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Department of Energy

Washington, DC 20585

April 14, 1999

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DNF SAFETY BOARD

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

Enclosed is the *Low-Level Waste Management Program Research and Development Implementation Plan.* The Department of Energy (Department) has developed this strategy pursuant to its commitments in the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2 Implementation Plan and the "Quarterly Progress Report for DNFSB Recommendation 94-2 January through March 1998."

The enclosed document describes the Department's implementation plan to address research and development aimed at reducing the uncertainty of evaluations of the long-term safety of disposed low-level waste and to seek out improved technology to enhance defense-in-depth for long term safety of disposed low-level waste. The document also identifies the roles of the field organizations, the Office of Waste Management and Low-Level and Mixed Low-Level Waste Center of Excellence, the Low-Level Waste Disposal Facility Federal Review Group and the Office of Science and Technology in the research and development implementation process.

The Department has completed the actions related to commitment IX B.4 "Prepare Strategy to Address Low-Level Waste Research and Development" and proposes closure of the commitment. If you have any questions concerning this information, please contact me at (202) 586-7710 or Mark Frei at (202) 586-0370.

Sincerely,

James M. Owendoff

James M. Owendoff
Acting Assistant Secretary
for Environmental Management

Enclosure

LOW-LEVEL WASTE MANAGEMENT PROGRAM

RESEARCH AND DEVELOPMENT

IMPLEMENTATION PLAN

U.S. Department of Energy
Office of Environmental Management

April 8, 1999

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LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
Board	Defense Nuclear Facilities Safety Board
Department	Department of Energy
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DQO	data quality objective
EPA	Environmental Protection Agency

Low-Level Waste Management Program
Research and Development Implementation Plan

1.0 INTRODUCTION

This document describes the Department of Energy's (DOE's or the Department's) implementation plan to address research and development needs relating to the long-term safety and performance of low-level waste disposal facilities. This plan addresses the Department's commitment IX B.4 "Prepare Strategy to Address Low-Level Waste Research and Development Needs," in the *Implementation Plan: Defense Nuclear Facilities Safety Board Recommendation 94-2, Conformance with Safety Standards at DOE Low-Level Nuclear Waste and Disposal Sites.*

1.1 Background

In the review of the Department's low-level waste management program, the Defense Nuclear Facilities Safety Board (DNFSB or the Board) identified five areas of technical study that should be addressed by the Department. These areas are:

(1) improving modeling and predictive capabilities for assessing migration of radionuclides;
(2) enhancing the stability of buried waste forms;
(3) enhancing the deterrence of intrusion;
(4) inhibiting the migration of radionuclides; and
(5) reducing the volume of waste to be disposed.

In response to Recommendation 94-2, the Department developed the *Implementation Plan: Defense Nuclear Facilities Safety Board Recommendation 94-2, Conformance with Safety Standards at DOE Low-Level Nuclear Waste and Disposal Sites.* The Implementation Plan included four commitments to address the low-level waste research and development program.

The Department completed two documents/commitments related to its low-level waste research and development needs: "*DOE Research and Development Activities Assessment*" (IX B.1) and "*DOE Research and Development Needs Assessment*" (IX B.2). As a result of the preparation of these documents, the Department determined that a site-specific, needs-based approach to identifying research and development must be undertaken. This approach is consistent with the Office of Environmental Management, Office of Science and Technology approach to identifying and funding research work.

At the time the Recommendation 94-2 Implementation Plan was developed, the specific research and development needs of the low-level waste management program were not sufficiently known. Actions taken since that time have allowed the Department to improve its understanding of the research and development needs of the low-level waste management program; such actions

include the development of the first two Recommendation 94-2 Implementation Plan research and development commitments, the completion of some disposal facility performance assessments and composite analyses, and the development of the new DOE Order 435.1. As a result, the Department adjusted its focus to address research and development needs relating to the long-term protection of the public and the environment from low-level waste disposal. The Department submitted the "*Complex-Wide Strategy for Maintenance of Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses*" to address Recommendation 94-2 Implementation Plan commitment IX B.3. That document describes the Department's integrating strategy for maintenance of low-level waste disposal facility performance assessments and composite analyses and provides a general strategy for addressing research and development for the low-level waste disposal program.

1.2 Purpose and Scope

The purpose of this document is to describe the Department's complex-wide implementation plan contained in the "*Complex-Wide Strategy for Maintenance of Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses.*" This implementation plan addresses research and development needs relating to the long-term protection of the public and the environment from low-level waste disposal, and describes how these needs will be met. Research and development, as used in this document, includes traditional research and development activities, such as basic scientific research and development of new technologies. The term also includes studies to address data gaps and technical information needs, as well as collection of data through use of monitoring and during routine operations. The primary focus of this plan is research and development aimed at reducing the uncertainty of evaluations of the long-term safety of disposed low-level waste; another focus is to seek out improved technology to enhance defense-in-depth for long-term safety of disposed low-level waste.

Section 2.0 presents an overview of the performance assessment and composite analysis process and the activities conducted by the Office of Science and Technology. Section 3.0 describes the general strategy used to identify and prioritize research and development needs related to low-level waste disposal and selection of an approach to meet these needs. Section 4.0 describes the roles of organizations that have responsibilities for implementing this plan, including the field organizations, Office of Waste Management and Low-Level and Mixed Low-Level Waste Center of Excellence, Low-Level Waste Disposal Facility Federal Review Group, and the Office of Science and Technology. Section 5.0 provides deliverables and dates for completing these deliverables to ensure that the research and development needs are met.

2.0 OVERVIEW

The research and development program described in this implementation plan must be integrated with other ongoing Department activities. Specifically, the performance assessment and composite analysis maintenance program provides the technical framework for identifying

research and development needs. In addition, research needs identified through this implementation plan may be integrated into the research programs managed through the Office of Science and Technology. The following sections provide an overview of the performance assessment and composite analysis process and of the Office of Science and Technology and its project review processes.

2.1 Performance Assessment and Composite Analysis Process

Site-specific performance assessments and composite analyses provide the primary means for assuring the long-term safety of low-level waste disposal facilities. As will be discussed in detail in later sections, the performance assessments and composite analyses are the primary tools for identifying research and development needs to be addressed by the activities implemented using this plan. The following paragraphs provide background information on performance assessments and composite analyses.

Performance assessments present the technical analyses required to provide a reasonable expectation that facilities used to dispose of low-level waste after September 26, 1988 will meet the performance objectives in DOE Order 5820.2A (or DOE Order 435.1 when issued). A facility performance assessment is to include calculations of potential releases from the facility and radiation doses to representative future members of the general public for a 1,000-year period after closure. The performance objectives specify maximum radiation doses to members of the general public by the air pathway and all pathways, as well as maximum radon flux rates. Sites are to implement performance assessment maintenance programs that include conducting studies, performing monitoring, and evaluating and updating the performance assessment analyses to ensure that expectations of long-term performance of the facility are based on the best data available.

The composite analyses present evaluations of potential doses to an offsite member of the public resulting from releases from all sources on the site that could overlap with releases from a low-level waste disposal facility. The estimated doses are compared with DOE criteria for radiation protection of the public. The composite analysis provides information for use in planning for future radiation protection of the public and to address mitigative actions before potential radiation protection problems occur. The site composite analysis maintenance program is to ensure that the composite analysis incorporates up-to-date information (e.g., on source terms, land use plans, potential interactions) and improved analyses (e.g., modeling) to support long-range radiation protection planning.

The Department requires that performance assessments and composite analyses be maintained to evaluate changes that could affect the performance, design, and operations of the low-level waste disposal facility. Maintenance, in the form of collecting additional data, conducting studies, improving models, and performing additional analyses, is a necessary element of the performance assessment or composite analysis process that must continue over the life of the disposal facility. The site-specific maintenance program is defined as a program for updating

performance assessments and composite analyses based on the acquisition of new information on waste streams or inventories and system component performance. It includes a process for improving confidence in projections about the long-term performance of a disposal facility, based on iterations between data collection (e.g., characterization, transfer coefficients), studies (e.g., infiltration through barriers, concrete degradation), and model improvement efforts.

Site preparation and Headquarters review of performance assessments and composite analyses have identified important areas of study or analysis that need to be addressed through the site performance assessment and composite analysis maintenance program for each facility. Performance assessments and composite analyses are being performed and maintained for continuing and future disposal of low-level waste at seven DOE sites. These sites are: Savannah River Site, Oak Ridge Reservation, Los Alamos National Laboratory, Idaho National Engineering and Environmental Laboratory, Nevada Test Site, Hanford Site, and Fernald Environmental Management Project.

2.2 Office of Science and Technology

As this plan addresses implementation of research and development, it is useful to understand how these planned activities relate to the Office of Science and Technology. The Office of Science and Technology's mission is to manage and direct basic research and technology development to support the Office of Environmental Management. The activities conducted through the Office of Science and Technology include basic scientific research, as well as development, testing, evaluation, and deployment of new technologies. As discussed later in Section 4.4, these activities comprise some of those appropriate for addressing research and development needs associated with low-level waste disposal.

The research and development conducted through the Office of Science and Technology is directed at significant environmental management problem areas existing across the DOE complex. The breadth of these areas encompasses much more than the concerns identified with long-term safety of low-level waste disposal. The Office of Science and Technology has organized research and development projects into Focus Areas and Cross Cut Programs. The Office of Science and Technology Focus Areas are Deactivation & Decommissioning, Mixed Waste, Subsurface Contaminants, Plutonium, and Tanks. These focus areas are mainly directed at supporting accelerated paths to closure, rather than addressing long-term waste disposal safety issues. For example, Deactivation & Decommissioning and Tanks address problems associated with closure of specific types of facilities. The Mixed Waste, Subsurface Contaminants, and Plutonium focus areas do, however, address some issues related to long-term safety of waste disposal. A similar situation exists with the Cross Cut Programs, which are Characterization, Monitoring, & Sensor Technology; Efficient Separations; Industry Programs; Robotics; and Integrated Process Analysis. Again, most of the research and development being conducted under these programs is focused on supporting accelerated closure, though some is relevant to long-term disposal safety.

The research and development activities being conducted through the Office of Science and Technology represent one means, but not the only means, of satisfying low-level waste research and development needs. The complete range of tools needed to satisfy research and development needs is discussed in more detail in Section 3.3.

2.3 Office of Science and Technology Project Review Process

As described above, some of the low-level waste research and development needs may be satisfied by research and development conducted through the Office of Science and Technology. The process used to review, prioritize, and fund individual research and development projects is summarized below. As Office of Science and Technology research and development projects represent an important means by which research and development needs related to low-level waste disposal safety may be addressed, it is important to understand this process and its relationship to research and development needs identified at individual sites.

On an annual basis, the Operations/Field Offices, through the Site Technology Coordination Groups, generate site-specific science and technology needs and opportunities statements from Project Baseline Summaries. Once the site needs are identified and approved by the Site Technology Coordination Group, the completed document is submitted to the Environmental Management Mixed Waste Focus Area early in the first quarter of the fiscal year. The Mixed Waste Focus Area addresses mixed low-level, low-level and transuranic waste issues. The Mixed Waste Focus Area uses these needs and opportunities statements to modify and construct out-year budgets.

The Environmental Management Mixed Waste Focus Area works closely with the site end users to identify and document site-specific science and technology requirements. On receipt of the site-approved and prioritized needs, the Mixed Waste Focus Area confirms the completeness of the definitions and contacts the end users for any additional requirements. While each Focus Area develops technical responses to each identified need within their "problem area", to ensure an optimum research and development portfolio the responses must be integrated and prioritized. To ensure that a technical response meets a field technology/data need, only those that are endorsed by a project manager will be considered for integration and prioritization into the portfolio. Prioritization is first done by the Focus Areas, and then thoroughly reviewed, changed as necessary, and approved by the Focus Area's User Steering Groups.

At this point the technical responses are compiled into work packages. These Focus Area-developed work packages represent a set of related technical responses to site needs. A national prioritization process is then applied on a work package basis. The output of the prioritization system goes through a final review panel where the Department's Field Office Managers and Environmental Management Deputy Assistant Secretaries determine the final integrated priority list.

This integrated priority list is the basis for the Congressional budget request for Environmental Management research and development. Each fiscal year, Congress provides Environmental Management funding for science and technology projects. These funds are allocated according to the integrated priority list described above and a set of work packages is authorized. All research and development initiatives funded through Office of Science and Technology are managed through the appropriate Focus Area.

3.0 STRATEGY

This chapter describes the strategy that will be used to develop and implement the low-level waste disposal research and development program. Section 3.1 describes the overall need for the research and development program, and how research and development needs relate to the Board concerns identified in Recommendation 94-2. Section 3.2 then describes the strategy used to identify, assess, and prioritize research and development needs. Finally, Section 3.3 describes the tools that will be used to conduct needed research and development.

3.1 Developing Understanding of Research and Development Needs

In Recommendation 94-2, the Board identified the need for studies in five areas. These areas are:

(1) improving modeling and predictive capabilities for assessing migration of radionuclides;
(2) enhancing stability of buried waste forms;
(3) enhancing deterrence of intrusion;
(4) inhibiting the migration of radionuclides; and
(5) reducing the volume of wastes to be disposed of.

These study areas were identified on the basis of recognized uncertainties and imperfect knowledge associated with common low-level waste disposal concerns across the Department of Energy complex. These study areas are all directly related to assessing and assuring the long-term safety of low-level waste disposal and increasing the "defense-in-depth" for disposal facilities. For example, improved radionuclide modeling and predictive capabilities can be used to improve the designs of engineered barriers for disposal facilities. Enhanced stability of waste forms will enhance near-term performance of a facility and increase the margin of safety, as well as reduce the likelihood and consequences of long-term releases from disposed waste. Deterred intrusion will reduce the probability of exposure by this pathway. Inhibiting radionuclide migration, such as through use of additional barriers to release of radioactive materials, will limit most potential future exposure pathways and effectively reduce near term performance uncertainties. Finally, although adequate disposal capacity exists, many disposal risks are proportional to the volume of waste disposed, so that reducing the waste volume will reduce risks. In order to implement an effective research and development program, it is necessary to:

(1) be able to identify specific uncertainties or system enhancements for defense-in-depth improvement related to these areas;
(2) identify data that can reduce uncertainties or improve DOE's defense-in-depth posture;
(3) prioritize research and development needs; and
(4) identify the most appropriate tools for implementing research and development.

The above study areas are primarily related to long-term disposal safety, but also includes areas, such as enhancing stability of waste forms, that do not necessarily contribute to long-term safety but increase the "defense-in-depth" for the facility. Increased engineering barriers can enhance the near-term performance of a facility and increase the margin of safety. It also gives additional barriers to the release of radioactive materials from the facility, which can effectively reduce near-term performance uncertainties.

Short-term, operational safety is assured through adherence to specific requirements for waste packaging, handling, transportation, and disposal, as contained in DOE Orders, regulations, and site-specific procedures. Operational safety concerns are well understood and short-term effects are more easily monitored and controlled than long-term effects. As a result, there is less priority for research in the area of operational safety. In addition, operational safety concerns can effectively be addressed through means other than traditional research and development.

Evaluating long-term safety (i.e., after closure of disposal facilities) through the performance assessment/composite analysis process must necessarily involve predicting future conditions. Regardless of the specific approach used, there is inherent uncertainty in this process. Sources of uncertainty include use of models that simplify complex and incompletely understood physical processes, limitations in data, and lack of knowledge of future conditions. Research and development needs, therefore, are related to quantifying and reducing this uncertainty.

It is important to note that uncertainty does not equate to lack of safety. Rather, the amount of uncertainty affects what must be done from a design and operational standpoint to assure safety, including the size and degree to which safety factors are used. The greater the uncertainty, the larger the safety factor and the more robust the contingency applied to assure safe operation. For example, if conditions affecting the rate of migration of contaminants are uncertain, barriers are conservatively designed for the worst case based on the ranges of possible values. For most of the range of possible conditions, the facility will be significantly over-designed. Similarly, if waste characteristics are uncertain, operational limits are conservatively based on the highest expected concentrations and inventories. If actual waste characteristics are significantly different than this worst case, the operating limits will be much more restrictive than necessary. Reductions in uncertainty, therefore, do not necessarily increase safety, but will reduce the design and operating conservatism needed to assure safety. Reduced conservatism ultimately will result in increased efficiency and reduced costs. Reduced uncertainty also results in increased confidence with respect to long-term safety (i.e., a better understanding of factors affecting safety).

The primary factor assuring long-term safety of the Department's low-level waste disposal facilities is compliance with the performance objectives contained in DOE Order 5820.2A (or DOE Order 435.1 after it becomes effective). The performance objectives specify the maximum radiation doses to which members of the general public can be exposed by various pathways resulting from radioactivity disposed of at a facility. To determine whether the performance objectives will be met, a site-specific performance assessment must be performed for the disposal facility. The performance assessment calculates predicted radiation doses to the public for a 1,000 year period after closure. These calculations are performed using radiation dose models that require data on the physical characteristics of the site and its surrounding environment; physical, chemical, and radiological characteristics of the disposed wastes; and characteristics of the exposed populations. A conceptual site model forms the conceptual framework upon which the computational models are developed. Consideration must also be given to reasonably foreseeable natural processes that might affect radionuclide release or transport, as well as probable land use and demographics.

The performance assessment evaluates the radiation dose associated with releases from a specific disposal facility. In addition to the performance assessment, a composite analysis is required to evaluate the impacts of releases from all sources of radioactive material remaining at the site, not just those from the low-level waste disposal facility. The composite analysis is to be performed using the same or similar models and data as used for the performance assessment.

Depending on the type, amount, and quality of the required input data that are available for a particular site, considerable uncertainty may exist in the results of the performance assessment and composite analysis. The significance of this uncertainty depends on several factors. One factor is how the range of possible outcomes compares with threshold values at which design or operations would be changed significantly. In the case of low-level waste disposal, the outcome is the calculated radiation dose and the thresholds are the maximum radiation doses specified in the performance objectives. In comparing a range of possible outcomes with thresholds, three scenarios are possible, as identified below and illustrated in Figure 3-1:

- the entire range of outcomes is below the threshold;
- the entire range of outcomes is above the threshold; or
- the threshold falls within the range of outcomes.

The effect of uncertainty is most significant in the latter case as the true value may be above or below the threshold, thus making it uncertain whether design or operations are protective. In this case, there is obviously value in reducing uncertainty. In the first and second cases, even with uncertainty, the true value is known to be below or above the threshold, respectively, and there is little value in reducing uncertainty as far as making this determination.

Uncertainty may also be significant due to its effect on design conservatism. In general, the greater the uncertainty, the more conservative a design must be. That is, the design must be made on the basis of the worst case. Reducing uncertainty can result in applying less design

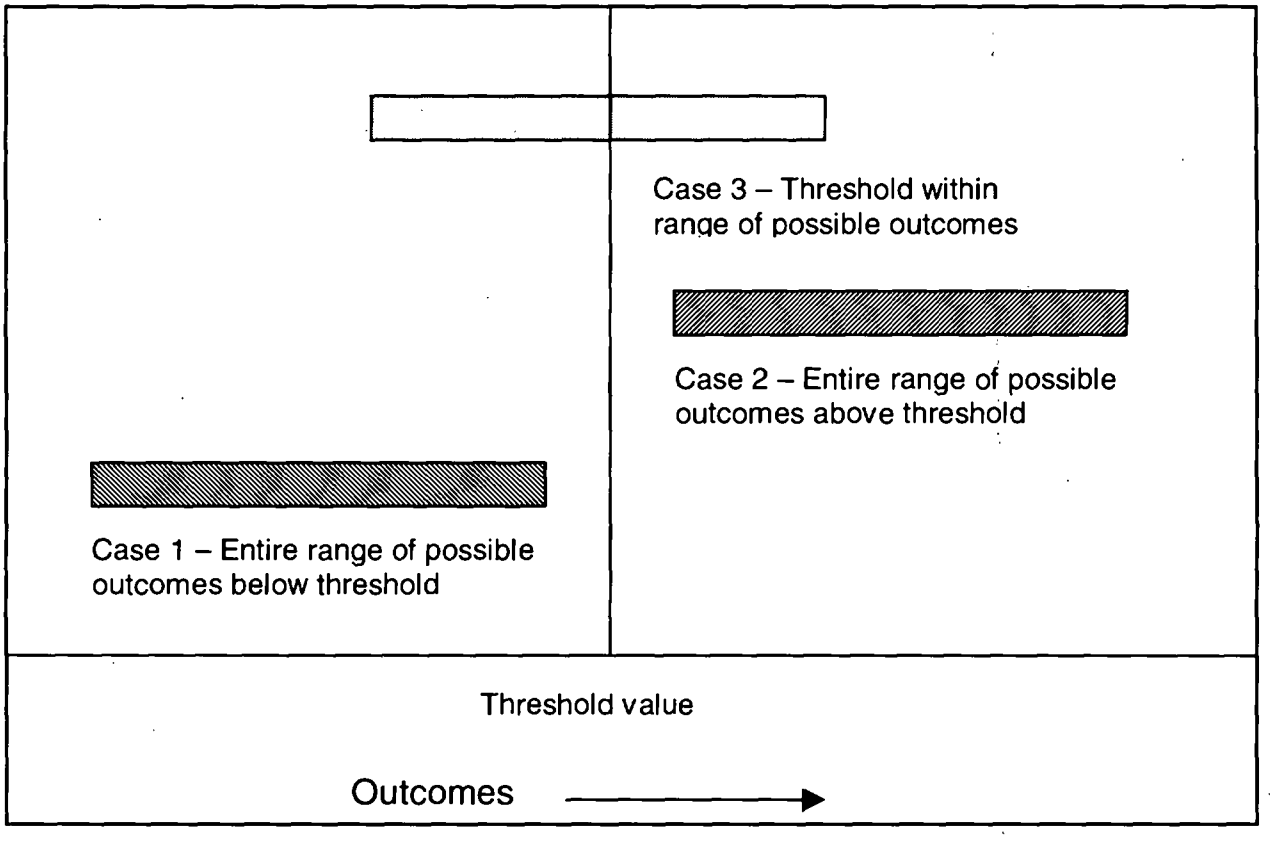

Figure 3-1. Comparison of Uncertain Outcomes with Threshold Value.

conservatism, which generally can result in lower costs. It should be noted, however, that the value of reducing uncertainty in this case will depend somewhat on how robust the design is. If the design is inherently robust (i.e., able to perform equally well under a wide range of conditions), reducing uncertainty may have no effect on the design. For example, a low-level waste disposal cell cover design may be very robust, resulting is very low infiltration over a wide range of recharge conditions. In this case, even if there is high uncertainty in future precipitation, evapotranspiration, runoff, and runon, there would be little uncertainty in design performance (infiltration). On the other hand, if a design is very sensitive to an uncertain parameter, there would be value in reducing the uncertainty. For example, if a design incorporates the natural attenuation capacity of soil to prevent radionuclide migration, the chemical characteristics of the waste and soil may have to be known with a high degree of certainty to assure effective performance.

In the case of low-level waste disposal, uncertainty may also be significant with respect to its impact on assuring that radionuclide releases are as low as reasonably achievable (ALARA), as required by DOE Order and Manual 435.1. That is, in addition to meeting the maximum radiation doses contained in the performance objectives, the future release of radionuclides from

disposal facilities to the environment must be maintained as low as reasonably achievable. Determination of whether releases are as low as reasonably achievable is to be made using the results of the performance assessment. Therefore, understanding the uncertainty of the performance assessment results is an important factor when determining whether releases are as low as reasonably achievable. Similarly, reducing uncertainty increases the confidence that releases are as low as reasonably achievable. For example, the maximum predicted total dose for a site may be highly uncertain, in the range of 0.1 to 10 mrem per year. This range of results is not of concern with respect to meeting the performance objectives as the entire range of possible results is below the threshold. From an "as low as reasonably achievable" perspective, however, there is a difference whether the true value is 0.1 as opposed to 10.

In summary, there is uncertainty in the factors affecting long-term radiological performance of low-level waste disposal facilities. Reducing this uncertainty can result in less design and operating conservatism, which can then lead to greater cost-effectiveness. Reduced uncertainty will also result in greater confidence that radioactive releases are as low as reasonably achievable. The next section discusses how research and development needs are to be assessed and prioritized.

3.2 Assessing and Prioritizing Research and Development Needs

This section discusses how research and development needs are identified, assessed, and prioritized. The process that has been used, and is being used, to identify and assess research and development needs related to low-level waste management is described in Subsection 3.2.1. The factors to be considered in prioritizing research and development needs are discussed in Subsection 3.2.2.

3.2.1 Identifying and Assessing Research and Development Needs

The performance assessment and composite analysis process provides the primary technical framework with which to identify site-specific research and development needs related to low-level waste management. Important research and development needs can be identified as the performance assessment and composite analysis are being conducted, after the results of the performance assessment and composite analysis are available, and during maintenance of the performance assessment and composite analysis. Identification of research and development needs during these steps of the process are described in more detail below.

Facility- and site-specific research and development gaps will first be identified during the formulation and development of the performance assessments and composite analyses. The conceptual site model identifies the radionuclide release, transport, and exposure processes that need to be considered in the performance assessment and composite analysis, and generally identifies the data required to simulate these processes. Specific analytical modeling tools are then used to evaluate those processes identified as important using the conceptual site model. Application of analytical modeling tools requires that input data values be provided; thus, data

gaps associated with model parameters are readily identified during this model formulation step. For example, a process considered at many sites is radionuclide transport in groundwater. Specific data needed to model the process may include those describing the rate of groundwater movement (aquifer thickness, hydraulic conductivity, gradient, and porosity), those describing the contaminant source (dimensions, release rate, inventory, and concentration), and those describing contaminant interactions (degradation rates, distribution coefficients). The process of applying a groundwater model requires the analyst to evaluate the adequacy of existing data in each of these categories and select the most appropriate values. The wider the range of potential values, the greater the uncertainty and, hence, the greater the effect on assessment results.

The analytical tools and available data are then used to conduct the performance assessment and composite analysis. The results, in particular the results of the uncertainty/sensitivity analysis conducted as part of the performance assessment, can then be used to refine the understanding of data gaps. The results of the performance assessment and composite analysis can then be used to assess the significance of these data gaps by determining how much each data gap contributes to the overall uncertainty of the results and how significant that uncertainty is. This evaluation is then used to determine those data gaps that need to be addressed through research and development.

The performance assessment and composite analysis maintenance process then provides a means for periodically re-evaluating and updating research and development needs. As data gaps are addressed through research or by other means, and new data become available, the performance assessment and composite analysis are updated. The updated results can then be used to re-evaluate the status of the data gaps and update plans for further research and development.

To date, the performance assessment and composite analysis implementation and maintenance process has identified research and development needs in the following areas: waste characterization, waste form, monitoring, subsidence, deterrence of intrusion, episodic natural phenomena, media exchange characteristics, waste projections, and barriers. These research and development needs are discussed in more detail below.

Waste Characterization. The physical, chemical, and radiological characteristics of low-level wastes are a major source of uncertainty in every performance assessment and composite analysis. Some improvements in waste characterization methods have been incorporated into procedures across the Department of Energy complex, but waste characterization remains a significant source of uncertainty for many waste streams, especially those containing difficult-to-detect radionuclides such as ^{14}C, ^{99}Tc, and ^{129}I. Although difficult to detect, these radionuclides can be significant contributors to projected doses. Improvement in the methods used for waste characterization are needed to increase the confidence in the results of performance assessments and composite analyses and to support decisions on inventories that can be received at a facility.

Waste Form. The performance assessment and composite analysis may include credit for improved performance of certain treated waste forms or waste packaging. Consideration of the

impacts of waste treatment technologies and packaging is often limited by the understanding of the long-term performance of the waste form or packaging. Uncertainties in performance assessments would be reduced and the selection of the best options for the management of the waste would be improved if the long-term performance of treated waste forms and packages were better understood. Treating waste to a different waste form has the potential of reducing the volume of waste to be disposed; treated waste forms and packaging also have the potential of enhancing site stability and inhibiting the migration of radionuclides.

Monitoring. In addition to demonstrating compliance with the environmental release criteria, monitoring can be used to verify projected near-field performance of a disposal facility or other source, thereby increasing confidence in analysis results. Generally, waste disposal facilities are not expected to release contaminants to the environment for many years after the waste has been disposed. Consequently, monitoring of properly operating waste disposal facilities at the point of assessment is not anticipated to provide any meaningful data during the operating lifetime of the facility. However, monitoring the performance of the disposal facility can indicate movement of water and/or radionuclides within a waste disposal facility long before releases occur. Developing performance monitoring technologies to provide data on the mechanisms associated with the transport of radionuclides would benefit the modeling and enhance the predictive capabilities of a performance assessment or composite analysis. In addition, as will be discussed in Section 3.3, monitoring is one tool available to address low-level waste research and development needs. Improved monitoring methods, therefore, could help reduce uncertainty in other areas.

Subsidence. Subsidence could compromise the performance of a disposal facility and is thus a concern at any low-level waste disposal facility. Current approaches to addressing the effects of subsidence in a performance assessment or composite analysis are approximations at best. Limited capabilities are available to project the occurrence of subsidence or the consequences of a subsidence event at a specific facility. The contributions of enhanced waste forms and disposal technologies to reducing subsidence and providing long-term stability to buried waste is largely unknown. Better understanding of the occurrence and consequences of subsidence will enhance confidence and reduce the inherent uncertainties in performance assessment and composite analysis results.

Deterrence of Intrusion. Protecting inadvertent intruders from exposure to disposed low-level waste has long been recognized as an important consideration for safe disposal of wastes. However, the most appropriate means for deterring an intruder from inadvertent exposure to waste is not clear. Performance assessments and composite analyses often rely on institutional controls as a form of intruder protection. Design features that deter inadvertent intrusion are much less understood. Not understanding the long-term performance to be attributed to intruder protection, substantial uncertainties are associated with the current measures being proposed for intruder protection. A more thorough understanding of the most effective steps for deterring inadvertent intrusion and properly considering the measures in analyses are needed.

Episodic Natural Phenomena. Performance assessments and composite analyses use long-term projection of climate based on available data. This approach to considering climate has been reviewed and endorsed several times. It is typically associated with annual climatological characteristics. However, meteorological events and other natural phenomena events of significance to the performance of a low-level waste disposal facility are episodic over very short periods of time (e.g., tornados, hurricanes, and severe storms). The effects of such natural phenomena are substantially diminished when the event is averaged over a year's time. But the consequences of episodic events can be significant and have impacts on performance that are long-lasting. Better understanding of how episodic events can be represented in the performance assessment and composite analysis is needed. Such understanding will reduce uncertainties in performance assessment and composite analysis and enhance confidence in their results.

Media Exchange Characteristics. The transfer of radioactivity from solid material in waste to liquid or gas in a disposal unit and then to soil or water in the environment is included in the source term analysis and the analysis of transport through the environment. These complex physical-chemical interactions are typically represented as simple linear processes. This simplification in modeling leads to conservative representations for source terms and environmental transport. Similarly, large uncertainties are associated with these simplified representations. Improvement in understanding the generation of source terms and the transport mechanisms and characteristics of radioactive material will contribute to reducing the largest source of uncertainty in transport modeling, leading to an improved predictive capability.

Waste Projections. Performance assessments and composite analyses for operating or future low-level waste disposal facilities rely on projections of future waste characteristics. These waste projections influence the projected dose, contribute to the development of waste acceptance criteria, and affect planning for replacement or expansion of disposal facilities. Projections of waste characteristics have rarely been compared with the actual characteristics of wastes. Such comparisons can provide a reasoned basis for planning future waste disposal facility design.

Barriers. Physical or chemical barriers for inhibiting the infiltration of water and the migration of radionuclides effectively enhance disposal technologies. An understanding of the long-term stability and effectiveness of physical and chemical barriers for inhibiting migration of radionuclides needs to be improved. Better understanding of the performance of physical and chemical barriers over time will contribute to improved modeling and greater confidence in results.

3.2.2 Prioritizing Research and Development Needs

The overall approach for prioritizing site- and facility-specific research and development needs is to evaluate the identified research and development needs to determine those that lead either to the most timely, cost-effective, and meaningful reductions in uncertainty, or to enhancements in

the disposal system. Prioritization factors and the importance given each factor may vary from site to site, but in general these factors are:

- Potential for reducing uncertainty or enhancing system design;
- Significance of uncertainty reduction or system enhancements; and
- Time and cost associated with uncertainty reduction or system enhancements.

General prioritization considerations are discussed below.

In general, the highest priority should be given to those research and development needs having the greatest potential for reducing uncertainty or enhancing system performance. Usually, these would be research and development needs associated with data to which the performance assessment/composite analysis results or disposal system performance are highly sensitive. The results of the uncertainty/sensitivity analysis can be used to determine which research and development needs have the greatest contribution to reducing overall uncertainty and/or enhancing system performance.

Another factor to consider is whether fulfillment of the research and development need will result in a meaningful reduction in uncertainty or enhancement of system performance. As discussed in Section 3.1, there can be cases where, although uncertainty is high, the entire range of possible outcomes is either above or below the threshold value. These cases would generally be given a low priority because reductions in uncertainty would not likely change design or operating conditions. Similarly, if system performance already meets or exceeds objectives, research and development to further enhance performance would be given a low priority.

There are two aspects of the time and cost associated with uncertainty reduction and system enhancement. The first of these is the time and cost associated with obtaining the needed data (i.e., the time and cost to perform the research and development). In general, those research and development needs that can be satisfied the most quickly and at the lowest cost will result in the most rapid uncertainty reduction or system enhancement. For example, within the context of the performance assessment and composite analysis maintenance process, there is an advantage in reducing uncertainty as rapidly as possible as it will help focus prioritization for longer-term efforts. As such, a higher priority should initially be given to research and development needs that can be satisfied the quickest and at the lowest cost. The second aspect of time and cost is the impact of the reduced uncertainty or enhanced performance on the life-cycle cost of low-level waste disposal. Those research and development needs that have the potential to result in significant life-cycle cost savings should be given high priority.

The above factors relate to facility- or site-specific considerations. Complex-wide considerations should also be included in the prioritization process. In general, research and development needs that address concerns identified at many sites across the complex should be given higher priority than those addressing very site-specific concerns. Similarly, research and development needs addressing programmatic issues having application to all sites should be given high priority.

Finally, research and development needs that have application across Department program areas should also be given high priority. For example, many of the issues associated with conduct of performance assessments and composite analyses are the same issues associated with evaluating long-term impacts at environmental restoration sites. Research and development addressing these issues, therefore, could be beneficial to both the Office of Waste Management and the Office of Environmental Restoration.

3.3 Implementation of Research and Development Program

This section describes the methods that will be used to implement the research and development program. The actual implementation will be carried out by a number of organizations, and their specific roles and responsibilities are described in Section 4.0. The purpose of this section is to describe the tools available to address the low-level waste research and development needs and selection of the approach to conducting required research and development.

3.3.1 Tool Kit for Addressing Research and Development Needs

A variety of tools are available to address low-level waste management research and development needs. For the purpose of this implementation plan, these tools have been aggregated into the following categories:

- traditional research and development;
- studies; and
- operations and monitoring.

There are no clear lines of demarcation between categories. Rather, the groupings are created to help illustrate the range of activities that are available to meet research and development needs. With respect to low-level waste research and development needs, traditional research and development could include such activities as development of new technologies, basic research into fundamental processes, and development of theoretically-based predictive tools. These types of activities are those typically conducted under the research and development projects managed by the Office of Science and Technology. Traditional research and development activities are typically performed by national laboratories and universities.

Studies include such activities as demonstration of newly-developed technologies, data collection and analysis using existing methodologies, and development of empirically-based predictive tools. This category also includes the technology deployment projects conducted through the Office of Science and Technology. Studies are typically performed by private research institutions, technology vendors, and consultants, as well as national laboratories, universities, and other agencies.

Operations and monitoring refers to collection of data concomitant with routine operations, rather than as part of a special study. This type of activity is typically performed by the facility operating contractor.

Low-level waste management programs have some research and development needs in common with other programs. For example, many media exchange research and development needs are common to environmental restoration as well as waste management. As a consequence, the tools available to meet low-level waste disposal research and development needs can include research and development activities being conducted to support other programs.

Table 3-1 provides illustrative examples of research and development activities under these three categories for the general classes of research and development needs identified in Section 3.2.1.

3.3.2 Selecting a Research and Development Approach

Several factors are to be considered in selecting a research and development strategy to assure that the most appropriate approach is selected. The first, and most important, is the quality of the data that will be produced. Other factors include time and cost considerations and integration of research and development with other activities. These factors are discussed in the following paragraphs.

Data Quality. It is imperative that the data resulting from research and development activities be of sufficient quality to support their intended use. On the other hand, generating data of higher than required quality is generally not an efficient use of resources and should be avoided. The data quality objectives (DQO) process can be useful in identifying the appropriate tools for research and development. The data quality objectives process was developed by the Environmental Protection Agency (EPA) for use in identifying data needs for environmental restoration projects, and has been incorporated into the Department's environmental restoration activities. The process also has application to any activity involving collection of data, as it determines how "good" data need to be to satisfy the intended data uses, thereby allowing selection of appropriate data collection methods. In this case, the process could thus avoid conducting traditional research and development when monitoring would suffice, as well as avoiding use of monitoring when research and development is needed.

The data quality objectives process starts by formulating a problem statement, identifying a decision that addresses the problem, identifying factors that affect the decision, and identifying the decision domain. In the case of the performance assessment/composite analysis process, these steps are defined by the process. That is, the problem statement relates to the potential future radiation exposure resulting from low-level waste disposal. The decision is whether the facility will meet the performance objectives, and the decision factors are the future radiation doses to the public. The decision domain defines temporal and spatial boundaries associated with the decision. In this case, the temporal domain is defined by the 1,000 year exposure period

Table 3-1. Examples of Activities for General Classes of Low-Level Waste Research and Development Needs.

General Class of Research and Development Need	Research Category		
	Traditional R&D	Studies	Operations/Monitoring
Waste Characterization	Development of new technologies for characterization of difficult-to-detect radionuclides (e.g., assay systems).	Additional characterization of wastes using existing technologies. Development of correlations between easy- and difficult-to-detect radionuclides.	More detailed waste characterization during routine operations (e.g., include isotope-specific analysis along with gross activity).
Waste Form	Development of new technologies for waste treatment and packaging. Research into chemistry of treatment processes.	Collection of empirical data on treated and packaged waste effectiveness to allow extrapolation of effectiveness into future.	Collection of monitoring data at sites where treated/packaged wastes are disposed.
Monitoring	Development of new technologies for monitoring.	Expanded monitoring using existing technologies.	Collection of routine monitoring data needed to calibrate or verify models.
Subsidence	Research into subsidence mechanisms. Development of theoretically-based predictive tools.	Collection of empirical subsidence data at existing disposal sites.	Diagnostics on operating facilities with potential for subsidence.
Deterrence of Intrusion	Research into basic design features needed to deter intruders.	Collection of empirical data for analogous situations (e.g., archaeological sites).	

Table 3-1. Examples of Activities for General Classes of Low-Level Waste Research and Development Needs. (Continued)

General Class of Research and Development Need	Research Category		
	Traditional R&D	Studies	Operations/Monitoring
Episodic Natural Phenomena	Development of analytical tools to model effects of severe weather.	Evaluation of historical weather data to develop design bases.	Collection of operating data needed to validate predictive tools.
Media Exchange Characteristics	Research into basic physical and chemical processes. Development of theoretically-based predictive tools.	Performance of laboratory studies using existing methods with previously unstudied radionuclides.	Collection of routine monitoring data needed to validate predictive tools. Collection of data to characterize observed releases.
Waste Projections		Development of empirical models for waste projection.	Collection of operating data providing more detailed information on waste types and sources.
Barriers	Research into basic physical and chemical processes. Development of theoretically-based predictive tools.	Performance of laboratory and field studies using existing methods (e.g., lysimeter studies).	Collection of routine monitoring data needed to validate predictive tools.

given in Departmental Order 435.1. The spatial domain is defined by the exposure pathways and locations of receptors, which are determined using the conceptual site model.

The next step in the data quality objectives process is to formulate logical statements that define the decision. In the case of the performance assessment/composite analysis process, the logical statements are based on comparison of predicted radiation exposures to performance objectives. For example, if the radiation exposure meets the performance objective, then the facility design and operating conditions are acceptable. If not, then the design or operating conditions must be revised.

The final two steps in the data quality objectives process are to define the allowable uncertainty associated with the decision and to design a data collection program. The uncertainty limits are generally defined as a probability or confidence limit associated with the decision. For example, the uncertainty limit could be to have 95% confidence that the maximum future radiation exposure is less than the performance objective. The data collection design is based around the analytical tools and models used to conduct the performance assessment and composite analysis. That is, these tools and models define the data that are needed, and the analytical constructs determine the amount of uncertainty that can be tolerated in the input data in order to meet the desired uncertainty in the results. The data collection design can then be used to identify research and development needs.

Application of the above data quality objectives process may yield four possible outcomes associated with identifying research and development needs for low-level waste disposal. These outcomes are:

(1) the required data do not exist;
(2) the required data exist, but the uncertainties associated with them are too great;
(3) data with acceptable uncertainties exist, and use of these data in the performance assessment/composite analysis shows that the performance objectives will be met; or
(4) data with acceptable uncertainties exist, and use of these data in the performance assessment/composite analysis shows that the performance objectives will not be met.

The resulting outcome then affects which tool or tools will be applied to fulfill research and development needs. In the first two cases, research and development will be needed to obtain data to conduct the performance assessment and composite analysis. The required data uncertainty will be defined through the data quality objectives process and will affect selection of the appropriate research and development tool. The research and development approach will also depend on the availability of data collection methods and the relationship of these methods to facility operations. Factors affecting selection of approaches are identified in Table 3-2.

Table 3-2. Selection of Research and Development Approaches Based on Data Quality Objectives Outcome.

Data Quality Objectives Process Outcome	Factors Affecting Selection of Research and Development Approach	Appropriate Research and Development Category
The required data do not exist.	Methods exist to collect data and data can be collected as part of routine operations.	Operations and monitoring
	Methods exist to collect data, but data would not normally be collected as part of routine operations.	Study
	Methods do not exist for collecting required data.	Traditional research and development
The required data exist, but the uncertainties associated with them are too great	Data uncertainty can be reduced by collection of more data. Data can be collected as part of routine operations.	Operations and monitoring
	Data uncertainty can be reduced by collection of more data. Data would not normally be collected as part of routine operations.	Study
	Data uncertainty can be reduced by collecting data using alternate, existing method.	Study
	Data uncertainty can be reduced by developing new technology for data collection.	Traditional research and development
Data with acceptable uncertainties exist, and use of these data in the performance assessment/composite analyses shows that the performance objectives will be met	No research and development need exists.	

Table 3-2. Selection of Research and Development Approaches Based on Data Quality Objectives Outcome. (Continued)

Data Quality Objectives Process Outcome	Factors Affecting Selection of Research and Development Approach	Appropriate Research and Development Category
Data with acceptable uncertainties exist, and use of these data in the performance assessment/composite analyses shows that the performance objectives will not be met.	New technologies are needed to reduce radionuclide migration or exposure (e.g., improved barriers, improved treatment).	Traditional research and development.

In the third case, there are no research and development needs associated with the decision of whether the performance objectives will be met. It may, however, also be necessary to address decisions related to maintenance of radiation exposure as low as reasonably achievable. If so, the data quality objectives process would be repeated for these decisions, and research and development needs could be identified. In these cases, there may be a lower threshold for confidence limits since errors will have less potential impact.

In the fourth case, there also would be no research and development needs associated with the decision of whether the performance objectives will be met. There could, however, be research and development needs associated with revising the facility design or operation. One means of revising operations to comply with performance objectives would be to place operational limits on the inventories of specific radionuclides that could be disposed. This approach would likely not require research and development. Another approach would be to revise the facility design or processes. For example, revised barrier designs could be used to reduce radionuclide release rates. Similarly, alternate waste treatment processes could be used to reduce contaminant mobility. It is possible that this approach would identify research and development needs associated with development of new technology for more cost-effective management in the future.

Other Considerations. The time and cost required to implement research and development is an important consideration. Typically, traditional research and development activities will take the longest to implement and will have the highest costs, followed by studies and then operations and monitoring. Generally, the fastest and lowest cost research and development approach that satisfies quality requirements should be selected.

If a long time will be required to fully implement a research and development program, consideration may be given to implementing a phased research and development approach. For example, if a traditional research and development program is necessary, but will take a long time to complete, there could be benefit in performing other short-term research and development activities concurrently. It may be possible, for example, to use monitoring to quickly collect better data than currently exist, thus reducing uncertainty while the traditional research and development program is underway.

Another consideration is integration of research and development activities with other ongoing or planned activities. In general, such integration could result in cost sharing or otherwise increase cost-effectiveness. The most obvious opportunity for integration is incorporation of research and development activities with operations and monitoring. For example, it may be possible to include collection of new data with ongoing operational or monitoring activities. In this way, the incremental costs of collecting the data would be less than the cost of implementing a separate data collection activity. Similarly, it may be possible to make use of a planned or ongoing research and development activity. Obviously, if a research and development activity is ongoing at a different site, but will provide the needed data, it should be used to avoid duplication of effort. The database that will be created by the Office of Waste Management and Low-Level and

Mixed Low-Level Waste Center of Excellence (see Section 4.2) will assist in identifying such opportunities. Other sources of useful information include interagency working groups, such as the Federal Remediation Technology Roundtable.

4.0 ROLES

Four organizations are responsible for implementing the Low-Level Waste Management Program's research and development activities: the Field, the Office of Waste Management and Low-Level and Mixed Low-Level Waste Center of Excellence, the Low-Level Waste Disposal Facility Federal Review Group, and the Office of Science and Technology. The specific role for each of these organizations is discussed in turn.

4.1 Field

As discussed in Section 3.0, the Field is responsible for identifying and assessing, prioritizing, and implementing responses to research and development needs. In its implementation of responses to research and development needs, the Field also should document these needs in appropriate planning documents, utilize existing products, tools, and data to meet research and development needs, and, where appropriate, request additional funding for implementing new research and development activities in the Department's Environmental Management Congressional Budget Request. Figure 4-1 outlines the various activities that comprise the Field role.

4.1.1 Develop an Understanding of Research and Development Needs

Each site is responsible for developing an understanding of its research and development needs associated with site-specific low-level waste management and disposal issues. The general strategy for developing an understanding of these needs is described in Section 3.1. Performance assessment and composite analysis maintenance is the principal component of the process of identifying research and development needs. Each site with a low-level waste disposal facility is responsible for preparing and maintaining performance assessments and composite analyses. As part of this process, the Field will identify research and development needs to reduce the uncertainty of the performance assessment and composite analysis results and to enhance safety and defense-in-depth. These research and development needs will be documented annually by the Field Office Low Level Waste Program Office.

4.1.2 Assess and Prioritize Research and Development Needs

The Field is responsible for assessing and prioritizing its research and development needs. The general strategy for assessing and prioritizing research and development needs is described in Section 3.2. These research and development needs will be documented annually by the Field Office Low Level Waste Program Office.

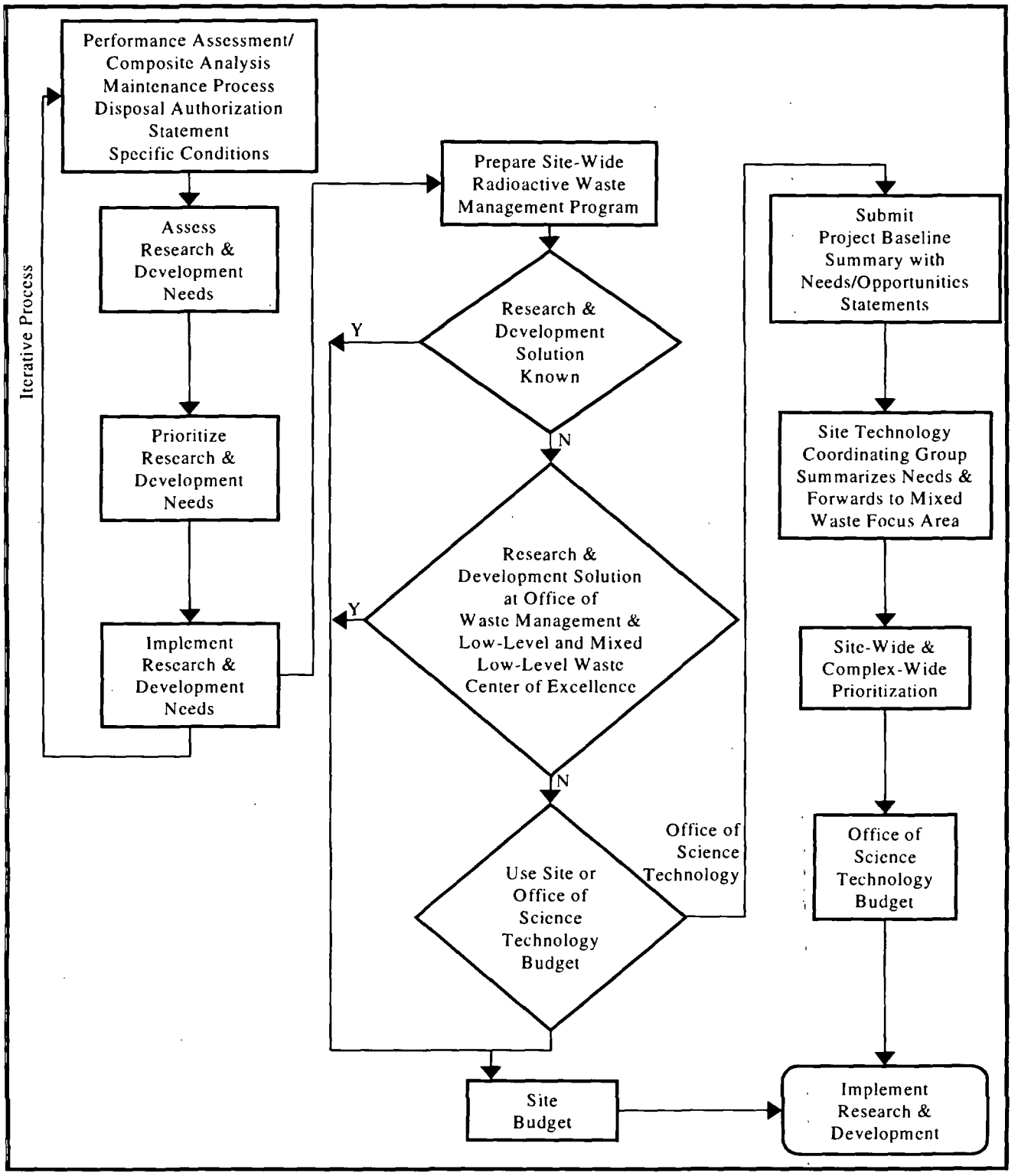

Figure 4-1. Field Role - LLW Management Research and Development Needs

4.1.3 Implement Responses to Research and Development Needs

4.1.3.1 Prepare Site-Wide Radioactive Waste Management Program

The Field will be required under DOE Order and Manual 435.1, *Radioactive Waste Management,* to develop and document a Site-Wide Radioactive Waste Management Program that uses a systematic approach for planning, executing, and evaluating the site-wide management of radioactive waste. The plan will include site-specific low-level waste management needs and the strategy for meeting those needs. The site-wide waste management plans will be used to

formulate a budget consistent with the integrated site strategy which allocates funds and resources based on priorities. The site-wide program will identify technical and programmatic issues and research and development needs and develop a strategy for addressing these issues. This includes research and development needs identified through evaluations of performance assessments and composite analyses. Identified site needs will be tied to the site's end state description for low-level waste at that site. The site-wide programs will support the development of the Complex-Wide Low-Level Waste Management Program and will significantly facilitate the development of integrated site strategies for resolution of technical and programmatic issues, research and development needs, and allocation of funds and resources.

The Field Element Manager is assigned the responsibility for the Site-Wide Radioactive Waste Management Program and is responsible for clarifying where technical needs exist. Research and development needs identified in the development of the site-wide program will, as appropriate, be forwarded to the Site Technology Coordination Groups at each site and incorporated into the site annual budget request.

4.1.3.2 Determine Whether Research and Development Needs are Met with Available Products

Existing research conducted by the Department, other agencies, universities, the private sector, etc., should be utilized to the greatest extent possible. Many of the studies, technical data or technologies identified as needed to respond to the research and development needs may be available. The Office of Waste Management and Low-Level and Mixed Low-Level Waste Center of Excellence will use existing or develop a new centralized computer database of practices, research results, and technologies applicable to the needs of the complex's low-level waste management activities. This centralized database will be updated quarterly, and new findings will be disseminated throughout the Department of Energy complex. Each site with identified research and development needs is responsible for reviewing this system to determine whether research and development needs can be met with existing research and development programs. This review shall be documented annually by the Field Office Low Level Waste Program Office.

4.1.3.3 If New Research and Development Activities are Needed, Submit Needs and Opportunities in Project Baseline Summaries

Where new research and development activities are needed, the Field needs to communicate these needs to the Office of Science and Technology through the needs and opportunities statements submitted along with Project Baseline Summaries. Field-approved Project Baseline Summary data used in budget formulation must be submitted to Headquarters annually by April of each year, or as otherwise directed. The Project Baseline Summaries link technology needs at sites to science and technology development and deployment efforts in the Environmental Management Office of Science and Technology. This information will be used to formulate and prioritize the Office of Science and Technology budget. Specifically, it will be used to validate research and development needs and opportunities statements and Focus Area work packages, develop a national prioritization scheme for the Office of Science and Technology funded activities, and improve the ability to measure the outcomes of Environmental Management investments in science and technology.

Project Baseline Summaries are critical because they are used by Site Technology Coordination Groups to collect the research and development needs and opportunities statements. Eventually, these needs and opportunities statements are used to generate an annual Integrated Priority List, which prioritizes Environmental Management project activities and is used by the Office of Science and Technology to prioritize its funding of research and development projects.

4.1.3.4 Implement Research and Development Solution

If there is no existing research regarding certain research and development needs, then the Field will need to implement a new research and development project. Two means are available for funding such new projects. They may be funded through the site's budget or through the Office of Science and Technology. The former is more appropriate for data collection associated with operations and monitoring and for site-specific studies. The latter may be more appropriate for traditional research and development projects having applicability across several sites. In either case, new research and development projects will be ranked with other Environmental Management needs within the site's budget and/or the Office of Science and Technology National Program budget.

4.1.3.4.1 Implementing New Research and Development Using Site Budget.

The Field can use current year funding for implementing new research and development activities. If there is no funding available in the current year, the Field will need to request funding in their annual budget request. Each Departmental site formulates its own budget request based on guidance issued by Headquarters. Site budget requests are based on the site's Integrated Priority List which prioritizes the Environmental Management activities starting with the most important to fund. These site budget requests are submitted to Headquarters and, along

with the National Programs budget requests, become the basis for the Department's Congressional Budget request.

4.1.3.4.2 Performance of New Research and Development Through Office of Science and Technology.

The Field also can utilize the Office of Science and Technology's research and development activities to address their needs. Because the Office of Science and Technology is a National Program, program planning, budgeting, and execution activities are the responsibility of Headquarters and are performed by Headquarters in conjunction with the Field. The planning and budgeting process is described in detail in Section 2.3. The primary field staff responsibility in this process is to generate site-specific science and technology needs and opportunities statements. These statements are prepared by the Site Technology Coordination Groups on an annual basis.

4.2 Office of Waste Management/Low-Level and Mixed Low-Level Waste Center of Excellence

The Office of Waste Management, with the assistance of the Low-Level and Mixed Low-Level Waste Center of Excellence, develops low-level and mixed low-level waste policies and requirements and assists the Field in implementing the same. In coordinating low-level waste research and development activities, the Office of Waste Management and the Low-Level and Mixed Low-Level Waste Center of Excellence will perform the following activities.

Identify technical needs relevant to multiple sites and submit to the Office of Science and Technology. As a result of review of the performance assessments and composite analyses by the Low-Level Waste Disposal Facility Federal Review Group, the Office of Waste Management and the Low-Level and Mixed Low-Level Waste Center of Excellence will compile a list of technology needs for waste management activities, including research and development needs, and annually submit these to the Office of Science and Technology with recommendations for development. The Office of Waste Management and the Low-Level and Mixed Low-Level Waste Center of Excellence will also evaluate, upon concurrence of Office of Science and Technology, the waste management related proposals that are submitted to Office of Science and Technology by the sites and provide recommendations for acceptance for those that the Office of Waste Management and the Low-Level and Mixed Low-Level Waste Center of Excellence believe will benefit waste management activities, including activities that will reduce the uncertainty associated with performance assessment and composite analyses and/or enhance disposal system performance.

Disseminate practices, research results, and technologies from the commercial sector, other federal agencies, and international agencies that could be of benefit to the Department's waste management program. The Office of Waste Management and the Low-Level and Mixed Low-Level Waste Center of Excellence will set up a centralized computer database of practices,

research results, and technologies applicable to the needs of the complex's low-level waste management activities. This centralized technologies listing will be updated quarterly and new findings will be disseminated throughout the Department of Energy complex.

Track the implementation of conditions contained in the low-level waste disposal facility Disposal Authorization Statement related to research and development. The Office of Waste Management and the Low-Level and Mixed Low-Level Waste Center of Excellence will develop and maintain a listing of all conditions associated with each disposal unit's Disposal Authorization Statements, including those related to research and development, no later than June 30, 1999. This listing will be cross-referenced with the unit's corrective action plan and schedule submitted by the site. Progress will be reviewed quarterly and the results of the review distributed to appropriate parties.

4.3 Low-Level Waste Disposal Facility Federal Review Group

The Low-Level Waste Disposal Facility Federal Review Group provides the Office of Environmental Management the information necessary to determine that low-level waste disposal facilities are designed, constructed, operated, maintained, and closed in a manner that protects the public and environment. The Low-Level Waste Disposal Facility Federal Review Group reviews each site's performance assessments and composite analyses to identify associated technical needs, including research and development. Conditions contained in the Disposal Authorization Statement(s) related to research and development will be identified by the Low-Level Waste Disposal Facility Federal Review Group and will be compiled and tracked by the Office of Waste Management and the Low-Level and Mixed Low-Level Waste Center of Excellence.

4.4 Office of Science and Technology

The Office of Science and Technology conducts research and development activities that support the needs of Environmental Management activities. The program manager and technical staff responsible for performance assessment and composite analysis maintenance will work with the Office of Science and Technology through the Site Technology Coordination Group to ensure research needs that support low-level waste disposal activities are identified, justified, and pursued. The Site Technology Coordinating Group will evaluate the need and importance of the research and development, rank the needs with others, and forward the research and development requirements to the Office of Science and Technology for funding. Similarly, sites will be asked for information on their research and development needs so that cross-complex needs can be submitted to the Office of Science and Technology.

Site personnel need to factor activities necessary to maintain the performance assessment and composite analysis (e.g., monitoring activities, studies, research, and analyses) into the programs at the site. Through this mechanism, the site, in conjunction with Headquarters, can integrate maintenance needs with other environmental management activities in the budget planning. Site

and Headquarters staff should integrate the maintenance needs (including research and development) into the budget priority list recognizing that some of the activities are conditions of operation of the low-level waste disposal facility or others are long-lead activities important to closing the facility in a manner that will provide long-term protection from the waste.

4.5 Relationship of the Four Organizations

Figure 4-2 outlines graphically the relationship and interaction between the four organizations performing low-level waste research and development functions, as described in the preceding sections. The figure also illustrates the sequencing of each organization's research and development activities.

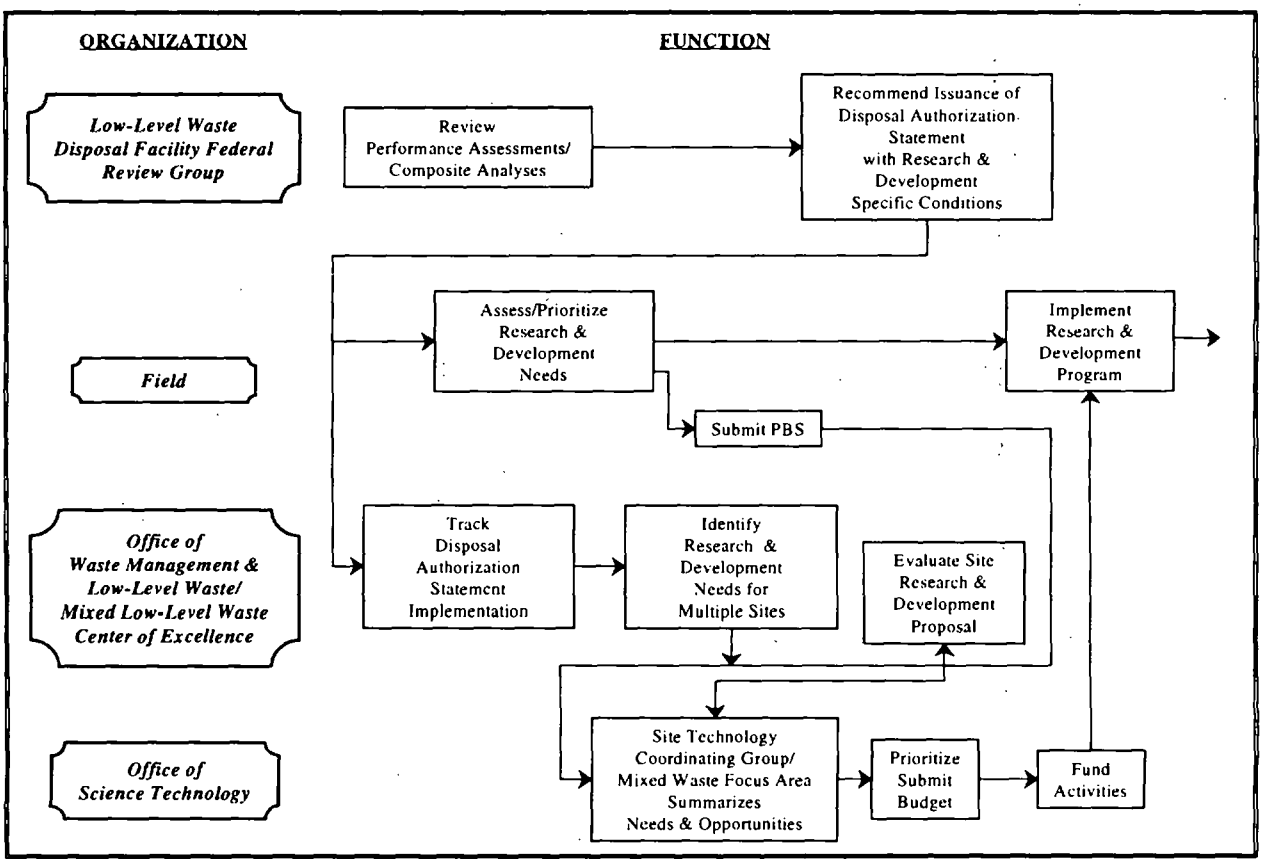

Figure 4-2. Organizational Roles

5.0 DELIVERABLES

The following deliverables are associated with implementation of the low-level waste research and development program described in this plan.

1. Develop an understanding of research and development needs

a. Description: Low-level waste research and development needs will be identified and documented at the field level through existing planning and analyses documents.

b. Milestones: Prepare a list of research and development needs using the following planning and analyses documents: performance assessment and composite analysis maintenance plan, Site-Wide Radioactive Waste Management Program, Project Baseline Summary, Integrated Priority List, Science and Technology Needs and Opportunities Statements.

c. Due Date: Annually. Complete by end of each fiscal year (September 30).

d. Responsibility: Field Office Low Level Waste Program Office.

2. Assess and prioritize research and development needs

a. Description: Assess and prioritize the research and development needs that are most important to reducing the uncertainty associated with performance assessments and composite analyses, maintaining performance assessments and composite analyses, facility operations, and closure.

b. Milestone: Prepare list of prioritized research and development needs.

c. Due Date: Annually. Complete by end of each fiscal year (September 30).

d. Responsibility: Field Office Low Level Waste Program Office.

3. Utilize existing research and development products

a. Description: Search computer system developed by Office of Waste Management and Low-Level and Mixed Low-Level Waste Center of Excellence and other agencies, Federal Remediation Technology Roundtable, universities, and private sector data bases for research applicable to the site's research and development needs.

b. Milestone: Document that existing research and development sources were searched prior to requesting funding for new research and development.

c. Due Date: Annually. Complete by end of each fiscal year (September 30).

d. Responsibility: Field Office Low Level Waste Program Office

4. Request funding for new research and development

a. Description: Request funding in the site's annual budget request and/or work through the Office of Science and Technology to address resolution of the site's research and development needs.

b. Milestone: Prepare budget request.

c. Due Date: Annually. April of each year.

d. Responsibility: Field Office Low Level Waste Program Office and Office of Science and Technology

5. Identify technical needs relevant to multiple sites and submit to the Office of Science and Technology.

a. Description: As a result of review of the performance assessments and composite analyses by the Low-Level Waste Disposal Facility Federal Review Group, the Office of Waste Management and the Low-Level and Mixed Low-Level Waste Center of Excellence will compile a list of technology needs for waste management activities, including research and development, and annually submit these to the Office of Science and Technology with recommendations for development.

b. Milestone: Develop a list of technology needs, including research and development, and submit annually to the Office of Science and Technology.

c. Due Date: Annually. Complete by end of each fiscal year (September 30).

d. Responsibility: Office of Waste Management and Low-Level and Mixed Low-Level Waste Center of Excellence

6. **Disseminate practices, research results, and technologies from the commercial sector, other federal agencies, and international agencies that could be of benefit to Department's waste management program.**

a. Description: Set up a system where practices, research results, and technologies applicable to the needs of the Department's low-level waste management function will be centralized. After the initial setup, the centralized technologies listing will be updated quarterly and new findings will be disseminated through out the

Department of Energy complex. This task will require interface with private entities, as well as other federal and international agencies.

b. Milestone: Develop computer system that will contain practices, research results, and technologies applicable to the needs of the complex's low-level waste management function. Update quarterly and provide copies to all applicable field offices.

c. Due Date: June 30, 1999. Provide updates quarterly.

d. Responsibility: Office of Waste Management and Low-Level and Mixed Low-Level Waste Center of Excellence

7. Track the implementation of conditions contained in the low-level waste disposal facility Disposal Authorization Statements related to research and development.

a. Description: Develop and maintain a listing of all conditions, including research and development, associated with each disposal unit's Disposal Authorization Statement. This listing will be cross-referenced with the unit's corrective action plan and schedule submitted by the site. Progress will be reviewed quarterly and the results of the review distributed to appropriate parties.

b. Milestone: Develop a computer system to track conditions contained in the low-level waste disposal facility Disposal Authorization Statement related to research and development. Keep system up to date.

c. Due Date: Develop the system by June 30, 1999. Update quarterly.

d. Responsibility: Office of Waste Management and Low-Level and Mixed Low-Level Waste Center of Excellence

8. Review each site's Performance Assessments/Composite Analyses and identify associated technical needs, including research and development.

a. Description: The Low-Level Waste Disposal Facility Federal Review Group was established to provide Office of Environmental Management management of the information necessary to determine low-level waste disposal facilities are designed, constructed, operated, maintained, and closed in a manner that protects the public and environment. The Low-Level Waste Disposal Facility Federal Review Group consists of Federal employees from Headquarters and Field organizations. It is the responsibility of the Low-Level Waste Disposal Facility Federal Review Group to review each site's performance assessments/composite

analyses and to identify associated technical needs, including research and development.

b. Milestones: Conditions contained in the Disposal Authorization Statement(s) related to research and development will be identified by the Low-Level Waste Disposal Facility Federal Review Group.

c. Due Date: Conditions developed after a Review Team has completed its review.

d. Responsibility: The Low-Level Waste Disposal Facility Federal Review Group.