collections, indexed and held in central facilities, and in the minds of the original data collectors. In recent years, some information has also been stored on personal computers. This past information culture



The Hanford Site's Past and Future Information Management Structure

resulted in fragmented sources and systems with overlapping functions that duplicated data or contained conflicting data. The Hanford Site now faces an ocean of data that consumes much time and expense to use.

The old information culture is still prevalent. For example, according to WHC's Data Standards and Administration, over 1,200 individual databases exist within WHC alone, 800 of which are still active. The other onsite contractors also have multiple databases. These numerous, often unrelated databases contain everything from financial reports to historical waste disposal data. While they were created to serve a well-intended purpose, the Hanford Site is now burdened with them. Because of the existence of all these databases with potentially conflicting data, users often experience difficulty getting the data they need and/or knowing the quality of the data. External stakeholders searching for official Hanford Site data have even more difficulty finding what they need within these current systems.

1.1.2 Is the Hanford Site Getting Its Money's Worth?

The Hanford Site is currently paying a hefty premium for its invisible information management costs. Frequently, only the visible costs, such as those determined by summing individual cost accounts specifically associated with information management, are considered when calculating costs. However, invisible costs can be significant. For example, to identify the Hanford Site's true information management costs, all Site staff and organizations dealing with the access, storage, or display of technical- and management-related information and records (whether manual or automated) would need to be identified. Such numbers are not available. Nonetheless, it can be confidently stated that the Hanford Site is incurring significant costs for the present approach to managing data. Opportunities exist for streamlining information management to both reduce cost and improve customer satisfaction. A sound strategic approach for achieving effective information management would help ensure long-term savings. As part of this strategic approach, the following should be considered:

- The Hanford Site needs to understand the state of its information management capabilities.
- Upfront investment is needed to move the Hanford Site from where it is today to where it needs to be.
- Cost reduction (through efficiency improvement) in how information is managed could help support development of future information management capabilities.
- Information management requires sustained strong management support.

In answer to the question, whether the Site is currently getting its money's worth, the answer is a resounding "no."

1.2 Moving Toward a New Information Culture

Today's ER mission requires a new and different information culture. An integrated multi-mission approach is needed that is streamlined, standardized, focused both inward and outward, and

networked. The right side of the figure on page 3 illustrates the culture envisioned in this plan. This culture requires a commitment to share information with multiple users and decision makers. ER is making some progress in moving toward this new culture. For example, the Hanford Environmental Information System (HEIS) integrates ER sampling data with sampling data from several other Site environmental programs and makes that data available either by the local area network or modem. This experience can serve as an example, but overall progress has been slow and lacking in organization and direction.

The Hanford Site's cleanup mission requires the Site to recast its relationships with external organizations and to shift its historical inward focus to one of external responsiveness. A key element in bringing this about lies in the rapid access to quality-assessed information. This new information culture will enable

- integrated electronic systems accessible through a modem or network
- closer integration of manual processes with electronic systems
- a macro, mission-wide vision of ER issues and information
- increased confidence in decisionmaking using multiple complementary information sources
- increased innovation and insight potential by examining collective information versus isolated information sources
- increased reliance on information of known quality
- broader availability of existing knowledge and expertise
- better preservation and more effective use of institutional memory
- greater availability of information derived from existing data sets
- an interface with the nation's growing "electronic superhighway" to enhance communications and provide access to non-Hanford information of interest to ER.

An effective information management program will enable the Hanford Site to (1) function more like an integrated business and collectively manage its total resources, (2) build stronger external relationships, and (3) develop stronger inter- and intramission teaming with real program/technical benefits. It will also enable stakeholders to better understand "what's going on at the Hanford Site?" and rapidly provide the regulators information essential to fulfilling their oversight responsibilities. The Site's credibility will be improved as prompt and consistent answers are provided to questions.

Traditionally, Hanford Site personnel have been the prime data generators and users. While management and operation contractors (e.g., Du Pont, General Electric, Atlantic Richfield, Rockwell, and WHC) have changed over time, much of the Site's knowledge base has been preserved through the efforts of onsite staff. However, in recent years, more offsite staff are generating data and key onsite staff are retiring or moving offsite. More subcontractor personnel are involved in Hanford Site

activities—both in generating data as well as in needing rapid access to information. In addition, there is an increased responsibility to (1) preserve and trace environmental data and other forms of information as waste site cleanup progresses, and to (2) produce legally defensible data. Finally, the success of the Site's role as a technology development and demonstration site is dependent on accurate data that can be accessed by industry, universities, and the national laboratories. Information must be adequately preserved and retained to accurately reflect completed work. To successfully meet these demands, an effective information management program is essential. In the next subsection, this plan will introduce the strategies that will leverage the strengths of ER's existing information management capabilities with new capabilities to allow the Site to better meet user needs.

An information management program that is clearly linked to the cleanup mission, focused on the user, managed to defined success indicators, and organized into an integrated entity will play a key role in improving the technical quality of the work, increasing stakeholders' confidence, improving quality decisionmaking, lowering costs, and increasing public trust in the management of ER programs.

1.3 Introducing the Environmental Restoration Information Management Strategies

The ER information management strategies to achieve this plan's vision are

- *enhance and refine a data collection process*, which includes identifying the needs for data collection as a prerequisite to the actual collection, document control, and records management for both electronic and manual ER systems so processes can be enhanced and refined

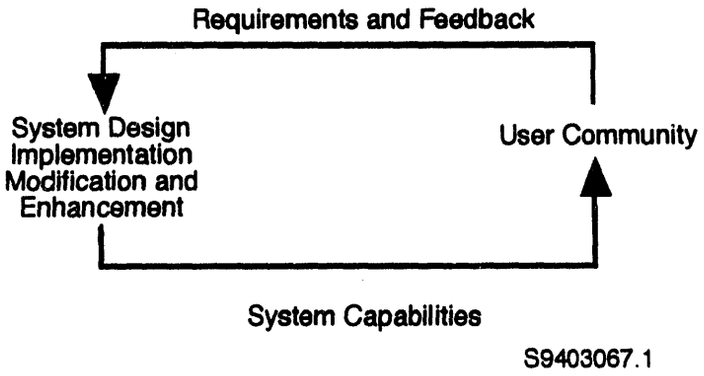
- *develop an information architecture that will support current and future ER information management needs*, including information systems design and implementation, information infrastructure, and standards

- *structure a management and control process for ER information management*, that will move information management from where it is to where it should be

- *develop data access and delivery mechanisms and associated processes* that ensure ER information is effectively available to authorized internal and external stakeholders

- *ensure that ER information management meets users' needs* in the most effective and efficient ways possible.

Top-level management must set the vision and environment for this new information management culture as well as provide resources for establishing and sustaining it. System design and implementation will come from the various information management teams, working from a common plan. Requirements for the systems' continued evolution will come from the user community and the feedback they provide as they interact with the systems on a day-to-day basis. A coordinated implementation plan must be developed and set in motion to identify where ER is today, where ER needs to be tomorrow, and what ER should do to get there.



To ensure that ER receives the greatest benefit possible from its information management, ER must work with the rest of the Site to take a long-term perspective on such technical issues as a modern, effective information infrastructure; the evolution of the computer industry; system and data portability; robust distributed systems; flexible networkability; and interoperability. Addressing these issues will help enable data usability and portability between systems, users, and locations. If these issues are not addressed up front, more deficiencies will develop requiring significant time and money to overcome. Planning must be as realistic, global, and as far-sighted as possible while at the same time meeting near-term needs. These concepts are not new. American corporations have recognized these needs for some time and have been proactive in making themselves more cost-effective by taking advantage of evolving information technology such as electronic mail, teleconferencing, and telecommuting (i.e., working at home). Private corporations are highly motivated in this direction since they recognize their survival depends on maximizing efficiency to maximize profitability.

1.4 Identifying Success Indicator Goals

In developing a useful approach to information management, ER must identify goals that will serve as indicators to gauge success. Normally, past performance would provide an indicator of future success. However, integrated information management within individual missions, let alone across all Hanford Site missions, has not taken place. Thus, ER will have to rely on other success indicators, such as

- increased end-user satisfaction
- increased electronic access and use of key information
- increased organizational use of integrated information systems
- increased percentage of data delivered electronically instead of on paper
- increased percentage of "once-entered data"

- reduced paper handling and manual information transcribing
- work efficiency improvements
- decreased costs of managing a unit of data
- faster, more efficient access to information
- increased use of information and comparisons in the decisionmaking process
- improved traceability of decisions to data
- increased availability and reliance on derived data sets.

Currently, many of these success indicators are not readily quantifiable. Requirements for quantifiable success indicators are unknown.

1.5 How This Plan is Organized

This section explains points related to the organization of the plan that are not apparent from reading the table of contents. The following is a brief guide for the reader who does not intend to read the plan from cover to cover.

The primary products of the plan are the vision and the strategies, which are outlined in the Executive Summary. The vision for the plan is explained in Section 2. The strategies are introduced in Section 1 and fully presented with near- and long-term actions in Section 5.

Appendix A describes the stakeholder-focused interactive planning process and explains how this process was applied to developing this strategic plan. Appendix B summarizes the findings from the 130 stakeholder interviews performed for the plan. Appendix C presents the results of the situational analysis, which was performed early in the planning process. The situational analysis is presented as an interim product that does not represent the final thinking of the core planning team. Appendix D presents a technical overview of the information architecture proposed in this plan.

2.0 Information Management Vision

This document presents a strategic plan for Hanford Site ER information management. The ER Program leads the cleanup of the Hanford Site's soil, groundwater, buried waste, and the decontamination and decommissioning of facilities. This ER strategic plan focuses on the current and future challenges of providing timely information of known and documented quality in a way that anticipates and responds to the needs of the user. The vision of this plan is to

> ***ensure that quality information is available to the people who need it, when they need it, at a convenient location, in a usable form, and at an acceptable cost.***

This can be accomplished by providing the infrastructure and program support for gathering and maintaining the information required for achieving the Hanford Site's ER mission and by integrating DOE's information needs with its internal and external stakeholders. How does this vision translate into reality for a user? If the Hanford Site ER Program implements the vision described in this plan, users will be able to perform the following typical activities:

- A manager responsible for selecting among different cleanup options needs to justify the infrastructure/technology requirements supporting those options. To formulate decisions, information can be compared on human health risk, costs, schedules, technology performance, and public acceptability issues. This will enable the manager to make a more defensible case to support the decision.

- A scientist modeling chemical movement in groundwater, or an engineer developing solutions to improve soil cleanup technologies will have electronic access to the Hanford Site's groundwater and geohydrologic data, previous soil test demonstration results, and contaminant data. The scientist or engineer will know how current and complete the data are as well as knowing the source.

- A regulator responsible for ensuring Hanford compliance to waste release regulations; or a stakeholder who wants to be kept informed about "What's happening at Hanford?"; or a university researcher who needs access to technical information on the nature and distribution of buried waste will have that access from an offsite location and can be confident that the information is current.

- A scientist or manager looking for a definitive document on a specific topic (e.g., a geologic profile about a certain area of the Hanford Site) of which the title or author is unknown, will be able to find that document online along with other related documents of which he or she may not have been aware. Figures and charts will also be seen and the document can be searched based on a user-defined context or searched for specific words and phrases. Subsequent documents can be searched to determine whether there are more current data available on the same topic.

3.0 Performance Parameters and Plan Mandates

3.1 Essential Performance Parameters for the Environmental Restoration Information Management Strategy

The ER information management process must establish the following parameters to achieve maximum return on investment:

- Environmental information should be captured once and managed to ensure future availability and integrity for achieving ER goals. Before capturing the data, it should be evaluated for relevance to the ER mission, whether the data will be used more than once by more than one user, and its method of capture (e.g., on paper, electronic, etc.) should be based on cost-effectiveness and required availability. The application of a well-defined Data Quality Objectives process before data collection will ensure reasonable, justifiable costs.

- ER must participate in the development and enforcement of Hanford Site data standards to maximize data sharing, comparability, and traceability as well as to minimize cost and schedule impacts resulting from redundant or conflicting data, data gaps, inaccurate data, incompatible data, and data recollection costs.

- Sufficient explanatory/clarifying information, including indicator(s) of data quality, should be captured with the data to provide the necessary context for that data. The amount of explanatory information should be based on the requirements of the users, any particular uniqueness of the data, and whatever information is considered necessary and cost-effective for data use. This explanatory data will facilitate future, unforeseen uses of the data.

- Both internal and external users should have appropriate access to environmental information. Access restrictions should be used only to protect individual and corporate rights and to avert improper use of preliminary data. Although information may be originally collected by a specific program, it should be recognized as a Site asset and available to all.

- Environmental information users should have access to indices and other reference tools to help them rapidly search for and locate relevant information. These tools should be flexible and easy to use.

- Flexibility must be provided for meeting the diverse needs of data users and decision makers.

3.2 Plan Mandates

This plan is intended to provide a technical baseline for information management within the ER Program through the following mandates:

- Develop an overall strategy and framework for managing and providing access to ER information.

- Make upper management aware of the importance of information management and obtain their critically needed support to commit resources and organizational responsibility to information management activities.

4.0 Strategic Goals and Objectives

This section outlines the goals and objectives for ER information management. Goals are written in terms of the broad ends ER is trying to achieve. The objectives are ends ER will try to achieve within the five-year planning window.

4.1 Strategic Goals

The following strategic goals have been developed to assist in achieving the vision of this plan:

- Reduce the cost and time required to identify and evaluate the data in support of the analysis and decisionmaking required to remediate the Hanford Site.
- Promote and participate in the development of a Sitewide discipline that effectively and efficiently manages information, regardless of format or medium.
- Promote and participate in the development of quality ER records management.
- Develop an information management environment that maximizes the integration of different types and qualities of data without jeopardizing data integrity and accessibility.

4.2 Objectives

The following objectives are considered fundamental to accomplishing the vision of this plan:

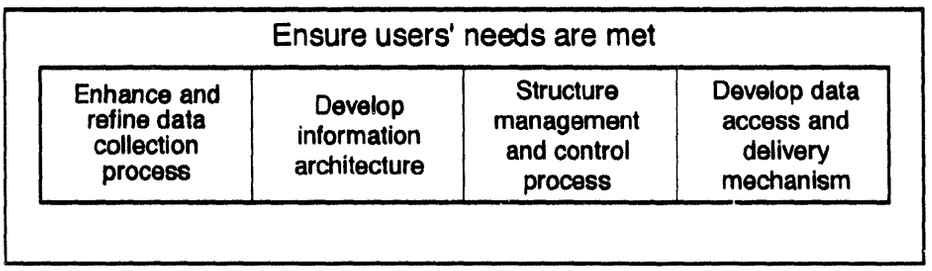
- Develop, implement, and maintain an information architecture that streamlines the processing of ER information and evolves over time to ensure the changing information needs of all appropriate users are met.
- Provide analysts and decision makers with current, accurate, and defensible data and information for formulating options and making decisions.
- Provide a vision to the ER stakeholders of what effective information management interfaces, procedures, and computing environments will look like five years into the future, and how it will add value to their work.
- Participate cooperatively with the rest of the Site in preserving the Hanford Site corporate memory.
- Provide an information management culture that supports and rewards doing it right the first time.
- Participate with the rest of the Hanford Site in moving toward paperless official records and data transfer mechanisms where electronic systems are maintained as the record copy of information and documents can be easily stored and retrieved electronically.

5.0 Strategies

The strategies for accomplishing the goals, objectives, and vision of this plan are presented in this chapter. These strategies, which are considered the vehicle of change for ER information management, are discussed in relationship to current status, both near-term and long-term initiatives, and criteria for judging the success of the strategy. In general, the near-term initiatives must be implemented within two years, while the long-term initiatives are anticipated to take two to five years to implement. Before implementation of many elements of the strategies can begin, an implementation plan must be developed. This plan must clearly demonstrate how value is added to the ER Program from the specific actions outlined in the plan.

The figure below illustrates the relationship of the five strategies: the first four are encompassed by the overall theme of the fifth strategy, to ensure that internal and external users' needs are met. This figure will introduce each of the strategies and will serve as a reminder of where that strategy fits in relation to the other strategies.

Environmental Restoration Information Management Strategies



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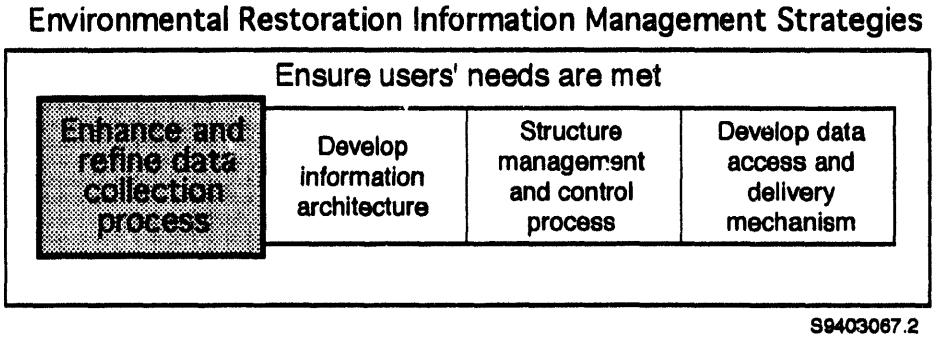
5.1 Strategy for Environmental Restoration Data Collection

Enhance and refine an environmental restoration data collection process.



5.1.1 Issue

Data have been collected to address specific problems or needs for the 50 years the Hanford Site has existed. For most of that time it was difficult to share data because of the classified nature of the work being performed. Data were shared only with those who had a valid "need to know." This lack of sharing was further encouraged by the "academic" concept of advancement, which was dependent on how many papers were published based on an individual's data.

For the most part, preserving the original data and the reasons for collecting the data never progressed beyond the logbook or notebook stage. Progress and technical reports often lacked the details of why and how the data were obtained or information on the quality of the measurement. Unless published in the report, the collected data were generally lost when the individual moved on to another assignment, left the Hanford Site, or retired.

Even now, though work is not classified, the old data collection mindset often persists. Individual programs tend to focus on their own data needs, which does not encourage the sharing of data. Sometimes it has been perceived as more cost-effective to collect data again rather than attempt to use existing data from other programs. At times, individual programs have chosen to collaborate on data collection efforts, share data, and cooperate in information management activities to the mutual benefit of all. While this activity is consistent with WHC's Data and Information Management Policy, it has mainly taken place on a voluntary basis without Sitewide management support or planning and, consequently, hasn't happened often enough.

No systematic approach, either manual or electronic, is consistently applied to ensure that quality-defined data are collected, delivered in a timely manner to those responsible for managing the data, and made available to those who need it. Processes need to be improved so the data flow can be likened to a symphony orchestra instead of a discordant beginning orchestra.

Preparing for effective electronic data capture and collection takes time. It is important that data requirements be defined and processing capabilities be in place when needed in support of Hanford Site cleanup. A significant portion of the data currently needed to support environmental and regulatory compliance demonstration has been from the historical files. ER is not fully prepared to effectively handle significant amounts of new environmental data collected by onsite contractors and their subcontractors since they are already overburdened with existing information and the volume of that information will continue to grow.

5.1.2 Strategy Description

Before the data collection process begins, the purposes for which the data are being generated should be defined. The overall use and requirements for that data should be considered. An integrated, consistent approach should be established and implemented for defining data quality, data use, and the data elements necessary to support the Tri-Party Agreement (TPA) and other decision-making processes. Consideration should be given to the requirements of the end user for "metadata" (i.e., data about the data). Once defined, cost-effective processes should be implemented to bring data to collection points where it can be stored, managed, and indexed for current and future use. Data should retain the metadata delineating the original intent for collection and an indication of accuracy. Data should be collected once, at the source. It should be collected electronically, where possible, and should be used by other systems to eliminate multiple data entry.

5.1.3 Current Status

The ER data collection process is improving but increased effectiveness is needed. If ER is to meet the demands for effective data capture by those who generate information and for more timely access by data users, more data must be initially collected electronically. Many data flow problems originate at the interfaces between organizations and companies.

The HEIS is currently used to store and provide access to data gathered from many types of environmental samples. The Waste Information Data System (WIDS) contains summary information on waste sites. The Hanford Geographic Information System (HGIS) stores map data and produces map-based output products. Procedures continue to be improved and refined in the Environmental Investigation Instructions to ensure that data quality for Site characterization is defined, that data are clearly identified, and the means for ensuring their safe arrival in an information management system are included. Streamlined implementation processes need to be developed for ER data deliverables.

In addition, an ER administrative record/Public Information Repository system has been established. The WHC-operated ER Program Information Center provides access to the administrative record, Public Information Repository files, and other TPA and ER Program information. And finally, document control is in place through systems that address preparation, review and approval, clearance and release, distribution/issuance, and revision/change control for ER Program documents.

Satellite Public Information Repositories have been established at several locations, primarily located in university libraries. A satellite of the ER Program Information Center is being set up in the Federal Building to perform document control and records management functions for RL staff working on ER.

An imaging system called Information Services Electronic Archival (ISEARCH) is being used to scan documents at 1820 Terminal Drive and the 200 Area. These images are stored using an optical disk jukebox system. Staff review and index the documents, create keywords, and store data about the documents on a Sitewide database. Both the location of the record copy and the location of the image on the jukebox are stored.

Several electronic and manual systems contain data about older documents. Although still in use, the older electronic systems need to be replaced because they are not user-friendly, cannot handle much more data, and are technologically limited. Existing manual systems contain valuable historic data that need to be preserved.

5.1.4 Near-Term Actions

The near-term actions in support of this strategy include the following:

- Continue defining requirements for data collection involving some of the processes used by the ER Program (other quality-defined data collection processes are being discussed).
- Establish and implement an integrated, consistent approach for defining data quality and data quality requirements through the Data Quality Objectives process. Apply that process before any samples are taken. Scope sampling to meet the intended use. Minimize redundant and inconsistent data capture.
- Improve the flow of data across organizations and companies.
- Examine and, where appropriate and cost-effective, implement electronic data capture as a means of obtaining data more accurately and delivering it in a more timely, cost-effective manner.
- Establish a useful and robust Administrative Record that is well linked to other data collection activities.
- Maintain a highly visible inventory and catalog of existing ER data resources, and provide indexes and other reference tools to help locate relevant information.
- Characterize all unscheduled ER records for development of records retention and disposition schedules for those records. Coordinate and integrate with similar efforts under way throughout the DOE complex to develop and defend record retention.
- Make fully functional the Federal Building satellite of the ER Program Information Center to perform document control and records management functions for RL staff working on ER.

- Investigate methodologies and information technologies for integrating the manual and electronic systems that store metadata about documents. Develop an approach that accommodates the legacy manual and electronic systems but gives priority to implementing a robust system to handle current, incoming documents.

- Design and implement information technology to manage the metadata for current, incoming documents.

5.1.5 Long-Term Actions

The long-term actions in support of this strategy include the following:

- Implement coordinated and automated processes for collecting Site environmental data and information.

- Assemble and index the historical elements of the Site record that are significant to the cleanup mission.

- Extend the information technology that manages metadata about current, incoming documents to handle document metadata from legacy systems also.

- Procure and implement large-scale intelligent character recognition systems that convert paper documents to electronic files that can be used by word processing software.

5.1.6 Success of Strategy 1

The success of this strategy can be judged by the following criteria:

- Management clearly recognizes the "value added" of consistently defining data quality and making this quality information routinely accessible to users in a consistent format.

- Standard automated processes for collecting Site environmental data and information are in place. Feedback mechanisms exist to continue focus on what is needed.

- Data is flowing smoothly across organizations.

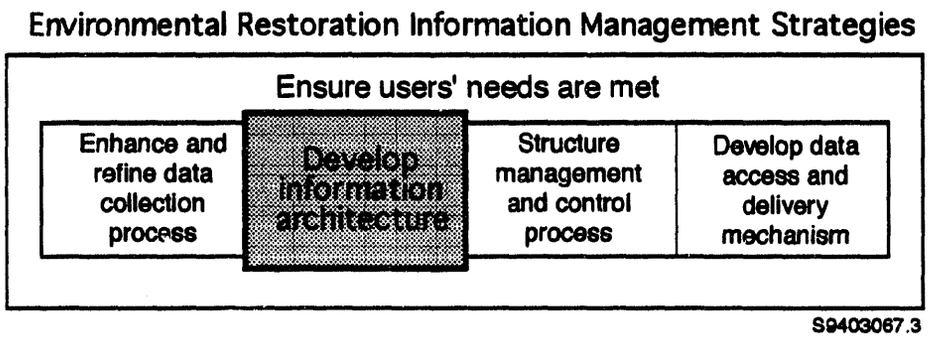
- Relevant data sets and documents that support the ER mission are located, indexed, and stored; and the quality is assessed.

- Data processing capabilities for handling newly collected data are in place and functional before large volumes of data are accumulated.

- An environmental historical record of the Hanford Site is developed and maintained. Data, documents, and information can be accessed in a timely and effective manner by all internal and external stakeholders.

5.2 Strategy for Environmental Restoration Information Architecture

Develop an information architecture that will support current and future environmental restoration information management needs.



5.2.1 Issue

An integrated information architecture is required to effectively manage ER information at the Hanford Site. This information architecture requires the interconnectivity and integration of an increasingly heterogeneous and distributed set of computer systems. It should be capable of meeting existing and future requirements. It should be designed for flexibility so it can meet unanticipated future requirements. It must accommodate data generated by legacy systems where cost effective.

Because the Hanford Site's information management environment is large, complex, and has a diverse user community (managers, technical staff, support staff, and regulators), this effort will require the attention and participation of all contractors and subcontractors involved in ER. The ER Program must actively support increasing integration and interoperability of existing systems. It must also support the design and development of new systems that are driven by user requirements, automate data quality and traceability controls, and deliver accurate, timely, and useful information to meet the needs of the entire user community.

Tomorrow's modern computer environments will be increasingly heterogeneous and distributed. Information sharing and remote access will be common. Information networks like Internet, Compuserve, and Prodigy are increasingly used. The nation's "electronic superhighway" is becoming a reality. In addition to the complexities of implementing an information architecture to handle this complex computer environment, the existence of multiple formats for data and information adds to the need for the earliest possible integration and interoperability of ER information management systems. To effectively support the use of such systems, a stable ER information management environment is required.

5.2.2 Strategy Description

To accomplish this task, ER must deal with planning, guidance, policy making, standards identification, and enforcement of standards for both the evolution of existing systems and the development of new systems. A phased implementation is needed to allow new systems to be built using the architecture, to incorporate existing systems into the architecture where feasible, and to allow existing systems to be modified or reimplemented so they can be integrated into the evolving information architecture. The major areas to be addressed include

1. *Information System Design and Implementation* - design and coordinate the implementation of an information architecture to make information available to the user community; this must be done under the guidance of the consolidated group of representatives from the Hanford Site contractors and DOE-RL involved in ER.

2. *Information Infrastructure* - increase the utility and accessibility of ER information to the end user by improving the existing Hanford Site information infrastructure.

3. *Standards* - evaluate and prioritize the need for information standards, establish standards based on prioritized needs and refine those standards over time.

5.2.3 Current Status

Information System Design and Implementation

- The Hanford Site local area network is available to onsite users and some offsite users. However, the network's performance is not adequate to meet ER needs.

- An inventory of information systems entitled "Tri-Party Agreement-Related Databases, Access Mechanisms and Procedures" has been developed. This effort is intended to ensure a consistent inventory to aid users in finding information relevant to their activities. Work is under way to develop a standard process for requesting access to these systems.

Information Infrastructure

- A new project entitled Training, Information, and Communication Enhancement (TICE) is under way. The project is investigating the feasibility of implementing multimedia-capable information and communication services for the Site.

- Each Hanford Site contractor has its information hardware system infrastructure documented. The underlying software infrastructure is not always documented.

- The WHC-operated ER Program Information Center provides access to indexes and other reference tools to help all ER information users locate relevant information, although not all information sources are currently available.

Standards

- A process to document and approve Sitewide information standards is established through the Hanford Data Administration Board, but only a few standards have been approved and established. There is no mechanism in place to ensure standards are being applied to systems.

- WHC's Data Standards and Administration organization is serving as a Sitewide resource to facilitate the formulation and approval of standards and conventions.

- Hanford Site data standards as well as proposed standards are available on the Hanford Site local area network.

- Several subcommittees for the study and resolution of specific standards development issues have been convened. These subcommittees consist of representatives from the data trustees/caretakers, end users, and the Hanford Data Administration Board.

5.2.4 Near-Term Actions

The near-term actions in support of this strategy include the following:

Information System Design and Implementation

- Design an information architecture that is open and flexible to support the integration of a variety of hardware and software options; focus on interconnection rather than dictating solutions based on specific hardware platforms or software environments. Users will transparently access information spread across physically separate systems and logically group data sets together to create new and meaningful perspectives.

- Establish the standards for interconnection; a system's future will be based on its ability to evolve and connect; systems that are too inflexible to adapt will be replaced or eliminated.

- Document existing environmental information systems and capabilities currently in use at the Hanford Site; document systems under development or planned for the Site; document the types of data managed by these systems; make this information available to users through the Hanford Site local area network.

- Continue efforts to provide access to information systems identified in the inventory entitled "Tri-Party Agreement - Related Databases, Access Mechanisms and Procedures."

- Investigate how the information architecture can be integrated with Hanford Site systems engineering information management efforts.

- Encourage the sharing and integration of systems; consider implementing new systems as components of existing systems where practical.

- Identify the information not currently available but required to meet the needs of ER stakeholders; identify information systems to handle that information.

- Identify the systems that will participate in the information architecture and plan for their participation. Where they are unable to participate and their data is needed by ER, identify and obtain funding to make them compatible with the architecture standards or make their information available to the user community through existing systems that participate in the architecture.

- Develop or identify methods for incorporating external information (i.e., data from other sites or systems that are not part of the architecture) into the information architecture.

- Review new developments in information technology. Plan for the deployment of information technology where needed and cost-effective.

- Create a prototype for an information system using the information architecture design; evaluate the prototype.

- Refine the definition of the information architecture; write an implementation plan for the architecture.

- Construct a conceptual model (a high-level, entity-relationship data model) identifying data needed to meet stakeholder requirements.

Information Infrastructure

- Develop and implement integrated planning and equipment and software selection interfaces with those organizations responsible for selecting the computer hardware and software at the Site to ensure that ER compatibility needs are met.

- Develop criteria and funding protocol for infrastructure support that ensures appropriate use and maximum impact.

- Influence infrastructure upgrade plans to ensure ER needs are met.

Standards

- Develop a plan for achieving ER staff endorsement of the need for standards and enforcing standards compliance.

- Ensure that ER systems use standards where they exist.

- Actively promote the development of standards relevant to ER.

- Continue identifying areas needing standards and develop those standards.

- Support and promote the development and enforcement of Sitewide standards.

5.2.5 Long-Term Actions

The long-term actions in support of this strategy include the following:

Information System Design and Implementation

- Implement the information architecture for the ER Program.
- Ensure that systems identified in the "Tri-Party Agreement - Related Databases, Access Mechanisms, and Procedures" are available to internal and external users.
- Include additional data sets in the conceptual model and the information architecture plan as they are identified and determined through user requirements to be necessary and cost-effective.
- Continue to evaluate new information technology for applicability to the information architecture.
- Evolve and sustain the information architecture by incorporating new information and by evaluating and adopting new technology as it becomes available, if practical benefits are expected.

Information Infrastructure

- Work with the Site to establish long-range computing infrastructure goals for the Hanford Site.
- Work with the Site to implement those infrastructure goals.

Standards

- Continue the adoption and refinement of Site data standards.
- Form participative linkages with the National Institute for Standards and Technology and the International Standards Organization.

5.2.6 Success of Strategy 2

The success of this strategy can be judged by the following criteria:

Information System Design and Implementation

- Funding is available for implementation of the ER information architecture.
- The required implementation plan for creating the information architecture is in place and being implemented.
- The ER information management user community is involved in developing and establishing operating parameters of the systems.

- The total ER information architecture is adequately defined and implemented and meeting current users needs.

- Users can reliably integrate data from multiple sources to meet user-specified needs.

- The ER information architecture is robust enough to allow new information requirements to be accommodated with minimal to no impact on existing systems.

- The users of ER information systems believe information management is an effective tool to perform their work; they do not feel controlled by the systems.

- The ER information management systems are integrated with necessary data, can successfully meet the needs of new system development, and are capable of appropriate expansion.

Information Infrastructure

- The performance of the network is adequate to meet user needs.

- The information infrastructure is in place to meet user needs.

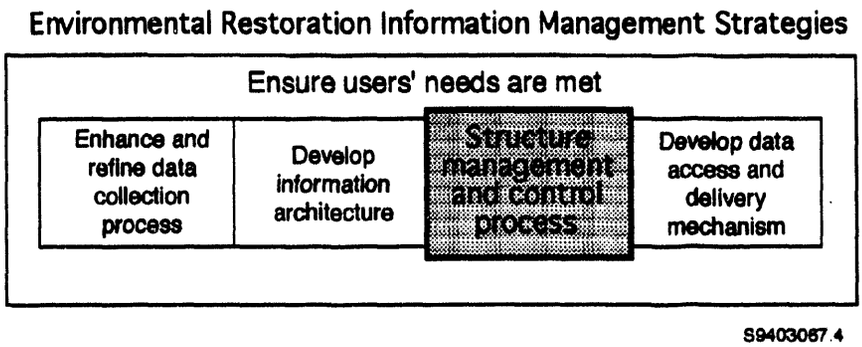
Standards

- Standards enable users to integrate information meaningfully.

- ER information management systems can exchange information seamlessly because of known data and systems standards and interoperability definitions.

5.3 Strategy for Management and Control

Structure a management and control process for environmental restoration information management.



5.3.1 Issue

A structured management and control process establishes a basis for strong understanding, involvement, and accountability by managers, which is essential to achieve the vision of integrated information management. This creates an environment with well-established rules and expectations that allows the integration of widely distributed responsibilities and accountabilities into an integrated whole.

Strong management involvement is essential if integrated information management is to be achieved. Without strong management control and participation in information management, individual organizations are free to participate in their own way or not participate at all. Information management is therefore less effective for the actively participating organizations and there is the potential for the loss of data and data configuration control. The bottom line is that maximum return on the present investment of funding and resources, such as staff and equipment, is far less than could be achieved with a stronger management and control process.

The ER information management efforts suffer from lack of visible management participation, fragmented funding, and lack of user understanding and support. The value and contribution of information management are generally not well understood. Information systems are not widely perceived as user-friendly, cost-effective, or essential to the ER process. If ER is to adopt a culture of using data of known quality for making decisions, the sooner the transition to the information architecture discussed in the last strategy is undertaken, the sooner ER will be able to take advantage of its benefits and the less costly it will be in the long term. While significant funding will be required to accomplish this transition, ER will benefit from effective information management. Duplicated and hidden information management activities will be eliminated. ER needs to focus its information management spending toward the common goal of effective information management for the entire user community.

External stakeholders, such as regulators, elected representatives, tribal officials, public interest groups and others, perceive that their access to ER information is unnecessarily limited. Agreement has been reached regarding the definition of appropriate access required to support regulator compliance and oversight activities. This problem is a complicated one for both external and internal stakeholders. ER information exists in a variety of formats and in both documented and undocumented locations, because of requirements existing at the time the information was created or last used. Key information sources are commonly shared by word of mouth.

Information sharing, the need for electronic access to environmental information, and the existence of increasingly heterogeneous and distributed computer systems is a problem for the ER Program. Therefore, an effective information management capability composed of people and computer systems must become the standard. The ER Program and information professionals must work together so the technology to meet users' information access needs today is flexible enough to take advantage of new technology to meet needs even more effectively tomorrow. A fully integrated decisionmaking process for information management is essential to ensure that duplication of effort is minimized and that the return on investment is maximized and focused on users' needs.

5.3.2 Strategy Description

An ER-wide information management effort is needed to build on and improve the existing capabilities that support ER information management needs. ER needs to obtain management and user support for implementing this strategic plan.

ER personnel need to work together to evaluate and communicate information requirements that apply to new development efforts as well as efforts to enhance existing systems.

5.3.3 Current Status

While much of the necessary raw data is currently being captured as data are created, or are being identified in historical documents and captured on an as-needed basis, many organizations are involved, and the collection systems are not integrated and lack user-friendly retrieval systems. Therefore, relevant data and information are not readily available, usable, or accessible to the ER Program and its stakeholders. Managing ER information also occurs in many organizations, sometimes with conflicting objectives. Currently, no one is responsible for setting priorities for making data available in a user-friendly manner.

There is no single point of contact for information. Instead a user must search individual programs. To the outside world, the Hanford Site is a single entity. In reality, it is more an alliance of separately governed programs, each with its own separately evolved mechanisms for information processing and storage. This adds complexity for information seekers and frustrates external stakeholders.

There are no incentives or motivation for cross-program and cross-project interaction to occur. Those few program and project interactions that are occurring are the result of individuals recognizing the importance of interactions and making them happen.

Electronic data are not recognized as "official records." The official record is the paper copy of the data. As a result, electronic forms of data cannot be cited as references without the paper backup. This outdated policy needs to be revised so that ER can take better advantage of modern computer technology. Both WHC and PNL have electronic imaging systems currently in use and/or under development. These systems are taking advantage of advanced computer technology. These efforts can help ER and the Site address the issue of electronic records as official records.

Several important management and control steps have been taken since work began on this plan. WHC created the Coordinating Action Board consisting of the multicontractor trustees of TPA-related information systems plus information systems professionals. DOE-RL has created a data management board consisting of representatives from major programs including ER. Charters reflecting roles and responsibilities for both groups are to be written and endorsed by DOE-RL. A staff member from DOE-RL's Site Infrastructure Division with assistance from a supporting contractor to DOE-RL is coordinating interactions between TPA-related databases. Data management unit manager meetings are being held with the regulators on a regular basis. DOE-RL has a staff member working full time on ER information management issues.

In the course of writing this strategic plan and the Sitewide information management strategic plan, many people have become more aware of the role of information management at the Site.

To achieve maximum benefit, many of the near-term actions presented below require implementation at the Site level. The ER Program is prepared to interface and support these Site level efforts.

5.3.4 Near-Term Actions

The near-term actions in support of this strategy include the following:

- The ER Program sanctions the creation of a Site Chief Information Officer. The officer must occupy a position that is a level above the program structure if that position is to have functional effectiveness. The position will be the prime integration point for Site-level information management activities.

- Information officers for each of the Site programs should be appointed to direct program information management activities and interface at the Site level with the Chief Information Officer. The ER information officer will be responsible for leading ER information management efforts and establishing a point of contact for external stakeholders who need access to ER information resources.

- Work with ER management to clarify information management roles, responsibilities, and accountabilities.

- Increase the level of visible management participation in information management by convincing managers that effective information management can affect the ER mission. Solicit their support in making sure all organizations participate in effective information management.

- The ER Program supports the creation of an active stakeholder Information Management Advisory Committee. ER will actively participate in this committee.

- Charter the Coordinating Action Board as a core information management planning team to provide coordination, support, and advice for the implementation of the ER and other programs' information management plans.

- Charter the DOE-RL information management program officers to approve or reject actions recommended by the Information Management Advisory Committee or the Coordinating Action Board and resolve conflicts between the advisory committee and other involved parties.

- ER proposes and will actively participate in a formal planning process for infusing Geographic Information System technology into the Site.

- Identify and implement applicable configuration management, data security, and quality assurance principles to manage ER information.

- Develop an overall approach to funding ER information management that facilitates the integration and sharing of information resources.

- Integrate information management principles into the ER work process so that information management becomes an integral part of doing work.

- Ensure that new systems are designed and developed to integrate between programs and projects; provide incentives for such integration.

- Ensure that new systems conform to ER and Site standards.

- Begin moving the control and management of data to occur as close to the source of the data as possible.

- Revisit DOE-RL's computer security policy on access to Site databases to make it easier to establish stakeholder access.

- Work toward recognizing electronic forms of data as official records.

- Develop a public involvement policy for access to ER information.

5.3.5 Long-Term Actions

The long-term actions in support of this strategy include the following:

- Ensure that the control and management of data occur as close to the source of the data as possible.
- Provide continued funding for ER information management that shares and integrates among programs.
- Make electronic forms of records to be official records.
- Participate in continued coordination and integration of ER information management with other programs' information management activities.

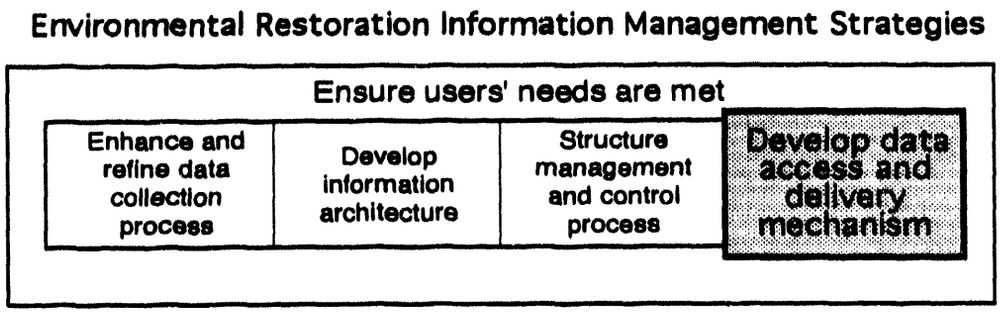
5.3.6 Success of Strategy 3

The success of this strategy can be judged by the following criteria:

- A DOE-RL Chief Information Officer is actively working with information management teams to implement this plan.
- Strong management support exists for information management so adequate funding resources are allocated, ER data are becoming integrated, and an information management culture is apparent within ER.
- ER information management roles, responsibilities, and accountabilities are established and understood.
- Both internal and external stakeholders know how to get to the information resources they need and they obtain the information they need.
- The ER Program acknowledges the importance of a single version of "official information."
- There are signs that information management has become an integral part of doing work.
- ER personnel are onsite leaders in effective information management.
- Clearly defined information-driven processes are used in ER decisionmaking.
- Duplication of information management development processes are minimized without obstructing the ER mission.

5.4 Strategy for Data Access and Delivery

Develop data access and delivery mechanisms and associated processes that ensure environmental restoration information is effectively available to authorized internal and external stakeholders.



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5.4.1 Issue

ER information resources are fragmented and spread over the Hanford Site in a hodge-podge fashion rather than integrated and coordinated. Environmental records, for example, are incomplete, and access is limited, complex, and time-consuming. Some information is only available in paper form. Access to auxiliary information, such as environmental regulations, regulatory standards, and procedures, is only partially available in formats that can be readily manipulated to meet user needs. There is no standard process or integrated vehicle for delivery of data to those who need it. It is difficult for Hanford Site personnel to determine who should be contacted to obtain the data. To an outsider or a Hanford Site newcomer, data access is almost impossible.

Through HEIS, ER users are able to gain access to relatively raw data, but there are no provisions for them to gain electronic access to information products such as site characterization inventories or the results of risk assessments. As Site cleanup continues, these kinds of information will need to be integrated with other information resources, such as how various technologies perform to develop and compare cleanup approaches and make well-informed decisions. ER users are just beginning to use tools such as geographic information systems and three-dimensional visualization to view data spatially, but they have not fully explored the potential use of these tools in analysis and decisionmaking. Only limited management planning is under way for developing and delivering these kinds of information products to users.

Information products must have sufficient metadata so a user can determine a product's applicability to the user's requirements. Information products must be peer reviewed, documented, quality-assessed, and controlled under configuration management procedures.

External stakeholders require access to ER information: regulatory officials need information for compliance monitoring and TPA participation reasons; elected representatives, tribal officials, public interest groups and the public at large also desire to be a part of the decisionmaking processes to ensure their interests and societal values are incorporated into the solution. DOE considers stakeholder participation to be a high priority issue for resolution. The developers of this plan recognized the importance of this issue and, as a consequence, involved 130 internal and external stakeholders to help in the plan's development.

5.4.2 Strategy Description

To accomplish this strategy, a standard, integrated process for the management, retrieval, and delivery of environmental data and information products must be provided so ER information may be collected, maintained, and made electronically accessible, when and where feasible. Existing historical data should be recovered, as needed and as cost-effective, and incorporated with other ER information. Modern state-of-the-art computer technology should be used as needed to accomplish the delivery.

Internal and external stakeholders should be provided with timely and agreed-upon levels of access to quality ER information through user-friendly information systems, which include providing access to metadata.

5.4.3 Current Status

The current status for ER data access and delivery is as follows:

- The ER administrative record/public information repository system and the WHC-operated ER Program Information Center are operational and available for use.
- The Hanford Environmental Information System is operational, user training is available, and some user access capabilities, though limited, are in place.
- The Waste Information Data System recently completed a requirements analysis that assessed existing and future user requirements.
- The Hanford Geographic Information System provides map-based output products as requested by ER staff. Plans call for making the electronic versions of those products available to users on their desktops.
- Users of the Hanford Site local area network have access to resources like Techlib, which provides information on resources available through the technical library, and Hanford Info, which provides information on a variety of topics of general Hanford Site interest.
- PNL has recently developed a local area network-based information system of statutory and regulatory information.

- WHC has developed a Windows-based system called the Baseline Analysis Matrix to aid in the generation of ER requirements baseline documents. Once a document is generated, the system can track compliance with document requirements and commitments.

- PNL and WHC are scanning and indexing old Hanford Site documents for future access as they go through declassification. This activity will preserve an important portion of Site history and make it electronically accessible.

- Options for establishing a central repository for metadata are being investigated.

- A feasibility study for a Site-level glossary will be completed in the near future.

- There is an effort under way throughout the DOE complex to develop and defend record retention schedules for environmental information.

- The DOE's Office of Scientific and Technical Integration issued a strategic plan for electronically exchanging scientific and technical information in January 1993. The plan is based on the use of Standard Generalized Markup Language tagging of documents to facilitate electronic access and delivery. WHC has a plan for development and prototyping of this emerging technology in the near future. PNL has also made investments in this area.

- Paper-based indices of documents available through the ER Program Information Center are located at Public Information Repository locations.

5.4.4 Near-Term Actions

The near-term actions in support of this strategy include the following:

- Use the information architecture for systems like HEIS and WIDS to deliver ER data and information to users.

- Promote shared and integrated information systems as appropriate to the functions being performed and minimize the duplication of development efforts for those functions.

- Begin planning for the delivery of information products to users. Involve stakeholders in developing the requirements for those products. Develop policies and procedures for ensuring that information products have sufficient metadata and are peer reviewed, documented, quality-assessed, and controlled under configuration management procedures.

- Use the information architecture to provide user-friendly graphical user interfaces as entry points to ER's distributed information resources.

- Develop policies and procedures that enable the electronic delivery, retrieval, storage, and retention of documents and Site records; ensure that the policies comply with legal requirements for records.

- Develop guidelines for creating and maintaining environmental data, information, and records in electronic form, building on standard data management methodologies and on DOE's commitment to the Standard Generalized Markup Language as a national DOE standard.

- If deemed feasible and cost-effective, develop, implement, and maintain a Site-level data element dictionary to facilitate consistent usage.

- If deemed feasible and cost-effective, develop, implement, and maintain a standard Site-level glossary to facilitate consistent use of terminology.

- Document the metadata managed by environmental information systems in use at the Hanford Site. Make this information available to users in the data element dictionary accessible through the Hanford Site local area network. Ensure that metadata such as quality and accuracy accompanies the data into information systems.

- Develop, implement, and maintain standards for information exchange and integration between systems.

- Develop record retention schedules for environmental information.

- Place personal computers in each public information repository so users can search electronically for document references instead of using a paper index that is updated once a month.

5.4.5 Long-Term Actions

The long-term actions in support of this strategy include the following:

- Ensure that users have access to the information they need to perform analysis and make sound decisions.

- Implement standard automated processes for accessing, retrieving, storing, and retaining Site environmental data and information with a focus toward a goal of a paperless office.

- Develop, implement, and maintain an integrated ER indexing system for information management systems that is compatible with other Hanford Site indexing systems.

- Integrate document images with document metadata and make it accessible to the user community through a user-friendly interface.

5.4.6 Success of Strategy 4

The success of this strategy can be judged by the following criteria:

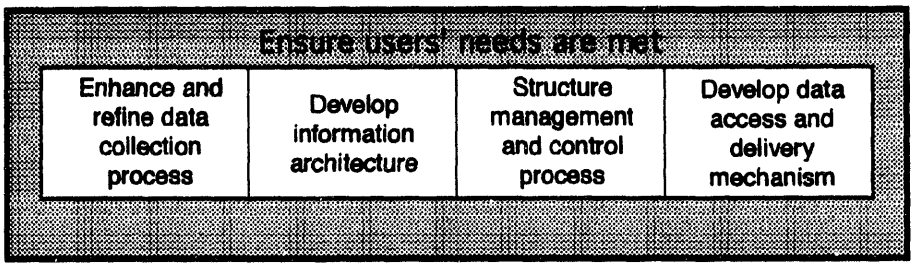
- Users have user-friendly electronic access to essential environmental information needed in fulfillment of their roles.

- Paper requirements for ER staff are drastically reduced.
- Metadata for ER information are readily available and maintained.
- A Site-level glossary and data element dictionary, if implemented, are available and maintained.
- Future information access needs are identified and planned for integration into the information management systems.
- Responsibilities for business and data modeling have been assigned and are maintained.

5.5 Strategy for Meeting the Information Requirements of the Environmental Restoration Community

Ensure that environmental restoration information management meets the users' needs in the most effective and efficient ways possible.

Environmental Restoration Information Management Strategies



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5.5.1 Issue

ER information management *must* focus on the needs of the community of users (i.e., DOE-RL, contractors, regulators, and other pertinent stakeholders/interested parties). To be effective and relevant, ER information systems must provide substantial value to those users. User requirements will drive the evolution of information management, defining need, scope, and priority. In turn, tactical management of information will make it possible to more accurately target areas where the need is greatest and where greatest cost benefit can be realized. With the relationship between information resources and the requirements of the user community well-understood, maximum value of ER information resources and the associated cost savings will be realized. If information management activities exist independently of user needs, they will be perceived as draining funds without sufficient return and will fail to be of value to the user.

5.5.2 Strategy Description

To accomplish this strategy, a coordinated effort to identify and address the information requirements of the ER community must be developed. User needs will be met *effectively* when the users have an adequate information infrastructure, user support facilities, reliable standards, and user-friendly access to the information resources they require to perform the tasks they set out to do. These needs will be met *efficiently* when users can perform these tasks productively without duplication of effort, using streamlined processes, and without wasting time or effort.

5.5.3 Current Status

Some of the problems that have been identified by ER users are as follows:

- Users are confused about the location of information resources, which limits user interaction and feedback.
- Inconsistencies in existing information resources hamper the use and the development of information products. These inconsistencies limit use and reduce ER's credibility.
- The perception exists that information is "locally owned/operated" instead of being valued as a corporate resource.
- There are dissimilar, complex user interfaces that are difficult to use and increase users' learning curves.
- Gaps, redundancies, and overlaps exist in system implementation.

5.5.4 Near-Term Actions

The near-term actions in support of this strategy include the following:

- Identify the information requirements of the ER user community.
- Provide user-friendly interfaces to ER information.
- Increase the utility of the ER information by continuing to improve information and systems.
- Assist the ER staff in becoming a more computer-literate community that values and uses information appropriately. Build on existing training programs to teach staff the mechanics of using information. Reorient part of the training program to raise the level of awareness of the benefits, advantages, and expectations of information management to the ER Program.
- Establish and maintain an ER or, if possible, a Sitewide information service center that provides the user with a single point of access for ER information resources. Its function will be to maximize use of existing resources. User feedback and statistics collected by the service center will identify important resources, identify redundant or useless ones, and identify deficiencies.
- Implement methods of informing the user community of new information resources and progress in updating existing information resources.
- Develop a plan and locate funding for support activities such as documentation, training, and help desks. These activities are essential for success and maximizing return on investment. Incorporate these activities with existing Sitewide capabilities where feasible.

- Help information management users and implementers develop realistic goals and expectations for new and established information management resources. Ensure that systems are not "oversold" to the user community.

5.5.5 Long-Term Actions

The long-term actions in support of this strategy include the following:

- Maintain the information service center.
- Establish a self-supporting information training center for the user community.

5.5.6 Success of Strategy 5

The success of this strategy can be judged by the following criteria:

- ER staff are leaders in the effective use of information management.
- User training requirements are met.
- User requirements are identified and met. Users are actively involved in requirements identification and planning.
- Users are able to quickly browse large amounts of data and access the specific data they need.
- Users can easily ascertain whether data is applicable to their needs.
- Users are able to use and build on the work of others.
- Programs and projects are able to easily use data from multiple programs and projects.
- There is a strong technical basis of information for decision makers.
- A single-point-of-contact service center is established for information management for the ER Program.
- Work is being performed with higher quality information products. The effort in accessing, using, and producing those products is reduced.
- There is positive feedback from stakeholders that their information needs are being met.

6.0 Obstacles

Several significant obstacles are presented in this section that must be addressed before the ER information management strategic plan can be successfully implemented. In this strategic plan, an obstacle is defined as any element or situation that hinders or becomes a barrier to achieving the vision. The following items fall into this category:

- The primary obstacle to achieving the vision is the current unavailability of funding to implement the information architecture. Although significant funds are spent on ER information management activities, there is no process to consolidate and prioritize the use of these funds to implement this plan. Implementation of the information architecture requires improvement of the Hanford local area network. These improvements are needed to support current and future demand. Although network improvements are planned, it is not clear when those improvements will benefit ER.

- The implementation of effective information management requires a commitment from managers that is equal to other business priorities. Historically, information management has not been considered a high priority in the Hanford Site's business planning process. Although information management technology is improving rapidly, obtaining and effectively deploying that technology effectively is time consuming. It may be several years before a return on the investment is visible to management. Such long time periods are in direct conflict with the Site's one-year budget cycle. Under these circumstances, it is difficult to convince management that the investment is worth the time and cost.

  The obstacles of a long-term commitment to excellence of information management within the short budget cycle, the need to be astute enough to select and maintain suitable information management technology in a changing technology environment, and the very complex restoration program needs will require considerable management vision and attention.

- The government funding process is based on dynamically competing priorities for limited resources at the federal and at the local levels. The result has been a long history of competition between Site programs. This plan calls for a vision of shared information resources. The Site's competitive culture and inherent resistance to change are counter to integrated information management.

- Both ER and the Hanford Site need to resolve the "not invented here" syndrome. ER needs to investigate the activity of others in the information management arena and determine which of those activities can be cost-effectively infused into the ER Program. At the same time, ER must be responsive to ER user requirements.

- The difficulty of establishing and maintaining Sitewide data standards requires that data and record management requirements become a part of the Site work-control process. This is a vital step in replacing the current hard-copy data records culture with an electronic information management culture as proposed in this plan.

- External stakeholders regard dealing with computer security programs as an obstacle to accessing needed data. Since the stakeholders were interviewed, progress toward overcoming this obstacle has been made, but more progress is needed.

These obstacles will only be considered obstacles until a solution to overcome them has been developed. The increased attention from management that these information management obstacles have received over the course of the past year represents a significant change in the way information management is perceived and understood at the Site. If plans like this plan, the Sitewide information management strategic plan, and the data management plans required by TPA milestone M-35-03 lead to management commitment to more effective information management, they will have served the intended purpose and will represent a major turning point in the way business is done at the Hanford Site.

Appendix A

The Planning Process

Appendix A

The Planning Process

This information management strategic plan was developed as one part of the strategic planning process for the U.S. Department of Energy, Richland Operations Office (DOE-RL), Environmental Restoration (ER) Program. A core planning team was chosen from DOE-RL, the Hanford Site contractors, and the U.S. Army Corps of Engineers to produce and document the strategic plan.

The core planning team was required to meet frequently to complete the planning steps and validate the following issues:

- The values reflected by this document are compatible with the values of the ER Program.
- The mission is supported by the necessary legal and organizational mandates to support the desired outcomes or vision.
- The vision reflects the values and mission in the form of a statement of what the plan is to achieve.
- The organizational goals and objectives bracket and articulate the desired vision.
- The situational analysis has identified who the stakeholders are, and the strengths, weaknesses, opportunities, and threats represented by the document as well as the risks.
- The stakeholder analysis evaluated and considered the values, interest, and expectations of both internal and external stakeholders.
- The strengths, weaknesses, opportunities, and threats analysis and the stakeholder analysis identified the various degrees of obstacles, which are identified as issues that are prioritized according to risk.
- The key obstacles are identified and strategies are developed.
- The strategies are examined to ensure they accomplish the stated outcomes as articulated in the vision.
- Ongoing activities were evaluated and fitted to the vision, and the initiatives accomplish the vision within the framework of the values and mission.
- Checks were made to ensure that the plan is consistent with and supports other organizational plans.

- The plan interface areas and contact points served to facilitate long-term relationships and interactions among the involved parties.

The planning model required the team to propose action plans that allow ongoing evaluation of the success of the process. It also required the planning group to identify significant incongruencies held by the stakeholders and the planning group, and to analyze their effects on potential attainment of the vision.

The plan has been validated through extensive input from both internal and external stakeholders. This stakeholder-focused planning process included an analysis of stakeholder input. In addition, interviews were conducted both internally and externally to gain a systems perspective that would foster an integrated planning effort. This effort builds on the ER strategic planning process and yet integrates information management goals, objectives, and activities with those of the other contractors and representatives affected by actions on the Hanford Site.

The team has attempted to present key aspects of the plan in a concise, summarized format. The plan ensures critical links among the goals, objectives, and key program activities. It is expected that measures of success will be continually developed, refined, and tracked over the 1994-1999 planning horizon in addition to annual plan revisions. Detailed planning will be a logical spinoff of this strategic plan, which will assist the ER Program in developing the specifics of workscope, budgets, organizations, and schedules.

Appendix B

Stakeholder Analysis

Appendix B

Stakeholder Analysis

B.1 Overview

A total of 130 internal and external stakeholders were interviewed in the process of preparing this plan. Internal stakeholders were represented by personnel from the U.S. Department of Energy, Richland Operations Office; the U.S. Army Corps of Engineers; Westinghouse Hanford Company; Boeing Computer Services, Richland; the Pacific Northwest Laboratory; and Kaiser Engineers Hanford. External stakeholders were represented by personnel or members of the U.S. Environmental Protection Agency; Government Accounting Office; the Agency for Toxic Substance and Disease Registry; the U.S. Army Corps of Engineers; the U.S. Geological Survey; a member of the Washington State House of Representatives; the Washington State Department of Ecology; three tribal governments; and the Sierra Club.

The stakeholders were invited to complete a questionnaire or be interviewed using a questionnaire developed to reflect the values, interest, and expectations of the stakeholders in relationship to the plan's information management vision. The questionnaire was specifically designed for the interview process and those who performed the interviews were trained in its use. The purpose and wording of the questions were designed to ensure that the situational analysis conducted by the core planning team was comprehensive and reflected the needs of ER information management. This process proved to be valuable because the interviews influenced the team's thinking by providing insight and strengthened the team's commitment to the importance of information management. The process also educated the stakeholders about information management issues, capabilities, and concerns. The process refocused the team to add the value of public/regulatory involvement in the planning process, which was omitted in the first draft of the strategic plan. The findings in this section have now been reflected throughout this plan.

B.2 Values Area Summary

There was high concurrence between the values guiding the development of the plan and the values of the internal stakeholders. In the early drafts of the plan, there was less concurrence with the values of the external stakeholders. An analysis indicated that the plan needed to be reviewed and revised to ensure that the values of information access and public involvement were included in the foundations of the plan. After these modifications, a repeat of the analysis indicated these values were consistent with the values of the external stakeholders throughout the interviews.

B.3 Interest Area Summary

In the interviews, stakeholders cited interest in a wide variety of information management capabilities: automated trending, interfaces with other systems, coordination of information, services available, equipment, decisionmaking, public information systems, documentation, medical/personnel information, multimedia, and political issues. The stated concerns that could affect the success of the plan were identified as the need for detailed objectives, information about the availability of technology, the need to minimize paper, people developing their own systems, issues of organizational territory, and the lack of decisionmaking processes. The concerns were addressed in the strategic plan and are represented both in the vision statement and the strategies.

B.4 Expectations and Issues Summary

The following expectations were identified by internal stakeholders as necessary for achieving the stated vision:

- Use an integrated funding approach for ER information management instead of funding on a program-by-program basis.
- Identify and appoint a Chief Information Officer.
- Initiate processes for rewarding people for teaming.
- Develop appropriate information systems to support risk assessment and decisionmaking.
- Provide a Sitewide information management capability for announcing the successes of the cleanup process.
- Develop clear data input and use policies.
- Develop clear policies regarding roles and responsibilities.
- Develop a stable funding base.
- Identify and meet significant information and user needs.

The following issues were identified by external stakeholders as requiring resolution:

- Provide integration of information systems.
- Provide clear identification of important information.

- Obtain the support for the plan from all affected organizations.
- Effectively use stakeholders in identifying the desired outcomes.
- Avoid the past failure to implement plans.
- Provide public and regulatory access to information systems.

The expectations, concerns, and issues of the stakeholders as represented above were used in the development of the strategies. The plan was analyzed to ensure that the plan addressed the resolution of the concerns and issues and there are actions in the plan to achieve the stakeholders' expectations.

Appendix C

Situational Analysis

Appendix C

Situational Analysis

This situational analysis was performed early in the process used by the core planning team to identify the obstacles that require resolution to accomplish the vision and goals. This was done through analysis of trends, assumptions, strengths, weaknesses, opportunities, and threats. This appendix represents a "snapshot" of where the team was when this analysis was performed and should not be considered comprehensive. The material covered in this section is a summary of the major points covered by that analysis.

C.1 Planning Assumptions

The planning assumptions include the following:

- The cleanup mission is supported by the public.
- Cleanup remains the prime Hanford Site mission.
- Effective information management will increase both the effectiveness and efficiency of the cleanup effort.
- Information access is essential for credibility and regulatory compliance.
- Based upon responses to expected funding trends in our stakeholder analysis, significant initial investments in information management will be required with somewhat declining investments after information management is successfully implemented.
- Technology is available for achieving the vision of this plan.

C.2 Strengths

The ER management at the U.S. Department of Energy, Richland Operations Office, has a growing understanding of the importance of information management to the success of the Hanford Site cleanup mission, and understands that effective and efficient ER information management is vital to the containment of cost and quality of work. The ER management is committed to working with stakeholders, including the regulators, in providing appropriate, high-quality information in a timely manner. It is also recognized that the needed staff expertise for developing the information management process is available onsite, although resources are limited.

C.3 Weakness

The need for the high degree of information management coordination and technology required to achieve Site cleanup and meet the stakeholders' needs for documentation and information is not generally recognized as a high priority. Also, while data are everyday tools for all managers onsite, the amount of effort required to develop data and store it is not frequently recognized by decision makers. The fragmented funding approach developed in part to ensure compartmentalization now hinders coordination and Sitewide efforts at integration and development of cost-effective information management. The multiple contractors and programs at the Site could be resistant to an open information management culture because of what they often view as proprietary or information ownership issues. It is difficult to obtain state-of-the-art technology because of obstacles presented by procurement processes. The current computer security requirements are also obstacles in spite of the new ER mission. How to use data in decisionmaking is not well understood. There are significant limitations with the existing network.

C.4 Opportunities

The development and review process for the ER information management strategic plan offers a unique opportunity to educate stakeholders about information management. The Tri-Party Agreement renegotiations have been useful in determining stakeholder information management needs. The processes used for development of successful solutions to Hanford Site ER information management problems are exportable to other missions and other sites. There are potential applications for the electronic superhighway that new technology and government initiatives are making a reality. There is also the potential for "value added" from the ER information management to have a secondary use as an infrastructure component for U.S. Department of Energy's economic transition initiative for the Hanford Site.

C.5 Threats/Risks

The successful implementation of this plan is in danger if ER fails to involve all groups of information management users in the process. It is essential that the majority agree with a common vision and a set of strategies. The failure to accept the premise that the user of the system is the chief stakeholder is a major concern as is the problem of the limited and fragmented funding approach to information management. The chief concern is the potential for congressional budget cutting that impacts the ability to implement this plan. A major success criterion is the need to ensure that data conform to established data standards while consistently documenting data quality.

Appendix D

The Information Architecture

Appendix D

The Information Architecture

What is an Information Architecture?

The purpose of this appendix is to provide a high-level overview of what is meant by "information architecture." The information architecture is a descriptive conceptual framework for information systems implementation and its associated, underlying computer-based infrastructure. The Hanford Site's information technology designers and implementers need this open and flexible framework to create, integrate, and upgrade the Site's information management capabilities. The focus of the architecture is on the ability to access data anywhere and to run critical applications when and where needed. The user will not have to be concerned about where the data resides but will focus on what that user wants. The architecture will function like the librarian who knows where the resources reside and can easily retrieve them. The user will be able to work in a multimedia environment that supports the integration of databases, documents, maps, images, video, and audio. As capabilities based on the architecture are implemented and information resources are made available through the architecture, users will have seamless access to that information. A phased implementation is needed to allow new systems to be built using the architecture, to incorporate existing systems into the architecture where feasible, and to allow other existing systems to be modified or reimplemented so they can be integrated into the evolving information architecture.

The architecture facilitates the integration of computer systems that are heterogeneous and distributed. The architecture is not a single computer system, but a set of computer systems that perform different functions and are physically distributed across the Site. The computer systems are tied together through networks. Different computer systems have different functions. Some computers are "servers" that manage large databases, data sets, documents, and other multimedia objects. Other computers are "clients" that reside on the users' desktops and provide users with access to information resources through graphical user interfaces. Another set of computers provides the linkages between the many clients and the servers.

Components of the Information Architecture

There are five major components of the information architecture: process, data, technology, applications, and organization. All these components together form a representation of the "enterprise" (or business) to which the information architecture is related.

1. The process component focuses on what the business does in order to accomplish its work.

2. The data component focuses on what data are needed, generated, updated, and stored. An accepted set of standards is required to provide consistency for data users.

3. The technology component considers network technology, including installed and planned networks and telecommunications; facilities and their locations; hardware configurations; operational, commercial, and development software; and technical services. This component also describes the policies, strategies, and processing standards for the architecture.

4. The application component provides software capabilities (referred to as "tools" hereafter) for accessing and using information resources.

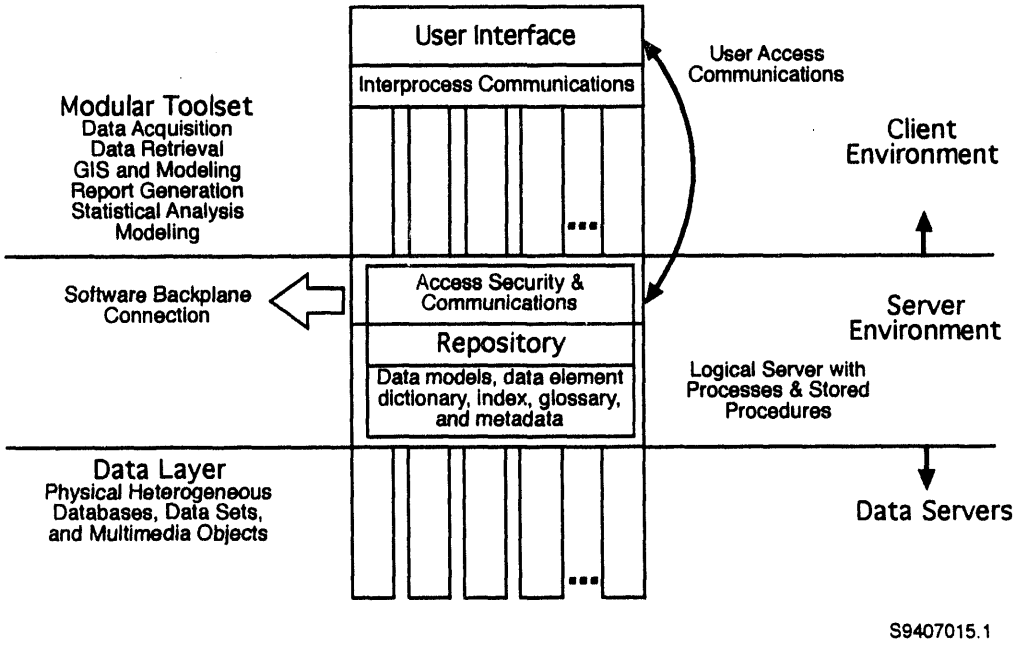
5. The organization component is a description of the organizations and their relationships.

Significant insight results when these various components are analyzed together so that the whole enterprise can be understood.

Since this strategic plan is heavily focused on needs for the technology and applications components of the architecture, the rest of this appendix is primarily focused on those two components.

The Technology and Applications Components

The approach to this information architecture is shown in the figure. This architecture is intended to be sufficiently robust to provide access to widely distributed users and information sources in a variety of forms. It must provide flexibility to modularly attach new tools so users' processing capabilities can be continually enhanced.



Information Architecture

In this multilayer model, the **data layer** forms the foundation of the architecture. It is comprised of databases, data sets, derived data, documents, images, and other multimedia forms of information. These data resources can be independently accessed by the tools in the modular toolset layer or through the user interface. The **repository layer** includes data models; locator data from the data element dictionary, index, and glossary; and metadata that describes the data sets and documents managed as part of the data layer. The repository may also contain Computer Assisted Systems Engineering (CASE) tools. The **access security and communications layer** ensures the long-term integrity of data resources by controlling access to those resources. The data must be protected from accidental or malicious damage. Confidentiality of data must be preserved. Users must have a user name and password before accessing data resources. Security will be provided through the computer systems and the database management systems. Users and systems use the **access security and communications layer** to reach information at other locations. The software "backplane" connection facilitates communication by providing a framework for attaching different packages without disturbing applications already connected. The **tool set layer** provides direct access to the repository and provides applications (e.g., data retrieval, statistical analysis, report generation, geographic information system functions, and modeling) that facilitate use of the data. The **interprocess communication layer** allows the individual applications to communicate by passing data from one to the other. The **user interface layer** provides consistent and easy invocation of the various applications.

The following key characteristics of this architecture are essential to accommodate rapid and continuous changes in technology:

- Open Systems Preference - Industry standard nonproprietary hardware and software solutions should be used whenever possible. There should be a strong focus on interoperability between the various components.

- Client/Server Approach - A decentralized, distributed, client/server style of computing facilitates the use of networked, high-capacity servers for data storage and retrieval and graphical workstations (e.g., high-end PCs or UNIX workstations) as clients for interactive display and analysis of data.

- Multilayer Architecture with Interchangeable Components - The architecture should be separated into multiple layers with well-defined interfaces between the respective components because the user community is large and has diverse needs, and also because change is inevitable and continuous. The goal is to incorporate new components with a minimum of cost, disruption, and perturbation to the overall system as the components available become better, faster, or cheaper.

- Integrated User Interface - A user interface should be defined and constructed that will allow users access to a wide variety of information systems and tools in a common manner to maximize productivity and ease of use.

Technical Guidelines for Implementing the Information Architecture

The following technical guidelines for implementing the information architecture are recommended:

- Use existing information architecture as well as Site- and program-based standards wherever possible. Expand both to meet growing user requirements.

- Concentrate on integration engineering rather than new system development. Based on the Site's information architecture, individual programs will develop capabilities to meet their own computer systems needs.

- Use a systems engineering lifecycle development process that includes clarifying what is to be achieved, analyzing requirements (through pilots and rapid prototypes, if applicable), building components, evaluating component performance against documented requirements, launching the component after final acceptance testing, operating the system (including required support, maintenance and enhancement releases), and finally, closing out the activity.

- Provide flexible support in meeting a variety of user needs and levels of data aggregation.

- Use an "evolutionary" systems engineering approach that adapts to emerging user needs and improving technology. This permits the ongoing use of operational systems and provides a context for the development of new systems and the migration/upgrade of existing systems.

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