Environmental Monitoring Task Group

Draft Input to Department of Energy (DOE) and Sandia National Laboratories/New Mexico (Sandia/NM) Long-Term Stewardship (LTS) Plan

March 2001

Members of the

Environmental Monitoring Task Group

Chris Campbell
Paul Catacosinos
Lois Chemistruck
Jens Deichmann
Dianne Duncan
Doug Earp
John Gould
Mark Holmes
Franz Lauffer
Bill McDonald
Tami Moore
Hans Oldewage
Jerry Peace
Ed Vigil
Lance Voss

Table of Contents

Acronyms

AEA	Atomic Energy Act
CAMU	Corrective Action Management Unit
CSM	Conceptual Site Model
CWL	Chemical Waste Landfill
DOE	U.S. Department of Energy
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration (Project)
ER/WM	Office of Environmental Restoration and Waste Management (DOE)
GWPP	Groundwater Protection Program
HSWA	Hazardous and Solid Waste Act
KAFB	Kirtland Air Force Base
LTS	Long-Term Stewardship
MOU	Memorandum of Understanding
MWL	Mixed Waste Landfill
NFA	No Further Action
NMED	New Mexico Environment Department
RCRA	Resource Conservation and Recovery Act
SWMU	Solid Waste Management Unit
TLD	Thermoluminescent dosimeter

1.0 Introduction

As Sandia National Laboratories/New Mexico (Sandia/NM) nears completion of its Environmental Restoration (ER) Project, the U.S. Department of Energy (DOE) and Sandia/NM are preparing a Long-Term Stewardship (LTS) Plan and have asked the general public for input and assistance. Three committees were formed in May 2000 to address the elements of LTS—one of which is the Environmental Monitoring Task Group.

The purpose of each Task Group, which consists of members of the public, Sandia/NM and DOE personnel, and representatives from the New Mexico Environment Department (NMED), is to identify community values and issues related to the development and implementation of long-term monitoring to support stewardship activities at Sandia/NM. This report summarizes the activities, concerns, and recommendations generated by this Task Group.

The goal of this report is to identify general strategies, elucidate specific areas of concern, and provide a framework for decision-making—not to prescribe the details of an environmental monitoring program—which is the responsibility of Sandia/NM, DOE and the NMED. The final LTS Plan will serve as a guide for DOE, Sandia/NM, regulatory organizations, and other stakeholders that will assume responsibility for ER sites, referred to as Solid Waste Management Units (SWMUs), that contain residual contamination after the ER Project is phased out. The current schedule projects the closure of all SWMUs to be completed by 2005, at which time the Sandia/NM ER Project will be closed out.

During the course of its tenure, the Environmental Monitoring Task Group was briefed and provided information on a variety of topics including Sandia/NM history, monitoring categories, existing regulations, and current Sandia/NM monitoring activities. Throughout these sessions, committee member concerns were presented, discussed, and analyzed. Ultimately, the focus or operational "problem statement" for this effort became "*how to monitor (within the Sandia/NM LTS Program) DOE legacy sites, or sites with restricted use, to ensure the long-term protection of human health and the environment from hazards posed by residual radioactivity and chemically hazardous materials.*"

What is Long-Term Stewardship (LTS)?

In establishing recommendations for future monitoring of sites, this Task Group was guided by the following definition of stewardship: "Activities necessary to maintain long-term protection of human health and the environment from hazards posed by residual radioactive and chemically hazardous materials." Long-term stewardship (LTS), as defined hereinafter refers to the physical and institutional controls that will be applied to closed SWMUs where residual contamination or other hazards remain. LTS also includes environmental monitoring and periodic assessment of sites to assure a safe status and remedial adequacy.

Sandia/NM's ER Project

Work conducted by DOE throughout its Nuclear Weapons Complex over the past 40 years has left a legacy of contaminated sites throughout the United States. DOE facility-specific ER Projects were created under DOE's Office of Environmental Restoration and Waste Management (ER/WM) to identify, assess, and remediate sites potentially contaminated by past spill, release and disposal activities. Initial identification of SWMUs at Sandia/NM was completed in 1987 as described in the document titled *Comprehensive Environmental Assessment and Response Program (CEARP) Phase I: Installation Assessment* (DOE 1987). The ER Project at Sandia/NM was formally initiated in 1992 to address all potentially contaminated sites resulting from Sandia/NM's past activities. The remediation and cleanup of SWMUs at Sandia/NM are regulated by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments Act of 1984 (HSWA). HSWA requirements apply to all SWMUs. Specific requirements for SWMUs are described in Module IV of Sandia/NM's RCRA Part B Operating Permit.

The SWMUs will be closed with varying levels of contamination. After remediation, a few sites, such as the Chemical Waste Landfill (CWL), the Corrective Action Management Unit (CAMU), and the Mixed Waste Landfill (MWL), will contain residual radioactive and/or chemical contaminants resulting from treated soils buried onsite or buried waste that will be contained and covered in place. For example, soils from the CWL, currently undergoing excavation, will be treated and placed in an engineered disposal cell at the CAMU. An engineered evapo-transpirative soil cover has been proposed for the MWL. The cover itself will be equipped with

various internal monitoring systems that will monitor soil moisture to detect any potential for contaminant migration.

Individual long-term environmental monitoring plans (EMPs), should be developed for these sites by DOE and approved by the NMED with stakeholder input. The EMPs should describe the type and frequency of monitoring with specific actions and mitigation measures that would be implemented if monitoring indicates contaminant migration. The specifics of these plans should be formed in part from the recommendations by the Environmental Monitoring Task Group.

2.0 Summary of Current Environmental Monitoring Programs at Sandia/NM

Sandia/NM's Environmental Management Department currently conducts environmental monitoring and surveillance as required, including air quality monitoring, terrestrial surveillance, groundwater surveillance, surface and storm water monitoring, wastewater sampling, and meteorological monitoring (see Appendix A). The current monitoring programs are developed to evaluate potential contaminant pathways from ongoing Sandia/NM operations (see Section 5.0). Examples are the site-specific groundwater monitoring wells that have been installed upgradient and downgradient from various SWMUs. Environmental restoration monitoring activities are designed for contaminant characterization at specific legacy sites.

3.0 Land Use Categories and SWMU Closure Status

When the NMED approves a SWMU through the NFA process, a future land use category is assigned to the site depending on the level of contamination remaining after cleanup. This section reviews land use categories (unrestricted and conditional release sites) and SWMU closure status categories, which discuss varying levels of administrative and physical controls and environmental monitoring requirements.

Land Use Categories

SWMUs are released under various land use categories depending on the type and extent of residual contamination remaining, if any. For example, in terms of future land use, the least restrictive land-use designation is “Residential,” which means there is no risk—or insignificant risk—present for future residents. Sites with higher residual contamination may not be appropriate for "Residential" but may still be safe for “Industrial” or “Recreational” land uses, such as constructing a factory or a parking lot, or providing a recreational open space area. A few sites, however, such as the CWL, the CAMU, and the MWL will remain unsafe for public use of any kind well into the future. These sites will require the highest level of institutional and physical controls to protect human health and the environment.

The post-closure (or release) status of all SWMUs at Sandia/NM can be divided into two broad categories as described below:

Unrestricted Release Sites – This includes SWMUs where no contamination was discovered during the remedial investigation process, as well as sites where cleanup efforts were successful in reducing the level of residual radioactive and/or chemical contamination to below regulatory levels of concern. This is a level that meets risk-based criteria for "Residential" use and therefore is considered safe for future unrestricted use. However, "Residential" land use does not necessarily imply that people will ever reside on the land. It simply designates the highest safety criteria.

In general, it is anticipated that sites approved for “Unrestricted Release” will require only an administrative/informational form of LTS. Although there are currently no plans to release any property from Sandia/NM or DOE control, records of the site investigation, cleanup methods, and final residual contamination status of these SWMUs must be maintained. No specific long-term environmental monitoring requirements are proposed or anticipated for these sites.

Conditional Release Sites - This includes SWMUs that have residual contamination above regulatory levels. There is a broad range of residual contamination, from the highest level

requiring some type of engineered remedy (covers, lined disposal cells, etc., which must be monitored and maintained indefinitely), to sites that have very little contamination and may be appropriate for "Industrial" and "Recreational" use. These designations are determined by the NMED based on risk-based criteria. Sites that would fall in the middle of this range include sites with chemical, radiological, or physical hazards, which would require a minimum of signs and fencing to protect human health.

SWMUs that are Conditionally Released may require long-term environmental monitoring depending on the physical form, level, and location of the contamination. Site-specific environmental monitoring plans (EMPs) should be developed for the three sites requiring engineered remedies (CWL, CAMU, and MWL). These plans must be adequate to ensure the integrity of the remedy, and to detect any contaminant migration from the site that may indicate an immediate or potential threat to human health or the environment. These site-specific EMPs proposed by the ER Project should be incorporated into the proposed LTS Plan for groundwater monitoring at some Conditionally Released sites.

Few if any, of these sites will require detailed site-specific EMPs (with the exception of the MWL, the CWL and the CAMU). In the opinion of the Environmental Monitoring Task Group, existing site-wide environmental surveillance programs should be modified to incorporate the long-term monitoring goals for all Conditionally Released sites.

SWMUs Closure Status

In 1992, at the inception of Sandia/NM's ER Project, there were more than 200 sites identified as being potentially contaminated based on past activities conducted by Sandia/NM. These sites included onsite and offsite areas in New Mexico and sites in Nevada, California, and Hawaii. From 1993 to 1996, 152 sites at Sandia/NM and offsite locations were investigated and proposed for "No Further Action" (NFA) after assessment and/or remediation. Many of these sites are still awaiting final acceptance by NMED for closure and issuance of an NFA. At the close of 1999, there were 146 SWMUs remaining on Sandia/NM's HSWA permit.

There are two types of NFA designations, either “Administrative” or “Risk Based.” It is anticipated that most SWMUs will eventually be signed off by the NMED with an NFA designation. However, this is not to say that regulatory oversight will stop or that Sandia/NM and DOE will have no further responsibilities for those sites. The challenge for ensuring proper and ongoing stewardship will continue for many years into the future. A designation of NFA can also be revoked at the discretion of the NMED if, at a later date, the NMED determines that further actions, such as excavation and cleanup, are required. The NMED may also change the level of monitoring required during the stewardship period. The LTS Plan must be a living and flexible plan amenable to changes as new information becomes available, or as requirements change.

Stewardship Categories

The SWMUs at Sandia/NM fall into one of the following four categories for stewardship:

1) **Engineered Units/Landfills –** There are currently three sites in this category: the CWL, the CAMU and the MWL. These units will require engineered controls, such as landfill covers and disposal cells, and sustained monitoring to ensure their closure status.

2) **Signed and Fenced Units –** There are currently 13 sites in this category. These sites have mainly physical hazards present, such as mineshafts or pits. A few of the sites in this group will contain sufficient levels of residual contamination to warrant long-term environmental monitoring.

3) **Signed Units –** There are currently 66 sites in this category, most of which have been issued NFA status. A few have residual contamination above background levels, but at low enough levels for an "Industrial" or "Recreational" land use designation. Because there is still some risk present, it is expected that some level of environmental monitoring will be necessary.

4) **No Site Control Required Units –** There are currently 135 sites in this category. Current land use scenarios indicate that all will be either "Industrial" or "Recreational." However,

these sites either pass "Residential" land-use criteria or all residual contaminants are below background levels. Periodic monitoring should be employed to ensure continuing safety.

4.0 Controls and Monitoring Requirements

Stewardship Requirements

Long-term stewardship requirements may include some or all of the following controls:

- **Fencing and Signage** – Physical controls must be properly maintained;

- **Engineered Controls** – Systems such as landfill covers and lined disposal cells will be monitored to assure containment of any residual contamination;

- **Environmental Monitoring Equipment** – Includes all monitoring systems such as groundwater monitoring wells, buried detection systems, and ambient radiation detectors (thermoluminescent dosimeters [TLDs]);

- **Land ownership documentation** – All significant historical information about the site must be documented so that any future land transfers will convey adequate information to ensure that future land uses are compatible with any hazards present; and

- **Dedicated Funding** – Funds must be available into the future from DOE, successor organizations, or other such delegated organizations, to assure that there will be enough resources to carry out all stewardship requirements.

Administrative and Physical Controls

Various levels of administrative and physical controls, dependent on the hazards present, must be instituted to ensure that future activities at the site are restricted and commensurate with the designated land use to ensure the protection of human health and the environment. They include the following:

- **Administrative Monitoring** – Assures deed restrictions, land use restrictions, etc., are enforced and not violated;

- **Physical monitoring** – Assures the integrity of physical structures (e.g., landfill covers, disposal cells, berms, operating remedial systems, gates, and fences); and

- **Contaminant monitoring** – Assures and maintains the safe status of areas under stewardship, as well as detect and locate any constituent release and migration.

Environmental Monitoring Program Design and Considerations

The primary goal of a LTS environmental monitoring program is to verify, through sampling that closure for each site continues to be protective of human health and the environment. To achieve this goal, monitoring programs should be designed to:

- Provide early detection of contaminant release;
- Identify the source of contaminants and allow for mitigation before any potential impacts to human health;
- Characterize trends in the natural, or unaffected system; and
- Verify compliance with environmental regulations and commitments made in regulatory permits or closure plans.

To effectively carry out the above goals, Sandia/NM must have an effective environmental monitoring program in place. The key in designing an effective monitoring strategy is to first identify the important contaminant pathways present at each site. (Contaminant pathways are detailed in Section 5.0). Environmental monitoring should be scaled to the requirements of each SWMU. Some SWMUs, such as the CWL, the CAMU and the MWL will require individual monitoring, while SWMUs with low-risk surface contamination may be monitored as a group.

Appropriate sampling locations would be based on topographical, hydrological, and meteorological considerations. Sampling at strategic locations, which could provide an

indication of the accumulation of contaminants from multiple SWMUs, is also the most cost efficient means of sampling. In the event that contamination is detected above a predetermined action level at a sampling site, a follow-up sampling strategy should be developed to determine the exact source(s) of the contamination.

The environmental media to consider in the design of a sampling program at Sandia/NM include air, surface and subsurface soils, vegetation, arroyo sediments, groundwater, and surface water (including storm water runoff and water from springs). Sampling may be performed directly in the transport medium, such as air or storm/surface water runoff, or in downwind or downstream media to detect the accumulation of contaminants over time. Direct sampling of air, surface water, and groundwater may be appropriate for those sites with the potential for significant releases.

5.0 Contaminant Pathways in the Environment

The types of monitoring required at various SWMUs will be dependent on the nature of the contaminants present and the potential pathways to receptors. Pathways are defined by routes—both direct and indirect—that can lead to inhalation or ingestion of contaminants. Direct pathways include exposure to radiation from a site, inhalation of suspended contaminated particles, ingestion of contaminated groundwater, and any other direct exposure to contaminants. Indirect pathways include contaminants that move through the food chain. For example, food could become contaminated by groundwater sources used for irrigation. Pathways in the environment are dependent on geologic and geographic factors, including soil type and consolidation, bedding structures, surface topography, depth to groundwater, faults and fractures, and the proximity to surface water runoff channels and arroyos, to name a few.

The following techniques are typically used to monitor potential contaminant pathways:

- **Groundwater Monitoring –** Contaminants on the surface or in the subsurface (vadose) may be transported to the groundwater by percolation through the vadose (or unsaturated) zone.

Groundwater contaminants could present a direct human exposure pathway through ingestion of contaminated drinking water, or indirectly following irrigation of crops and subsequent ingestion of contaminated foodstuffs.

- **Terrestrial Surveillance –** Contaminants in soil and vegetation could be consumed allowing contaminants to persist in the food chain.

- **Air Monitoring –** Surface contamination may become airborne and pose a risk to receptors. Airborne contaminants can present a direct human exposure pathway through inhalation and external exposure, or may be deposited elsewhere on soil, vegetation and surface water, and provide a subsequent exposure pathway through ingestion.

- **Ambient External Radiation Monitoring –** For sites contaminated with radioactive materials, ambient radiation measurements may be appropriate using thermoluminescent dosimeters (TLDs).

- **Surface Water and Storm Water Monitoring –** Contaminants present at the surface could be transported by surface water runoff from a site and subsequently deposited elsewhere on soil, sediments, or vegetation, or carried to a surface water body. Waterborne contaminants may present a human exposure pathway through ingestion of contaminated water, by ingestion of contaminated soil or food, or external exposure to deposited contamination (in the case of radioactive material).

- **Vadose Zone Monitoring –** The vadose zone is the unsaturated zone above the water table (from the surface to the saturated zone). Vadose zone monitoring will primarily consist of near surface measurements of soil moisture and soil gas at engineered closure sites. Any changes in soil moisture or soil gas within an engineered system may indicate a potential mechanism for contaminants to become mobile.

6.0 Decision Logic for SWMUs and Determining the Monitoring Method

Because there are still ER Project cleanup activities in progress and the final status of each SWMU is currently unknown, the Environmental Monitoring Task Group cannot be expected to define the details of a long-term environmental monitoring program. However, the Task Group developed a basic decision-making process for groundwater shown in Appendix B, which will serve as a guide for Sandia/NM and DOE to develop an effective environmental monitoring program as more details become available. The decision logic chosen should define the long-term monitoring strategy; specific monitoring methods should be detailed in site-specific environmental monitoring plans (EMPs).

Site stewards need to understand the potential for breaks in the barriers to occur, and have contingency plans for addressing the situation before problems occur. This information can be organized and characterized for each SWMU with a management tool called an "uncertainty management matrix" as shown in Appendix C.

7.0 Monitoring Roles and Responsibilities

The members of the Environmental Monitoring Task Group recognize the need for the NMED and local regulatory input on the LTS concept. The public requires and deserves a firm commitment by the federal government to provide the resources for long-term monitoring and additional remediation, if it becomes necessary. Members of the Task Group suggested that a Memorandum of Understanding (MOU) be developed between the DOE, NMED, the City of Albuquerque, Bernalillo County, and affected Tribal governments to formalize a multi-agency LTS commitment. The MOU should identify which agencies are responsible for administrative controls, funding, physical controls, and monitoring constituents of concern.

8.0 Concerns and Recommendations

The Environmental Monitoring Task Group brought up the following concerns. Specific recommendations address each concern. Additional stand-alone recommendations are also listed.

- **Regulatory Drivers**

  Concern: The Task Group recognizes that Sandia/NM is contractually obligated to conduct an environmental surveillance program in accordance with DOE Orders. However, this Task Group also recognizes that there are no regulations specifically addressing the issue of LTS. The Task Group is concerned that without a hard regulatory driver it may be difficult for the DOE and Sandia/NM to obtain the necessary funding and resources to carry out their responsibilities to the community in the future. Also, there is a concern about the lack of formal regulations regarding the vadose zone.

  Recommendation: The Task Group recommends that specific regulations should be developed by NMED to establish drivers for a LTS Plan. Although the existing legal framework applied to environmental monitoring is well regulated, regulations specific to the vadose zone are mainly non-existent. Therefore regulations should be developed to ensure that LTS requirements are protective of the vadose zone and its potential pathways. This is a condition that should be remedied by either Congress or the State legislatures, or both.

- **Funding**

  Concern: The routine environmental surveillance programs at Sandia/NM are indirectly funded (out of corporate overhead) as opposed to directly funded from DOE. Over the past several years, the funding level for all indirect programs has been reduced—with that trend likely to continue. The Task Group is concerned that a monitoring program for LTS will result in an increased demand for resources, in a situation where budgets have been, and will continue to be, reduced. This must not occur. Long-term environmental surveillance programs should be added to the existing permit.

Recommendation: The Task Group recommends that DOE, and its successors, commit to specific, direct funding for long-term monitoring under the LTS program. Consideration should be given by DOE to provide direct funding for all environmental surveillance programs conducted at the labs. The Task Group feels that these critical programs, which are in place to verify Sandia/NM's and DOE's commitment to protecting public health and the environment, should not be subject to arbitrary corporate budget cuts, but rather should have a secure source of funding in the future.

- **Flexibility of Monitoring Plans**

  Concern: The Task Group believes that future monitoring plans must be prepared to manage and predict our physical environments as the dynamics of the monitoring changes. Therefore, the Task Group is concerned that monitoring plans remain flexible over time. The frequency of monitoring should be determined according to risk type at each site or group of sites, which may change as a result of site dynamics or regulatory requirements. An agreement by State, County, and City agencies is necessary if any significant changes are made to monitoring plans.

  Recommendation: The Task Group recommends that monitoring plans be designed to remain flexible to take advantage of new technologies, changing public expectations and, to an extent, changing budget constraints, but not to the detriment of maintaining integrity of the monitoring. Periodic technical review and reevaluation should be part of the overall monitoring plan. However, development of specific environmental monitoring plans and procedures should be left to DOE and Sandia/NM technical specialists, with review and oversight by appropriate regulatory entities and the public.

- **Site-Specific Environmental Monitoring Plans (EMPs)**

  Recommendation: The Task Group recommends that site-specific EMPs be developed for the "Conditionally Released" sites requiring engineered remedies for closure (CWL, CAMU, and MWL). The Task Group has been presented with a draft overall monitoring plan for the MWL. The proposed plan is being reviewed, and may change, but the Task Group feels that

for this approach, site-specific plans for the higher risk sites are appropriate.

- **Scope of Monitoring**

  Recommendation: The Task Group recommends that LTS be maintained for as long as necessary with DOE accepting continued responsibility for all of its sites. In addition to monitoring sites to determine contaminant migration outside the SWMU boundary, monitoring programs should also be designed to monitor the contaminants within the site to continually assess the risk associated with the site and to evaluate if additional remediation may be undertaken without undo risk to site workers.

- **Groundwater Monitoring Wells**

  Recommendation: The Task Group recommends the use of longer screened, multi-ported groundwater wells to increase well life and reduce cost.

- **Public Involvement**

  Concern: The Task Group recognizes that there is a need for on-going public input to the LTS process to develop a sense of the public's concerns regarding the stewardship plan for Sandia/NM.

  Recommendation: The Task Group recommends that the site-specific monitoring plans and any modifications to Sandia/NM's existing surveillance programs be documented and made available to the public for review. The public should have the opportunity to periodically review and comment on this and other monitoring plans as they become available.

- **Overall Groundwater Monitoring Plan for LTS**

  Recommendation: The Task Group was briefed on the draft *"Sandia/NM Long-term Groundwater Monitoring Proposal"* (see Appendix D). This proposal addresses groundwater monitoring specifically related to those sites that will remain with a known or potential source of groundwater contamination. The Task Group recommends that this proposal be adopted, with appropriate modifications given the known conditions at the time of site closure. The proposal is based on proven, complex hydrogeologic models, and

provides a systematic and defensible approach for monitoring, utilizing the concept of "sentry wells" to provide early indication of a groundwater problem. The proposal, coupled with the site-wide Groundwater Protection Program (GWPP), provides the appropriate level of public assurance that DOE and Sandia/NM are committed to the monitoring and protection of this valuable resource.

- **Environmental Surveillance Programs**

  Recommendation: The Task Group recommends that the existing environmental surveillance programs at Sandia/NM be utilized, to the maximum extent that is technically defensible, to accomplish long-term monitoring in support of LTS. Some modifications to the programs will likely be required to ensure that the objectives of LTS are met, and these modifications should be based on known site conditions at the time of site closure.

- **Quality Assurance Program**

  Recommendation: Since public confidence in the monitoring data collected during LTS is critical to the success of LTS, a very visible and prominent data quality assurance program needs to be included in the LTS Plan.

- **Uncertainty Matrices**

  Recommendation: The Task Group recommends the development of uncertainty matrices for "Conditionally Released" sites (see Appendix C).

- **Models**

  Recommendation: The Task Group recommends the development of post remediation conceptual site models as illustrated in the draft *DOE Long-Term Stewardship Study* (DOE 2000).

  Recommendation: The Task Group recommends that Sandia/NM's sediment testing and multiple location sampling model be used for environmental monitoring.

Recommendation: The Task Group recommends that a soil transport model be used to calculate timing for contaminant transport within arroyos.

References

DOE 2000 U.S. Department of Energy, *DOE Long-Term Stewardship Study*.

DOE 1987 U.S. Department of Energy/Albuquerque Operations Office (DOE/AL), *Comprehensive Environmental Assessment and Response Program (CEARP) Phase 1: Installation Assessment*, draft DOE/AL, Environment, Safety and Health Division, Albuquerque, NM (September 1987).

SNL 2001 Sandia National Laboratories, *1999 Annual Site Environmental Report, Sandia National Laboratories, Albuquerque, New Mexico,* SAND 2001-2228. Sandia National Laboratories, Albuquerque, NM (Final version remains unpublished pending DOE release).

SNL 1996 Sandia National Laboratories, *Environmental Monitoring Plan, Sandia National Laboratories, Albuquerque, New Mexico,* 75-1013. Sandia National Laboratories, Albuquerque, NM (1996).

Glossary

Baseline – A quantitative expression of planned costs, schedule, and technical requirements for a defined project. Baselines should include criteria to serve as a standard for measuring the status of resources and the progress of a project.

Cleanup – The process of addressing contaminated land, water and facilities, nuclear materials, and hazardous waste produced by past nuclear weapons production activities in accordance with applicable requirements. Cleanup does not imply that all hazards will be removed from the site. This function encompasses a wide range of activities, such as stabilizing contaminated soil; treating groundwater; decommissioning process buildings, nuclear reactors, chemical separation plants, and many other facilities; and exhuming sludge and buried drums of waste. The term "remediation" is often used synonymously with cleanup.

Conceptual Site Model (CSM) – A set of qualitative assumptions used to describe a system or subsystem for a given purpose. CSMs are used during cleanup actions to depict the relationship between existing hazards, environmental transport mechanisms, exposure pathways, and ultimate human and ecological receptors. CSMs can also be used to distinguish between unknown and known site conditions (such as the existence of fractured bedrock and other preferential pathways for groundwater flow).

Contingency Plan – Preparations for unexpected or unwanted circumstances, such as the failure of an engineered control or an unfavorable environmental change (e.g., flooding).

Conditional Release – Land use status that restricts the types of activities that may occur. An ER site with minimal contamination, but which is still above regulatory standards may be appropriate for "Industrial" use or "Recreational" use but no "Residential" use. Higher level hazards remaining at a site will not be appropriate for any public use and will require stricter controls including fences, signs, and monitoring.

Decommissioning – The process of removing a facility from operation followed by closure activities that include decontamination, entombment, dismantlement, or conversion to another use.

DOE Orders – Internal requirements of the DOE that establish policy and procedures, including those for compliance with applicable laws. DOE Orders are established by DOE under the Authority of the Atomic Energy Act (AEA), and are not enforceable by external parties (e.g., other federal regulators).

Engineered Control – Man-made controls designed to isolate and contain residual contaminants in place. These include landfill covers and caps for radioactive, hazardous, and sanitary landfills; vaults; repositories; and in-situ stabilization.

Exposure Pathway – A route that a chemical or physical agent takes through the environment from the source of contamination to an exposed organism. This may include direct exposure pathways such as through the air or indirect exposure pathways in which contaminants accumulate within environmental media and are passed along through the food chain.

Hazards – Chemical or radioactive materials or physical conditions that have the potential to cause adverse affects to health, safety, or the environment.

Hazardous Waste – A category of waste regulated under the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. 6901 et seq.). Hazardous waste is a sub-category of "RCRA Solid Waste" (which includes liquids). RCRA hazardous waste exhibits at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity—or is specifically listed by the U.S. Environmental Protection Agency (EPA) in 40 CFR 261.31 to 40 CFR 261.33. Radiological waste (including source, special nuclear, or by-product materials) as defined by the Atomic Energy Act (AEA) are not regulated under RCRA. However, mixed waste, which contains both hazardous and radiological constituents is regulated by RCRA.

In-situ – In its natural position or place. This may refer to in situ remediation, which treats buried hazardous materials in place such as through bioremediation, grouting, and vapor extraction.

Long-Term Stewardship (LTS) – The physical controls, administrative management, and environmental monitoring that will be implemented after the remediation and closure of past release sites, or Solid Waste Management Units (SWMUs), where residual contamination or physical hazards remain. LTS includes all activities required to protect the human health and the environment from hazards remaining after cleanup is complete.

Radiation – In the context of radioactivity, this is energy in the form of ionizing radiation produced from radioactive decay and primarily includes alpha and beta particles and gamma emissions.

Radioactivity – The spontaneous transformation of unstable atomic nuclei.

Radionuclide – An unstable radioisotope, which undergoes spontaneous transformation and emits radiation.

Receptor – Any human or other living thing that could be exposed and/or threatened by hazardous or toxic contaminants.

Risk – Risk defines the probability or likelihood that a hazard will cause potential harm to a receptor, including human populations or ecological communities. The existence of a hazard does not automatically imply the existence of a risk since risk requires a pathway (to a receptor) for an exposure to occur. Risk is expressed (qualitatively or quantitatively) in terms of the likelihood that an adverse effect will occur as a result of the existence of the hazard.

Unrestricted Release – Land use status upon which there are no restrictions on the types of activities that may occur, including permanent residential use.

Appendix A

Current Scope of Sandia/NM's Environmental Programs

Regulatory requirements and U.S. Department of Energy (DOE) Orders drive the environmental programs currently in place at Sandia National Laboratories, New Mexico (Sandia/NM). Detailed descriptions of these, and other environmental monitoring programs at Sandia/NM can be found in the *Environmental Monitoring Plan* (SNL 1996), and in the 1999 *Annual Site Environmental Report* (SNL 2001) as well as specific program documents such as procedures and sampling and analysis plans. The scope of Sandia/NM's environmental programs is briefly described below.

Groundwater Protection Program (GWPP)

- Focus on regional ground water quality and characterization of ground water flow
- Base-wide GWPP includes:
  - Monthly water level measurements in 126 wells
  - Annual water quality measurements in 14 wells and one spring, analyzed for volatile organic compounds (VOCs), total organic halogens (TOX), phenols, general inorganics, metals, radioactive constituents (gamma, isotopic uranium, alpha/beta, and radium-226/228)
- Work closely with Environmental Restoration (ER) Project monitoring programs (52 wells)

Storm Water Program

- Currently five stations, 4 more planned - sampled when flow is present, analyzed for metals, ammonia, nitrate plus nitrite, chemical oxygen demand (COD), total kjeldahl nitrogen (TKN), cyanide, oil/grease, radioactive constituents (alpha/beta), and polychlorinated biphenyls (PCBs)
- Construction-related fencing and monitoring
- Solid Waste Management Unit (SWMU)-specific monitoring (four current in Arroyo del Coyote - Site 16 and Burn Site)

Air Quality Program (Clean Air Network)

- Particulate matter less than 10 μm in diameter (PM_{10}) (four stations - sampled 24 hours every 6 days), analyze for mass loading, metals and radioactivity
- Criteria Pollutants (one station - continuous sampling), analyze for SO_2, CO, NO, NO_2, O_3
- VOCs (four stations - sampled 24 hours monthly), analyze for 25 VOC species

Meteorological Monitoring Program

- Site-wide network of eight meteorological towers
- Data supports modeling efforts for other air quality programs and emergency management
- Continuous data collection at all towers, server updated every 15 minutes

Terrestrial Surveillance Program

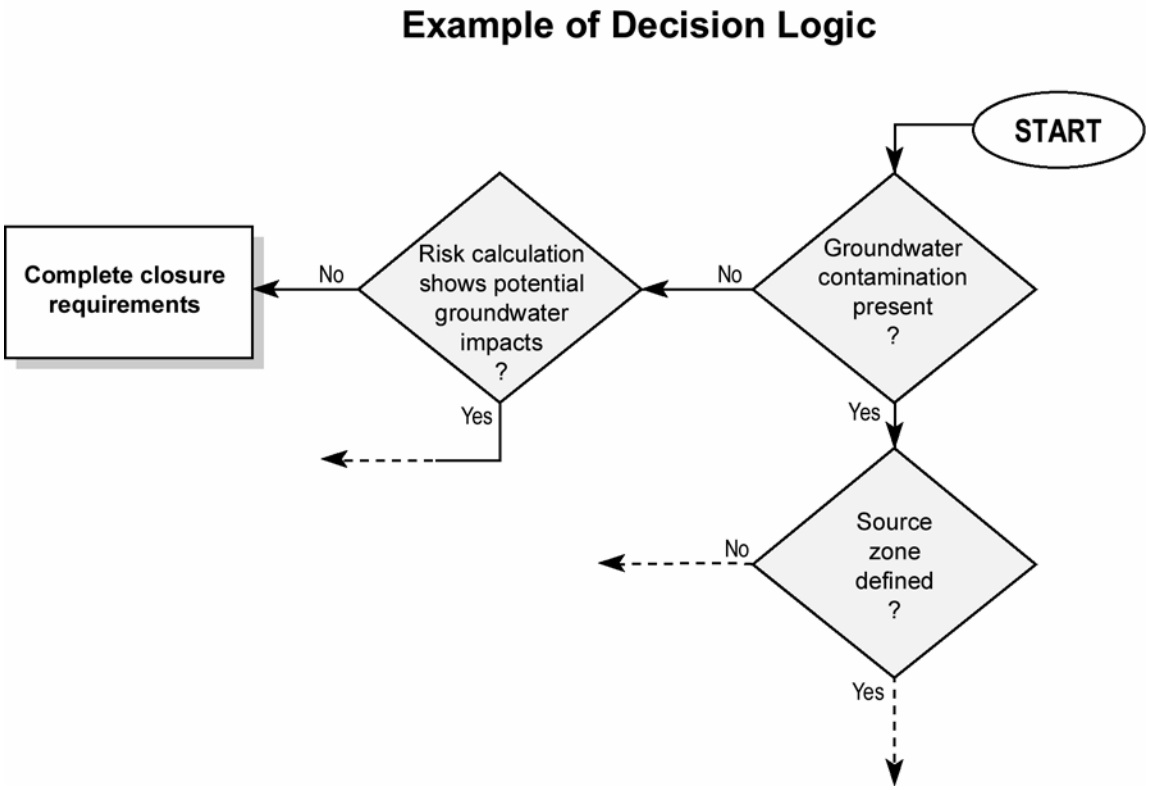
- Sampling conducted annually at 39 on-site, 17 perimeter, and 16 offsite locations
- Sample media: soil (49), sediment (10), and vegetation (29), analyzed for metals and radioactive constituents (gamma spectroscopy, tritium and total uranium)
- Ambient radiation monitoring using thermoluminescent dosimeters (TLDs) at 34 locations
- Trending and other statistical analysis to compare on-site and perimeter results with community

Ecological Surveillance Program

- Small mammal, large mammal, reptile, and bird population studies
- Small mammal contamination studies, analyzed for metals and radioactive constituents (gamma, tritium, isotopic strontium-90)
- Vegetation population study

Appendix B

LTS Decision Logic Process



Appendix C

Example Uncertainty Matrix for Long-Term Stewardship

Expected Condition	Reasonable Failure	Probability of Occurrence	Time to Respond	Impact	Monitoring Plan	Contingency Plan
Cover prevents infiltration and subsequent leachate development.	Burrowing animals or plant roots will breach cover integrity.	High. Operations of other landfills indicate that over time this is a common intrusion scenario.	Short for animals. In the case of plants, it takes time to establish a deep root system.	Significant since cover integrity will be lost and leachate is likely to carry contaminants to the groundwater.	Site inspection every 3 months to ensure integrity of cover.	A biointrusion barrier could be installed to deter burrowing animals. Since lead times are quite short for this pathway, it may be better to install this barrier at the onset (robust design). Plant removal upon detection should mitigate root intrusion.
Access and institutional controls will prevent excavation through cover.	Humans will dig in the area of the landfill, breaching integrity of the cover.	Low. Additional controls (i.e., land use restrictions and a fence) are in place to prevent human intrusion.	Short for direct contact of humans, longer for loss of cover effectiveness with respect to infiltration	Same as above. In addition, intrusion into the soil would likely result in dermal contact with radioactive contaminants, posing an unacceptable risk to human health.	Site inspection will include surveillance of cover condition, evaluation of fence integrity and maintenance of land use controls..	Reevaluation of remedy will be conducted if humans breach the integrity of the cover and land use controls are not functional. Options may include more sophisticated fence designs, site security, and armoring
Contaminants in the groundwater will naturally attenuate to levels below Maximum Contaminant Levels (MCLs) within a 20-year timeframe.	Contaminants do not attenuate naturally to levels below MCLs within the required timeframe.	Low. Based on modeling of site conditions, contaminant characteristics, and the general trend established by existing monitoring data, MCLs will be attained within a 20-year time frame.	Long. Monitoring data will indicate if the current trend in contaminant reduction changes. Based on these data, the site manager will have advance warning if end objectives will not be met in 20 years.	High. If groundwater remediation goals cannot be reached in 20 years, regulators will require a different more costly remediation approach. 2. Low. Land use restrictions and alternate drinking supply prevent ingestion.	Wells within the plume will be sampled every three months to ensure that natural attenuation is reducing the concentration of contaminants in the groundwater. Sentinel wells will be monitored quarterly to detect any escape near receptor wells.	If data indicate significant negative deviation from predicted trends in plume concentrations, an extraction type of remedy

Appendix D

Draft MWL Groundwater Monitoring Proposal

Currently groundwater is being monitored on an annual basis. This monitoring frequency should be continued. However, we are also proposing both landfill cover and vadose zone monitoring systems at the MWL.

For the purpose of verifying their performance, the vadose zone and cover systems should be monitored quarterly for a period of three years. If no releases are detected, monitoring should be reduced to semi-annually for the next three years. Thereafter, a request for an approval of annual monitoring should be submitted to NMED.

Performance/monitoring reports should be submitted annually for the first three years. Following this period, reports detailing the cover performance and monitoring results should be submitted every three years (during the entire monitoring period, the annual analytical results for groundwater monitoring at the MWL would also be included in the permit-required Annual Groundwater Monitoring Report).

Any verified exceedances of expected cover parameters should be reported to NMED within 5 days. Any verified groundwater or vadose zone analytical results indicating possible contamination should be reported to NMED within 24 hours. NMED should be requested to split verification samples.

Reports to the public on the MWL should be presented annually as part of our permit-required quarterly public meetings.

At ten-year intervals, a report should be prepared considering the feasibility of remediating the landfill. This report should address the expected current activity levels of the waste, the threat to remediation workers from that activity level, advances in remediation technologies, the availability of off-site disposal facilities, any possible land use changes or land transfers, and the projected costs of excavation/waste disposal, as well as a summary of the performance and

monitoring data collected to date. These reports should be submitted to NMED and presented to the public in specific, well-advertised public meetings.

Following each of these decadal reports, NMED would, as they would at any time during the stewardship period, have the option of requiring remediation of the landfill if it is determined that the MWL poses a threat to human health or the environment.

If at any time monitoring should indicate that there has been a release from the landfill with the potential to impact human health or the environment, the Department of Energy has the option of initiating a voluntary corrective action to remediate the problem. Approval of the remediation plan should be sought from NMED.