2-16-2022

Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill - March 2012, Revision I February 16, 2022

Sandia National Laboratories/NM

Certified Mail - Return Receipt Requested

February 16, 2022

Daryl Hauck
Manager
U.S. Department of Energy
NNSA/Sandia Field Office
P.O. Box 5400, MS 0184
Albuquerque, NM 87185-5400

Johnathan Huff
Director
Sandia National Laboratories
P.O. Box 6200, MS-1512
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RE: APPROVAL
CLASS 1 PERMIT MODIFICATION (WITH PRIOR NMED APPROVAL)
SANDIA NATIONAL LABORATORIES
EPA ID# NM5890110518
HWB-SNL-21-016

Dear Messrs. Hauck and Huff:

The New Mexico Environment Department (NMED) received the *Request for Modification 21-019 to Resource Conservation and Recovery Act (RCRA) Facility Operating Permit, Sandia National Laboratories/New Mexico (SNL/NM)* with cover letter dated December 16, 2021, submitted by the U.S. Department of Energy on behalf of itself and National Technology & Engineering Solutions of Sandia, LLC (collectively, the Permittees) on December 21, 2021.

NMED has completed review of the request for Permit Modification. In the submittal, the Permittees proposed to revise the Solid Waste Management Unit 76 Mixed Waste Landfill (MWL) Long-Term Monitoring and Maintenance Plan (LTMMP). The LTMMP is incorporated by reference into Permit Attachment M, Long-Term Monitoring and Maintenance Plan for Solid Waste Management Units and Areas of Concern Granted Corrective Action Complete with Controls.

The Permittees explained that the changes to the LTMMP include updates of the description to reflect current conditions, allow updates to the inspection forms (inspection requirements are not affected by this change), removing redundant documents from lists of operating procedures, and change minor details to monitoring procedures for soil vapor, radon, and tritium.

The requested modifications to the Permit are documented in four enclosures that were attached to the permit modification request cover letter. Details of the proposed changes to the MWL LTMMP are described below:

- Enclosure 2: Summary of Requested Modifications to MWL LTMMP.
- Enclosure 3: Revisions to the MWL LTMMP, Redline/Strikeout Format.
- Enclosure 4: Revisions to the MWL LTMMP, Clean Copy.
- Enclosure 5: Additional information for Item 48 of Enclosure 2.

Following review of the permit modification request and related documents the NMED determined that the proposed change is a Class 1 Permit Modification requiring prior approval from the Department pursuant to 40 CFR §270.42(d)(2)(i)), as specified in Appendix I to 40 CFR §270.42. The requested Permit Modification is hereby approved.

Since the Permit Modification is not a self-implementing change but one that required approval from NMED, the Permittees must, pursuant to 40 CFR §270.42(a)(ii), send out a notice of the Permit modification to all persons on the Facility mailing list previously received from the Department. This notification must be made within 90 calendar days from the date the Permittees receive this letter of approval.

Additionally, the Permittees must also incorporate the attached Enclosure 4, the clean copy of the revised pages of the LTMMP, into the appropriate sections of the current LTMMP previously issued in March 2012.

Further, the New Mexico Hazardous Waste Management Fee Regulations 20.4.2 NMAC require assessment of fees when administrative review of a document is complete. NMED has attached an invoice to this letter. Payment of the fees is due within sixty (60) calendar days from the date that you receive the invoice.

If payment is by check, then you must provide the invoice number on the check. If payment is transmitted electronically, then you must submit a letter to Mr. Dave Cobrain, NMED Hazardous Waste Bureau, indicating the invoice number, payment amount, and the assessed activity prior to transferring the funds.

Should the Permittees need to request an extension of the sixty-day period the request must be submitted at least seven days prior to the end of the sixty-day period. Should the Permittees disagree with the fee assessed you may file an Administrative Appeal under the provisions of the New Mexico Hazardous Waste Management Regulations at 20.4.2.302 NMAC.

If you have any questions regarding this letter, please contact Naomi Davidson at (505) 690-7567.

Sincerely,

Rick Shean
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
B. Wear, NMED HWB
C. Amindyas, NMED HWB
N. Davidson, NMED HWB
L. King, EPA Region 6 (6LCRRC)
B. Wechsler, DOE/NNSA/SFO, MS-0184
L. Tello, DOE/NNSA/SFO, MS-0184
A. Reiser, SNL/NM, MS-0729
D. Jesus, SNL/NM, MS-1512

File: SNL 2022 and Reading

Sandia National Laboratories

Sandia National Laboratories/New Mexico Environmental Restoration Operations

LONG-TERM MONITORING AND MAINTENANCE PLAN FOR THE MIXED WASTE LANDFILL

MARCH 2012
Revision 1 February 16, 2022

United States Department of Energy
Sandia Field Office

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA-0003525.

EXECUTIVE SUMMARY

The Mixed Waste Landfill (MWL) is an inactive site, designated as a Solid Waste Management Unit, at Sandia National Laboratories, New Mexico (SNL/NM). The SNL/NM facility is owned by the U.S. Department of Energy (DOE). On May 1, 2017, the management and operating contractor for SNL/NM underwent a name change from Sandia Corporation to National Technology & Engineering Solutions of Sandia, LLC. The DOE and its contractor are hereinafter referred to the Permittees throughout this document. The MWL is located in Technical Area III of SNL/NM, which is within the boundaries of the federally-owned Kirtland Air Force Base, south of the City of Albuquerque. The MWL has undergone corrective action in accordance with the following regulatory criteria:

- New Mexico Administrative Code, Title 20, Chapter 4, Part 1, Section 600 incorporating Title 40 of the Code of Federal Regulations, Part 264

- Module IV of Resource Conservation and Recovery Act Permit No. NM5890110518 (U.S. Environmental Protection Agency [EPA] August 1993), as revised and updated

- New Mexico Environment Department (NMED) Class 3 Permit Modification for the MWL (NMED August 2005)

- New Mexico Secretary of the Environment Final Order No. HWB 04-11(M) in the matter of request for a Class 3 Permit Modification for Corrective Measures for the Mixed Waste Landfill No. HWB 04-11(M) (Final Order) (Curry May 2005)

- NMED Compliance Order on Consent (Consent Order) (NMED April 2004)

In the Final Order on the MWL, NMED selected a vegetative soil cover with a biointrusion barrier as the final remedy, hereinafter referred to as the MWL evapotranspirative (ET) Cover, and requested the identification of specific monitoring trigger levels to be implemented as part of a Long-Term Monitoring and Maintenance Plan (LTMMP). Deployment of the MWL final remedy was completed in September 2009, and the MWL Corrective Measures Implementation (CMI) Report (SNL/NM January 2010, Revision 1) was approved by NMED on October 14, 2011 (Bearzi October 2011).

This LTMMP defines monitoring, inspection/maintenance/repair, reporting, and physical and institutional control (IC) requirements for the MWL. The Permittees will implement the LTMMP to determine whether the MWL ET Cover is performing as designed and confirm that site conditions remain protective of human health and the environment. The MWL monitoring program is based upon the results of the site investigation process (SNL/NM September 1990 and September 1996), probabilistic performance-assessment modeling presented in the MWL CMI Plan (Ho et al. January 2007), and input from NMED and the public. The program addresses air, surface soil, vadose zone, groundwater, and biota. The following parameters will be monitored:

- Radon concentrations in the air
- Tritium, gamma-emitting radionuclides, and metal concentrations in surface soil
- Soil moisture in the vadose zone

- Volatile organic compound (VOC) concentrations in the vadose zone soil vapor
- VOCs, specific metals, and radionuclide concentrations in groundwater
- Gamma-emitting radionuclides in biota

The monitoring and sampling activities, data quality objectives, frequencies, and analytical methods are presented for each parameter in the sampling and analysis plans provided in the appendices. Although monitoring is planned for radionuclides in various media at the MWL, the information related to radionuclides is provided voluntarily to NMED by the Permittees.

Monitoring trigger levels have been established as the criteria against which the monitoring results will be compared. In the event that a trigger level is exceeded, an evaluation process has been established that ensures the collection of sufficient data to assess trends and determine whether further investigation is warranted. Specific trigger levels include numerical thresholds derived from EPA, DOE, and NMED regulatory standards.

Routine surveillance and maintenance of the ET Cover, monitoring networks, and physical controls (i.e., fences, signs, gates, locks, and survey monuments) will also be performed to ensure the integrity of the ET Cover, monitoring networks, and site physical controls. Surveillance will be conducted to evaluate the following:

- Physical condition of the site and ET Cover (vegetation survey, signs of erosion, settlement, water ponding, intrusion by animals, contiguous areas lacking vegetation)

- Surface-water diversion structures

- Groundwater monitoring wells, soil-vapor sampling wells, and neutron access tubes

- Security fence, signs, gates and locks, and survey monuments

Maintenance will be performed to prevent deterioration or failure of the ET Cover or associated networks and features and, if needed, repairs will be implemented to restore conditions to the original specifications.

ICs are a key element of the long-term monitoring and maintenance strategy for the MWL. Categories of ICs in place at the MWL include:

- Government ownership
- Entry restrictions
- Warning notices
- Active controls
- Resource-use management
- Site information systems

The application of multiple ICs at the MWL is consistent with a conservative strategy that incorporates multiple, independent layers of controls to protect human health and the environment. In the event of the temporary failure of a control, others are in place to mitigate significant consequences of the failure.

Contingency procedures are addressed through the trigger evaluation process, which will be used to evaluate any monitoring results that exceed the specified trigger levels. Potential failure scenarios are presented, along with possible corrective action responses. Any such response will be assessed on a situation-specific basis in accordance with NMED requirements.

The purpose of the long-term monitoring and maintenance program is to ensure that the MWL, with the ET Cover deployed, remains protective of human health and the environment. The comprehensive, multi-media long-term monitoring program, combined with media-specific trigger levels and evaluation process, provides for early detection of potentially changing conditions and reflects the priority placed on protecting groundwater. The long-term maintenance program ensures that the ET Cover and monitoring systems will be regularly inspected and repaired as needed so they operate according to design specifications. Reports that document monitoring and maintenance activities and evaluate the effectiveness of the ET Cover over time will be submitted to NMED annually and allow for continued public involvement.

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ACRONYMS AND ABBREVIATIONS

µg	microgram(s)
bgs	below ground surface
CAC	corrective action complete
CAMU	Corrective Action Management Unit
CFR	Code of Federal Regulations
Ci	curie(s)
cm	centimeter(s)
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CWL	Chemical Waste Landfill
CY	calendar year
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ET	evapotranspirative
FLUTe™	Flexible Liner Underground Technologies
ft/day	feet per day
ft/yr	feet per year
g	gram(s)
GPS	global positioning system
HWB	Hazardous Waste Bureau
IC	institutional control
KAFB	Kirtland Air Force Base
L	liter(s)
LTMMP	Long-Term Monitoring and Maintenance Plan
m^2	square meter
MCL	maximum contaminant level
MDL	method detection limit
mm	millimeter(s)
MP	Monitoring Plan
MWL	Mixed Waste Landfill
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NOD	Notice of Disapproval
P&A	plug and abandonment
PCE	tetrachloroethene
pCi	picocurie(s)
ppmv	part(s) per million by volume
PQL	practical quantitation limit
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
s	second
SAP	Sampling and Analysis Plan
SNL/NM	Sandia National Laboratories, New Mexico
SWMU	Solid Waste Management Unit

ACRONYMS AND ABBREVIATIONS (Concluded)

TA	Technical Area
TCE	trichloroethene
UNM	University of New Mexico
VOC	volatile organic compound
yr	year

1.0 INTRODUCTION

The Mixed Waste Landfill (MWL) at Sandia National Laboratories, New Mexico (SNL/NM) is a Solid Waste Management Unit (SWMU) that has undergone corrective action in accordance with the following regulatory criteria:

- New Mexico Administrative Code (NMAC), Title 20, Chapter 4, Part 1, Section 600 (20.4.1.600 NMAC) incorporating Title 40 of the Code of Federal Regulations (CFR), Part 264 (40 CFR 264.101)

- Module IV of Resource Conservation and Recovery Act (RCRA) Permit No. NM5890110518 (U.S. Environmental Protection Agency [EPA] August 1993), as revised and updated

- New Mexico Environment Department (NMED) Class 3 Permit Modification for the MWL (NMED August 2005)

- New Mexico Secretary of the Environment's Final Order in the matter of request for a Class 3 Permit Modification for Corrective Measures for the Mixed Waste Landfill No. HWB 04-11(M) (Final Order) (Curry May 2005)

- Compliance Order on Consent (Consent Order) (NMED April 2004)

On May 26, 2005, NMED issued the Final Order on the MWL selecting a vegetative soil cover with biointrusion barrier as the final remedy for the MWL, hereinafter referred to as the MWL evapotranspirative (ET) Cover. NMED Final Order and the Class 3 Permit Modification require a Long-Term Monitoring and Maintenance Plan (LTMMP) to address monitoring, maintenance, physical and institutional controls (ICs), and reporting at the MWL following remedy implementation. Deployment of the MWL final remedy was completed in September 2009. The MWL Corrective Measures Implementation (CMI) Report (SNL/NM January 2010, Revision 1) documenting ET Cover construction in accordance with the MWL CMI Plan (SNL/NM November 2005) was approved by NMED on October 14, 2011 (Bearzi October 2011).

1.1 Purpose

This LTMMP describes how the U.S. Department of Energy (DOE) and the SNL/NM management and operating contractor (National Technology & Engineering Solutions of Sandia, LLC) after May 1, 2017, and Sandia Corporation prior to May 1 2017), hereinafter collectively referred to as the Permittees, will meet the long-term monitoring and maintenance requirements for the MWL. This plan satisfies the requirement for an LTMMP in the Final Order and the Class 3 Permit Modification. This LTMMP describes the necessary physical controls and ICs to be implemented, the maintenance and monitoring activities for the site and ET Cover, the frequencies at which such activities will be conducted, and the associated reporting. These activities will be performed, documented, and reported in accordance with this LTMMP to ensure that the MWL ET Cover performs as designed and site conditions remain protective of human health and the environment. The Five-Year Reevaluation Report required by NMED Final Order and the Class 3 Permit Modification is also addressed.

1.2 Regulatory Background

The NMED Final Order and Class 3 Permit Modification were issued in May and August 2005, respectively. On November 3, 2005, the Permittees submitted a CMI Plan (SNL/NM November 2005) incorporating the final remedy selected by NMED. The CMI Plan presented the design for a 3-foot-thick, vegetated soil cover, underlain by a 1-foot-thick biointrusion barrier and a subgrade layer that varies from 2 to 40 inches in thickness. The CMI Plan also included detailed engineering design drawings and construction specifications, a construction quality assurance plan, and the results of a fate and transport model with proposed triggers to be implemented during the long-term monitoring period.

In November 2006, NMED issued a Notice of Disapproval (NOD) for the MWL CMI Plan (Bearzi November 2006). The NOD contained two sets of comments, requesting 1) clarification regarding the MWL cover design and fate and transport model, and 2) additional triggers for long-term monitoring. The Permittees' responses to the NOD (Wagner December 2006 and January 2007) included clarifications regarding the MWL cover design, the fate and transport model, and a revised list of monitoring triggers for long-term monitoring. NMED issued a second NOD (Bearzi October 2008a) that clarified resolution of issues related to the initial NOD. The Permittees' response (Davis November 2008) and revised CMI Plan were subsequently approved with conditions by NMED (Bearzi December 2008). ET Cover construction began approximately five months later, in May 2009, and was completed in September 2009.

The MWL CMI Report documenting cover construction in accordance with the CMI Plan was submitted to NMED in January 2010 (SNL/NM January 2010, Revision 1). NMED held a public meeting on the CMI Report on December 14, 2010, and issued an NOD in May 2011 (Bearzi May 2011) with eight comments. The Permittees submitted comment responses (Wagner August 2011), and the CMI Report was approved by NMED on October 14, 2011 (Bearzi October 2011). All conditions related to NMED approval of the CMI Plan are addressed in the CMI Report and in this revised LTMMP.

The Final Order and Class 3 Permit Modification require the Permittees to submit an LTMMP to NMED within 180 days after NMED approval of the CMI Report. In 2007, while NMED comments on the CMI Plan were being addressed, the Permittees developed and submitted a MWL LTMMP (SNL/NM September 2007) at the request of NMED. NMED held a public comment period from October 31, 2007, through January 31, 2008, and posted the 2007 LTMMP on NMED web site. However, by the December 2010 public meeting for the CMI Report, NMED had determined that a revised LTMMP would be required due to significant changes at the MWL (e.g., a new groundwater monitoring network that was installed in 2008 and the ET Cover that was constructed in 2009). NMED required submittal of the revised LTMMP within 180 days of NMED approval of the CMI Report (Kieling October 2011). In December 2011 the Permittees withdrew the 2007 MWL LTMMP (Wagner December 2011); the withdrawal was formally accepted by NMED (Kieling December 2011).

The trigger evaluation process and final trigger levels for long-term monitoring are presented in Chapter 5.0 of this document. Triggers for long-term monitoring have been developed for both hazardous and radiological constituents; however, the triggers and monitoring for radionuclides are provided to NMED voluntarily by the Permittees. The voluntary inclusion of such radionuclide information shall not be enforceable and shall not constitute the basis for any enforcement because such information falls wholly outside the requirements of the Consent Order. Additional information on radionuclides and the scope of the Consent Order is available in Section III.A of the Consent Order (NMED April 2004).

1.3 Legal and Regulatory Requirements

The MWL is designated as a SWMU, subject to corrective action under 20.4.1.600 NMAC incorporating 40 CFR 264.101. The NMED Hazardous Waste Bureau (HWB) is the lead regulatory agency and oversees corrective action at the MWL under the corrective action provisions of the Consent Order (NMED April 2004) issued pursuant to the New Mexico Hazardous Waste Act.

A requirement to develop an LTMMP was presented in the NMED Final Order on the MWL (Curry May 2005) and the Class 3 Permit Modification (NMED August 2005). Although the Consent Order (NMED April 2004) governs the remedy selection process for the MWL, it does not contain any requirements related to long-term monitoring, other than requirements for monitoring well replacement. Rather, the Consent Order defers to Module IV of SNL/NM RCRA Permit NM589011051 (as revised by the August 2005 Class 3 Permit Modification for the MWL) for implementation of long-term controls for SWMUs. Following NMED approval of this LTMMP, the Permittees will request a Class 3 Permit Modification for corrective action complete (CAC) at the MWL.

The 2005 Class 3 Permit Modification provides the framework for the LTMMP and states the following in Section V(6):

> A long-term monitoring and maintenance plan, which includes all necessary physical and institutional controls to be implemented in the future shall be submitted by the Permittees to the Administrative Authority for approval within 180 days after the Administrative Authority's approval of the CMI Report. The Administrative Authority may require monitoring, maintenance, and physical and institutional controls different than those specified in the Corrective Measures Study report referenced in V.1 of this section. The plan shall also include contingency procedures that must be implemented by the Permittees if the remedy set forth in Section V.2 above fails to be protective of human health and the environment.

The 2005 Class 3 Permit Modification also requires the Permittees to prepare a report every five years, reevaluating the feasibility of excavating the MWL contents and analyzing the continued effectiveness of the MWL remedy. NMED determined the first five-year period will begin upon NMED approval of this LTMMP (Kieling October 2011). Additional information regarding the Five-Year Reevaluation reporting requirements is provided in Section 4.8.2.

1.4 Implementation Requirements

This section describes the roles of the Permittees relative to implementing this LTMMP; regulatory requirements for maintaining, inspecting, and monitoring the MWL; future land use requirements; and the process to change or amend this LTMMP.

1.4.1 Roles of the Owner and Operator

DOE is the facility owner and National Technology & Engineering Solutions of Sandia, LLC is the facility operator for hazardous waste management and corrective action, in accordance with 20.4.1.900 NMAC incorporating 40 CFR 270. The Owner and Operator (the Permittees) are responsible for implementation of and proposing revisions to the LTMMP.

The monitoring and maintenance activities and requirements are based on an annual reporting period. The Permittees are responsible for preparation and submittal to NMED of an annual long-term monitoring and maintenance report for each annual reporting period, as detailed in Section 4.8.1. In addition, the Permittees are responsible for the preparation and submittal of a Five-Year Reevaluation Report as described in the Final Order and Section 4.8.2.

1.4.2 Regulatory Requirements for Solid Waste Management Units

The Permittees will maintain the final remedy at the MWL as described in Chapters 3 and 4 of this LTMMP and summarized as follows:

- Maintain the integrity and effectiveness of the ET Cover, including making repairs, as necessary, to correct the effects of settling, subsidence, erosion, or other events
- Operate and maintain the monitoring systems described in Sections 3.4 and 3.5 of this LTMMP, and comply with all other applicable requirements as detailed in Chapters 3.0 and 4.0
- Prevent run-on and runoff from eroding or otherwise damaging the ET Cover
- Protect and maintain survey monuments

1.4.3 Security Requirements

The Permittees will comply with all security requirements as specified in Section 4.5 of this LTMMP.

1.4.4 Inspection and Monitoring

The Permittees will inspect and record the results of each inspection performed of the ET Cover, monitoring networks, sampling/monitoring equipment, and physical controls at the MWL in accordance with the Inspection and Maintenance/Repair Schedule described in Section 4.6 of this LTMMP.

DOE/Sandia shall perform all monitoring following the procedures and requirements described in Chapter 3.0 and the Sampling and Analysis Plans (SAPs) of this LTMMP.

1.4.5 Future Land Use Requirements

DOE/Sandia will not allow any use of the MWL that will disturb the integrity of the ET Cover or the function of the unit's monitoring systems during the long-term monitoring period.

1.4.6 LTMMP Revision

The Permittees will request permit modification(s) to authorize change(s) as needed in response to MWL events and conditions, including changes in monitoring and maintenance requirements. Requests will be made in accordance with applicable requirements of 20.4.1.901 NMAC incorporating 40 CFR 270.42, and will include a copy of the proposed amended portions of this LTMMP for approval by NMED.

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2.0 FINAL SITE CONDITIONS

This chapter presents general information on the MWL, including current site conditions with the ET Cover and 2008 groundwater monitoring network in place. The current site conditions and conceptual site model provide the context for long-term monitoring and maintenance activities and are based upon more than 20 years of groundwater monitoring, extensive site investigations, and corrective action implementation.

2.1 Location, Conditions, and Description of the MWL

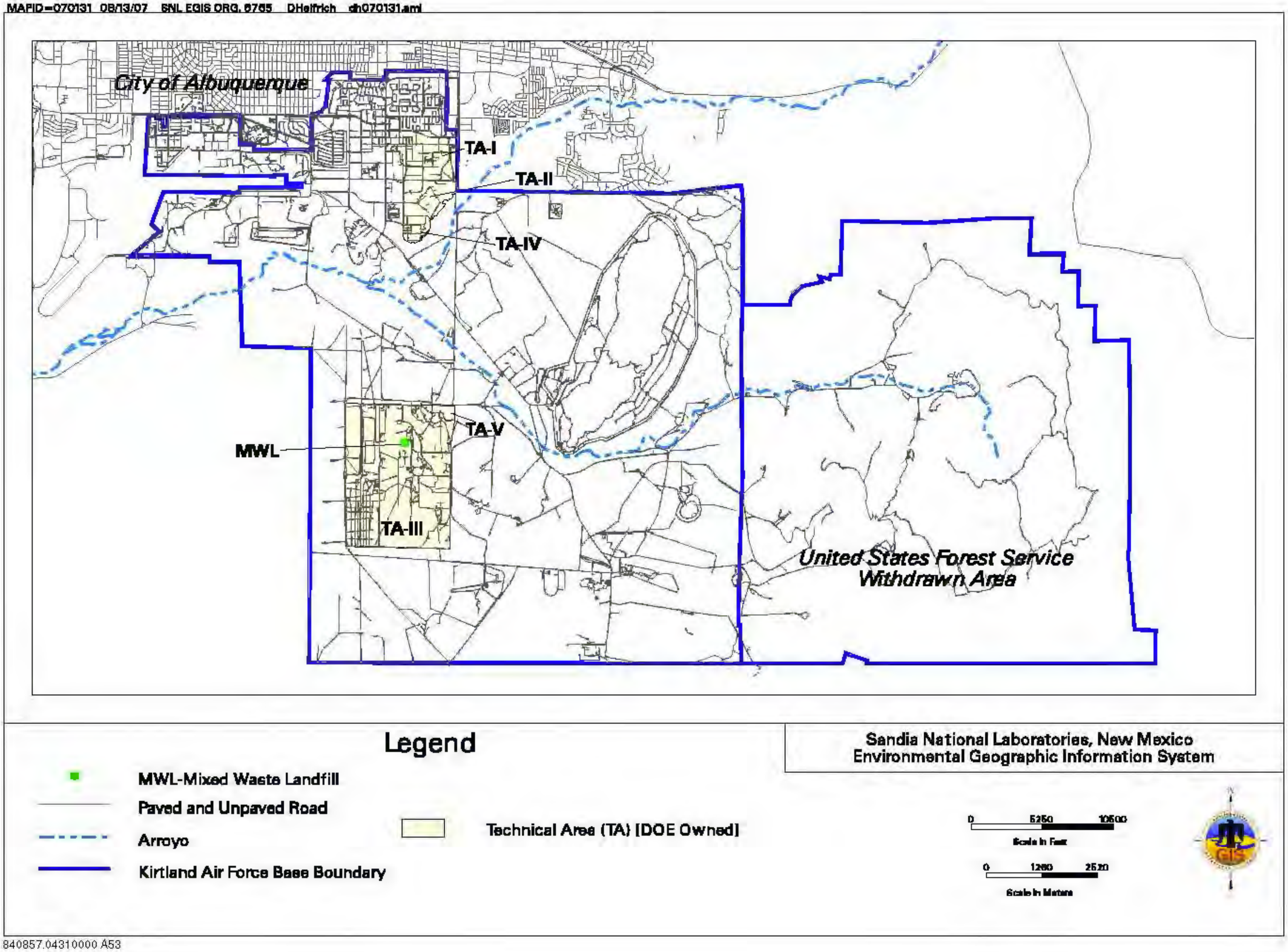
This section presents a brief history of the disposal activities at the MWL and summarizes the results of the two RCRA facility investigations (RFIs) conducted at the site. Groundwater flow conditions and the MWL monitoring well network are also discussed, and surface features are summarized. The toluene investigation (conducted in 2009 through 2010) and the CMI Report documenting ET Cover construction in accordance with the CMI Plan are also summarized. Additional MWL characterization data and ET Cover deployment information are available in the following documents:

- Report of the Phase 1 RFI of the Mixed Waste Landfill (SNL/NM September 1990)
- Report of the Mixed Waste Landfill Phase 2 RFI (SNL/NM September 1996)
- Mixed Waste Landfill Groundwater Report, 1990 through 2001 (Goering et al. December 2002)
- Mixed Waste Landfill Annual Groundwater Monitoring Report, Calendar Year 2009 (SNL/NM June 2010)
- Mixed Waste Landfill Toluene Investigation Report (SNL/NM October 2010)
- Mixed Waste Landfill CMI Report (SNL/NM January 2010, Revision 1)

2.1.1 Location and Description

SNL/NM is located within the boundaries of Kirtland Air Force Base (KAFB), immediately south of the City of Albuquerque in Bernalillo County, New Mexico (Figure 2.1.1-1). The MWL is located 4 miles south of SNL/NM's central facilities and 5 miles southeast of Albuquerque International Sunport. The MWL is located in the north-central portion of Technical Area (TA)-III at SNL/NM (Figure 2.1.1-2).

The MWL disposal area comprises 2.6 acres and accepted containerized and uncontainerized low-level radioactive waste and minor amounts of mixed waste from SNL/NM research facilities and off-site DOE and U.S. Department of Defense generators from March 1959 to December 1988.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City of Albuquerque
TA-I
TA-II
TA-IV
TA-V
MWL
TA-III
United States Forest Service
Withdrawn Area
Legend
MWL-Mixed Waste Landfill
Paved and Unpaved Road
Arroyo
Kirtland Air Force Base Boundary
Technical Area (TA) [DOE Owned]
Sandia National Laboratories, New Mexico
Environmental Geographic Information System
840857.04310000 A53

Figure 2.1.1-1

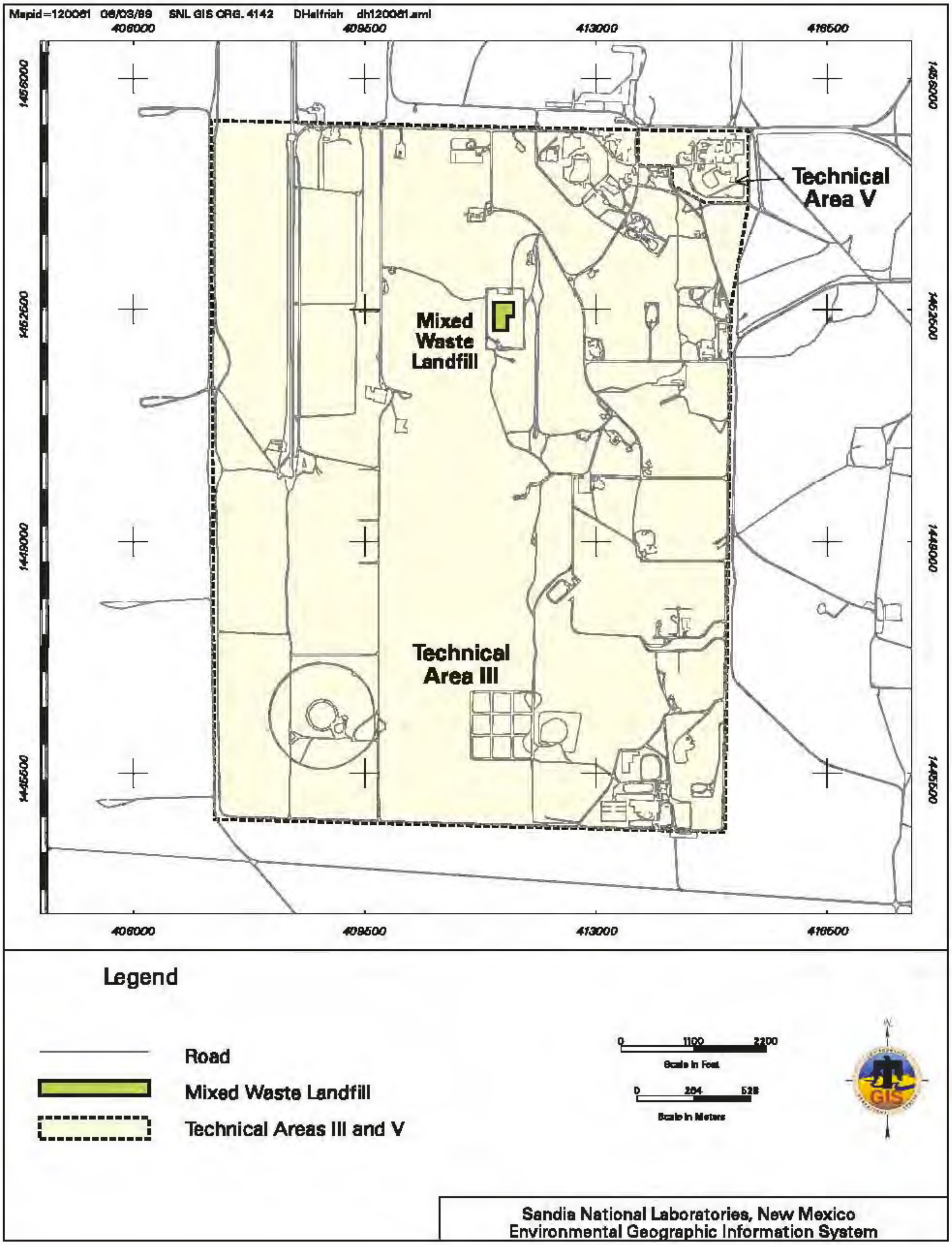

Figure 2.1.1-2
Location of the Mixed Waste Landfill within Technical Area III

Approximately 100,000 cubic feet (3,700 cubic yards) of low-level radioactive waste (excluding packaging, containers, demolition and construction debris, and contaminated soil) containing an estimated 6,300 curies (Ci) of activity (at the time of disposal) were disposed of at the MWL. Disposal cells (i.e., pits and trenches) at the MWL are unlined and were backfilled and compacted to grade with stockpiled soil.

Two distinct disposal areas are present at the MWL: the classified area (occupying 0.6 acres) and the unclassified area (occupying 2.0 acres) (Figure 2.1.1-3). Wastes in the classified area were disposed of in a series of vertical, cylindrical pits. Historical records indicate that early pits were 3 to 5 feet in diameter and 15 feet deep; later pits were 10 feet in diameter and 25 feet deep. Once pits were filled with waste, they were backfilled with soil and capped with concrete. Wastes in the unclassified area were disposed of in a series of parallel, north-south–trending trenches. Records indicate that trenches were 15 to 25 feet wide, 150 to 180 feet long, and 15 to 20 feet deep. Trenches were backfilled with soil on a quarterly basis and, once filled with waste, were capped with the original soil that had been excavated and locally stockpiled.

Containment and disposal of routine waste commonly occurred using tied, double-polyethylene bags, sealed A/N cans (military ordnance metal containers of various sizes), fiberboard drums, wooden crates, cardboard boxes, and 55-gallon steel and polyethylene drums. Larger items, such as glove boxes, spent fuel shipping casks, and contaminated soil, were disposed of in bulk without containment. Disposal of free liquids was not allowed at the MWL, except for the 1967 disposal of 204,000 gallons of reactor coolant water in Trench D. Liquids such as acids, bases, and solvents were solidified with commercially available agents before containerization and disposal. A detailed MWL waste inventory, by pit and trench, is provided in the Environmental Restoration (ER) Operations (formerly ER Project) “Responses to NMED Technical Comments on the Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation Dated September 1996” (SNL/NM June 1998).

A Phase 1 RFI was conducted in 1989 and 1990 to determine whether a release of RCRA contaminants had occurred at the MWL (SNL/NM September 1990). A Phase 2 RFI was conducted from 1992 to 1995 to determine the contaminant source, define the nature and extent of contamination, identify potential contaminant transport pathways, evaluate potential risks posed by the levels of contamination identified, and provide remedial action alternatives for the MWL (SNL/NM September 1996).

Both investigations revealed that tritium has migrated from the pits and trenches of the MWL. Tritium was detected during the Phase 2 RFI in surface and near-surface soil in and around the classified area of the MWL at levels ranging from 1,100 picocuries (pCi) per gram (g) in surface soil to 206 pCi/g in subsurface soil. The highest tritium levels were within 30 feet below ground surface (bgs) in soil adjacent to and directly beneath the classified area disposal pits. At distances greater than 30 feet bgs, tritium levels decreased rapidly in soil. Tritium was detected to a maximum depth of 120 feet bgs beneath the MWL. Tritium also occurs as a diffuse air emission from the MWL. A study conducted in 2003 estimated the annual tritium flux from soil to air to be 0.09 Ci per year (yr) (URS Corporation February 2004).

2.1.2 Groundwater

Groundwater occurs approximately 500 feet bgs within the Santa Fe Group deposits (basin fill) in either fine-grained alluvial fan deposits or coarse-grained Ancestral Rio Grande deposits. The

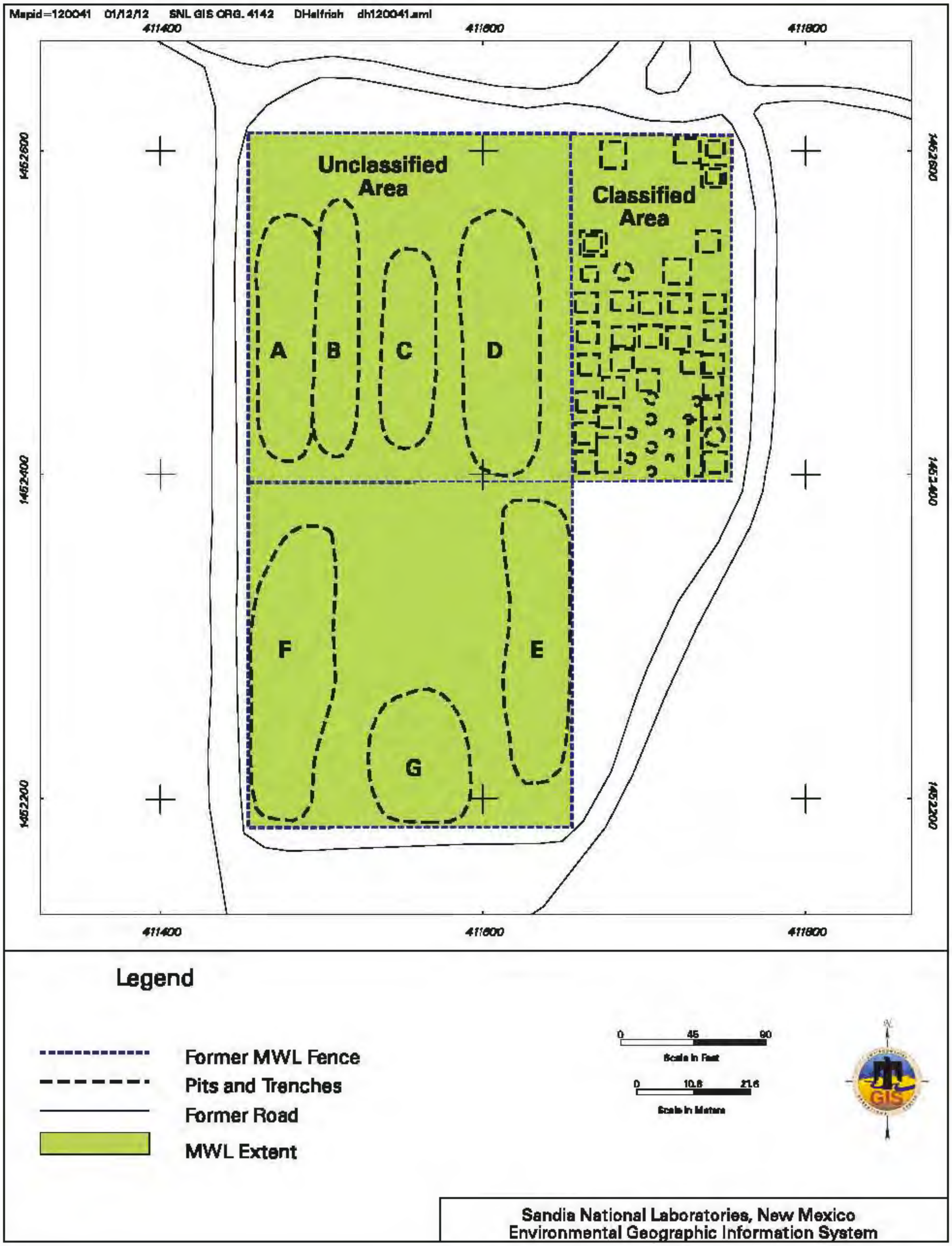

Figure 2.1.1-3
Map of the Mixed Waste Landfill Disposal Areas

upper surface of the regional aquifer occurs in the alluvial fan deposits, which are finer-grained and overlie the coarser-grained Ancestral Rio Grande deposits. A detailed analysis of the regional aquifer is presented the "MWL Groundwater Report, 1990 through 2001" (Goering et al. December 2002); a brief summary is provided as follows.

Hydraulic conductivities average 1.64×10^{-2} feet per day (ft/day) in the alluvial fan deposits and 1.81 ft/day in the Ancestral Rio Grande deposits. Groundwater flows westward at an average velocity of 0.17 feet per year (ft/yr) in the alluvial fan deposits and 18.5 ft/yr in the Ancestral Rio Grande deposits. Although the upper surface of the regional aquifer is within alluvial fan deposits, the majority of the groundwater occurs in the underlying, coarser grained, and more productive Ancestral Rio Grande deposits. Figure 2.1.2-1 shows the potentiometric surface of the regional aquifer west of the Sandia fault complex. Figure 2.1.2-2 shows the localized potentiometric surface of aquifer at the MWL. Groundwater levels beneath the MWL declined at an average rate of approximately 0.5 ft/yr as a result of ongoing large-scale removal of water by the City of Albuquerque and KAFB from production wells through 2007. The nearest production well, KAFB-4, is located 3 miles north of the MWL. From 1990 through 2001 the average rate of decline based on all wells at the MWL was 0.77 ft/yr, and total water level decline was approximately 7 feet. A strong vertical downward gradient exists in the regional aquifer beneath the MWL due to regional pumping and the declining aquifer surface.

Due to the declining water level, the original groundwater monitoring well network (MWL-BW1, MWL-MW1, MWL-MW2, and MWL-MW3) installed in 1988 and 1989 was replaced, and four new wells were installed in 2008 (MWL-BW2, MWL-MW7, MWL-MW8, and MWL-MW9). The completion intervals of the four 2008 wells are deeper, with the well screens across the uppermost part of the regional aquifer. The aquifer hydraulic conductivity values based upon slug test results performed in the 2008 wells, range from 1.95×10^{-1} to 1.48×10^{-2} ft/day, with an average of 8.58×10^{-2} ft/day. The hydraulic conductivity for the 2008 wells is generally higher than that for the original MWL groundwater monitoring wells, indicating an increase in hydraulic conductivity with depth and proximity to the highly conductive Ancestral Rio Grande deposits.

Water levels were lower than expected in the 2008 monitoring wells relative to the water levels in the older wells. The lower groundwater elevations in MWL-MW7 through MWL-MW9 appear to be related to the following two major factors:

- Variation in hydraulic conductivity in the upper part of the regional groundwater system (showing increasing hydraulic conductivity with depth)

- Ongoing large-scale removal of water by the City of Albuquerque and KAFB, which has created a strong downward vertical gradient at the MWL

The completion intervals of the new wells are deeper and within a higher hydraulic conductivity layer than the shallower wells they replaced (MWL-BW1, MWL-MW1, MWL-MW2, and MWL-MW3). Thus, the vertical gradient and drawdown of the regional aquifer have greater impact in the new wells, resulting in a lower groundwater elevation relative to the previous monitoring well network.

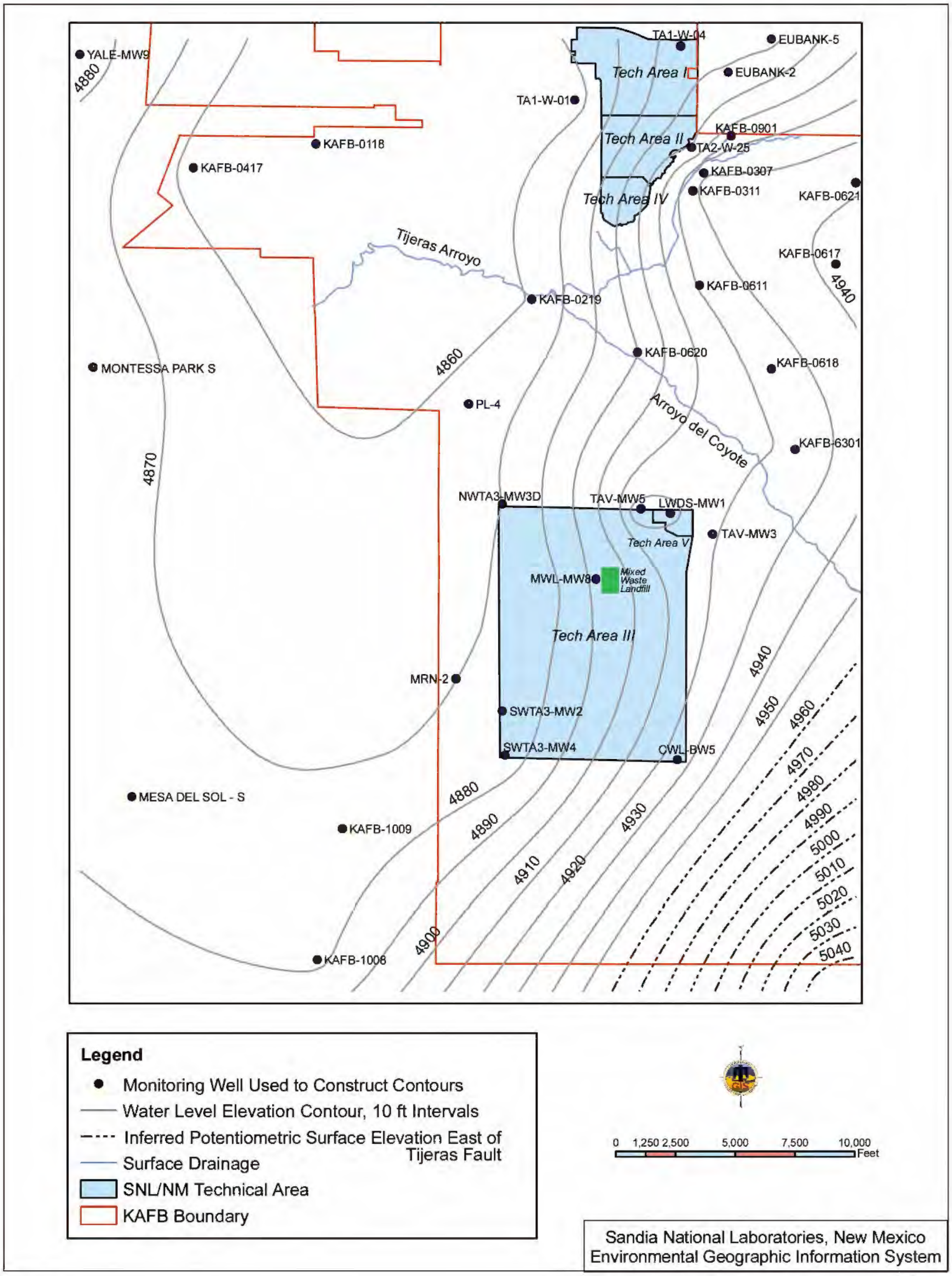

Figure modified from the *Annual Groundwater Monitoring Report, Calendar Year 2010* (SNL/NM September 2011)

Figure 2.1.2-1
Potentiometric Surface of the Regional Aquifer near the Mixed Waste Landfill, October 2010

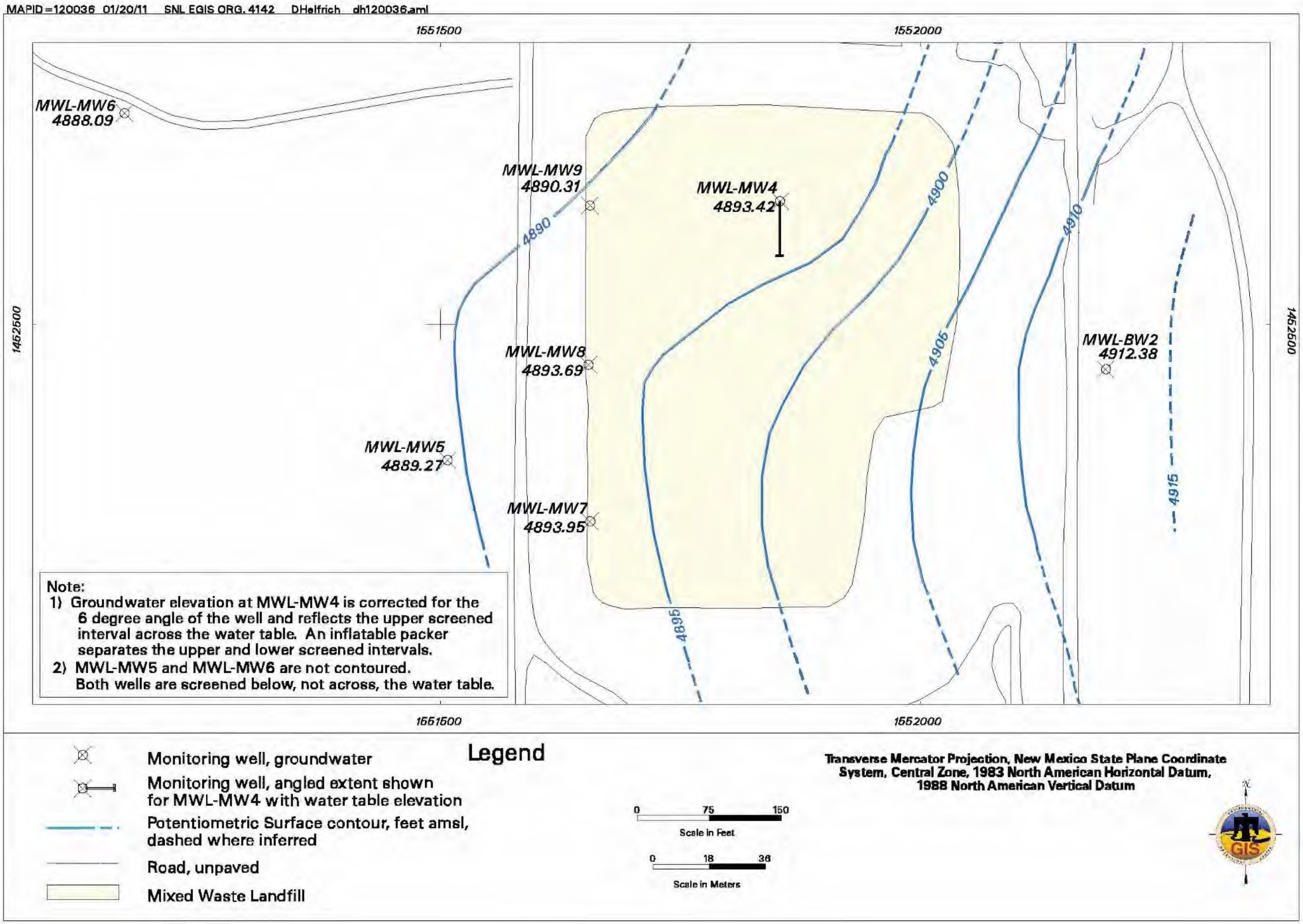

Figure 2.1.2-2
Localized Potentiometric Surface of Basin Fill Aquifer at the Mixed Waste Landfill, October 2011

A more detailed explanation of the lower water levels in the 2008 monitoring wells, the hydraulic conductivity of the uppermost part of the regional aquifer, and an update to the MWL hydrogeologic conceptual model presented in the "Mixed Waste Landfill Groundwater Report, 1990 through 2001" (Goering et al. December 2002) is included in the NMED-approved "Mixed Waste Landfill Annual Groundwater Monitoring Report, Calendar Year 2009" (SNL/NM June 2010).

2.1.3 Surface Features

No permanent aboveground structures are located at the MWL. All disposal pits and trenches were excavated below grade. No perennial streams are present in the immediate area of the MWL. Surface runoff is regionally controlled and generally to the west. The MWL ET Cover slopes gently and sheds surface-water runoff to the site perimeter. An engineered drainage swale located immediately east, north, and south of the ET Cover diverts surface run-on and runoff around the ET Cover to the west. Figure 2.1.3-1 presents the current topography of the ET Cover and immediate vicinity of the MWL, as well as the location of the engineered drainage swale along the eastern, northern, and southern perimeter of the ET Cover.

2.2 Description of the Engineered Cover

The MWL ET Cover was constructed from May through September 2009 and consists of four main layers: compacted subgrade, biointrusion barrier, compacted native soil, and topsoil. The Subgrade varies in thickness from 0 to 3.3 feet, and the combined average thickness of the overlying ET Cover layers (Biointrusion, Native Soil, and Topsoil Layers) is 5.37 feet. The overall footprint of the ET Cover is 4.1 acres including side slopes. The ET Cover was constructed with approximately 33,000 cubic yards of soil fill and 6,800 cubic yards of rock (in-place, compacted volumes) that meet the CMI Plan specifications (SNL/NM November 2005) based upon 113 laboratory tests (Standard Proctor, Gradation, Classification, and Saturated Hydraulic Conductivity), 271 field tests (in-place density and moisture), and visual inspections. All MWL ET Cover construction activities were observed, inspected, and documented by an independent third-party construction quality assurance contractor. The ET Cover construction is detailed in the MWL CMI Report (SNL/NM January 2010, Revision 1). A schematic cross-section of the cover is shown in Figure 2.2-1.

The Topsoil Layer was seeded with native grasses to mitigate surface erosion and promote evapotranspiration. The native grass species were selected based upon biological assessments of TA-III (Sullivan and Knight 1992, Peace et al. November 2004), and consist of black grama, spike dropseed, galleta grass, and ring muhly. This plant community was designed to approximate the dominant and subdominant species in TA-III and is expected to develop into a climax community indistinguishable from the surrounding TA-III natural community.

During MWL ET Cover construction in early August 2009, two single-port soil-vapor monitoring wells (MWL-SV01 and MWL-SV02) were installed as required by NMED (Bearzi December 2008). The location, depth, and construction of the two monitoring wells were selected and

Figure 2.1.3-1
Mixed Waste Landfill Final ET Cover Grading Plan

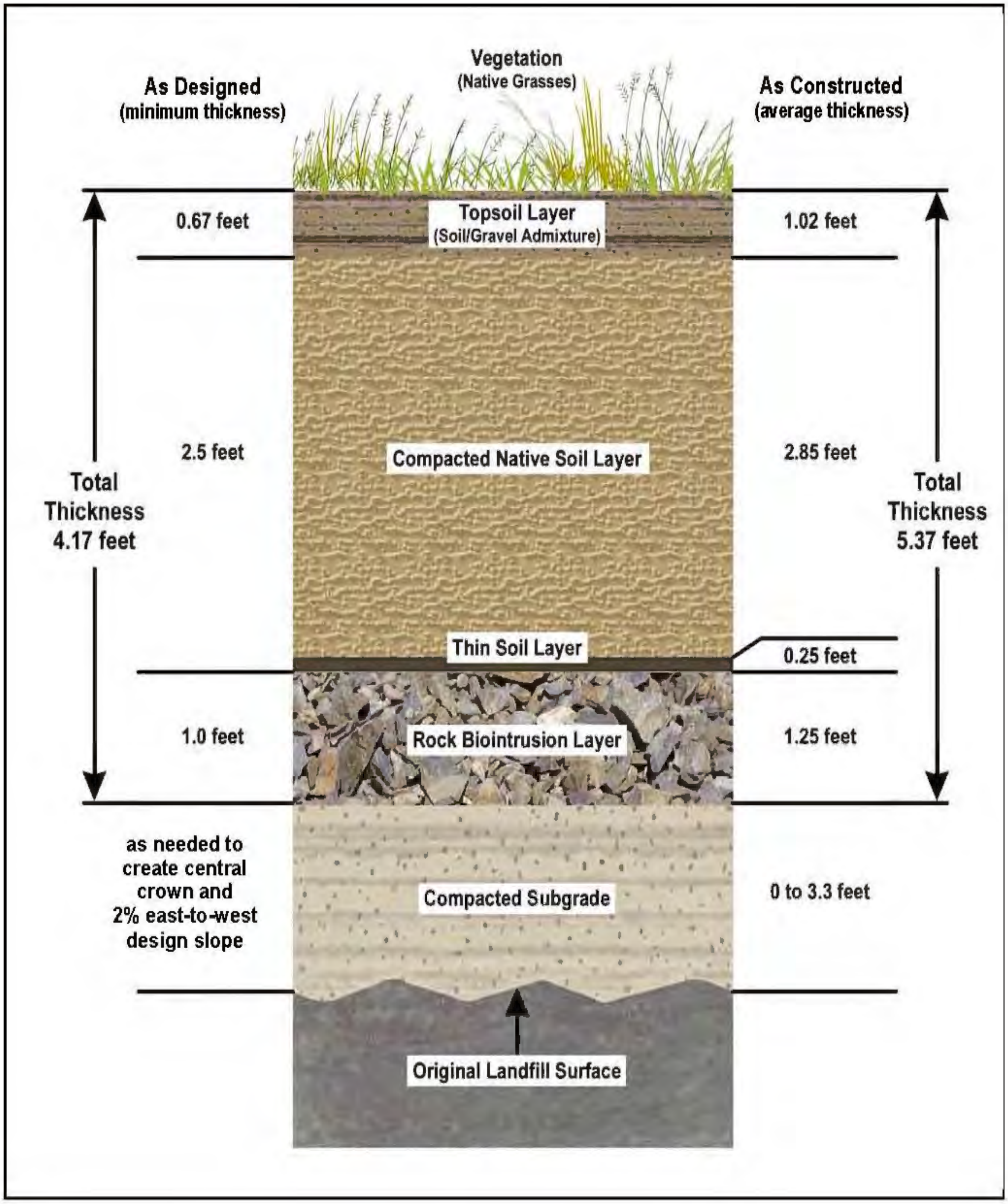

Figure 2.2-1
Schematic Profile of the Mixed Waste Landfill ET Cover Layers

approved by NMED prior to installation as documented in the Installation Report presented in Appendix A. These wells were installed during the construction of the ET Cover but prior to placement of the Topsoil Layer to minimize the impact of drilling and installation activities on the ET Cover.

Additional details for the MWL ET Cover construction are presented in the NMED-approved MWL CMI Report (SNL/NM January 2010, Revision 1). The CMI Report includes a summary of the MWL cover construction activities, as-built drawings and specifications, a photographic log, and the construction quality assurance report.

Since completion of the MWL ET Cover, supplemental watering and cover maintenance activities have been performed to promote the growth and establishment of seeded native grasses, control and remove undesirable invasive annual species (i.e., weeds), and complete minor cover repairs. Supplemental watering and cover maintenance activities performed from 2009 through 2011 are summarized in Appendix B.

2.3 Storm-Water Diversion Structures

Surface drainage features designed to control surface-water run-on and runoff are shown in the MWL Final Grading Plan (Figure No. 2, 2009 Alternative Cover As-Built Drawings, Construction Quality Assurance Report, Appendix A of the CMI Report [SNL/NM January 2010, Revision 1]).

The primary storm-water diversion structure incorporated into the MWL remedy is a continuous drainage swale along the eastern, northern, and southern perimeter of the ET Cover, shown in Figure 2.1.3-1. This feature diverts storm-water run-on around the northern and southern ends of the ET Cover where the water then travels west, preventing erosion of the cover. The aboveground profile; vegetated, gently sloping cover surface topography (2-percent grade from east to west); broad central crown; 6:1 side slopes; and eastern boundary drainage swale prevent storm-water run-on to the ET Cover. Surface water originating from the ET Cover is controlled by the gentle, vegetated slopes (cover surface and side slopes) and diverted towards the perimeter swale (eastern, northern, and southern sides) or western perimeter of the ET Cover, away from the MWL.

3.0 MONITORING ACTIVITIES AND FREQUENCIES

This section describes all monitoring activities to be conducted at the MWL as part of the LTMMP. The activities include monitoring of air, surface soil, vadose zone, groundwater, and biota. Monitoring methods, frequencies, analytical parameters, and EPA Test Methods (EPA November 1986) are also presented.

3.1 Introduction

The primary objective of the monitoring activities at the MWL is to ensure that the final remedy and site conditions are protective of human health and the environment. Long-term monitoring of the air, surface soil, vadose zone, groundwater, and biota will be conducted at the MWL for the foreseeable future. Air will be monitored for radon; surface soil will be monitored for tritium, metals, and gamma-emitting radionuclides; the vadose zone will be monitored for volatile organic compounds (VOCs) and moisture; groundwater will be monitored for VOCs, specific metals, and radionuclides (tritium, gamma-emitting radionuclides, and gross alpha/beta activity); and vegetation will be monitored for gamma-emitting radionuclides.

Although monitoring is planned for radionuclides in various media at the MWL, the information related to radionuclides is provided voluntarily by the Permittees. The voluntary inclusion of such radionuclide information shall not be enforceable and shall not constitute the basis for any enforcement because such information falls wholly outside the requirements imposed by NMED, as specified in Section III.A of the Consent Order (NMED April 2004).

A summary of the long-term monitoring program, including information on the frequency, parameters, and monitoring methods, is presented in Table 3.1-1. The media-specific monitoring activities and more detailed information on analytical methods are presented in Sections 3.2 through 3.6. The SAPs and Monitoring Plans (MPs) for each type of monitoring are provided in Appendices C through G.

Changes to sampling parameters, monitoring frequencies, or other aspects of the long-term monitoring program may be warranted as trends are established and additional data needs are identified. If changes to the monitoring program are warranted, the Permittees will submit a permit modification request in writing to NMED. More information regarding revising this LTMMP is provided in Section 1.4.6.

3.2 Air Monitoring

Air monitoring for radon shall be conducted at the MWL along the perimeter and at select locations on the ET Cover. This section discusses the rationale and approach for radon air monitoring, and why air monitoring for tritium and other radionuclides will not be performed.

Table 3.1-1
Summary of Long-Term Monitoring Parameters, Frequencies, and Methods
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Sampling Media	Monitoring Parameters[a]/ Constituents of Concern	Monitoring Frequency[a]	Number of Samples Per Event	Locations	Monitoring Method	Comments
Air	Radon	Year 1 – Quarterly Year 2 – Quarterly Year 3 – Semiannual Year 4 – Semiannual Year 5 and subsequent years – Annual	17	10 detectors placed at corners and midpoints of perimeter fence 5 detectors placed on completed cover 2 detectors at background locations (TBD)	Radon detectors (at breathing level) capable of long exposure periods; sampling and analysis per Appendix C	Samples are time-weighted average and will be collected over a 3-month to 1-year monitoring period.
Surface Soil	Tritium	Annual	4	One sample collected from each corner of the MWL ET Cover.	Grab samples of soil collected; moisture extracted and analyzed for tritium using liquid scintillation	Samples will continue to be collected from the original MWL ground surface at the four corners of the ET Cover.
Vadose Zone	VOCs in soil vapor	Year 1 – Semiannual Year 2 – Semiannual Year 3 – Semiannual Year 4 and subsequent years – Annual	17	Samples collected from 3 perimeter multi-port FLUTe™ or equivalent wells (5 sampling ports per well) and 2 single-port soil-vapor monitoring points installed through the ET Cover	Sampling and analysis per Appendix D (Compendium Method TO-15 or equivalent). Table 3.4.1-1 presents list of analytes	The 3 multiport FLUTe™ wells or equivalent are proposed and located at the MWL perimeter. Sampling ports planned for depths of 50, 100, 200, 300, and 400 ft bgs. The 2 single-port soil-vapor monitoring points have a sampling port approximately 35 ft below the original ground surface.
Vadose Zone	Moisture content underneath the ET Cover	Year 1 – Semiannual Year 2 – Semiannual Year 3 and subsequent years – Annual	171	3 soil-moisture monitoring access tubes Measurements obtained at 1-ft increments from 4 ft to 25 ft bgs, then 5-ft increments to total depth of the access tube (200 linear ft)	Soil-moisture monitoring per Appendix E	Moisture content in vadose zone beneath the cover is measured using a neutron probe to evaluate moisture infiltration through the ET Cover.

Refer to footnotes at end of table.

Table 3.1-1 (Concluded)
Summary of Long-Term Monitoring Parameters, Frequencies, and Methods
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Sampling Media	Monitoring Parameters[a]/ Constituents of Concern	Monitoring Frequency[a]	Number of Samples Per Event	Locations	Monitoring Method	Comments
Groundwater	VOCs, metals, tritium, radon, gamma-emitting radionuclides (short list), and gross alpha/beta activity	Semiannual	4	MWL compliance groundwater monitoring well network: MWL-BW2, MWL-MW7, MWL-MW8, and MWL-MW9	Sampling and Analysis per Appendix F. Table 3.5.4-1 lists specific analytes and EPA Methods[b]	Monitoring wells MWL–MW4, MWL-MW5, and MWL-MW6 will be retained for information only.
Biota – Surface Soil	RCRA Metals plus Cu, Ni, V, Zn, Co, and Be; and gamma-emitting radionuclides (short list)	Annual	Up to 4 (2 each, if they exist)	Variable - ant hills and animal burrows on the MWL ET Cover located during ET Cover inspections, if present	Grab sampling and analysis of surface soil at animal burrow and/or ant hill feature per Appendix G	Soil sampling will be performed in August or September to evaluate potential for mobilization of contaminants by biota. If no features are identified, no samples will be collected.
Biota – Cover Vegetation	Gamma-emitting radionuclides (short list) in vegetation	Annual	Up to 2 if they exist	Variable - potentially deep-rooted vegetation overlying former disposal areas located during ET Cover inspections, if present	Grab sampling and analysis of vegetation, including the plant and root system per Appendix G	Vegetation sampling will be performed in August or September to evaluate potential for mobilization of contaminants by plants. If no potentially deep-rooted plants are present, no samples will be collected.

[a]Monitoring parameters and frequency will be reevaluated every five years in the Five-Year Reevaluation Report, and a permit modification will be requested, as necessary.
[b]EPA November 1986.

bgs = Below ground surface.
EPA = U.S. Environmental Protection Agency.
ET = Evapotranspirative.
FLUTe™ = Flexible Liner Underground Technologies.
ft = Foot (feet).
MWL = Mixed Waste Landfill.
RCRA = Resource Conservation and Recovery Act.
TBD = To be determined.
TO-15 = EPA Method TO-15 (EPA January 1999).
VOC = Volatile organic compound.

3.2.1 Radon

The MWL fate and transport model predicts no potential for release of radon-222 into the atmosphere in excess of regulatory standards, as long as the sealed sources containing radium-226 within the MWL inventory remain intact (Ho et al. January 2007). This modeling prediction is consistent with the results from two studies conducted in 1997 and 2008 to measure radon surface flux from the MWL (Haaker January 1998, ERG April 2008). Both studies, which involved placement of 4-inch-diameter activated charcoal radon canisters across the MWL surface, evaluated radon surface fluxes in the vicinity of the MWL and at background locations. The results showed that the radon fluxes above the MWL are not significantly different from background values. A comparison of the 1997 and 2008 results shows that radon emissions for the MWL and background areas have not changed significantly from 1997 to 2008 (SNL/NM August 2008). The median radon flux in the vicinity of the MWL was 0.33 pCi per square meter (m^2) per second (s), while the median background flux was 0.35 pCi/m^2/s in 1997 (Haaker January 1998). In April 2008 the average flux recorded for the MWL was 0.33 pCi/m^2/s, which is below the background mean of 0.60 pCi/m^2/s. The maximum measured fluxes for the MWL were 1.02 pCi/m^2/s in 1997 and 0.43 pCi/m^2/s in 2008.

The MWL fate and transport model also predicts that if the sealed sources containing radium-226 degrade over time, a potential exists for radon to be emitted to the atmosphere at concentrations that exceed regulatory standards. For this reason, radon monitoring over a long exposure period, three months to one year, will be conducted to determine whether significant quantities of radon are being emitted from the MWL surface. Commercially available detectors capable of long exposure monitoring, such as alpha track (also referred to as track-etch), electret ion chamber, or equivalent long exposure detectors, will be used to obtain long-term average concentrations. These detectors will provide an integrated average concentration of radon in air over long exposure periods. Other alternative monitoring detectors, such as charcoal canisters, are useful for only short exposure periods, on the order of a few days.

Radon monitoring locations within the MWL boundary were selected based upon the MWL inventory (SNL/NM June 1998), and Table 3.2.1-1 lists pits and trenches containing radium-226. Figure 3.2.1-1 shows the relative locations of these pits and trenches within the MWL. As Table 3.2.1-1 indicates, four of the MWL pits contain millicurie quantities of radium-226 (a potential source for radon at the MWL). Because these pits contain the highest concentrations of radium-226, radon emissions from these pits would have the greatest potential to exceed the regulatory standard, should the sealed sources degrade over time. For this reason, these pits will be monitored for radon emissions.

The fifth radon sampling point within the MWL boundary will be located over Trench D, where a damaged radium-226 source was disposed. The exact location of the source in Trench D is unknown. The detector will be placed above the middle of the trench.

Figure 3.2.1-2 shows the radon sampling locations. All detectors will be placed on posts approximately 3 to 5 feet above the ground surface. Ten detectors (RN1 through RN10) will be placed on the MWL perimeter fence, five detectors (RN11 through RN15) will be placed at locations within the MWL boundary above pits and trenches with radium-226 sealed sources, and two detectors (RN16 and RN17) will be placed at locations within TA-III away from the MWL to characterize background radon concentrations.

Table 3.2.1-1
Pits and Trenches Containing Radium-226 at the Mixed Waste Landfill
Sandia National Laboratories, New Mexico

Location	Ra-226 Quantity (mCi)	MWL Inventory Listing[a]
Trench D	Unknown	Damaged Ra-226 source in plastic holder
Pit 33	250	Ten 25-mCi Ra-226 sources encapsulated in concrete-filled 55-gallon drums
Pit 31	4.01	One 10-µCi Ra-226 ionostat; one 4-mCi Ra-226/Be source
Pit 16	3.12	Two nonfunctional 1.5-mCi Ra-226 ionization alphatron gauges encapsulated in a concrete-filled A/N can; twenty 5-µCi Ra-226/Be sources in lead container encapsulated in concrete-filled, A/N can; two 10-µCi Ra-226/Be sources in lead container encapsulated in a concrete-filled, 5-gallon A/N can
Pit 24	1.5	Three 500-µCi Ra-226 sources
Pit 32	<1.0	Ra-226, Na-22, Ba-133, Co-60, Co-57, Mo-54, and mixed isotopes (1.0 mCi) in lead pig
Pit 26	0.86	Four 10-µCi Ra-226/Be sources in a lead container encapsulated in concrete-filled, 55-gallon drum; five sealed 160-µCi Ra-226 sources; two sealed 10-µCi Ra-226 check sources; eighteen 1.8-µCi Ra-226 ionization alphatron gauges encapsulated in concrete-filled, 32-gallon A/N can
Pit 17	0.5	One 0.5-mCi Ra-226/Be source
Pit 13	0.1103	One 98-µCi Ra-226 source, one 1.3-µCi Ra-226 source, two 5-µCi Ra-226 sources, and one 1-µCi Ra-226 source encapsulated in concrete-filled A/N can
Pit 15	0.107	One 102.1-µCi Ra-226/Be source and one 5.5-µCi source encapsulated in a concrete-filled, 55-gallon drum; fume hood filters; and filter housings
Trench C	0.1	One 0.1-mCi Ra-226/Be source encapsulated in concrete-filled A/N can
Pit 18	0.07	Seven 10-µCi Ra-226/Be sources in a lead container encapsulated in concrete-filled, 55-gallon drum
Pit 25	0.0516	One 11.6-µCi Ra-226 dew pointer in brass cylinder; four 10-µCi Ra-226/Be sources in a lead container encapsulated in concrete-filled, 55-gallon drum

[a]SNL/NM June 1998.
µCi = Microcurie(s).
mCi = Millicurie(s).
MWL = Mixed Waste Landfill.

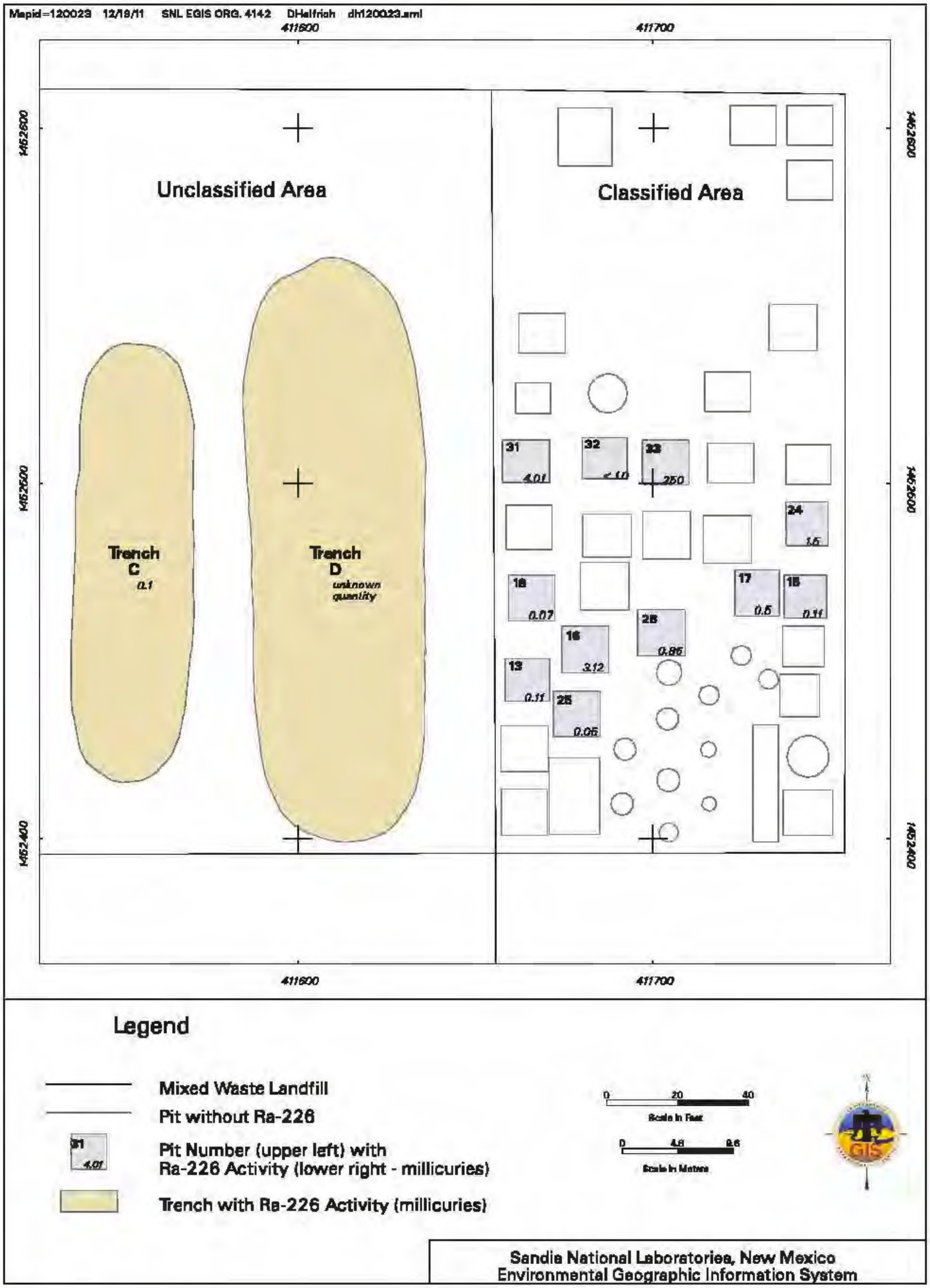

Figure 3.2.1-1
Pits and Trenches Containing Radium-226 at the Mixed Waste Landfill

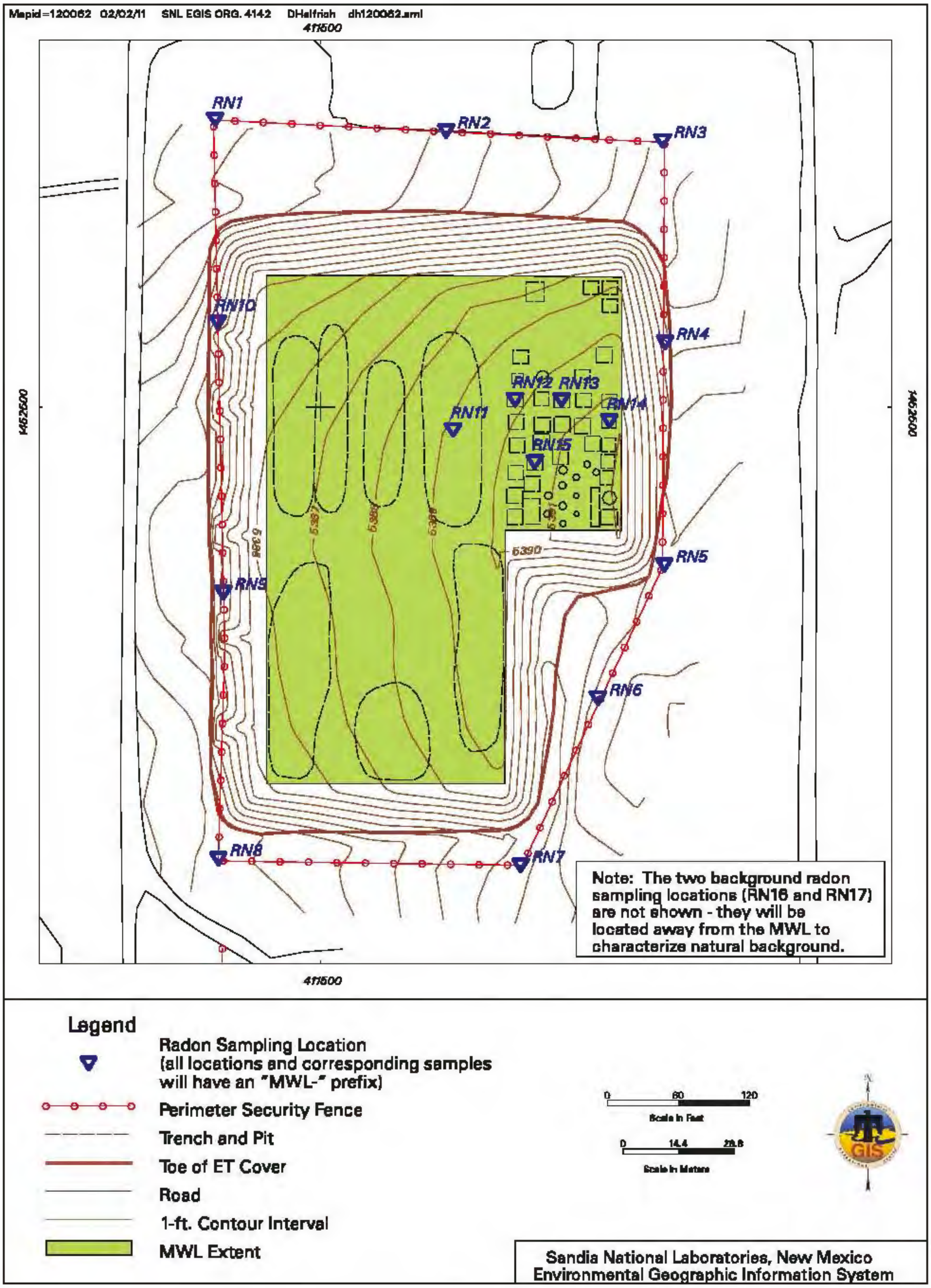

Figure 3.2.1-2
Radon Sampling Locations at the Mixed Waste Landfill

Radon gas alpha-track detectors have a radiosensitive element that records alpha particle emissions (alpha tracks) from the natural radioactive decay of radon. For electret ion chamber detectors, the ionization resulting from the decay of radon and its progeny reduces the voltage on the electret, which is an electrostatically charged disk. The number of alpha tracks or voltage reduction along with the long exposure period provides the basis for calculating the average radon concentration. The resulting data are reported in pCi of radon per liter (L) of air. An equivalent detector would function in a similar manner, providing radon air concentration over a long exposure time (i.e., three months to one year).

The frequency for voluntary radon monitoring is detailed in Table 3.1-1. Results will be compiled and compared with the trigger level in the annual MWL long-term monitoring and maintenance report. The trigger level and evaluation process for radon in air are discussed in Section 5.2.1, and additional details for the radon monitoring are presented in Appendix C, "Air Sampling and Analysis Plan for the Mixed Waste Landfill."

3.2.2 Tritium and Other Radionuclides

Air monitoring for tritium and radionuclides other than radon will not be conducted due to the significant decline in tritium emissions from the MWL over the last decade, as well as the lack of a reasonable transport scenario to the atmosphere for other radionuclides. Although the MWL is a diffuse source for tritium to the environment, studies conducted during 1992, 1993, and 2003 reveal that tritium concentrations released to the atmosphere are at low levels and do not pose a threat to human health or the environment (Radian Corporation September 1992, November 1992, and 1994; URS Corporation February 2004). These studies indicate that, as expected, tritium concentrations released from the MWL to the atmosphere declined significantly during the 10-year period from 1993 to 2003. The estimated tritium emitted from the MWL to the atmosphere in 1993 was 0.486 Ci/yr, while the estimated tritium emitted from the MWL in 2003 was 0.090 Ci/yr. This significant reduction reflects the natural radioactive decay of tritium and its relatively short half-life of 12.3 years. Because tritium levels in the MWL inventory will continue to decline due to radioactive decay, concentrations released to the atmosphere will also continue to decline.

The maximum predicted dose to an exposed site worker and an off-site worker was orders of magnitude below regulatory limits in 1993 (Phase 2 RFI; SNL/NM September 1996) and even lower in 2003. Because it is highly unlikely that tritium could be released from the MWL to the atmosphere above regulatory limits, long-term monitoring of tritium in air at the MWL will not be conducted.

Similarly, there is no reasonable scenario for the transport of other radionuclides from the MWL to the air pathway. Tritium is the primary radionuclide disposed of at the MWL with the potential to move through vapor transport upward into the atmosphere. The remaining radionuclides within the MWL inventory are relatively immobile and are buried under 3 feet or more of backfill, up to 3.3 feet of subgrade soil, and on average another 5.37 feet of rock and soil (Biointrusion, Native Soil, and Topsoil Layers). Because no reasonable scenario exists for the potential transport of radionuclide contaminants upward through the ET Cover and into the atmosphere, no air monitoring for other radionuclides will be performed at the MWL.

3.3 Tritium Surface Soil Monitoring

Surface soil monitoring will be performed for tritium, which is the primary constituent of concern based upon the MWL Phase 2 RFI (SNL/NM September 1996) and the most mobile radionuclide disposed of at the MWL. Surface soil samples for metals and radionuclides will be collected at animal burrows and/or ant hills to address potential mobilization of contaminants by biota and are discussed in Section 3.6.

The SNL/NM Terrestrial Surveillance Program has monitored concentrations of tritium and gamma-emitting radionuclides in surface soil at the MWL on an annual basis since 1985. As part of the SNL/NM Terrestrial Surveillance Program, soil samples are collected annually at the four corners of the MWL (outside the former perimeter fence) and analyzed for tritium and gamma-emitting radionuclides using liquid scintillation and gamma spectroscopy, respectively. As the ET Cover Subgrade Layer (2006) and later the ET Cover (2009) were completed, the soil sampling locations were moved laterally to the corners of the toe of the slope so the samples could be collected from the original ground surface. Starting in 2010, the tritium surface soil samples have been collected at the four corners of the ET Cover side slopes; these locations will continue to be used for long-term tritium monitoring (Figure 3.3-1). Tritium is routinely detected in soil samples, with the highest concentrations most often detected at the northeastern corner of the MWL at location TS-2NE. These concentrations have been diminishing with time due to natural radioactive decay of tritium. During the 2008 MWL soil-vapor investigation, tritium soil samples were collected from the subsurface in the immediate vicinity of the disposal areas. These samples had significantly higher tritium activities than the surface samples collected by the Terrestrial Surveillance Program (SNL/NM August 2008). The conservative risk assessment performed as part of the 2008 investigation used the maximum activity of tritium detected and assumed it was on the surface of the MWL. The risk assessment calculations show that tritium activities at the MWL do not pose a threat to human health or the environment (SNL/NM August 2008).

The Permittees will continue to sample surface soil at the four corners of the MWL (Figure 3.3-1) on an annual basis to allow long-term data trending in accordance with the MWL Tritium and Biota SAP presented in Appendix G. The locations represent the closest available points to the original MWL corners where the original land surface can be sampled without disturbing the ET Cover. Tritium is very mobile and should a significant release of tritium from the subsurface occur, increased tritium would be detected in soil samples during the annual sampling events. Results will be compiled and compared with the trigger level in the annual MWL long-term monitoring and maintenance report. The trigger level and evaluation process for tritium in surface soil are discussed in Section 5.2.2.

3.4 Vadose Zone Soil-Vapor and Soil-Moisture Monitoring

The vadose zone beneath the MWL extends nearly 500 feet from ground surface to groundwater. Because VOCs released from the MWL have the potential to migrate via the soil-vapor phase to groundwater (Ho et al. January 2007), a monitoring system is planned for the vadose zone at the MWL to serve as an early detection system for protecting groundwater. This system will provide timely evidence of potential threats to groundwater and will allow corrective action to be initiated before groundwater contamination occurs.

Long-term monitoring of the vadose zone is planned for both soil vapor (VOCs) and moisture content to provide assurance that the MWL site conditions remain protective of human health

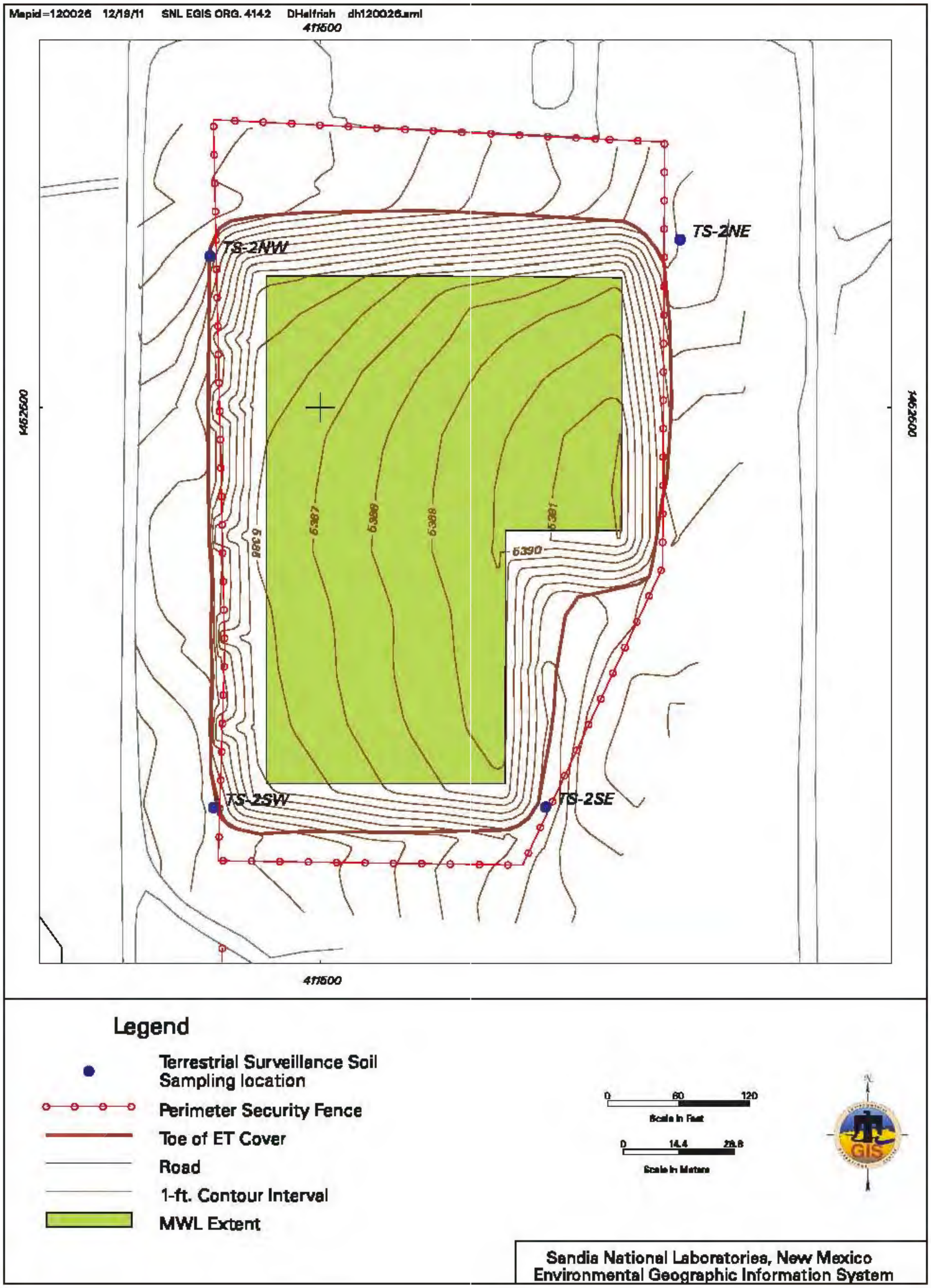

Figure 3.3-1
Soil Sampling Locations for Tritium at the Mixed Waste Landfill

and the environment. The details of the monitoring systems for VOCs and moisture content are presented in the following sections.

3.4.1 Vadose Zone Soil-Vapor Monitoring for VOCs

VOCs are the most mobile of the hazardous constituents detected in the soil beneath the MWL. During the MWL Phase 2 RFI, two passive and three active soil-gas surveys at the MWL showed the presence of low concentrations of VOCs in soil gas (soil vapor) (SNL/NM September 1996). Low concentrations of VOCs were also detected in subsurface soil samples collected from boreholes drilled during the MWL Phase 2 RFI (SNL/NM September 1996). More recently (2008) a second soil-vapor survey was conducted to determine whether the survey data collected during the 1990s were still representative of site conditions. The 2008 soil-vapor survey results show that, in general, vadose zone VOC concentrations have decreased since 1994 (SNL/NM August 2008).

VOC concentrations in the vadose zone will be monitored using two existing single-port soil-vapor monitoring wells installed through the MWL ET Cover and three proposed Flexible Liner Underground Technologies (FLUTe™) or equivalent multi-port soil-vapor monitoring wells (hereinafter referred to as FLUTe™ or equivalent wells). The three multi-port FLUTe™ or equivalent wells will provide VOC concentration data at various depths beneath the MWL, whereas the single-port soil-vapor monitoring wells will monitor VOC concentrations immediately beneath the disposal areas. Together these five soil-vapor monitoring wells will provide a robust monitoring system to characterize VOC soil-vapor concentrations throughout the thick vadose zone beneath the MWL and provide an early detection system for the protection of groundwater from the downward movement of the most mobile contaminants.

In early August 2009, during MWL ET Cover construction, two single-port soil-vapor monitoring wells (MWL-SV01 and MWL-SV02) were installed as required by NMED (Bearzi December 2008). The location, depth, and construction of the two monitoring wells were selected and approved by NMED prior to installation as documented in the Installation Report presented in Appendix A. The wells were installed with a Geoprobe Systems® direct-push drilling rig and include polyethylene tubing connected to a single, 6-inch-long by ½-inch-diameter, stainless steel screen (i.e., sampling port). The locations of MWL-SV01 and MWL-SV02 were selected based upon the highest VOC soil-vapor detections identified during the 1994 and 2008 subsurface soil-vapor surveys. The depth of the sampling ports is approximately 35 feet below the original surface of the MWL and 10 feet below the bottoms of the waste trenches and pits. These wells were installed immediately after placement of the topsoil layer, but prior to tilling, seeding, and mulching this layer, to minimize the impact of drilling and installation activities on the ET Cover.

The FLUTe™ wells were constructed in vertical boreholes located immediately outside the perimeter of the ET Cover in July 2014 near locations where the highest concentrations of VOCs have been detected during earlier studies at the MWL. Soil-vapor sampling ports were installed in each FLUTe™ well at depths of 50, 100, 200, 300, and 400 feet bgs. Figure 3.4.1-1 shows the existing locations of the two single-port soil-vapor monitoring wells (MWL-SV01 and MWL-SV02) and the locations of the three FLUTe™ wells (MWL-SV03, MWL-SV04, and MWL-SV05).

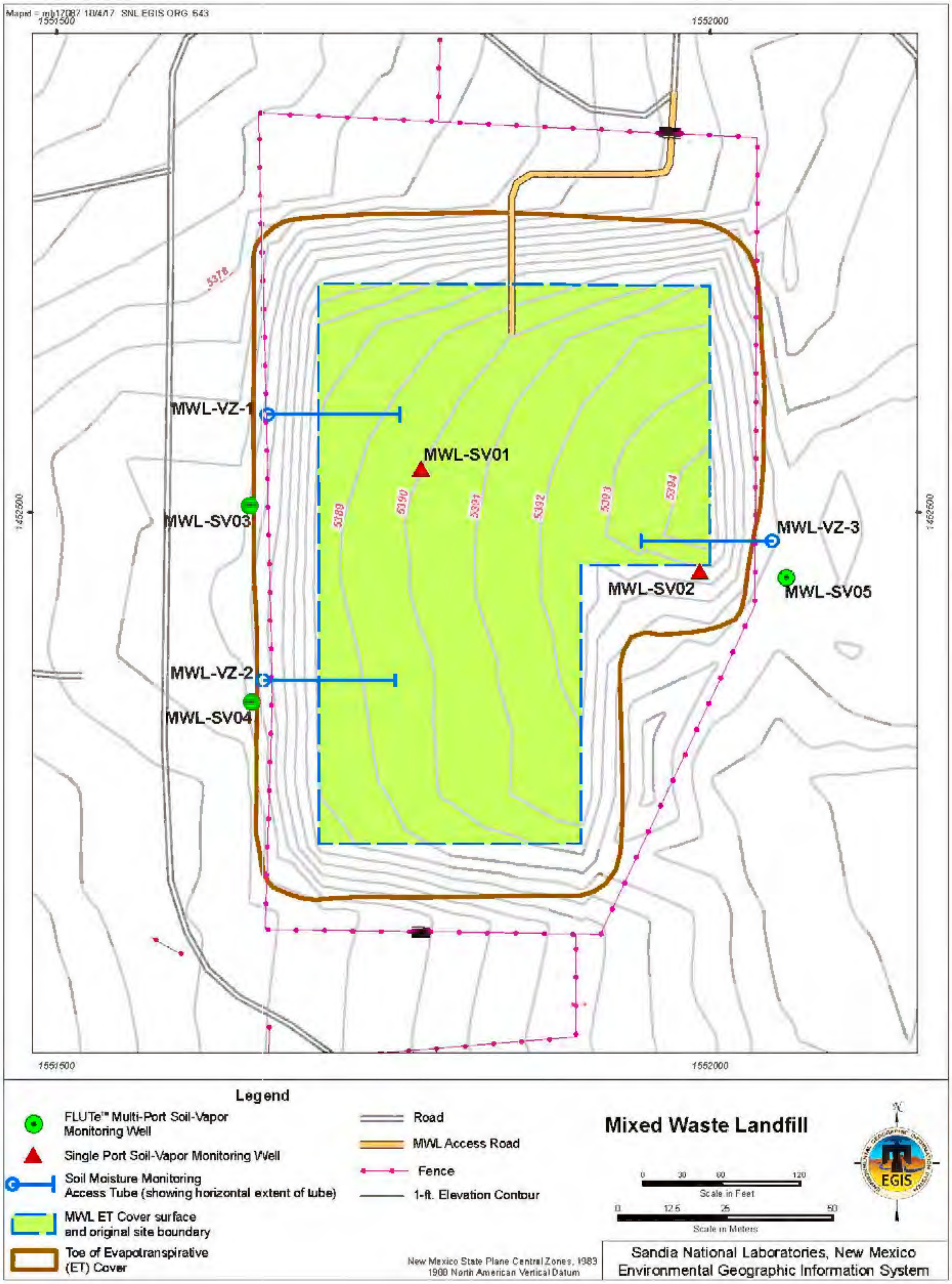

Figure 3.4.1-1
Soil-Vapor Monitoring Well and Soil-Moisture Monitoring Access Tube Locations at the Mixed Waste Landfill

Data collected from the soil-vapor monitoring well network will be used to assess VOC distributions with depth and to monitor VOC concentrations over time. Soil-vapor samples will be collected and analyzed for the VOCs listed in Table 3.4.1-1 according to EPA Compendium Method TO-15 (EPA January 1999) or equivalent semiannually for the first three years and may transition to annually thereafter. This approach allows for early identification of potential threats to groundwater from the most mobile MWL constituents of concern (i.e., VOCs).

Table 3.4.1-1
Mixed Waste Landfill Soil-Vapor Monitoring Analyte List[a]

Compound	Compound
Acetone	1,2-Dichloropropane
Benzene	cis-1,3-Dichloropropene
Benzyl chloride	trans-1,3-Dichloropropene
Bromodichloromethane	Ethyl benzene
Bromoform	4-Ethyltoluene
Bromomethane	Hexachlorobutadiene
2-Butanone	2-Hexanone
Carbon disulfide	Methylene chloride
Carbon tetrachloride	4-Methyl-2-pentanone
Chlorobenzene	Styrene
Chloroethane	1,1,2,2-Tetrachloroethane
Chloroform	Tetrachloroethene
Chloromethane	Toluene
Dibromochloromethane	1,1,2-Trichloro-1,2,2-trifluoroethane
1,2-Dibromoethane	1,2,4-Trichlorobenzene
1,2-Dichloro-1,1,2,2-tetrafluoroethane	1,1,1-Trichloroethane
1,2-Dichlorobenzene	1,1,2-Trichloroethane
1,3-Dichlorobenzene	Trichloroethene
1,4-Dichlorobenzene	Trichlorofluoromethane
Dichlorodifluoromethane	1,2,4-Trimethylbenzene
1,1-Dichloroethane	1,3,5-Trimethylbenzene
1,2-Dichloroethane	Vinyl acetate
1,1-Dichloroethene	Vinyl chloride
cis-1,2-Dichloroethene	m-, p-Xylene
trans-1,2-Dichloroethene	o-Xylene

[a]EPA Method TO-14 analyte list that was used for the 1994 and 2008 Soil-Vapor Surveys (SNL/NM August 2008).
EPA = U.S. Environmental Protection Agency.

The results will be compiled and compared with the trigger levels in the annual MWL long-term monitoring and maintenance report. The annual report will also present summary data tables listing trichloroethene (TCE), tetrachloroethene (PCE), and total VOC results, organized by well and port, and laboratory data sheets providing all TO-15 or equivalent results. After the first three years of semiannual monitoring are completed, concentration versus time graphs will be presented. The trigger levels and evaluation process for VOCs in the vadose zone are discussed in Section 5.2.3. The Soil-Vapor SAP for the MWL is presented in Appendix D.

3.4.2 Soil-Moisture Monitoring

A soil-moisture monitoring system has been installed beneath the MWL and consists of three soil moisture access tubes drilled at a 30-degree angle (from vertical) directly below waste disposal cells. Using this system, infiltration through the cover shall be monitored in the vadose zone beneath the MWL. The monitoring system functions as an early detection system, providing infiltration and cover performance information.

In August 2003, three angled, 4.5-inch-outside-diameter, 3.75-inch-inside-diameter steel access tubes were installed in the shallow vadose zone directly beneath the MWL, two angled eastward and one angled westward (Figure 3.4.1-1). The access tubes (MWL-VZ-1 through MWL-VZ-3) are located at the outer edge of the ET Cover to provide optimal coverage beneath the MWL without compromising the integrity of the cover. The tubes are spaced at equal increments in a north-south direction, with the east access tube (MWL-VZ-3) halfway between the two west access tubes (MWL-VZ-1 and MWL-VZ-2). The tubes were installed using the Resonant Sonic drilling technique. Resonant Sonic is the preferred drilling technique for this application because it fluidizes and displaces the surrounding soil as the drill string advances, creating a very tight fit between the drill string and the formation.

Each access tube is completed at the toe of the ET Cover side slopes. Each borehole was drilled 200 linear feet at 30 degrees to a true vertical depth of 173 feet (Figure 3.4.2-1). Each tube remains open to the vadose zone at the bottom, and a protective cover constructed of steel pipe extends approximately 2 feet bgs and 3 feet aboveground. Each protective cover is fitted with a locking cap. A 3- by-3-foot concrete pad has been constructed around each protective cover to prevent preferential flow down the annulus, and protective bollards have been placed at the outer corners of each concrete pad.

Moisture content with depth shall be monitored using a neutron probe, a technique developed in the 1950s that provides an efficient and reliable method for monitoring soil moisture. The neutron probe consists of a source of fast (energized) neutrons, a detector of slow (thermalized) neutrons, and an electronic gauge to monitor the flux of slow neutrons scattered by the soil. The probe is lowered into the access tube, and the emitted neutrons interact with soil water surrounding the tube and are detected by the instrument. Because energized neutrons can easily travel through steel, the steel access tube is essentially invisible to the neutrons, allowing direct measurement of moisture in the surrounding soil.

Moisture content shall be measured semiannually for the first two years and annually thereafter using neutron logging. The data will be compared to baseline moisture content data collected prior to deployment of the ET Cover. This method allows cover performance to be assessed without compromising the integrity of the ET Cover. A significant increase in moisture content beneath the MWL may indicate that the ET Cover is not performing as originally designed and that infiltration through the cover is greater than originally predicted. Moisture content data will be evaluated to ensure that the performance objective of infiltration through the ET Cover is less than the EPA-prescribed technical equivalence criteria of 10^{-7} centimeters (cm)/s (equivalent to 31.5 millimeters [mm]/yr). Results will be presented in soil moisture versus depth graphs and compared with the trigger level in the annual MWL long-term monitoring and maintenance report. The trigger level and evaluation process for soil moisture in the shallow vadose zone are discussed in Section 5.2.3.2, and Appendix E presents the MWL Soil-Moisture MP.

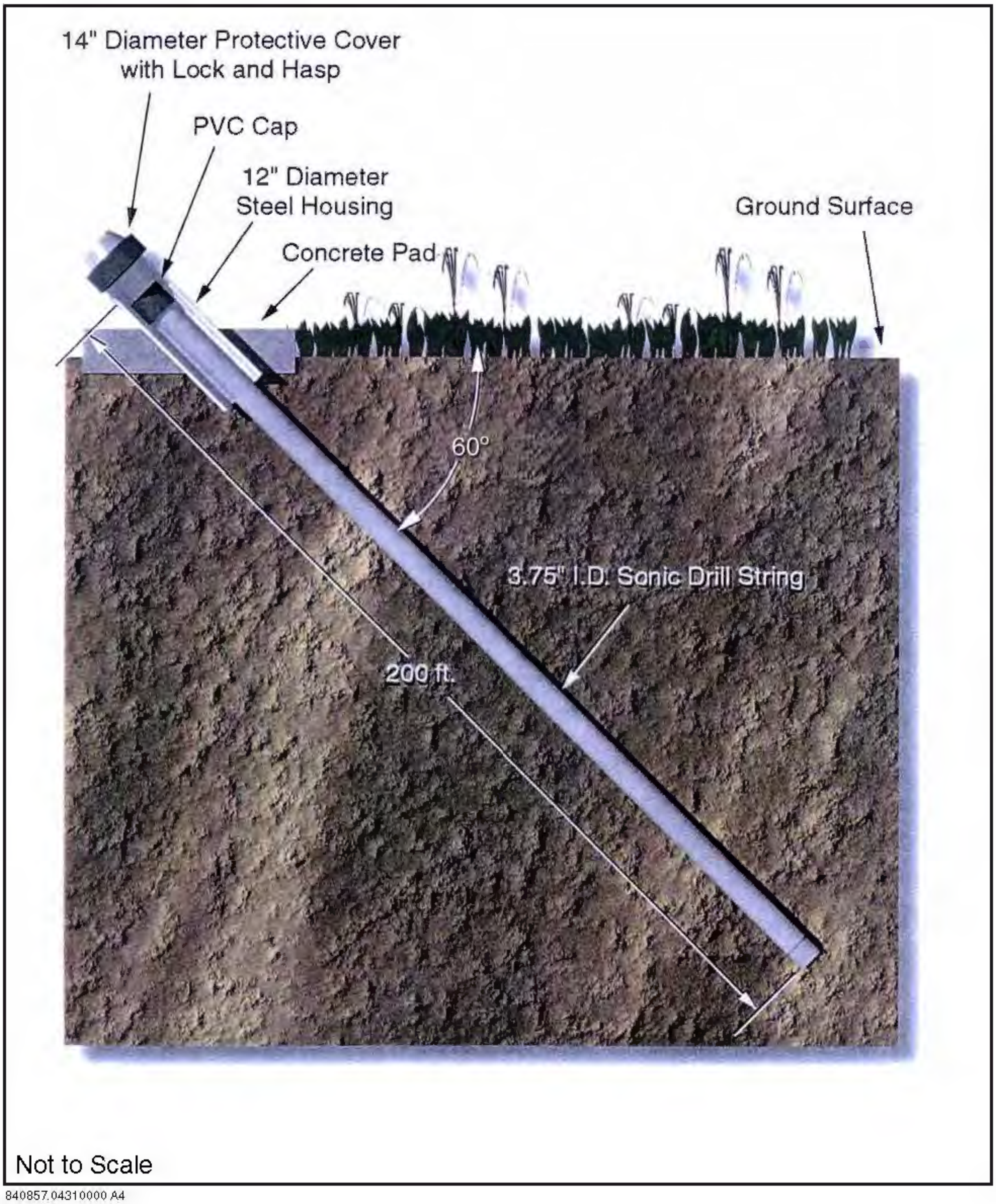

Figure 3.4.2-1
Soil-Moisture Monitoring Access Tube, Mixed Waste Landfill

3.5 Groundwater Monitoring

Since 1990, groundwater in the area of the MWL has been extensively characterized for major ion chemistry, VOCs, semivolatile organic compounds, nitrate, metals, radionuclides, and perchlorate. Data collected indicate that groundwater has not been contaminated by releases from the MWL (Goering et al. December 2002; SNL/NM November 2001, January 2002, April 2002, July 2002, October 2002, April 2003, September 2003, April 2004; Lyon and Goering April 2005; SNL/NM November 2006, January 2008, May 2009, June 2010, and September 2011). The following sections present information on the MWL groundwater monitoring network, plug and abandonment (P&A), well replacement, and monitoring parameters and frequency.

3.5.1 MWL Monitoring Well Network

The MWL groundwater monitoring well network was modified in 2008 (SNL/NM May 2009). Due to declining water levels, four monitoring wells (MWL-BW1, MWL-MW1, MWL-MW2, and MWL-MW3) were plugged and abandoned, and four new monitoring wells (MWL-BW2, MWL-MW7, MWL-MW8, and MWL-MW9) were installed. The monitoring wells and installation reports were approved by NMED (Bearzi October 2008b and January 2009). The MWL monitoring well network (Figure 3.5.1-1) consists of seven wells completed within interfingering, fine-grained alluvial fan deposits and coarse-grained Ancestral Rio Grande deposits (Goering et al. December 2002, SNL/NM June 2010). This network includes one background well (MWL-BW2), one on-site well (MWL-MW4), and five downgradient wells (MWL-MW5, MWL-MW6, MWL-MW7, MWL-MW8, and MWL-MW9). All seven wells are constructed of 5-inch, Schedule 80 polyvinyl chloride (PVC) casing and slotted well screens. Table 3.5.1-1 presents well construction information and recent water levels measured in existing monitoring wells. Well database summary sheets showing monitoring well completion diagrams are presented in Appendix H.

Monitoring well MWL-MW4 was installed in 1993 directly beneath a disposal trench and completed at an angle of 6 degrees from vertical, with two discrete well screen intervals 20 feet apart to evaluate various aquifer parameters with depth. An inflatable packer separates the screened intervals, and pressure is maintained in the packer to prevent the mixing of water from the two screened sections of the aquifer. Monitoring wells MWL-MW5 and MWL-MW6 were installed in 2000 with their respective screen intervals in the Ancestral Rio Grande sediments, below the top of the regional aquifer water table. While these three wells will be retained for information purposes (water levels, water quality parameters, other data as needed), they are not part of the MWL compliance network for long-term groundwater monitoring required analytes.

The long-term groundwater monitoring compliance network consists of the four wells installed in 2008 screened across the uppermost part of the regional aquifer: MWL-BW2 (upgradient background well) and MWL-MW7, MWL-MW8, and MWL-MW9 (downgradient wells). The point-of-compliance is defined as the three downgradient wells (MWL-MW7, MWL-MW8, and MWL-MW9) located along the western MWL boundary at the toe of the ET Cover.

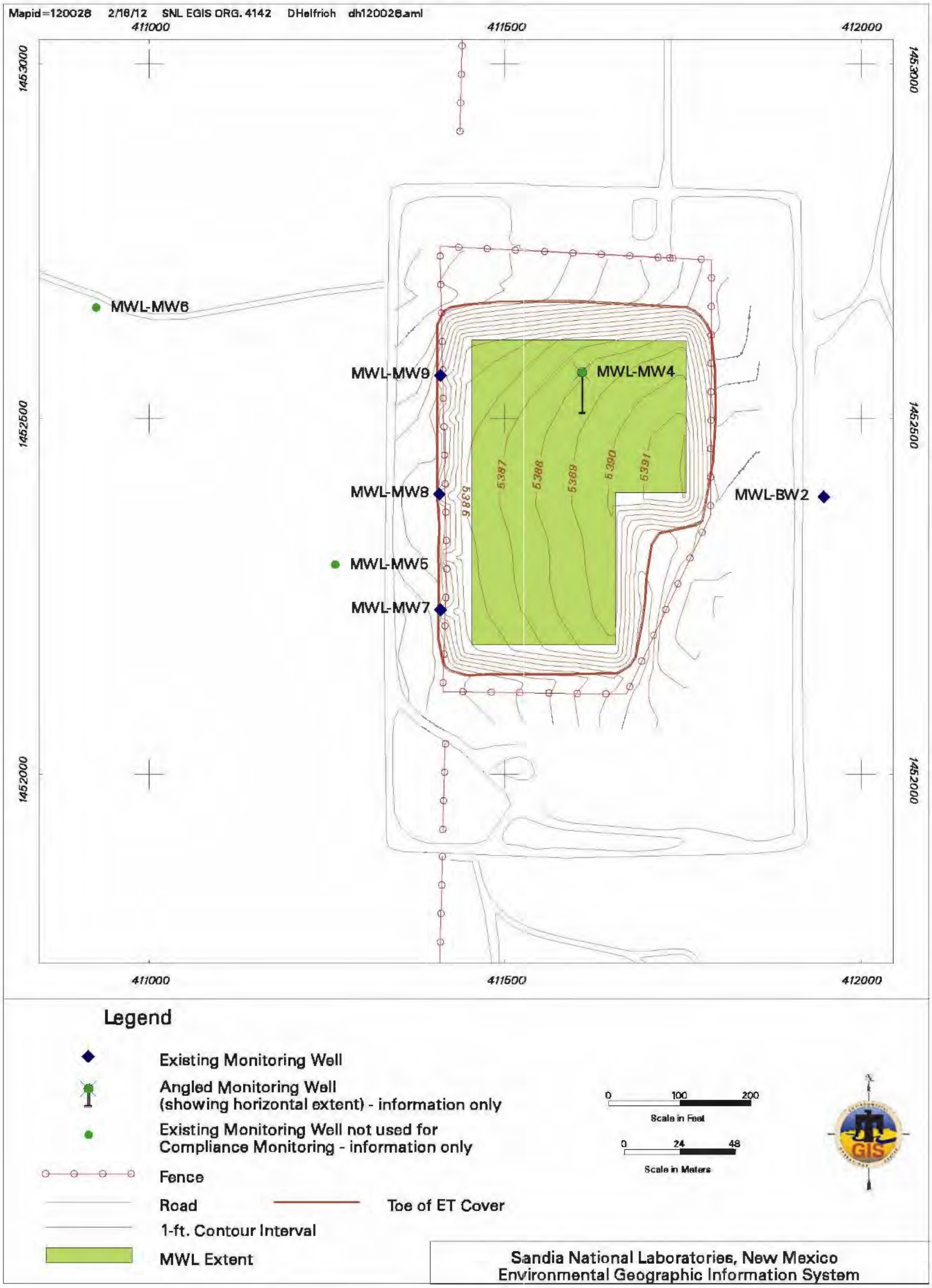

Figure 3.5.1-1
Mixed Waste Landfill Groundwater Monitoring Wells

Table 3.5.1-1
Monitoring Well Construction Details and Recent Water Levels
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Monitoring Well	Top of Inner Casing[a] (FAMSL)	Ground Surface Elevation (FAMSL)	Well Depth (FBGS)	Top of Well Screen (FBGS)	Bottom of Well Screen (FBGS)	Bottom of Well Screen (FAMSL)	October 2011 Measured Depth to Water (FBGS)	October 2011 Water Level (FAMSL)	Screened Lithology	Comments
Compliance Wells										
MWL-BW2	5391.02	5388.70	502.0	467.0	497.0	4891.70	478.64	4912.38	Alluvial Fan	Screen intervals are across the upper surface of the regional aquifer.
MWL-MW7	5383.30	5380.90	498.80	464.7	494.0	4886.90	489.35	4893.95	Alluvial Fan	
MWL-MW8	5384.67	5382.40	500.00	465.0	495.0	4887.40	490.98	4893.69	Alluvial Fan	
MWL-MW9	5381.91	5379.30	500.00	465.0	495.0	4884.30	491.60	4890.31	Alluvial Fan	
Information Only Wells										
MWL-MW4[b] (upper)	5391.70	5390.20	511.09[c]	488.4	508.4	4879.11	501.02	4893.42[d]	Alluvial Fan	Well contains two screens 20 feet apart, hydraulically separated by a pneumatic packer.
MWL-MW4[b] (lower)	5391.70	5390.20	553.9	528.4	548.4	4841.80	NM	NM	Alluvial Fan/ Ancestral Rio Grande	
MWL-MW5	5382.56	5380.40	521.50	496.5	516.5	4863.90	493.29	4889.27	Alluvial Fan/ Ancestral Rio Grande	Screen intervals are below the top of the regional aquifer.
MWL-MW6	5375.31	5372.70	530.50	505.5	525.5	4847.20	487.22	4888.09	Ancestral Rio Grande	

[a]Top of inner casing is the measurement point for the well.
[b]Well MWL-MW4 is screened at two intervals and is angled 6 degrees from vertical. All measurements and elevations not corrected for the 6 degree angle of the borehole except the October 2011 groundwater elevation.
[c]Well depth based on approximate depth (feet below ground surface) to top of the inflatable packer separating the upper and lower screen intervals.
[d]Groundwater elevation for MWL-MW4 is adjusted/corrected for the 6-degree angle of the monitoring well/borehole.
BW = Background well.
FAMSL = Feet above mean sea level.
FBGS = Feet below ground surface.
MW = Monitoring well.
MWL = Mixed Waste Landfill.
NM = Not measured.

3.5.2 Monitoring Well Plugging and Abandonment Guidance

Requirements for monitoring well replacement are presented in the Consent Order (NMED April 2004). MWL monitoring wells will be plugged and abandoned when they are no longer required in the monitoring network, no longer provide representative groundwater samples because of declining water levels or insufficient productivity, or become damaged beyond repair. The goal of well abandonment is to seal the well in such a manner that it cannot act as a conduit for the migration of contaminants from the ground surface to the saturated zone. Well P&A plans will be prepared for any wells that meet these criteria and will be submitted to the NMED for approval as a permit modification. No groundwater monitoring wells at the MWL will be abandoned without prior written approval of the NMED.

3.5.3 Monitoring Well Replacement

Additional wells may be necessary to replace wells that require P&A due to the expected continual decline of regional groundwater levels. Additional monitoring wells will be constructed to the specifications provided in Sections VIII.A and VIII.B of the Consent Order (NMED April 2004).

Replacement wells for long-term monitoring at the MWL will have 30-foot-long PVC screens to maximize the monitoring life of the wells. Replacement wells will comply with the requirements of the Consent Order (NMED April 2004) as well as the guidelines established in EPA guidance, including, but not limited to, the following:

- “RCRA Groundwater Monitoring: Draft Technical Guidance,” EPA/530-R-93-001 (EPA November 1992)

- “RCRA Groundwater Monitoring Technical Enforcement Guidance Document,” OSWER-9950.1 (EPA September 1986)

- “Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells,” EPA 600/4-89/034 (Aller et al. 1991)

3.5.4 Groundwater Monitoring Parameters, Frequency, and Reporting

The long-term groundwater monitoring compliance network comprised of the four wells installed in 2008 (Section 3.5.1) will be sampled semiannually according to the MWL Groundwater SAP presented in Appendix F. The groundwater monitoring analytical requirements and EPA Test Methods (EPA November 1986) are summarized in Table 3.5.4-1. Sampling for the other parameters may be conducted on an as-needed basis to characterize major ion chemistry and determine groundwater characteristics. The Groundwater SAP provides guidance, methods, and analytical protocols for collecting and analyzing groundwater samples during the long-term monitoring period consistent with historical monitoring at the MWL.

Table 3.5.4-1
Groundwater Monitoring Parameters, Test Methods, and Selection Criteria
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Parameter	EPA Method[a]	Monitoring Method
Volatile Organic Compounds	SW846-8260 or Equivalent	Sampling and Analysis per Appendix F
Metals: total uranium, total chromium, cadmium, and nickel	SW846-6020 or Equivalent	
Tritium	EPA 906.0 or Equivalent	
Radon	SM 7500 series	
Gamma Spectroscopy (short list)	EPA 901.1 or Equivalent	
Gross Alpha/Beta Activity	EPA 900.0 or Equivalent	

[a]EPA November 1986.
EPA = U.S. Environmental Protection Agency.
SM = Standard Methods
SW = Solid Waste.

Results will be compiled, presented, and compared with historical results and trigger levels in the annual MWL long-term monitoring and maintenance report. Time versus concentration graphs for specific constituents will be included to show data trends if appropriate. The trigger levels and evaluation process for groundwater are discussed in Section 5.2.4.

In addition to semiannual sampling and analysis, the groundwater surface (i.e., potentiometric surface) elevation, hydraulic gradient, flow direction, and flow rate will be determined annually and included in the annual MWL long-term monitoring and maintenance report.

3.6 Biota Monitoring

Biotic mobilization of contaminants is a potential transport mechanism that will be evaluated as part of the MWL long-term monitoring program. The 1.25-foot-thick Biointrusion Layer of the MWL ET Cover considerably reduces this potential. The intent of the biointrusion rock barrier is to prevent any intrusion by burrowing animals, and it should also restrict plant root growth as long as the underlying materials are relatively dry (Anderson and Forman September 2002). The potential for biotic mobilization of contaminants is also reduced by the compacted Subgrade Layer (2 to 40 inches in thickness) underlying the biointrusion barrier and the overall thickness of the ET Cover (5.37-foot average thickness; Figure 2.2-1).

Biota monitoring will include two sampling and analysis approaches. Sampling of surface soil from animal burrows and ant hills addresses the potential transport of less mobile contaminants (i.e., metals and radionuclides) by biota. Deep-rooted vegetation growing on the MWL also has the potential to uptake contaminants from the subsurface and bring them to the surface. This potential is largely eliminated by the thickness of the ET Cover and the fact that deep-rooted plant species will not be allowed to grow to maturity on the ET Cover as specified by the inspection and maintenance protocol for the ET Cover vegetation (Section 4.2). Both monitoring approaches are described in the following sections, the analytical methods are detailed in Table 3.6-1, and the SAP is presented in Appendix G.

Table 3.6-1
Biota Monitoring Parameters, Test Methods, and Selection Criteria
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Parameter	EPA Method[a]	Monitoring Method
Surface Soil Samples from Animal Burrows and/or Ant Hills		
RCRA metals[b] plus copper, nickel, vanadium, zinc, cobalt, and beryllium	SW846-6020/7470 or Equivalent	Sampling and Analysis per Appendix G
Gamma Spectroscopy (short list)	EPA 901.1 or Equivalent	
Vegetation samples		
Gamma Spectroscopy (short list)	EPA 901.1 or Equivalent	Sampling and Analysis per Appendix G

[a]EPA November 1986.
[b]RCRA metals consist of arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.
EPA = U.S. Environmental Protection Agency.
RCRA = Resource Conservation and Recovery Act.
SW = Solid Waste.

3.6.1 Surface Soil

Features such as animal burrows and ant hills will be noted and described as part of the ET Cover inspection process presented in Section 4.2. If these features are noted during routine inspections, surface soil samples will be collected to evaluate the potential for contaminant mobilization by ant and/or animal activities. Up to two ant hills and two animal burrows will be located, surveyed with a global positioning system (GPS) unit, and sampled annually if they are present. If ant hills and animal burrows are not identified on the ET Cover, this will be documented and no sampling will occur. Grab samples of surface soil will be collected from the burrow entrance and/or ant hill and analyzed for metals and gamma-emitting radionuclides (short list) (Table 3.6-1). Samples will be collected in August or September, near the end of the growing season when biota activity should be high.

Sampling locations will be presented on a site map, and the results will be presented and compared with both NMED-approved background levels for metals and radionuclides (Dinwiddie September 1997) and trigger levels (metals only) in the annual MWL long-term monitoring and maintenance report. The trigger levels and evaluation process for metals in surface soil are discussed in Section 5.2.2.

3.6.2 Vegetation

Although the potential for biotic mobilization of contaminants by deep-rooted vegetation is very low, two samples of vegetation will be collected annually near the end of the active growing season (August or September) if any plants with root systems capable of extending below the ET Cover are present. The assessment of whether any existing plants have roots potentially extending beneath the ET Cover will be performed by the staff biologist during cover inspections. If any potentially deep-rooted plants are identified over the former disposal areas, up to two plants will be sampled annually in either August or September. The grab sample(s) will include portions of the entire plant including the root system, if possible, and will be analyzed for gamma-emitting radionuclides (Table 3.6-1). Sampled locations will be surveyed with a GPS unit.

Sampling locations will be presented on a site map, and the results will be presented and evaluated in the annual MWL long-term monitoring and maintenance report. No trigger levels are established for radionuclides in vegetation.

4.0 INSPECTION/MAINTENANCE/REPAIR ACTIVITIES AND FREQUENCIES

Surveillance and maintenance will be conducted on the following systems associated with the MWL and documented on the long-term monitoring inspection checklists/forms listed as follows:

- ET Cover Vegetation and Surface – documented on the *Biology and Cover Inspection Checklist/Form*, respectively
- Surface-Water Diversion Structures – documented on the *Cover Inspection Checklist/Form*
- Groundwater, Soil-Vapor, and Soil-Moisture Monitoring Networks and Sampling Equipment – documented on Monitoring Network/Equipment-Specific Inspection Checklists/Forms (three separate forms for each monitoring network)
- Perimeter security fence, security signs, gates, locks, and survey monuments – documented on the *Cover Inspection Checklist/Form*

Inspection, maintenance, and repair of these systems shall be conducted on a regularly scheduled basis to ensure the integrity and proper functioning of the ET Cover, the monitoring networks, the surface-water diversion structures, the perimeter fence, security signs, gates, locks (i.e., access controls), and survey monuments. Repair work will be initiated as needed based upon the results of the inspections. Example inspection checklists/forms are presented in Appendix I. Inspection, maintenance, repair, and associated documentation requirements are presented in the following sections.

4.1 Criteria for Successful Revegetation

In addition to routine inspection and maintenance, the ET Cover vegetation will be monitored to ensure the revegetation effort is successful. Establishing a self-sustaining native community of plants on the ET Cover is a critical element in the long-term performance of the cover.

The following information summarizes a climax plant community typical of the undisturbed ecosystem of TA-III (Peace et al. November 2004).

- Total percent foliar coverage equals 22.5 percent (i.e., 22.5 percent of the land surface is covered with living plants versus 77.5 percent bare surface area).
- Of the 22.5 percent of total foliar coverage, 19.2 percent is comprised of native perennial species and 3.3 percent is comprised of annual species, which includes native annual species and nonnative, transitory (or invasive) plant species.
- Considering only the total percentage of foliar coverage, 85.3 percent consists of native perennial species, and 14.7 percent comprises annual species (the majority of the annual species are nonnative, transitory species).

Based upon this information, the following criteria were established for achieving successful revegetation for the MWL ET Cover:

- Total percent foliar coverage equals 20 percent (i.e., 20 percent of the land surface is covered with living plants versus 80 percent bare surface area).
- Of the 20 percent total foliar coverage, 50 percent or greater comprises native perennial species and less than 50 percent comprises annual species.
- No contiguous bare spots greater than 200 square feet (approximately 14 by 14 feet) are present.

If these criteria are met, it will be concluded that the native plant community is successfully reestablished. Successful revegetation is projected to take three to five years after the initial seeding completed in September 2009. The cover monitoring, inspection, and maintenance/repair activities described in Section 4.2 will document the cover revegetation effort and determine whether or not the criteria are met. Local climate trends will have a major impact on plant growth and health and will be documented, evaluated, and summarized together with vegetation survey results in the annual MWL long-term monitoring and maintenance report.

4.2 Final Cover System Inspection/Maintenance/Repair

This section describes the inspection, maintenance, and repair process for the ET Cover vegetation and the ET Cover surface. Both of these ET Cover inspection components include maintenance and repair requirements. ET Cover inspections are documented as described in Sections 4.2.1, 4.2.2, and 4.2.3 and summarized as follows:

- Vegetation Inspection, including maintenance and repair activities are documented on the *Biology Inspection Checklist/Form*
- Cover Inspection, including maintenance and repair activities are documented on the *Cover Inspection Checklist/Form*

The results of these inspections and the associated checklists/forms will be included in the annual MWL long-term monitoring and maintenance report.

4.2.1 Vegetation Inspection

Cover vegetation monitoring shall be accomplished using a two-phase approach. The first phase will concentrate on establishing the vegetation on the cover from seed to a mature plant community. This phase is anticipated to take from three to five years, depending on many factors. Normal succession processes should occur and continue once native flora comprises 50 percent or greater of the established foliar coverage, and the total foliar coverage is 20 percent of the ET Cover surface. During this period, a staff biologist will inspect and document the inventory of the main flora populating the cover on a quarterly basis (i.e., Biology Inspection); inspect the cover for contiguous areas lacking vegetation in excess of 200 square feet, animal burrows, and ant hills; and recommend cover repairs as described in Section 4.2.3

and deemed appropriate to establish a long-term, sustainable, native plant community. Deep-rooted plants, such as four-wing saltbush and other shrubs and trees, will be removed if they are present on the cover. Although these inspections will occur quarterly until successful revegetation criteria are met, the most meaningful inspections relative to determining the foliar coverage of living plants will be the ones performed during the growing season (March through September) and, in particular, the inspection performed at the end of the growing season (August or September).

During this initial phase of quarterly monitoring, the staff biologist will be responsible for noting deep-rooted plants and interpreting signs of animal intrusion. Biota sampling presented in Section 3.6 will be implemented based upon these inspections. Biota sampling locations will be marked in the field, surveyed with a GPS unit, and shown on a site map. At the end of the fourth quarter of each annual monitoring period, the staff biologist will compile the results of the quarterly inspections in a summary report that will be included in the annual MWL long-term monitoring and maintenance report submitted to NMED.

Once native flora has been established and is self-sustaining, the second phase of monitoring will begin. Cover vegetation will be monitored by the staff biologist on an annual basis near the end of the growing season (August or September) to gauge the overall health of the cover vegetation. Based upon these observations, the staff biologist will submit in writing any recommendations for cover repairs as described in Section 4.2.3 and deemed necessary to maintain established vegetation. The presence of deep-rooted plants growing on the cover will be noted along with signs of animal intrusion, and potentially deep-rooted plants will be removed by field technicians (Section 4.2.3) within 60 days.

Barren areas greater than 200 square feet will not require immediate repair after ET Cover vegetation has been determined to meet the criteria for successful revegetation if these areas are the result of relatively short-term climate stresses (e.g., severe short-term drought) and are consistent with the surrounding undisturbed ecosystem of TA-III. Appropriate action will be determined by the staff biologist. No action will be required if it is determined that the area(s) will naturally fill in over time. However, these areas will be noted and tracked during inspections and reviewed annually by the staff biologist and project leader to determine whether action is required based upon comparison to surrounding vegetation. Related documentation will be included in the annual MWL long-term monitoring and maintenance report.

4.2.2 Cover Inspection

A field technician will perform cover inspections on a quarterly basis. Settlement of the cover surface in excess of 6 inches, erosion of the cover soil in excess of 6 inches deep, areas of ponding water on the ET Cover surface in excess of 100 square feet, animal burrows in excess of 4 inches in diameter, ant hills, contiguous areas lacking vegetation in excess of 200 square feet, and any other conditions that may impact the cover integrity or be of interest relative to site monitoring will be noted on the *Cover Inspection Checklist/Form*. Documentation of animal burrows in excess of 4 inches in diameter and contiguous areas lacking vegetation in excess of 200 square feet will be noted quarterly on the *Biology Inspection Checklist/Form* instead of the *Cover Inspection Checklist/Form* until successful revegetation criteria have been met. These features will be noted on both the quarterly *Cover Inspection* and annual *Biology Inspection Checklists/Forms* once the Biology Inspection frequency changes to annual.

4.2.3 Cover Maintenance/Repair

Field technicians will perform soil augmentations, surface scarification, reseeding, or other vegetation maintenance/repair (such as removal of deep-rooted plants) as necessary based upon inspection results. Damage to cover vegetation that exceeds the criteria listed in Section 4.2.2 will be repaired within 60 days of notation on the *Cover Inspection Checklist/Form* to a condition that meets or exceeds the original design. Repairs to the cover will be done using materials consistent with the cover installation specifications, according to soil classification and gradation specifications in the MWL CMI Plan (SNL/NM November 2005). Repair specifications include, but are not limited to, the following:

- Perform soil augmentations, surface scarification, reseeding, or other corrective actions for areas lacking vegetation in excess of 200 square feet and reestablishing the topsoil layer to provide a suitable seedbed.

- Backfill and reseed settlement and/or erosion areas exceeding a depth of 6 inches, areas of ponding water in excess of 100 square feet, and animal burrows in excess of 4 inches in diameter using either stockpiled clean soil from the cover installation (i.e., previously sampled and confirmed to meet CMI Plan specifications) or clean fill with properties meeting the MWL CMI Plan specifications. Compaction will typically not be required for repairs of the ET Cover surface to promote seedling growth and root establishment. However, in the cases of settlement or erosion areas exceeding 6 inches deep, the project leader will determine whether compaction is appropriate.

- Conduct supplemental watering to promote seedling growth in reseeded areas. If extreme climate conditions (e.g., extreme drought) could significantly jeopardize the ET Cover vegetation in the judgment of the staff biologist, additional supplemental watering may be performed across the entire ET Cover.

Supplemental watering has been an important, effective measure in the initial effort to establish a long-term sustainable native plant community on the ET Cover (Appendix B). Supplemental watering will be performed only during the long-term monitoring period if determined to be necessary by the staff biologist. Monitoring and documentation requirements and limits proposed by the Permittees in 2011 (Wagner March 2011) and approved by NMED (Bearzi April 2011) shall apply to any supplemental watering performed and are summarized as follows:

- The amount of water used and the duration of each watering event will be tracked as a precipitation event, along with all natural precipitation in the vicinity of the MWL (natural precipitation will be monitored at a nearby SNL/NM meteorological monitoring station).

- Supplemental watering will be performed in a flexible manner to augment natural precipitation. Care will be taken to minimize the volume of water applied.

- No more than 3 inches of supplemental water will be applied over a 30-day period, and no more than 0.5 inches will be applied during any one daily supplemental watering event.

- The total water (natural plus supplemental) applied to any portion of the MWL ET Cover over the calendar year (CY) should not exceed 16.5 inches and will be documented in the annual MWL long-term monitoring and maintenance report submitted to NMED.

4.3 Storm-Water Diversion Structure Inspection/Maintenance/Repair

This section describes the quarterly inspection, maintenance, and repair process for the storm-water diversion structures associated with the MWL ET Cover. The inspection results and any associated maintenance and repair activities will be documented on the *Cover Inspection Checklist/Form* and included in the annual MWL long-term monitoring and maintenance report.

4.3.1 Inspection

The function of storm-water diversion structures associated with the cover is to prevent storm-water run-on from eroding the cover and to reduce the amount of water that could potentially infiltrate the cover. The storm-water diversion structures will be inspected by a field technician on a quarterly basis to verify structural integrity and ensure adequate performance. Inspections will document erosion of the channels or sidewalls in excess of 6 inches deep and accumulations of silt greater than 6 inches deep or debris that blocks more than one-third of the channel width.

4.3.2 Maintenance/Repair

Based upon the results from the storm-water diversion structure inspections, any areas that exceed the inspection criteria specified in Section 4.3.1 will be repaired within 60 days of notation on the *Cover Inspection Checklist/Form* to a condition that meets or exceeds the original design. Reseeding of the surface drainage features may also be performed to facilitate revegetation and erosion resistance, if necessary.

4.4 Groundwater and Vadose Zone Monitoring Network Inspection/Maintenance/Repair

This section describes the inspection, maintenance, and repair process for groundwater and vadose zone monitoring networks. These include groundwater monitoring wells, soil-vapor monitoring wells, soil-moisture monitoring access tubes, and associated sampling/monitoring equipment. These inspections will occur at the same frequency as the associated monitoring (Table 3.1-1). The inspections and any associated maintenance and repair activities will be documented on monitoring network-specific inspection checklists/forms and included in the annual MWL long-term monitoring and maintenance report. There is a separate inspection checklist/form for each of the three monitoring networks and associated sampling/monitoring equipment.

4.4.1 Inspection

The groundwater monitoring wells, soil-vapor monitoring wells, and soil-moisture monitoring access tubes will be inspected at the same frequency as the associated monitoring (Table 3.1-1). The inspection will note the condition of the components including protective casings and stanchions or bollards, wellhead covers/caps, locks, well casing, soil-vapor sampling ports (i.e., permanent tubing), and well identification markings. Groundwater and soil-vapor pumps and sample tubing will also be inspected prior to each sampling event. The neutron probe and cable system used for soil-moisture monitoring will be inspected as part of each soil-moisture monitoring event. Field operating procedures associated with each of the monitoring activities include operational checks for all related equipment.

4.4.2 Maintenance/Repair

The groundwater monitoring wells, soil-vapor monitoring wells, and soil-moisture monitoring access tubes components shall be maintained/repaired/replaced within 60 days of discovery of any needed repairs. Pump replacement and maintenance and tubing replacement will be performed on an as-needed basis based upon pump performance, inspections, and review of analytical sampling results. The neutron probe and cable system used for soil-moisture monitoring will be repaired and/or replaced as necessary. Maintenance activities will also include ensuring that all system components are protected from the weather to the extent possible.

4.5 Security Fence Inspection/Maintenance/Repair

This section describes the inspection, maintenance, and repair process for the perimeter security fence, gates, locks, warning signs, and survey monuments. The inspection results and any associated maintenance and repair activities will be documented on the *Cover Inspection Checklist/Form* and included in the annual MWL long-term monitoring and maintenance report.

4.5.1 Inspection

The fence, gates, locks, warning signs, and survey monuments will be routinely inspected. The inspections will document the condition of the fence, including fence wires, posts, gates, gate locks, and warning signs. In addition, excessive accumulations of wind-blown plants and debris that would obscure warning signs, block access to the MWL, or interfere with any monitoring events will be documented.

4.5.2 Maintenance/Repair

The fence, gates, warning signs, and survey monuments will be maintained and/or repaired within 60 days of discovery of a problem by routine inspections. Activities may include, but are not limited to, removing excessive accumulations of wind-blown plants and debris, repairing broken wire sections and posts, repairing and oiling gates, cleaning or replacing locks, repairing or replacing warning signs, and removing excess soil and/or vegetation covering survey monuments.

4.6 Inspection Schedule, Corrective Actions, and Recorded Results

A schedule for implementing inspections and prescribed maintenance and repairs of the ET Cover; storm-water diversion structures; monitoring networks; and perimeter security fence, gates, locks, warning signs, and survey monuments is provided in Table 4.6-1.

Example inspection forms are included in Appendix I of this LTMMP; however, alternate formats may be used to detail the information. The results of each inspection conducted shall be recorded in accordance with this Section. At a minimum, the records shall include the date of the inspection, the name and signature of the inspector, all required inspection parameters, results, and observations; and the date and nature of any repairs or other remedial actions taken. The records shall be clearly legible and in a format similar to the example forms in Appendix I, with all information in ink, and errors will be crossed out with a single line, initialed, and dated by the individual making the correction. The records shall be retained for the period of time specified in Section 4.8 of this LTMMP. Completed inspection checklist/forms and a summary of results will be included in the annual MWL long-term monitoring and maintenance report.

Repairs and maintenance will be undertaken to ensure the integrity of the ET Cover, monitoring networks, and site features; protect human health and the environment; and mitigate any potential hazards. If an inspection of the MWL reveals that a problem has developed, the necessary repairs, maintenance, or replacement will be completed within 60 days of notation on the inspection checklist/form, unless circumstances beyond the control of the Permittees cause further delay. The one exception to this 60-day time limit involves ET Cover vegetation repairs; implementation of reseeding can be delayed until an appropriate time during the growing season.

The Permittees will limit any such delays to as short a time period as reasonably possible. If an unexpected event or issue outside of the Permittees’ control causes the repairs to take longer than 60 days to complete, then NMED will be consulted to discuss the impacts to the schedule. If a hazard appears imminent or a hazardous situation already exists, remedial action will be initiated immediately. Any remedial action taken pursuant to an inspection will be noted on the inspection checklist/form.

4.7 Personnel Training

An MWL-specific personnel training program for inspection, monitoring, maintenance, and repair of the MWL during the long-term monitoring period is not required. However, all personnel working at the MWL shall be qualified to perform their assigned tasks, shall be trained to the appropriate level of their assigned activities, shall have prior experience or conduct work under the supervision of a person with prior experience, and shall have read and understood this LTMMP as it applies to the specific tasks being performed. All activities will be performed in accordance with the requirements of this LTMMP.

Table 4.6-1
Long-Term Monitoring, Inspection, and Maintenance Schedule
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

MWL System to be Inspected	Inspection Parameters	Inspection Frequency	Maintenance Implementation	Maintenance/ Repair Frequency[a]
ET Cover Surface	Vegetation Inventory	Quarterly until vegetation is established, annually thereafter by a staff biologist[b]	Soil augmentations and/or reseeding	Within 60 days of discovery of needed repairs. Reseeding repairs may be delayed to await appropriate growing season.
	Contiguous areas of no vegetation >200 ft^2		Revegetate barren areas that exceed prescribed limits	
	Animal intrusion burrows in excess of 4 inches in diameter		Repair cover system damage that exceeds prescribed limits	
ET Cover Surface	Settlement of cover surface in excess of 6 inches	Quarterly by a field technician	Repair cover system damage that exceeds prescribed limits	Within 60 days of discovery of needed repairs. Reseeding repairs may be delayed to await appropriate growing season.
	Erosion of cover soil in excess of 6 inches deep			
	Ponding of water on the ET Cover surface in excess of 100 ft^2			
	Animal intrusion burrows in excess of 4 inches in diameter			
	Contiguous areas of no vegetation >200 ft^2 [c]		Revegetate barren areas that exceed prescribed limits[c]	Within 60 days of discovery of needed repairs.
Surface-Water Drainage Features	Channel or sidewall erosion in excess of 6 inches deep	Quarterly by a field technician	Repair erosion that exceeds prescribed limits	Within 60 days of discovery of needed repairs.
	Accumulations of sediment in excess of 6 inches deep or debris that blocks more than 1/3 of the channel width		Remove sediment and debris accumulations that exceed prescribed limits	
Soil-Vapor Monitoring Wells, Soil-Moisture Monitoring Access Tubes, and Groundwater Monitoring Wells	Concrete pads, stanchions, and protective casings	Groundwater and Vadose Zone Network Components: Field technician to inspect at same frequency/time that monitoring occurs	Maintain, clean, repair, replace, re-label, as appropriate	Within 60 days of discovery of needed repairs.
	Well cover caps and Swagelok® (or equivalent) dust caps			
	Monitoring wells and soil-vapor sampling port labels			
	Locks			
	Sampling pumps and tubing Neutron probe and cable system			

Refer to footnotes at end of table.

Table 4.6-1 (Concluded)
Long-Term Monitoring, Inspection, and Maintenance Schedule
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

MWL System to be Inspected	Inspection Parameters	Inspection Frequency	Maintenance Implementation	Maintenance/ Repair Frequency[a]
Fence	Presence of wind-blown plants and debris	Quarterly by a field technician	Remove wind-blown plants and debris	Within 60 days of discovery of needed repairs.
	Condition of fence wires, posts, gates, gate locks, warning signs, and survey monuments in the local area		Repair broken wire sections and posts, repair/oil gates, clean/replace locks, repair/replace warning signs, clear dirt/debris from monuments	

[a]Maintenance/repairs will be performed as necessary, based upon the results of inspections.
[b]As explained in Section 4.2.1, the transition from quarterly to annual inspections by a staff biologist is based upon meeting successful revegetation criteria as determined by the staff biologist.
[c]Barren areas exceeding >200 ft^2 will not require corrective action after ET Cover vegetation is determined to have met successful revegetation criteria if they are the result of relatively short-term climate stresses (e.g., severe short-term drought), and the staff biologist determines they will naturally fill in over time. However, these areas will be noted and tracked during inspections and reviewed annually by the staff biologist to determine whether action is required based upon comparison to surrounding vegetation.
ET = Evapotranspirative.
ft^2 = Square feet.
MWL = Mixed Waste Landfill.

4.8 Record Keeping and Reporting

The Corrective Action Management Unit (CAMU) Administrative Trailer, located south of the MWL in TA-III, will be the field office for MWL long-term monitoring and maintenance activities. The following active records shall be maintained at the CAMU Administrative Trailer and the SNL/NM Records Center:

- Current and complete copy of the MWL LTMMP, including all appendices
- Current written versions of operating procedures (administrative, standard, and laboratory) and related guidance referenced in the LTMMP
- A written Operating Record that includes the following:
  - All completed inspection forms
  - Annual MWL long-term monitoring and maintenance reports for the past three years
  - All waste management documentation for the last three years
- Site-specific health and safety plan (current version)

Additionally, the following MWL records shall be maintained at the SNL/NM Records Center:

- All correspondence and other documents from NMED and any other governmental agencies related to long-term monitoring and maintenance
- All training records for current employees and training records for any former employee for a minimum of three years from the last date the employee worked at the MWL
- All completed annual MWL long-term monitoring and maintenance reports
- All groundwater, soil-vapor, soil moisture, surface soil (tritium and biota monitoring), and vegetation monitoring results and records, including full laboratory data packages/reports
- All records of actions taken to prevent or mitigate releases of hazardous waste or hazardous constituents to the environment

The Permittees will comply with the record-keeping provisions of 20.4.1.500 NMAC incorporating 40 CFR 264.74, concerning the availability, retention, and disposition of records.

4.8.1 Annual Long-Term Monitoring and Maintenance Report

During the long-term monitoring and maintenance period, the Permittees will submit an MWL long-term monitoring and maintenance report to NMED on an annual basis. The report will present data and include the following components for the preceding annual reporting period:

- Summary of inspection, maintenance, and repair activities, and an explanation of whether implemented repairs were effective and met the original specifications

- Results for air, surface soil (tritium and biota monitoring), vadose zone soil vapor and soil moisture, groundwater, and vegetation monitoring and an evaluation of the results

- Where applicable, a comparison of results with monitoring triggers, indicating whether trigger levels were exceeded for any constituent

- Summary of any problems that either endangered or presented significant potential to endanger human health and the environment for the reporting period and what was done to mitigate such problems

- Review of the regulatory standards and screening levels that were used to develop the media-specific trigger levels presented in Section 5.2 and documentation of any changes being made through the permit modification process

The annual reporting period for long-term monitoring is defined as April 1 through March 31. The annual report is due by June 30 of each CY and will cover the previous annual reporting period. Each annual report will be made available to the public.

4.8.2 Five-Year Reevaluation Report

The Permittees will also submit to NMED a report every five years reevaluating the feasibility of excavation and analyzing the continued effectiveness of the selected remedy. The report will include a review of the annual long-term monitoring and maintenance reports for that five-year period and any other pertinent data, as well as additional documentation required by NMED. The main scope of the Five-Year Reevaluation Report as defined in the Final Order (Curry May 2005) is summarized as follows:

- Reevaluate the feasibility of excavating the MWL, including a review of new excavation technologies since the MWL Corrective Measures Study (CMS) Report (SNL/NM May 2003) was approved and provide an update of waste disposal pathways. Worker and site risks associated with any newly identified excavation technologies will also be assessed and reported. In summary, the MWL CMS Report "full excavation alternative" will be reviewed, reevaluated, and updated as appropriate based upon current information.

- Analyze the continued effectiveness of the ET Cover and the likelihood of contaminants reaching groundwater using current monitoring results and any other pertinent data.

- Update, if necessary, the fate and transport model for the MWL with current data. Current monitoring results will be compared to the modeling performed in 2005. If the results indicate current conditions are not significantly different from the conditions previously modeled in 2005, the fate and transport model will not be updated. If the monitoring results fall significantly outside the range of conditions previously modeled, the fate and transport model will be updated to determine the likelihood of contaminants reaching groundwater.

- All efforts to ensure that any future releases or mobilization of contaminants are detected and addressed well before any effect on groundwater or increased risk to public health or the environment occurs will be detailed and will include a summary of the multi-media long-term monitoring program.

The first five-year reevaluation period will begin upon NMED approval of this MWL LTMMP (Kieling October 2011). The first Five-Year Reevaluation Report will be submitted to NMED five years after approval of the LTMMP and include monitoring results for the first four years under the LTMMP to allow time to prepare and submit the report. Subsequent Five-Year Reevaluation Reports will cover a full five-year monitoring period. The Permittees will make the report available to the public in accordance with the requirements in the Final Order (Curry May 2005).

4.9 Potential for Exposure

The MWL ET Cover provides a significant barrier between the surface environment and the buried wastes. The following measures have been implemented to reduce the risk of exposure from the wastes buried at the MWL:

- The ET Cover is designed to minimize the potential for the migration of precipitation into the MWL.
- Monitoring of the vadose zone will be conducted to determine whether the most mobile contaminants are migrating and pose a threat to groundwater.
- Monitoring of the air and surface soil will be conducted to determine whether there is a threat to receptors at the surface.
- Security and IC measures will be maintained to restrict access to the area.
- Federal ownership and the industrial land-use designation will prevent inappropriate use of the MWL site.
- Inspections, maintenance, and repairs (as necessary) will be performed on a regularly scheduled basis and in accordance with this LTMMP.

4.10 Potential for Emergency

Due to the current conditions at the MWL, the potential for fire, explosion, or unplanned release of radionuclides or RCRA-regulated hazardous waste or hazardous waste constituents that would significantly threaten human health or the environment is very low. In the unlikely event of an emergency, the SNL/NM emergency response organization will provide coordination, resources, and appropriate emergency equipment on an as-needed basis.

5.0 TRIGGERS FOR LONG-TERM MONITORING

The Final Order (Curry May 2005) required the MWL CMI Plan (SNL/NM November 2005) to include triggers (i.e., concentration limits) for media-specific constituents to be monitored after implementation of the selected remedy (ET Cover with biointrusion barrier). Trigger levels are to be implemented as part of the MWL LTMMP to provide early detection of potentially changing conditions at the surface, in the vadose zone, and in the groundwater. If a trigger is exceeded, additional testing and further investigation will be performed to provide the data needed to evaluate conditions and determine whether additional action is warranted. The comprehensive media-specific long-term monitoring program is detailed in Chapter 3.0.

Based upon the results of the probabilistic performance-assessment modeling for the MWL presented in the MWL CMI Plan (SNL/NM November 2005, Ho et al. January 2007), the following parameters were identified for long-term monitoring and the development of trigger levels:

- Surface emissions of tritium and radon
- Infiltration through the ET Cover
- Concentrations of uranium in groundwater
- Concentrations of specific VOCs in the soil vapor and groundwater

Monitoring triggers were established for these parameters and documented in the CMI Plan (SNL/NM November 2005). Some of these triggers have been changed based upon NMED CMI Plan comments (Bearzi November 2006 and October 2008a), and additional triggers have been added (triggers for the complete EPA Method 8260 VOC Target Compound List, tritium, radon, and specific metals in groundwater samples and triggers for specific metals in surface soil samples). Final media-specific trigger levels are presented in this chapter that reflect recent updates to regulatory screening levels and guidance from NMED (Bearzi October 2008a and NMED February 2012). These triggers were conservatively derived from EPA (May 2009 and November 2011), DOE (1993), and NMED (February 2012) and NMED Water Quality Control Commission (2002) regulatory standards in accordance with NMED requirements (Bearzi October 2008a). Triggers for radionuclide monitoring of surface soil and plant material are not established; however, data evaluation and reporting requirements are addressed in Section 3.6.

The trigger evaluation process is described in Section 5.1. This process will be initiated if a monitoring result, confirmed by resampling, exceeds the corresponding trigger level during long-term monitoring at the MWL. The media-specific monitoring trigger levels are presented in Section 5.2.

5.1 Trigger Evaluation Process

A trigger evaluation process will be applied during long-term monitoring activities (Figure 5.1-1) in accordance with requirements in the Consent Order (NMED April 2004) and the SNL/NM RCRA Permit (EPA August 1993). The trigger evaluation process is designed to ensure the protection of human health and the environment, while allowing adequate data collection to

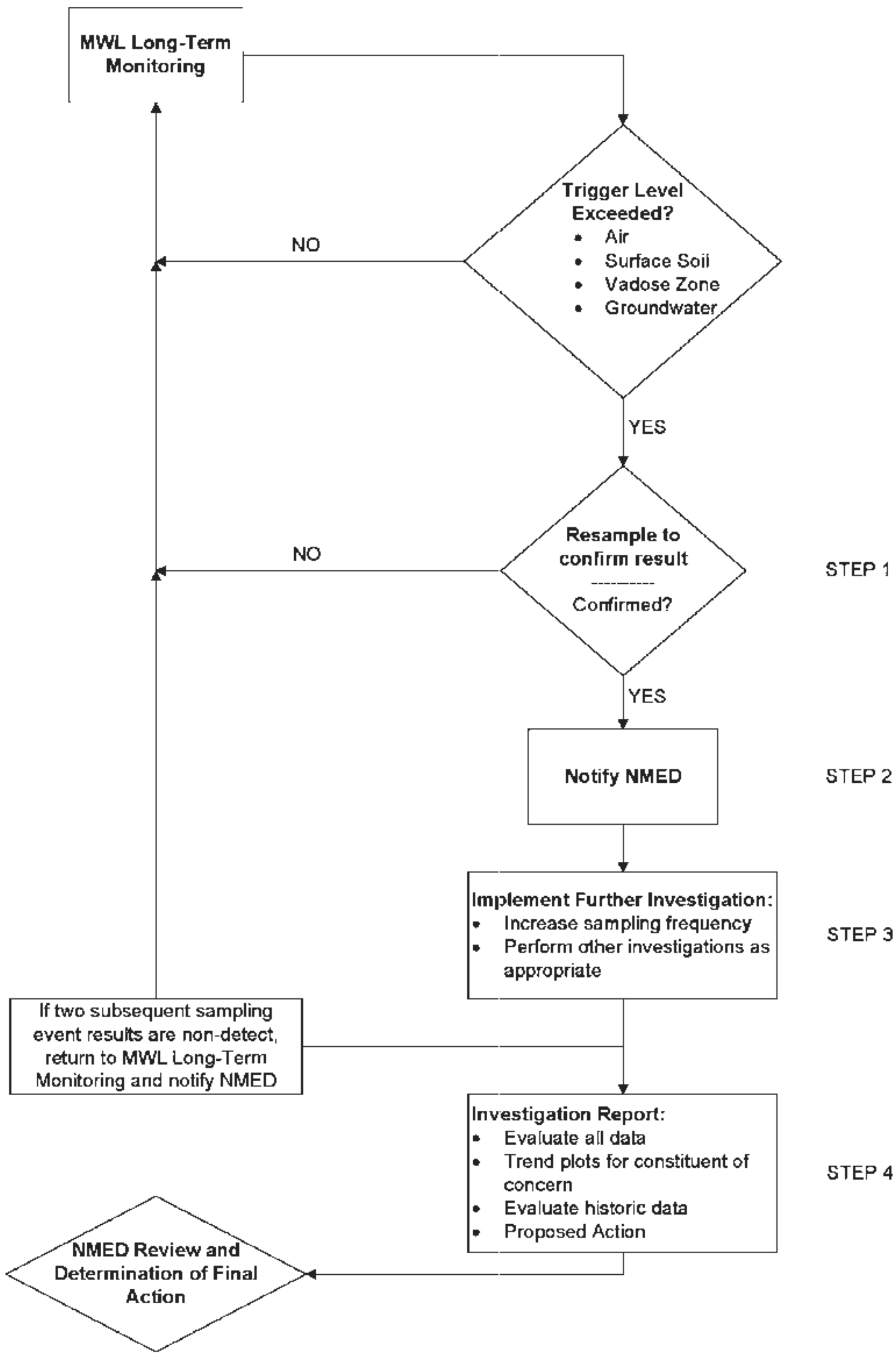

Figure 5.1-1
Trigger Evaluation Process for the Mixed Waste Landfill

eliminate field sampling and/or laboratory error and identify short-term exceedances that do not reflect long-term trends. This is particularly important relative to specific groundwater monitoring trigger levels that are at or near the analytical laboratory practical quantitation limit (PQL).

Regardless of the environmental medium, the four steps shown in Figure 5.1-1 and discussed in the following sections apply. Section 5.2 presents the media-specific trigger levels and requirements.

5.1.1 Step 1 – Resample to Confirm the Result

In the event that a monitoring result is greater than a corresponding trigger level, the first step is to *resample to confirm the result*. Resampling shall be completed within two weeks of discovery that a monitoring result is greater than a corresponding trigger level. If the average of the results for the original and resample is less than the trigger level, no further actions are required. For situations in which the exceeded trigger level is at or near the analytical laboratory detection limit, the original and resampling results will not be averaged. Instead, the resampling result will be compared directly with the trigger level; if it is below the trigger level, no further action is required. If the average result or resampling result confirms that the trigger level has been exceeded, the trigger evaluation process proceeds to *Step 2, Notification to NMED*.

5.1.2 Step 2 – Notification to NMED

The second step involves submitting *notification to NMED* following the receipt of the validated analytical results. For the resampling process, the Permittees will have no more than two weeks from the date of the receipt of results from the analytical laboratory to perform final validation.

For groundwater samples, if the resampling result or the average of the original result and its resampling result exceeds any applicable New Mexico Water Quality Control Commission standard specified in 20.6.2.3103 NMAC, notice shall be given in accordance with 20.6.2.1203.A NMAC to the Chiefs of both NMED Groundwater Quality Bureau and the HWB. However, if the resampling result or the average of an original result and its resampling result is less than or equal to any applicable New Mexico Water Quality Control Commission standard, and also greater than its corresponding trigger level, notice shall be given to the Chief of NMED HWB.

The notification provided to NMED specified in this section will provide information on implementing Step 3, which is *further investigation* and, if applicable, will also contain the information required under 20.6.2.1203.A(1) NMAC.

5.1.3 Step 3 – Further Investigation

This third step includes, but is not limited to, the collection of more data at an increased frequency over the subsequent one-year period. The one-year period begins upon the date of NMED notification. Once data are collected, an *investigation report* will be prepared to meet the requirements of the fourth step.

5.1.4 Step 4 – Investigation Report

The fourth step involves compiling all relevant data and information into an *investigation report* that shall be submitted to NMED within one year of the exceedance notification. The investigation report will provide an evaluation of historical data and additional data collected as part of *Step 3, Further Investigation*. The increased frequency of data collection associated with Step 3 will ensure that adequate data are collected and evaluated to rule out false positives due to field and/or laboratory error and to identify trends that will allow the determination of appropriate follow-up actions. Trend plots and other statistical method results, as appropriate based upon the available data set(s), shall be included in the investigation report along with other relevant information (e.g., historical investigation results, inventory analysis, fate and transport modeling results, other relevant site case histories, etc.) to support recommendations for future actions.

Thus, any recommendations for further investigation and/or corrective action because of a trigger level exceedance will be based upon data trends and all available information, rather than upon a single confirmed result above the trigger level. This one-year process takes into account the conservative trigger levels, multi-media monitoring approach, extremely slow-moving nature of contaminant migration, isolated location of the site relative to receptors, and the need to collect sufficient data to confirm and characterize potentially changing site conditions.

NMED will review the investigation report and determine final actions to be implemented, which could include one or more of the following:

- No further action (i.e., resume monitoring according to the LTMMP)
- Continue increased monitoring frequency of specific media
- Conduct other investigations
- Implement corrective action

5.2 Monitoring Trigger Levels

Based upon both the results of the probabilistic performance-assessment modeling conducted for the MWL (SNL/NM November 2005, Ho et al. January 2007) and subsequent input received from NMED and the public, monitoring trigger levels have been established for the air, soil, vadose zone, and groundwater at the MWL. These trigger levels are summarized in Table 5.2-1 and discussed in the following sections. Trigger levels will be used as part of the comprehensive media-specific monitoring program described in Chapter 3.0 of this LTMMP and provide early detection of potentially changing conditions that would warrant further investigation. Should any monitored constituent exceed its respective trigger level, then the trigger evaluation process described in Section 5.1 and shown in Figure 5.1-1 will be implemented.

The regulatory standards and screening levels that were used to develop the media-specific triggers shall be periodically reviewed, at a minimum annually, to determine whether any changes by EPA or NMED have occurred. Any changes that affect a trigger level will be documented and submitted to NMED as a Class 1 permit modification with prior approval that will include the revised trigger level(s) according to NMED guidance (Bearzi October 2008a), along with an explanation of the change(s). The revised trigger level(s) will become effective after NMED approval of the permit modification.

Table 5.2-1
Summary of Long-Term Monitoring Parameters with Trigger Levels
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Sampling Media	Monitoring Parameter[a]/ Constituent of Concern	Monitoring Method	Trigger Level	Comments
Air	Radon	Track-etch detectors (at breathing level) placed at various locations at the site – sampling and analysis per Appendix C.	4 pCi/L	Samples are time-weighted average and will be collected over a 3-month period. Trigger levels apply to perimeter locations.
Surface Soil	Tritium	Grab samples of surface soil collected at four corners of the MWL – sampling and analysis per Appendix G.	20,000 pCi/L in soil moisture	Sampling being collected as part of the ongoing SNL/NM Terrestrial Monitoring Program will be continued to allow long-term data trending.
Surface Soil – Biota Monitoring	Metals	Grab samples of soil collected from animal burrows and/or ant hills on the MWL ET Cover – sampling and analysis per Appendix G.	NMED Industrial/Occupational Soil Screening Levels (Table 5.2.2-1)	Trigger levels established by NMED during the CMI Plan NOD process and updated according to the most recent NMED guidance (NMED February 2012).
Vadose Zone	VOCs in soil vapor	Soil vapor sampling and analysis at the 5 soil-vapor monitoring wells; 3 of these wells are multi-port wells and 2 are single-port wells – sampling and analysis per Appendix D.	PCE = 20 ppmv TCE = 20 ppmv Total VOCs = 25 ppmv	Trigger levels apply only to the deepest sampling ports of the 3 multi-port soil-vapor monitoring wells. All other soil-vapor data will be reported and evaluated in the annual MWL long-term monitoring and maintenance report.
Vadose Zone	Moisture content in underlying vadose zone	Neutron probe measurements made in three soil-moisture monitoring angled boreholes – sampling and analysis per Appendix E.	Average 23% volumetric soil moisture content	Trigger level applies to linear depths of 10 to 100 feet (vertical depths of 8.7 to 86.6 feet) along the neutron probe access tubes.
Groundwater	VOCs, metals, and radiological parameters	Groundwater sampling and analysis per Appendix F.	Listed in Table 5.2.4-1	Groundwater compliance network is comprised of monitoring wells MWL-BW2, MWL-MW7, MWL-MW8, and MWL-MW9. Trigger levels apply to MWL-MW7, MWL-MW8, and MWL-MW9.

[a]Monitoring parameters, frequency, and analytical methods are detailed in Chapter 3.0 and Table 3.1-1.

BW = Background well.
CMI = Corrective Measures Implementation.
ET = Evapotranspirative.
MW = Monitoring well.
MWL = Mixed Waste Landfill.
NMED = New Mexico Environment Department.
NOD = Notice of Deficiency.
PCE = Tetrachloroethene.
pCi/L = Picocurie(s) per liter.
ppmv = Parts per million by volume.
SNL/NM = Sandia National Laboratories, New Mexico.
TCE = Trichloroethene.
VOC = Volatile organic compound.

Although trigger levels for long-term monitoring have been developed for both hazardous and radioactive constituents, the trigger levels and monitoring for radionuclides are provided voluntarily by the Permittees. The voluntary inclusion of such radionuclide information shall not be enforceable and shall not constitute the basis for any enforcement because such information falls wholly outside the requirements of the Consent Order. Additional information on radionuclides and the scope of the Consent Order is available in Section III.A of the Consent Order (NMED April 2004).

5.2.1 Air Monitoring Trigger Levels

The trigger level for radon in air is 4 pCi/L (Table 5.2-1) and the point of compliance is the MWL perimeter (RN1 through RN10). This value is the EPA action threshold for radon in household air (EPA September 2005). This value is significantly lower than the simulated radon-gas concentrations (greater than 10,000 pCi/L) at the surface of the MWL, which yielded fluxes that exceeded the design standard of 20 pCi/m^2/s (Ho et al. January 2007).

5.2.2 Surface Soil and Biota Monitoring Trigger Levels

Surface soil trigger levels are established for tritium and metals. Tritium is the primary constituent of concern based upon the MWL Phase 2 RFI (SNL/NM September 1996) and the most mobile radionuclide disposed of at the MWL. Triggers for metals in surface soil samples collected at animal burrows and/or ant hills address concerns regarding potential mobilization of contaminants by biota.

5.2.2.1 Tritium in Surface Soil

The performance-assessment model (Ho et al. January 2007) indicates a very low (2 percent) probability that tritium emitted from the MWL may exceed the performance objective of 10 millirem/yr dose to the public via the air pathway. Therefore, a conservative trigger value of 20,000 pCi/L in surface soil at the MWL perimeter has been established. Because the trigger value is four to five orders of magnitude less than simulated concentrations that yielded exceedances in the dose via air, the trigger value serves as a conservative early detection mechanism for potential future exceedances of the tritium dose via air.

The tritium trigger applies to surface soil samples collected annually at the four corners of the MWL. Soil samples will be collected and analyzed annually as described in Section 3.3. Any increase in tritium emissions from the MWL will be indicated by elevated tritium concentrations in these soil samples relative to previous results.

5.2.2.2 Biota Monitoring

Trigger levels for metals in surface soil samples collected at animal burrows and/or ant hills are NMED industrial/occupational soil screening levels (NMED February 2012), which are presented in Table 5.2.2-1, except for cobalt, which was specified by NMED (Bearzi October 2008a). Some of the trigger levels have been changed since the CMI Plan NOD process to reflect NMED industrial/occupational soil screening level updates made in February 2012

(NMED February 2012). Surface soil samples collected at animal burrows and/or ant hills will also be analyzed for gamma-emitting radionuclides. There are no trigger levels established for radionuclides; the results will be compared with NMED-approved background activity levels (Dinwiddie September 1997) and included in the annual MWL long-term monitoring and maintenance report.

Table 5.2.2-1
Mixed Waste Landfill Surface Soil Trigger Levels

Parameter	Trigger Level in mg/kg
Arsenic	17.7
Barium	100,000
Cadmium	897
Chromium (as Chromium VI)	63.1
Lead	800
Mercury	73.6
Selenium	5,680
Silver	5,680
Copper	45,400
Nickel	22,500
Vanadium	5,680
Zinc	100,000
Cobalt	20,500
Beryllium	2,260

All trigger levels for metals are based upon NMED Industrial/Occupational Soil Screening Levels (NMED February 2012) except cobalt, which was provided by NMED (Bearzi October 2008a).
CMI = Corrective Measures Implementation.
mg/kg = Milligram(s) per kilogram.
NMED = New Mexico Environment Department.

Sampling of potentially deep-rooted vegetation growing on the ET Cover will also be performed, if present. Vegetation samples will be analyzed for gamma-emitting radionuclides. Similar to the monitoring of radionuclides in surface soil near animal burrows and/or ant hills, no trigger levels are established. These results will be reported and evaluated in the annual MWL long-term monitoring and maintenance report.

5.2.3 Vadose Zone Monitoring Trigger Levels

Long-term monitoring of the vadose zone is planned for both soil vapor and moisture content to evaluate the effectiveness of the ET Cover and ensure that MWL site conditions remain protective of human health and the environment. The trigger values for vadose zone soil vapor and moisture content are discussed in the following sections. Additional details regarding vadose zone monitoring activities are presented in Section 3.4.

5.2.3.1 Volatile Organic Compounds in Soil Vapor

Trigger levels for PCE, TCE, and total VOCs in soil vapor at the MWL are 20 parts per million by volume (ppmv) for PCE and TCE, and 25 ppmv for total VOCs as established in the MWL fate and transport model (Ho et al. January 2007). All trigger levels apply only to samples collected from the deepest sampling port (i.e., 400 feet bgs) in each of the three FLUTe™ or equivalent soil-vapor monitoring wells.

5.2.3.2 Moisture Content

Infiltration through the ET Cover will be determined by monitoring the moisture content in the vadose zone beneath the MWL as described in Section 3.4.2. A significant increase in moisture content beneath the MWL may indicate that the disposal cell cover may not be performing as originally designed, and that infiltration through the cover is greater than originally predicted.

The established trigger level is the moisture content that corresponds to an unsaturated hydraulic conductivity equal to the EPA-prescribed technical equivalence criteria of 10^{-7} cm/s (31.5 mm/yr). The moisture content at which this occurs is 23 percent by volume; therefore, the trigger level is 23 percent by volume. This value is based on the EPA-prescribed technical equivalence criteria and does not necessarily indicate that hazardous constituents or radionuclides are migrating from the MWL.

The 23-percent trigger applies to linear depths of 10 and 100 feet (vertical depths of 8.7 to 86.6 feet) along the neutron probe access tubes in the vadose zone beneath the MWL. This interval is the “regulated interval” because it lies beneath the root zone, yet is shallow enough that a response would be detected fairly rapidly if infiltration through the cover significantly increases.

5.2.4 Groundwater Monitoring Trigger Levels

Groundwater monitoring at the MWL has been conducted since September 1990 and provides more than 20 years of empirical data supporting the conclusion that the MWL has not contaminated groundwater. Monitoring triggers for VOCs, metals, and radionuclides in groundwater at the MWL are presented in Table 5.2.4-1 and discussed in the following sections. The point of compliance is at each downgradient monitoring well (MWL-MW7, MWL-MW8, and MWL-MW9) along the western perimeter of the MWL. MWL-BW2 is the background monitoring well; data from this well provide information regarding the quality of groundwater upgradient of the MWL. Additional details regarding long-term groundwater monitoring at the MWL are presented in Section 3.5.

Table 5.2.4-1
Mixed Waste Landfill Groundwater Monitoring Trigger Levels

Groundwater Monitoring Parameters	Final Trigger Levels (µg/L)[a]	Trigger Level Source[a]	2011 Laboratory Reporting Limits	
			Method Detection Limit (µg/L)	Practical Quantitation Limit (µg/L)
EPA Method 8260 Volatile Organic Compounds				
1,1,1-Trichloroethane (1,1,1-TCA)	15	25% NMED WQCC MAC	0.325	1
1,1,2,2-Tetrachloroethane	5	50% NMED WQCC MAC	0.25	1
1,1,2-Trichloroethane[b]	2.5	50% EPA MCL	0.25	1
1,1-Dichloroethane	12.5	50% NMED WQCC MAC	0.3	1
1,1-Dichloroethene	2.5	50% NMED WQCC MAC	0.3	1
1,2-Dichloroethane	2.5	50% EPA MCL	0.25	1
1,2-Dichloropropane	2.5	50% EPA MCL	0.25	1
2-Butanone (methyl ethyl ketone)[b]	1,225	25% EPA RSL	1.25	5
2-Hexanone	17	50% EPA RSL	1.25	5
4-methyl-, 2-Pentanone (Methyl isobutyl ketone)[b]	250	25% EPA RSL	1.25	5
Acetone[b]	3,000	25% EPA RSL	1.25 – 5.0	5.0 – 15.0
Benzene	2.5	50% EPA MCL	0.30 – 1.0	1.0 – 3.0
Bromodichloromethane	0.6	50% NMED SL	0.25	1
Bromoform	4.0	50% EPA RSL	0.25	1
Bromomethane	3.5	50% EPA RSL	0.3	1
Carbon disulfide	180	25% EPA RSL	1.25	5
Carbon tetrachloride	2.5	50% EPA MCL	0.3	1
Chlorobenzene	25	25% EPA MCL	0.25	1
Chloroethane (ethyl chloride)	5,250	25% EPA RSL	0.3	1
Chloroform	25	25% NMED WQCC MAC	0.25	1
Chloromethane	47	25% NMED SL	0.3	1
Dibromochloromethane	0.75	50% NMED SL	0.3	1
Ethyl benzene	175	25% EPA MCL	0.25	1
Methylene chloride	3[c]	60% EPA MCL	3	10
Styrene	25	25% EPA MCL	0.25	1
Tetrachloroethene (PCE)	2.5	50% EPA MCL	0.3	1
Toluene[b]	187.5	25% NMED WQCC MAC	0.25 – 1.0	1
Trichloroethene (TCE)	2.5	50% EPA MCL	0.25	1
Vinyl acetate	103	25% EPA RSL	1.5 – 5.0	5
Vinyl chloride	0.5	50% NMED WQCC MAC	0.5	1
Xylene	155	25% NMED WQCC MAC	0.3	1
cis-1,2-Dichloroethene	17.5	25% EPA MCL	0.3	1
cis-1,3-Dichloropropene (1,3-Dichloropropene)	2.2	50% NMED SL	0.25	1
trans-1,2-Dichloroethene	25	25% EPA MCL	0.3	1
trans-1,3-Dichloropropene (1,3-Dichloropropene)	2.2	50% NMED SL	0.25	1
Dichlorodifluoromethane	47.5	25% EPA RSL	0.3	1
Metals with Trigger Levels				
Uranium (total)	15	50% EPA MCL	0.05	0.2
Chromium (total)	43	NMED-approved background concentration	2.5	10
Cadmium	2.5	50% of EPA MCL	0.11	1
Nickel	50	25% of NMED WQCC standard of 0.2 mg/L	0.5	2

Refer to footnotes at end of table.

Table 5.2.4-1 (Concluded)
Mixed Waste Landfill Groundwater Monitoring Trigger Levels

Groundwater Monitoring Parameters	Final Trigger Levels [a]	Trigger Level Source[a]	2011 Laboratory Reporting Limits	
			Method Detection Limit (µg/L)	Practical Quantitation Limit (µg/L)
Radiological Constituents with Trigger Levels				
Tritium	4 mrem/yr	EPA MCL	—[d]	—[d]
Radon	1,000 pCi/L	No Regulatory Standard	—[d]	—[d]
Gross Alpha Activity	15 pCi/L[e]	EPA MCL	—[d]	—[d]
Gross Beta Activity	4 mrem/yr	EPA MCL	—[d]	—[d]

[a]All trigger levels reviewed and updated in February 2012 and are based upon current EPA (November 2011) RSLs for Tap Water, EPA (May 2009) MCLs, NMED WQCC (2002) MACs for Tap Water, and NMED (February 2012) SLs for Tap Water. Percentage of standard/screening level based upon NMED guidance (Bearzi October 2008a).
[b]Common laboratory contaminants specified in EPA (November 1992) technical guidance.
[c]Methylene chloride trigger level is adjusted to 60% of the EPA (May 2009) MCL, which is the analytical laboratory method detection limit.
[d]Critical level and minimum detectable activity for all radiological analyses vary greatly but are below the associated trigger level.
[e]Gross alpha activity data corrected for naturally occurring uranium in accordance with 40 CFR Parts 9, 141, and 142, Table I-4.
— = Not applicable.
µg/L = Micrograms per liter.
CFR = Code of Federal Regulations.
EPA = U.S. Environmental Protection Agency.
MAC = Maximum Allowable Concentration.
MCL = Maximum Contaminant Level.
mg/L = Milligram(s) per liter.
mrem/yr = Millirem per year.
NMED = New Mexico Environment Department.
pCi/L = Picocurie(s) per liter.
RSL = Regional Screening Level.
SL = Tap Water Screening Level.
WQCC = Water Quality Control Commission.

5.2.4.1 Volatile Organic Compounds

VOCs are of particular concern because they are highly mobile in the vapor phase. Soil-vapor surveys conducted in the mid-1990s and 2008 do not indicate significant downward VOC contaminant migration in the vapor phase. However, earlier studies (Johnson et al. 1995, Klavetter August 1995) and the probabilistic performance-assessment modeling in the CMI Plan (Ho et al. January 2007) have shown that the potential exists for VOCs to contaminate groundwater at the MWL.

Vadose zone VOC monitoring described in Section 5.2.3.1 forms the first line of defense for the long-term protection of groundwater and will provide early detection of significant downward VOC contaminant migration well before groundwater is impacted.

Groundwater monitoring represents the second line of defense for groundwater protection. VOC groundwater trigger levels have been developed for all EPA Method 8260 Target Compound List VOCs using a conservative approach consistent with NMED requirements (Bearzi October 2008a). The groundwater trigger levels for VOCs are presented in

Table 5.2.4-1 and are based upon EPA and NMED regulatory standards or tap water screening levels and NMED guidance (Bearzi October 2008a).

Five of the VOCs have trigger levels that are at or below the analytical laboratory PQL, including 1,1,2-trichloroethane, benzene, bromodichloromethane, dibromochloromethane, methylene chloride, and vinyl chloride. Methylene chloride and vinyl chloride have trigger levels set at the analytical laboratory method detection limit (MDL), which is the lowest concentration the laboratory instrumentation can detect (all detected values between the PQL and MDL are qualified as estimated by the analytical laboratory). In addition, several of the VOCs, including methylene chloride, are ubiquitous laboratory contaminants that are routinely detected in groundwater samples as a result of cross-contamination occurring in the laboratory. In addition, NMED-approved MWL Toluene Investigation Report documented that the very low concentrations of toluene detected in MWL and other groundwater samples was the result of other ambient sources and not representative of actual concentrations in groundwater (SNL/NM October 2010). For these reasons the issue of false positive results that exceed the trigger level are of particular concern relative to groundwater monitoring.

5.2.4.2 Metals

Uranium occurs naturally in groundwater beneath the MWL at concentrations ranging from 1.34 to 9.23 micrograms (μg)/L and averaging 5.97 μg/L. Total uranium concentrations in groundwater beneath the MWL are well within the total uranium ranges (0.1 to 86 μg/L) established by the U.S. Geological Survey for the Middle Rio Grande Basin (USGS 2002), but commonly exceed NMED-approved background concentration of 5.2 μg/L. Isotopic analyses of uranium have demonstrated that it is of natural origin (Goering et al. December 2002).

The probabilistic performance-assessment modeling for the MWL (Ho et al. January 2007) indicates the possibility that uranium will reach the groundwater (although none of the simulations showed the uranium concentrations exceeding the EPA Primary Drinking Water Standard of 30 μg/L). For this reason, a monitoring trigger of 15 μg/L (one-half of the EPA maximum contaminant level [MCL]) is established for uranium in MWL groundwater at the point of compliance.

Based upon NMED requirements, trigger levels are also established for total chromium, cadmium, and nickel (Bearzi October 2008a) as shown in Table 5.2.4-1.

5.2.4.3 Radionuclides

Radionuclide trigger values for groundwater are provided in Table 5.2.4-1 for tritium, radon, and gross alpha/beta activity. The trigger levels are based upon EPA MCLs except for radon, which does not have an established EPA MCL. A trigger level for radon is required by NMED (Bearzi October 2008a). There are no trigger levels for the radionuclides associated with the gamma spectroscopy analysis, but the results will be included in the annual long-term monitoring and maintenance report. Gross alpha and beta activity results provide a general screening method; they do not provide radionuclide-specific information. Naturally occurring uranium in groundwater beneath the MWL affects both radon and gross alpha activity results. In accordance with 40 CFR, Parts 9, 141, and 142 (Table I-4), gross alpha activity results will be corrected for total uranium. This is deemed appropriate when uranium is naturally occurring and total uranium analytical results are obtained separately, as is the case with both historical and future MWL groundwater monitoring.

Based upon the probabilistic performance-assessment modeling conducted for the MWL (Ho et al. January 2007), the primary medium of concern for tritium and radon is air. Radon air monitoring and the associated trigger level are addressed in Section 5.2.1. Surface soil monitoring for tritium provides information relative to the flux of tritium from the soil to the air; this monitoring and the associated trigger level are addressed in Section 5.2.2.1. As with vadose zone VOC soil-vapor monitoring, the air and surface soil monitoring of radon and tritium, respectively, are expected to provide early detection of significant contaminant migration if any unexpected changes in conditions occur. However, groundwater monitoring for these constituents will be performed as required by NMED (Bearzi October 2008a).

5.3 Summary of Trigger Levels

Based upon the results of the probabilistic performance-assessment modeling conducted for the MWL (Ho et al. January 2007) and input from NMED and the public, monitoring trigger levels have been developed for the air, surface soil, vadose zone, and groundwater at the MWL. Specific triggers include numerical thresholds for the following:

- Radon concentrations in the air
- Tritium and metals in surface soil
- VOCs in vadose zone soil vapor
- Soil moisture in the vadose zone
- VOCs, metals, and radionuclide concentrations/activities in groundwater

The trigger values were derived from EPA (May 2009 and November 2011), DOE (1993), NMED regulatory standards/screening levels (NMED WQCC 2002 and NMED February 2012), and NMED-approved background concentration for chromium in groundwater (Dinwiddie September 1997). If a trigger is exceeded, then the Permittees will initiate the trigger evaluation process (Section 5.1 and Figure 5.1-1) that will allow sufficient data collection to assess trends and recommend appropriate further investigation and/or corrective action, if necessary.

By utilizing these media-specific early detection trigger levels during long-term monitoring at the MWL, the Permittees will ensure that the MWL remedy and site conditions continue to be protective of human health and the environment, while meeting the performance objectives for the ET Cover and the corrective action objectives established in the MWL CMS Final Report (SNL/NM May 2003).

6.0 INSTITUTIONAL CONTROLS

6.1 Introduction

This chapter describes the ICs to be implemented and maintained at the MWL during the long-term monitoring and maintenance period. ICs are mechanisms used to control access to and restrict the use of contaminated land, facilities, and environmental media, thereby limiting exposure to remaining contamination. ICs can take the form of administrative controls, legal controls, physical barriers or markers, and methods to preserve information and data and inform current and future generations of hazards and risks. ICs are generally used to supplement active remediation measures/final remedies (EPA September 2000) by instituting post-remediation/final remedy administrative and/or physical controls.

ICs typically used at DOE sites include the following:

- Government ownership (e.g., federal or state)
- Warning notices (e.g., no trespassing signs, notification signs for hazardous and sensitive areas)
- Entry restrictions (e.g., requirements for security badges, fencing, training for persons entering hazardous or sensitive areas)
- Resource-use management (e.g., land use and real property controls, excavation permits)
- Site information systems (e.g., information tracking systems on the location and nature of waste sites or geographic based-information archives)

6.2 Institutional Controls at the Mixed Waste Landfill

ICs are a key element of the long-term monitoring and maintenance strategy for the MWL. Various ICs are already in place for the MWL. The application of multiple ICs at the MWL is consistent with a conservative strategy that uses multiple, independent layers of controls to protect human health and the environment. Thus, if one control temporarily fails, other controls will be in place to mitigate significant consequences of the failure. The ICs applicable to the MWL are discussed in depth in the following sections.

6.2.1 Government Ownership

Government ownership is an IC that restricts or prevents unauthorized access to sites with hazardous or radioactive materials. The MWL is located on DOE-owned land in TA-III, one of five TAs at SNL/NM, and is within the boundaries of KAFB. TA-III is a test area containing numerous buildings and test facilities owned by DOE; the area is expected to remain under DOE control (and on land owned by the federal government) indefinitely.

Figure 6.2.1-1 shows the location of SNL/NM TAs and land uses within KAFB. Future land-use designations are based upon the Kirtland Area Office input for DOE Future Use Report (DOE et al. September 1995).

In case of the unlikely scenario that DOE relinquishes ownership of TA-III and the property is transferred to state or local authorities or to private ownership, the site would have to be reevaluated to determine what, if any, measures would be required to make the site acceptable for its expected land use after ownership transfer.

6.2.2 Entry Restrictions

Entry restrictions are another category of ICs imposed at the MWL. Entry restrictions include security requirements and fencing. Access to the MWL is strictly controlled because of its location on both KAFB and within TA-III, which is a restricted area. Access to KAFB is strictly limited to members of the workforce, construction/maintenance contractors, visitors with badges, and to families of military personnel who live on base. Access to KAFB is controlled 24 hours per day, 7 days per week, and is limited to personnel who have a need to enter the base. Access is restricted by armed guards at the gates to KAFB. Access to TA-III is limited to DOE-authorized personnel and is controlled using a gate.

Three tiers of fences limit access to the MWL. Both KAFB and TA-III are fenced along their perimeters. A 44-inch-high, barbed-wire fence surrounds the MWL perimeter. The fence incorporates three strands of barbed-wire with tee-posts set into the ground, and steel corner posts set in concrete.

The MWL fence has two 16-foot-long, 42-inch-high gates comprised of tubular steel with galvanized chain links, located near the northeastern and southeastern corners of the site. The gates are locked at all times except as necessary to provide access for surveillance, maintenance, and monitoring activities. This is the only perimeter security fence that is subject to the inspection, maintenance, and repair requirements of Section 4.5.

6.2.3 Warning Notices

A third category of ICs at the MWL are warning notices, including “no trespassing” signs and radiological postings for the site. To ensure visual notification, the fence line is posted with signs having at a minimum a legend reading, “Caution—Unauthorized Personnel Keep Out” and warning against entering the area without specific permission of the Owner. The signs are legible from a distance of at least 25 feet. The size of the visual warning and the spacing of the warning signs are large enough and close enough to ensure that one or more of the signs can be seen from any approach prior to an individual actually making contact with the fence line.

Radiological warning signs are also on the fence. The signs read, “Caution: Underground Radioactive Material, Controlled Area, Authorized Personnel Only.” The radiological signs are legible from a distance of at least 25 feet and are visible from any approach to the fence. Warning notices and radiological postings in Spanish are also installed on the fence.

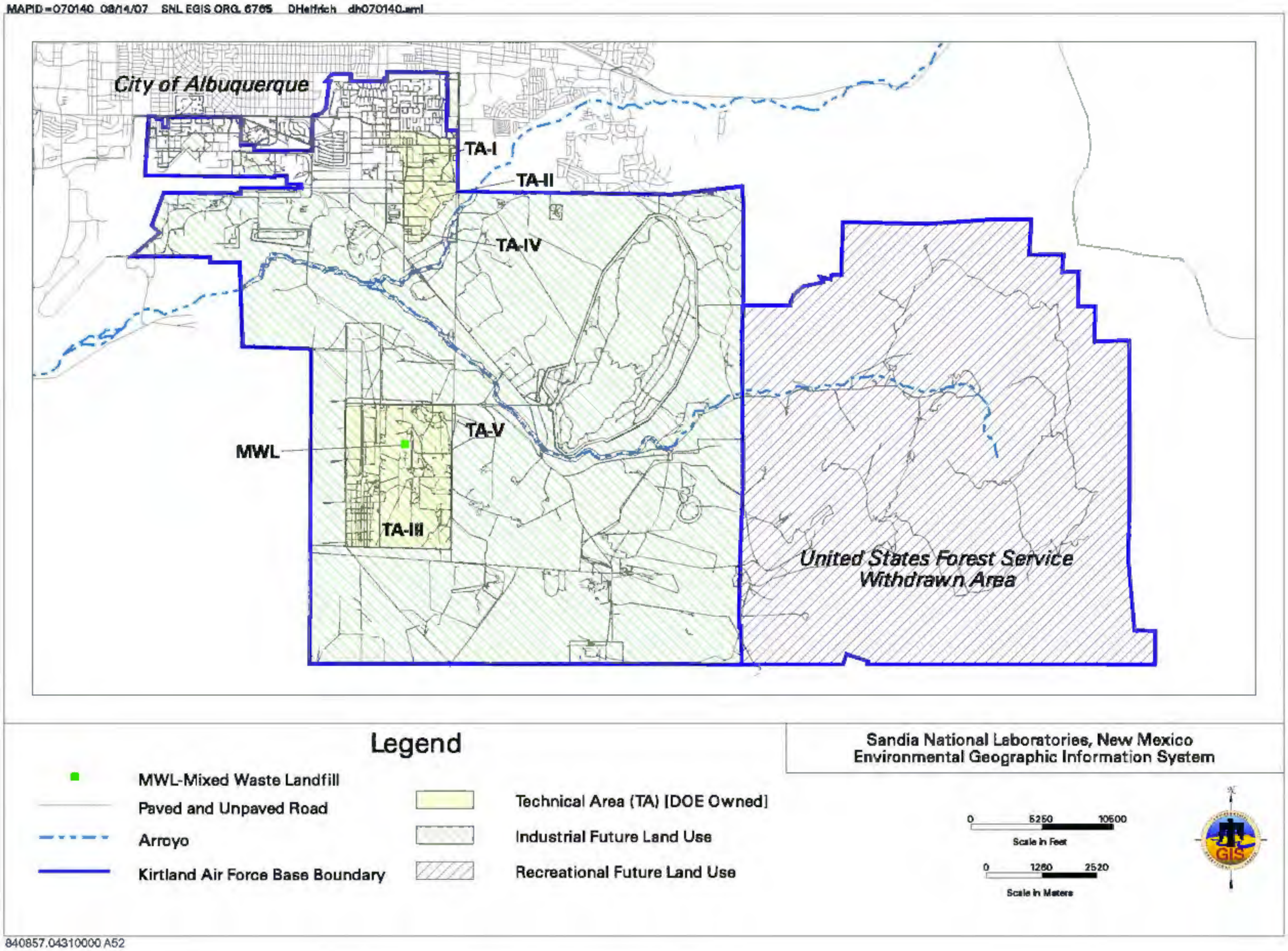

Figure 6.2.1-1
Future Land-Use Designations on Kirtland Air Force Base

6.2.4 Active Controls

Another category of ICs are active controls that rely on the presence of humans to fulfill safeguard and maintenance responsibilities. These include monitoring to ensure that contaminant migration is not occurring and the containment design is functioning appropriately and conducting routine inspections and maintenance at the site. The comprehensive, multi-media long-term monitoring program is detailed in Chapter 3.0 of this document and includes monitoring of air, soil, vadose zone soil vapor and soil moisture, and groundwater. Inspection, maintenance, and repair activities are discussed in Chapter 4.0, and the early detection trigger evaluation process is presented in Chapter 5.0.

6.2.5 Resource-Use Management

ICs addressing land use and excavation are also in place at SNL/NM and hence, the MWL. Land use within TA-III is managed in accordance with all applicable requirements. Land-use controls are mechanisms intended to ensure that land use follows the appropriate planning process and are intended to minimize the potential for unplanned disturbances of sites containing hazardous or radioactive material.

Resource-use controls at the MWL include the following:

- Excavation permits or other internal work procedures to reduce the potential for unplanned disturbances, to inform and protect workers regarding potential exposure to hazardous or radioactive waste, and to reduce the likelihood of mobilizing contaminants from contaminated areas due to human intrusion

- Radiological work permits or other internal work procedures to identify radiological conditions and establish worker protection and monitoring requirements

Land-use restrictions as defined in this LTMMP will be documented in the DOE Property Management System, and the information will be available at the time of any future property transfer.

6.2.6 Site Information Systems

SNL/NM has a number of information systems in place that help to manage activities at the MWL. These include the following:

- SNL/NM Records Center

- SNL/NM GIS [Geographic Information System] Program

- SNL/NM geographical environmental management system

- The Government Information Department Public Reading Room at the University of New Mexico (UNM) Zimmerman Library

- SNL/NM database of institutional controls at SWMUs

The Administrative Record is the body of documents and information that was considered, or relied upon, to arrive at a final decision for remedial action or hazardous waste management at the MWL. The documents related to the MWL in the Administrative Record include, but are not limited to, RFI Work Plans, Phase 1 and Phase 2 RFI Reports, Responses to NODs, the MWL CMS Final Report, the MWL CMI Plan, the MWL CMI Report, and other relevant correspondence and documents. The Administrative Record may be reviewed at the Government Information Department at the UNM Zimmerman Library and at NMED in Santa Fe, New Mexico.

Additional information on the MWL is contained in the SNL/NM Records Center. The Records Center maintains all records on the MWL and other SWMUs at SNL/NM, including location, waste type, and current status. The Records Center is maintained by SNL/NM personnel in accordance with DOE Orders on records maintenance. The long-term preservation of waste site information is one of the key responsibilities of the Records Center.

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7.0 CONTINGENCY PROCEDURES

This section details contingency procedures to be implemented if the MWL ET Cover fails to be protective of human health and the environment. Actual contingency responses will be addressed on a situation-specific basis in cooperation with NMED according to the Trigger Evaluation Process for the MWL presented in Section 5.1.

The MWL Class 3 Permit Modification for the MWL states:

> The [long-term monitoring and maintenance] plan shall also include contingency procedures that must be implemented by the Permittees if the remedy set forth in Section V.2 above [the vegetative soil cover with biointrusion barrier] fails to be protective of human health and the environment.

The MWL LTMMP is designed to provide for early detection of potentially changing conditions and allow for contingency measures to be taken, as appropriate. Contingency measures are designed to accommodate any unanticipated events, should the remedy not be protective of human health and the environment.

Possible MWL failure scenarios and contingencies are listed in Table 7-1. The contingencies identified depend heavily upon the implementation of the Trigger Evaluation Process (Section 5.1) and the results of further investigation initiated as part of the process. Trigger levels for long-term monitoring at the MWL are presented in Section 5.2. If the monitoring trigger levels are exceeded, then the Trigger Evaluation Process (Figure 5.1-1) will be initiated, as described in Section 5.1.

Should a specific trigger level be exceeded, then the process shown in Figure 5.1-1 will be used to ensure that adequate data are collected to determine whether additional actions are warranted. The increased frequency of data collection in Step 3 of the trigger evaluation process (Figure 5.1-1 and Section 5.1.3) will ensure that adequate data are collected to eliminate field sampling and/or laboratory error or short-term exceedances that do not reflect long-term trends. Thus, any recommendations for further investigation and/or corrective action because of trigger level exceedance(s) will be based upon data trends rather than upon a single detected value above the trigger level. NMED will be notified and involved throughout the process.

The Trigger Evaluation Process presented in Section 5.1 is an early detection system that allows specific contingencies to be addressed on a situation-specific basis in full coordination with NMED. An exceedance of a trigger level does not necessarily constitute failure of the remedy or site conditions that are not protective of human health and the environment. However, a confirmed trigger level exceedance does indicate that further investigation and additional data evaluation are necessary to determine whether additional actions are required to protect human health and the environment.

Table 7-1
Possible Failure Scenarios and Contingencies
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Failure Scenario	Notes	Procedure	Possible Corrective Action
Radon concentrations in air exceed trigger level of 4 pCi/L	Scenario unlikely based upon historical measurements of radon emissions from MWL without cover (Haaker January 1998).	1. Verify exceedance of trigger level. 2. If verified, notify NMED in writing. 3. Increase sampling frequency. 4. Reevaluate all relevant data. 5. Submit Investigation Report to NMED within one year of confirmed exceedance notification. 6. If data indicate persistent and increasing concentrations of radon, determine appropriate action in consultation with NMED.	1. Assess compliance with NESHAP and DOE Orders. If all regulatory standards are met, no further action is necessary. 2. Consider augmenting cover soil to reduce radon concentrations emitted to atmosphere. 3. Consider limited MWL excavation
Tritium in surface soil exceeds trigger value of 20,000 pCi/L in soil moisture	Scenario possible.	1. Verify exceedance of trigger level. 2. If verified, notify NMED in writing. 3. Increase sampling frequency. 4. Reevaluate all relevant data. 5. Submit Investigation Report to NMED within one year of confirmed exceedance notification. 6. If data indicate persistent and increasing concentrations of tritium, consider appropriate action.	1. Assess compliance with NESHAP and DOE Orders. If all regulatory standards are met, no further action is necessary. 2. Evaluate risk to human health and the environment. If risk is negligible, no further action is required. 3. If risk is significant, implement appropriate engineering and/or administrative controls to reduce risk.
Radionuclides in surface soil at animal burrows and ant hills exceed NMED-approved maximum background concentrations	Scenario likely as small exceedances of background concentrations are relatively common and not unexpected.	1. Continue to monitor annually and determine trends over time. 2. Include results in annual MWL long-term monitoring and maintenance report. 3. If data indicate persistent and increasing trend, perform risk assessment to determine appropriate actions.	1. Assess compliance with DOE Orders. If all regulatory standards are met, no further action is necessary. 2. Evaluate risk to human health and the environment. If risk is negligible, no further action is required. 3. If risk is significant, consider eliminating ant hills and removing animals creating the burrows. 4. If biotic mobilization of contaminants continues to be a major concern, consider adding additional thickness to MWL cover.

Refer to footnotes at end of table.

Table 7-1 (Continued)
Possible Failure Scenarios and Contingencies
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Failure Scenario	Notes	Procedure	Possible Corrective Action
Metals concentrations in surface soil near animal burrows and ant hills exceed trigger values (Table 5.2.2-1)	Scenario unlikely due to thickness of ET Cover and biointrusion barrier.	1. Verify exceedance of trigger level. 2. If verified, notify NMED in writing. 3. Increase sampling frequency. 4. Reevaluate all relevant data. 5. Submit Investigation Report to NMED within one year of confirmed exceedance notification. 6. If data indicate persistent and increasing concentrations of RCRA metals, determine appropriate action in consultation with NMED.	1. Assess compliance with SSLs and DOE Orders. If all regulatory standards are met, no further action is necessary. 2. Evaluate risk to human health and the environment. If risk is negligible, no further action is required. 3. Consider eliminating ant hills and removing animals creating the burrows. 4. If biotic mobilization of contaminants continues to be a major concern, consider adding additional thickness to MWL cover.
Gamma-emitting radionuclides detected in vegetation growing on ET Cover surface	Scenario unlikely due to thickness of ET Cover, inspection/repair requirement to remove potentially deep-rooted plants, and biointrusion barrier.	1. Continue to monitor annually and determine trends over time. 2. Include results in annual MWL long-term monitoring and maintenance report. 3. Eliminate deep-rooted plants on a more frequent basis.	1. Assess compliance with DOE Orders (including 450.1A [DOE 2008] and 5400.5 [DOE 1993]). If all regulatory standards are met, no further action is necessary. 2. Evaluate risk to human health and the environment. If risk is negligible, no further action is necessary. 3. If risk is significant, consider changes to monitor for and eliminate deep-rooted plants more frequently and consider design changes to the cover.

Refer to footnotes at end of table.

Table 7-1 (Continued)
Possible Failure Scenarios and Contingencies
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Failure Scenario	Notes	Procedure	Possible Corrective Action
Moisture in vadose zone at linear depths of between 10 to 100 ft exceed trigger levels	Scenario unlikely due to anticipated performance of the cover.	1. Verify exceedance of trigger level. 2. If verified, notify NMED in writing. 3. Increase sampling frequency. 4. Reevaluate all relevant data. 5. Submit Investigation Report to NMED within one year of confirmed exceedance notification. 6. If data indicate persistent and increasing moisture in vadose zone, determine appropriate action in consultation with NMED.	1. Determine whether ponding and preferential flow down the boreholes is responsible for the elevated moisture content. If preferential flow is occurring, regrade surface adjacent to soil-moisture monitoring access tubes to divert surface runoff or replace access tubes. 2. Evaluate infiltration through the cover using alternative methods such as double-ring infiltrometers or air-entry permeameters. 3. Assess performance of cover; if cover is not reducing infiltration sufficiently to meet the RCRA-prescribed equivalence criteria of 10^{-7} cm/s, determine reasons for poor performance of the cover. 4. Consider remedial measures to improve cover performance, such as discing native soil layer to increase porosity and vegetation growth characteristics. Replant native vegetation to enhance evapotranspiration.
VOCs in vadose zone exceed trigger levels	Scenario possible, based upon MWL fate and transport model results (Ho et al. January 2007).	1. Verify exceedance of trigger level. 2. If verified, notify NMED in writing. 3. Increase sampling frequency. 4. Reevaluate all relevant data. 5. Submit Investigation Report to NMED within one year of confirmed exceedance notification. 6. If data indicate persistent and increasing concentrations of VOCs in vadose zone, determine appropriate action in consultation with NMED.	1. Refine conceptual site model of contaminant distributions and transport through additional soil-vapor samples. 2. Update fate and transport model with additional data to predict potential impacts. 3. If groundwater contamination appears likely, consider corrective action before contaminants reach groundwater. 4. Corrective action may include soil-vapor extraction to reduce the contaminant source term.

Refer to footnotes at end of table.

Table 7-1 (Concluded)
Possible Failure Scenarios and Contingencies
Mixed Waste Landfill, Sandia National Laboratories, New Mexico

Failure Scenario	Notes	Procedure	Possible Corrective Action
VOC concentrations in groundwater exceed trigger levels	See Table 5.2.4-1 for trigger levels. Scenario possible based upon MWL Fate and Transport Model (Ho et al. January 2007).	1. Verify exceedance of trigger level. 2. If verified, notify NMED in writing. 3. Increase sampling frequency. 4. Reevaluate all relevant data. 5. Submit Investigation Report to NMED within one year of confirmed exceedance notification. 6. If data indicate persistent and increasing concentrations of VOCs, determine appropriate action in consultation with NMED.	1. Conduct risk assessment with contaminant data. 2. Consider additional corrective action measures based upon fate and transport model results and risk assessment results. 3. Propose possible remedial measures including monitored natural attenuation or active pump and treat. 4. Consider installation of passive venting to control VOCs in the vadose zone above the aquifer. 5. Consider controlling VOC migration through the vadose zone using soil-vapor extraction.
Metals concentration (including total uranium) in groundwater exceed trigger level	Scenario highly unlikely without significant increase in infiltration through the MWL cover.	1. Verify exceedance of trigger level. 2. If verified, notify NMED in writing. 3. Increase sampling frequency. 4. Reevaluate all relevant data. 5. Submit Investigation Report to NMED within one year of confirmed exceedance notification. 6. If data indicate persistent and increasing contamination of groundwater, determine appropriate action in consultation with NMED.	1. Conduct risk assessment with contaminant data. 2. Consider additional corrective action measures based upon fate and transport model results and risk assessment results. 3. Reduce metals concentrations through monitored natural attenuation. 4. Install pump and treat system to remediate metals in groundwater to less than the regulatory standard.

cm/s = Centimeter(s) per second.
DOE = U.S. Department of Energy.
ET = Evapotranspirative.
ft = Foot (feet).
MWL = Mixed Waste Landfill.
NESHAP = National Emissions Standards for Hazardous Air Pollutants.
NMED = New Mexico Environment Department.
pCi/L = Picocurie(s) per liter.
RCRA = Resource Conservation and Recovery Act.
SSL = Soil screening level.
VOC = Volatile organic compound.

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APPENDIX A
Installation Report for Two Soil-Vapor Monitoring Wells at the Mixed Waste Landfill

Sandia National Laboratories

Sandia National Laboratories/New Mexico Environmental Restoration Project

INSTALLATION REPORT FOR TWO SOIL-VAPOR MONITORING WELLS AT THE MIXED WASTE LANDFILL

OCTOBER 2010

United States Department of Energy
Sandia Site Office

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
CMI	Corrective Measures Implementation
DOE	U.S. Department of Energy
ER	Environmental Restoration
ET	Evapotranspirative
Geoprobe	Geoprobe Systems®
KAFB	Kirtland Air Force Base
MWL	Mixed Waste Landfill
NMED	New Mexico Environment Department
PC	protective casing
RCT	Radiological Control Technician
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
Sandia	Sandia Corporation
SNL/NM	Sandia National Laboratories, New Mexico
TA-III	Technical Area III
VOC	Volatile organic compound
WDC	WDC Exploration and Wells

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1.0 INTRODUCTION

This report documents the installation of two soil-vapor monitoring wells (soil-vapor wells) at the Mixed Waste Landfill (MWL) at Sandia National Laboratories, New Mexico (SNL/NM). The activities were performed in August 2009 by the SNL/NM Environmental Restoration (ER) Operations (formerly ER Project) personnel and the drilling contractor WDC Exploration and Wells (WDC).

1.1 Site Description and History

The MWL is located in the central part of Kirtland Air Force Base (KAFB), south of the City of Albuquerque, New Mexico. Within KAFB, the MWL is located in the north-central portion of SNL/NM Technical Area-III (TA-III), on federally owned land controlled by KAFB and permitted to the U.S. Department of Energy (DOE) (Figure 1-1). The MWL accepted containerized and uncontainerized low-level radioactive waste and minor amounts of mixed waste from SNL/NM research facilities and off-site DOE and U.S. Department of Defense generators from March 1959 to December 1988. Approximately 100,000 cubic feet of low-level radioactive waste (excluding packaging, containers, demolition and construction debris, and contaminated soil) containing 6,300 curies of activity (at the time of disposal) were disposed of at the MWL. Disposal cells at the landfill are unlined and were backfilled and compacted to grade with stockpiled soil.

Two distinct disposal areas are present at the MWL: the classified area (occupying 0.6 acres) and the unclassified area (occupying 2.0 acres). Wastes in the classified area were disposed of in a series of vertical, cylindrical pits. Historical records indicate that early pits were 3 to 5 feet in diameter and 15 feet deep; later pits were 10 feet in diameter and 25 feet deep. Once pits were filled with waste, they were backfilled with soil and capped with concrete. Wastes in the unclassified area were disposed of in a series of parallel, north-south trenches. Records indicate that trenches were 15 to 25 feet wide, 150 to 180 feet long, and 15 to 20 feet deep. Trenches were backfilled with soil on a quarterly basis and, once filled with waste, were capped with the original soil that had been excavated and locally stockpiled.

Containment and disposal of routine waste commonly occurred using tied, double-polyethylene bags, sealed A/N cans (military ordnance metal containers of various sizes), fiberboard drums, wooden crates, cardboard boxes, and 55-gallon steel and polyethylene drums. Larger items, such as glove boxes, spent fuel shipping casks, and contaminated soil, were disposed of in bulk without containment. Disposal of free liquids was not allowed at the MWL, except for the 1967 disposal of 204,000 gallons of reactor coolant water in Trench D. Liquids such as acids, bases, and solvents were solidified with commercially available agents before containerization and disposal. A detailed MWL waste inventory, by pit and trench, is provided in the “Responses to NMED Technical Comments on the Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation Dated September 1996, Volumes 1 and 2” (SNL/NM June 1998).

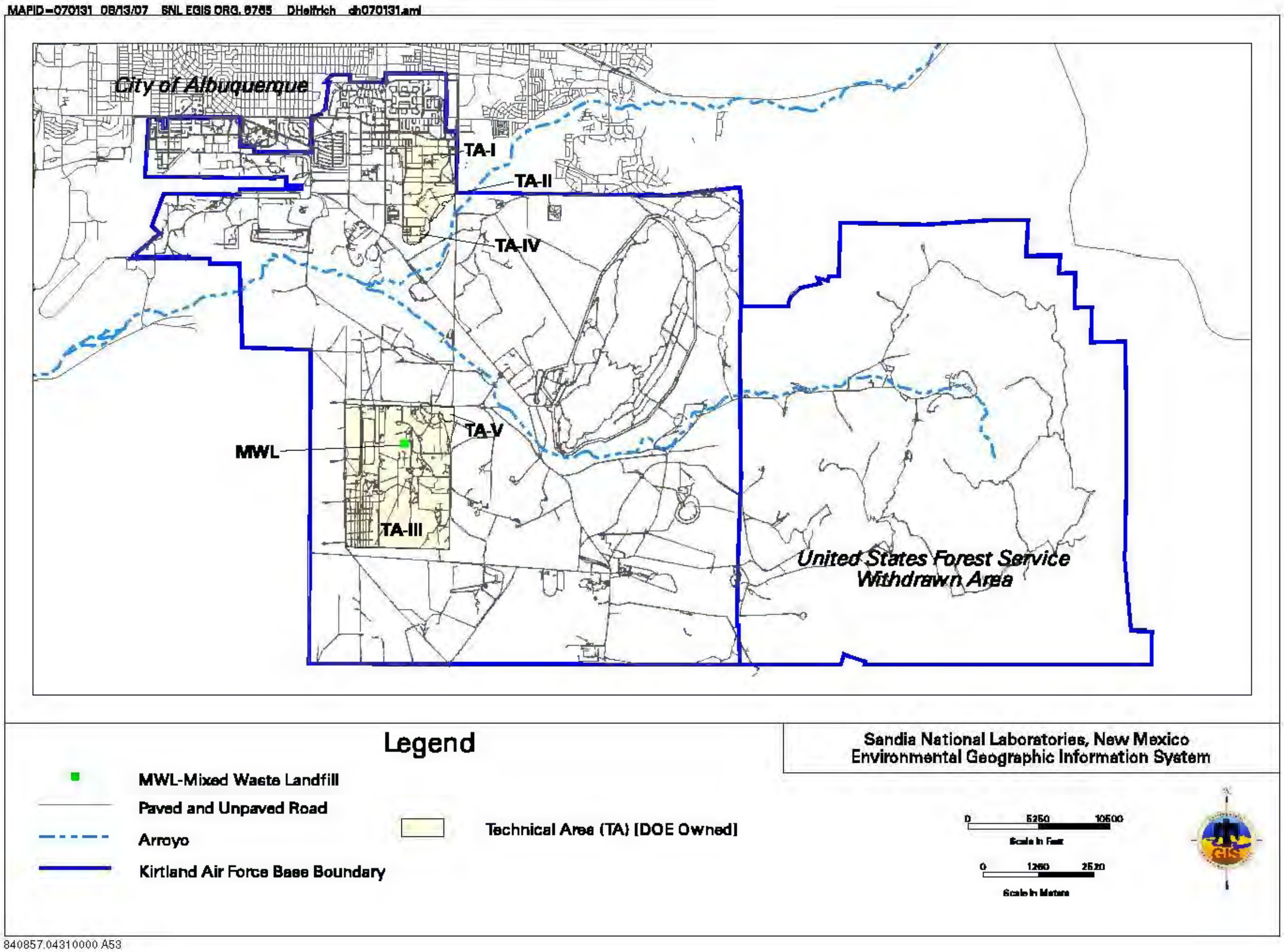

Figure 1-1
Location of the Mixed Waste Landfill, Sandia National Laboratories, and Kirtland Air Force Base

A Phase 1 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was conducted in 1989 and 1990 to determine whether a release of RCRA contaminants had occurred at the MWL (SNL/NM September 1990). A Phase 2 RFI was conducted from 1992 to 1995 to determine the contaminant source, define the nature and extent of contamination, identify potential contaminant transport pathways, evaluate potential risks posed by the levels of contamination identified, and provide remedial action alternatives for the MWL (SNL/NM September 1996).

Soil-vapor volatile organic compound (VOC) samples, tritium soil samples, and radon samples were collected at the MWL in 1994, 1995, and 1997, respectively. To determine whether subsurface conditions at the MWL had changed since the mid-1990s, the New Mexico Environment Department (NMED) required that additional soil-vapor VOC, tritium soil, and radon samples be collected at the site. This additional investigation was completed at the MWL in April and May 2008, and is described in the "Investigation Report on the Soil-Vapor Volatile Organic Compounds, Tritium, and Radon Sampling at the Mixed Waste Landfill" (SNL/NM August 2008).

1.2 Soil-Vapor Well Regulatory History and Interaction

On October 10, 2008, the NMED sent a letter to the DOE National Nuclear Security Administration and Sandia Corporation (Sandia) regarding the MWL Corrective Measures Implementation (CMI) Plan (SNL/NM November 2005). The NMED letter was entitled "Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005, Sandia National Laboratories, NM5890110518, SNL-05-025" (Bearzi October 2008) and contained comments on the MWL CMI Plan. On November 26, 2008, the DOE/Sandia submitted responses to the NMED comments (Davis November 2008) and in Part 2, Comment 6 of the response letter, DOE/Sandia proposed to install two permanent soil-vapor sampling points (wells) within the MWL boundary. On December 22, 2008, the NMED conditionally approved the DOE/Sandia responses and the CMI Plan (Bearzi December 2008) and reiterated the requirement for two permanent soil-vapor points (i.e., monitoring wells) within the MWL boundary.

On May 20, 2009, locations for the two soil-vapor wells were proposed to NMED via e-mail correspondence (Sanders May 2009). These two proposed locations were selected based on the highest soil-vapor VOC detections in 1994 and 2008 subsurface soil-vapor samples collected at the MWL. NMED concurred with the two proposed locations in a reply e-mail dated May 22, 2009, which also further specified that one of the wells be installed along the now-removed original MWL boundary fence along the southern edge of the MWL classified area, near the "old acid pit" (Moats May 2009). The old acid pit was one of the names used for the waste disposal cell located at the southeast corner of the MWL classified area. NMED personnel also confirmed that both soil-vapor wells needed to be installed at a depth of 35 feet below the original surface of the MWL such that the sampling ports were approximately 10 feet below the bottom of the waste trenches and pits.

The proposed locations for the two soil-vapor wells that were approved by the NMED via e-mail on May 22, 2009, were further confirmed during a meeting with NMED personnel on June 29, 2009.

1.3 Objective

The objective of this project was to install two soil-vapor wells to a depth of approximately 35 feet below the original surface of the MWL, at locations approved by the NMED. A secondary objective was to minimize impact to the reseeded surface of the MWL evapotranspirative (ET) cover (hereinafter referred to as the ET Cover). This was accomplished by installing the two wells immediately after placement of the topsoil layer, but prior to tilling, seeding, and mulching this layer.

The locations of the two soil-vapor monitoring wells (MWL-SV01 and MWL-SV02) and the locations of the former waste burial trenches and cells (including the old acid waste pit) are shown in Figure 1-2.

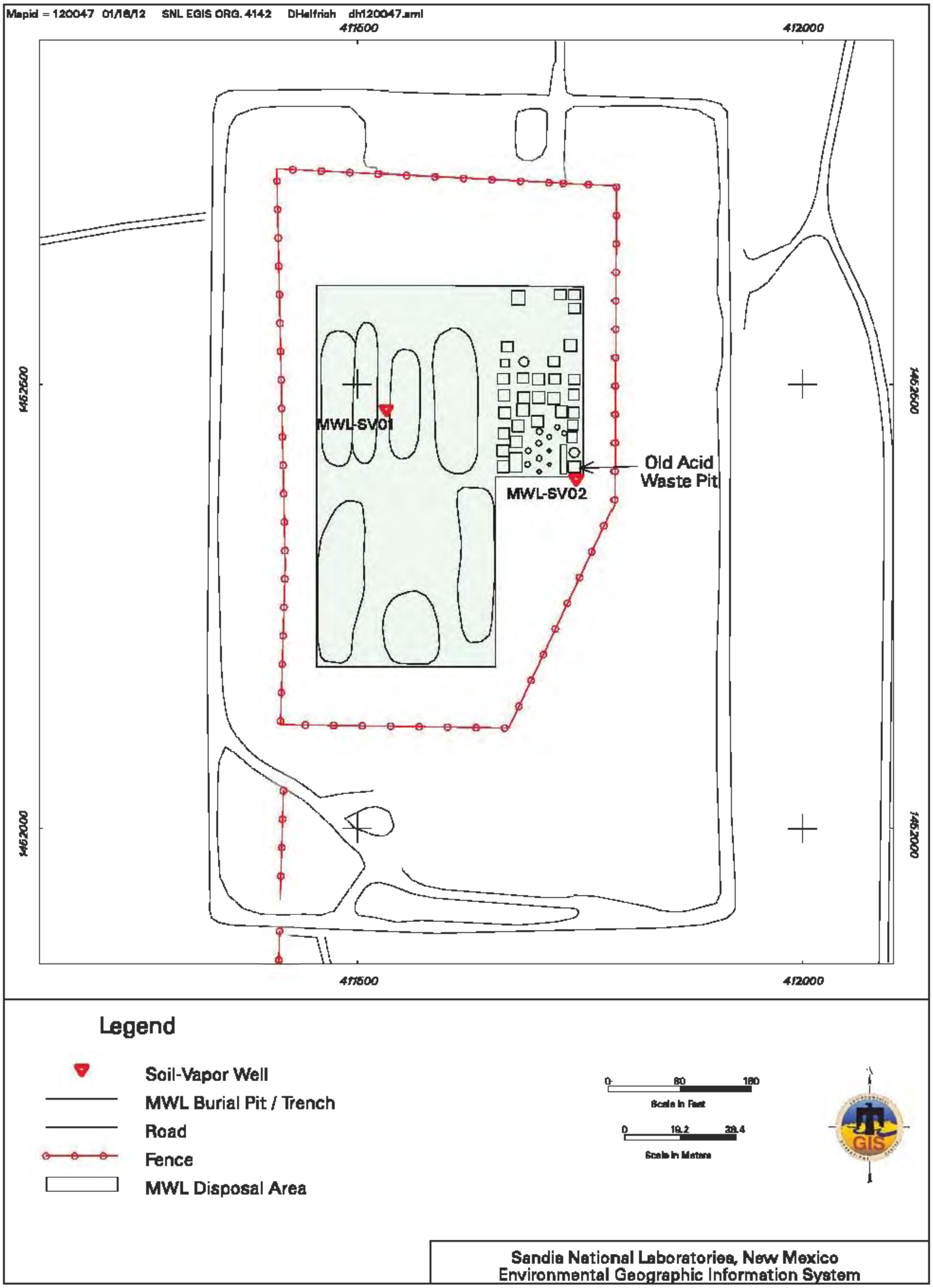

Figure 1-2
Mixed Waste Landfill Location of Soil-Vapor Wells MWL-SV01 and MWL-SV02

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2.0 SOIL-VAPOR WELL INSTALLATION

On August 5, 2009, WDC personnel mobilized a Geoprobe Systems® (Geoprobe) Model 7730DT direct-push drill rig to the decontamination pad in TA-III, and the initial equipment decontamination was performed with a pressure washer. A baseline radiological screening survey was then completed by an SNL/NM Radiological Control Technician (RCT) to confirm that the equipment was not radiologically contaminated before being brought to the MWL. No evidence of radiological contamination was detected, and the Geoprobe was transported to the first drilling location, at the southern edge of the MWL classified area (MWL-SV02 in Figure 1-2).

2.1 Soil-Vapor Well Construction

The combined thickness of both the subgrade and MWL ET Cover at MWL-SV02 was determined to be approximately 6.25 feet based upon construction surveys of the individual ET Cover layers. To meet the NMED requirement that the soil-vapor wells be completed at a depth of 35 feet below the original surface of the MWL, the targeted depth for installation of the 6-inch-long Geoprobe soil-vapor implant (i.e., screen) was 41 feet below ground surface (bgs) (top of screen) to 41.5 feet bgs (bottom of screen). Personnel from the NMED Hazardous Waste Bureau were on site for several hours the afternoon of August 6, 2009, to observe the soil-vapor well installation process.

The two soil-vapor wells were installed utilizing the procedures described in the “Implants Operation” technical literature from Geoprobe, presented as Attachment 1 of this report (Geoprobe July 2009).

MWL-SV02 was constructed in the following manner. A sacrificial stainless steel drive tip was attached to a 2.25-inch outer diameter by 4-foot-long Geoprobe rod. This rod attached to a series of other 4-foot-long rods that were hydraulically driven with the Geoprobe direct–push drilling rig to the target soil-vapor implant sampling depth (41 to 41.5 feet bgs) (Figure 2-1). After the Geoprobe rods were pushed to the required total depth, the soil-vapor implant and ¼-inch-diameter, polyethylene tubing were prepared for insertion into the inside of the rods. The soil-vapor implant consisted of a 6-inch-long by ½-inch-diameter, woven, stainless steel screen, with a conical-shaped stainless steel weight attached to the bottom. The polyethylene tubing was pushed onto a small fitting on the top of the implant (Figure 2-2), and the implant/tubing assembly was then lowered down inside the rods to 41.5 feet bgs.

Once the implant was lowered to the required depth, approximately 12 inches of 10/20 silica sand was poured into the annulus between the rods and the polyethylene tubing. The sand was installed to approximately 6 inches above the top of the implant, or 40.5 feet bgs. The silica sand was installed to create a “sand pack” around the soil-vapor screen implant, through which depth-specific soil vapor could be collected during future sampling events. Once the silica sand was installed, the remainder of the borehole from the top of the silica sand to the ground surface was sealed to ensure that soil-vapor samples would be collected from the formation at the desired depth.

Figure 2-1
Pushing the Geoprobe rods to the target soil-vapor sampling depth at the soil-vapor well MWL-SV02 location, August 5, 2009 (view to the southeast).

Figure 2-2
Geoprobe soil-vapor implant attached to 1/4-inch-diameter polyethylene tubing, which was inserted into the Geoprobe rods and lowered to the required soil-vapor sampling depth at soil-vapor well MWL-SV02 location, August 6, 2009 (view to the south).

The borehole was sealed from the top of the silica sand to the surface in the following manner. Depths to the top of materials as they were added to the borehole were determined (tagged) with a depth sounding cable provided by SNL/NM. Once the implant and 10/20 silica sand were placed, the Geoprobe rods were retracted approximately 5.5 feet, to 36 feet bgs. The section of open borehole was then backfilled through the rods with dry crushed bentonite (Baroid QuikGrout®) to a depth of approximately 38 feet bgs (2.5 feet above the top of the sand, and 2 feet below the bottom of the rods). This first lift of bentonite was then hydrated by inserting a ¾-inch-diameter rubber tube into the Geoprobe rods and lowering the tubing inside the rods to within a few inches of the top of the first bentonite lift. It was important to keep the inside of the rods dry to prevent the bentonite from sticking to and plugging up the inside of the rods as the borehole was being backfilled with the material. Once the rubber tubing was positioned at the required depth, approximately half a gallon of deionized water was poured into the tubing through a funnel and then drained into the bentonite to hydrate the material (Figure 2-3).

Once the first bentonite lift was hydrated and the rods were retracted, an additional 4 feet of borehole was backfilled with bentonite. This rod retraction/bentonite plugging and hydration procedure was repeated in approximately 4-foot lifts until the borehole was backfilled to the surface.

Care was taken to avoid damaging the polyethylene tubing as the Geoprobe rods were retracted from the borehole. The rods were also checked for potential radiological contamination by an on-site SNL/NM RCT after being withdrawn from the borehole. No radiological contamination was detected by the RCT. Once the borehole was sealed to the surface, the length of polyethylene tubing extending above the ground surface was capped, loosely coiled, and temporarily protected with a 30-gallon plastic tub.

The second soil-vapor well (MWL-SV01) was installed at a location in the northwest part of the MWL (Figure 1-2) on August 6 and August 7, 2009. The thickness of both the subgrade and MWL cover at the MWL-SV01 location was determined to be approximately 7.25 feet based upon construction surveys of the individual ET Cover layers. To meet the NMED requirement that the soil-vapor well be completed at a depth of 35 feet below the original surface of the MWL, the implant was installed at a depth of 42 to 42.5 feet bgs at this location. The installation and borehole plugging procedure previously described for MWL-SV02 was followed to complete MWL-SV01.

Upon completion of the two soil-vapor wells, the integrity of the polyethylene tubing and implant screen for each of the wells was field-checked for possible blockages or leaks by SNL/NM personnel. This was accomplished by using a portable vacuum pump to draw a test vacuum on the tubing and measuring the amount of vacuum with a gauge. The vacuum measured for the MWL-SV01 and MWL-SV02 tubing ranged from –5 to –10 inches of mercury. This was a similar range of vacuum that was measured when subsurface soil-vapor samples were previously collected with the same pump assembly at the MWL in April and May 2008. The field testing indicated that no damage or blockage had occurred to the tubing or implant screens during installation at either well.

Figure 2-3
Hydrating the bentonite plug by pouring deionized water into tubing inserted into the Geoprobe rods at soil-vapor well MWL-SV01 location, August 7, 2009 (view to the southwest).

2.2 Soil-Vapor Well Surface Completions

The surface construction of the two wells was accomplished on August 12 and August 13**,** 2009**.** For each of the soil-vapor wells a 3-foot-deep hole was carefully hand-excavated around the polyethylene tubing and bentonite-filled borehole to avoid damaging the tubing. A 6-foot-long by 6-inch-diameter piece of protective steel surface casing was installed around the tubing and into the 3-foot-deep hole. A 4-foot-square by 4-inch-thick concrete well pad was then constructed around the surface casing, and the surface casing was cemented into place. A brass cap stamped with the well name was inserted into the concrete well pad while it was still wet. Three protective bollards were also installed around the new well pad. The bases of the bollards were installed at 2 feet below the cover surface and projected 3 feet above the surface. The bollards were cemented into the ground with concrete and filled with concrete.

Once the protective casings (PCs) were installed at each well, both were filled with 10/20 silica sand from the top of the hydrated bentonite plug at the MWL ET Cover surface to within approximately 8 inches below the top of the PC. The polyethylene tubing extending above the sand was carefully coiled and stowed inside the PC, and a small rubber end cap was placed over the end of the tubing. A locking well cover was then installed on top of the PC. The final step consisted of painting the PC and bollards with high-visibility yellow paint.

The soil-vapor well construction diagrams are provided as Figures 2-4 and 2-5.

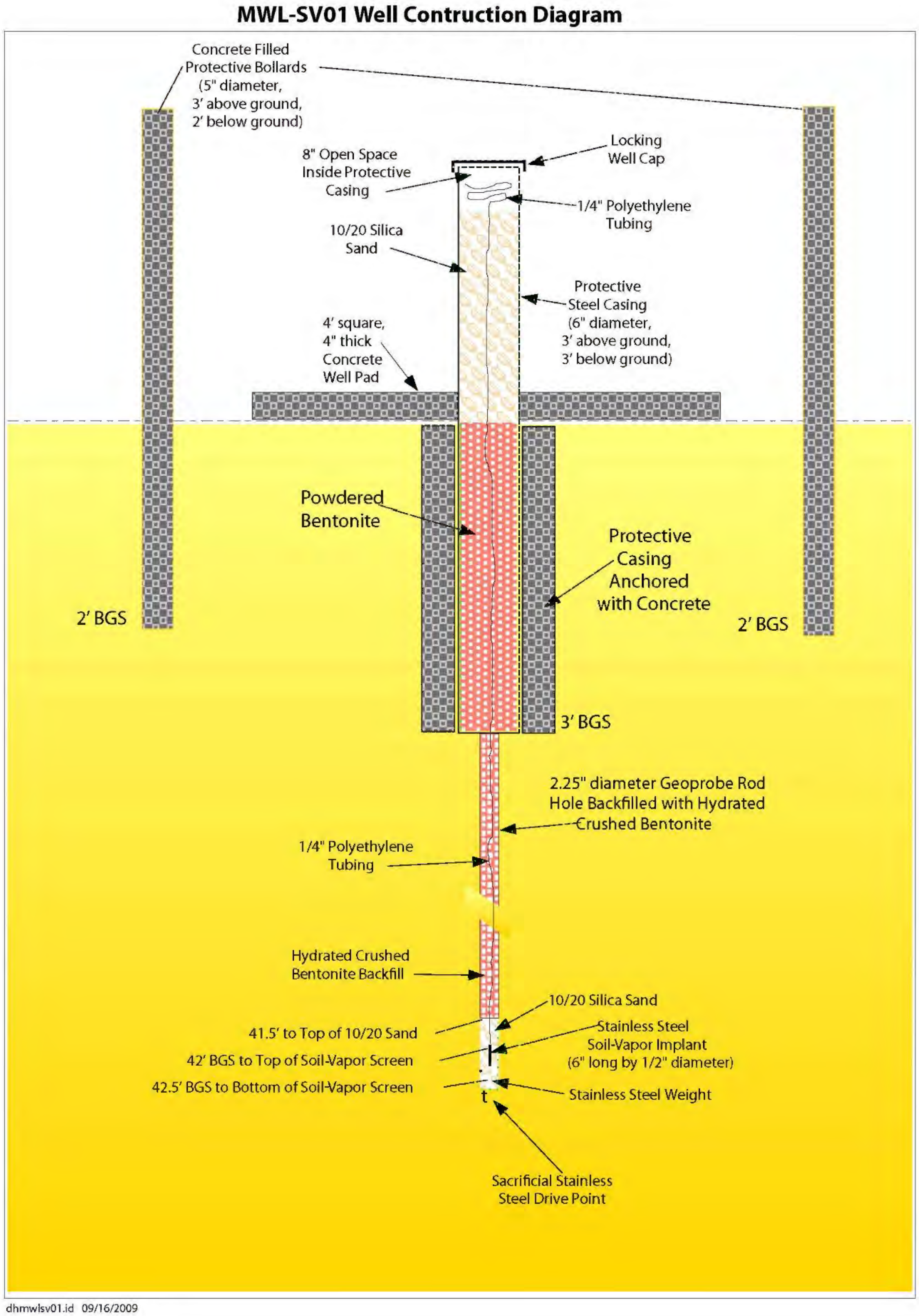

Figure 2-4
Soil-Vapor Well MWL-SV01 Construction Diagram

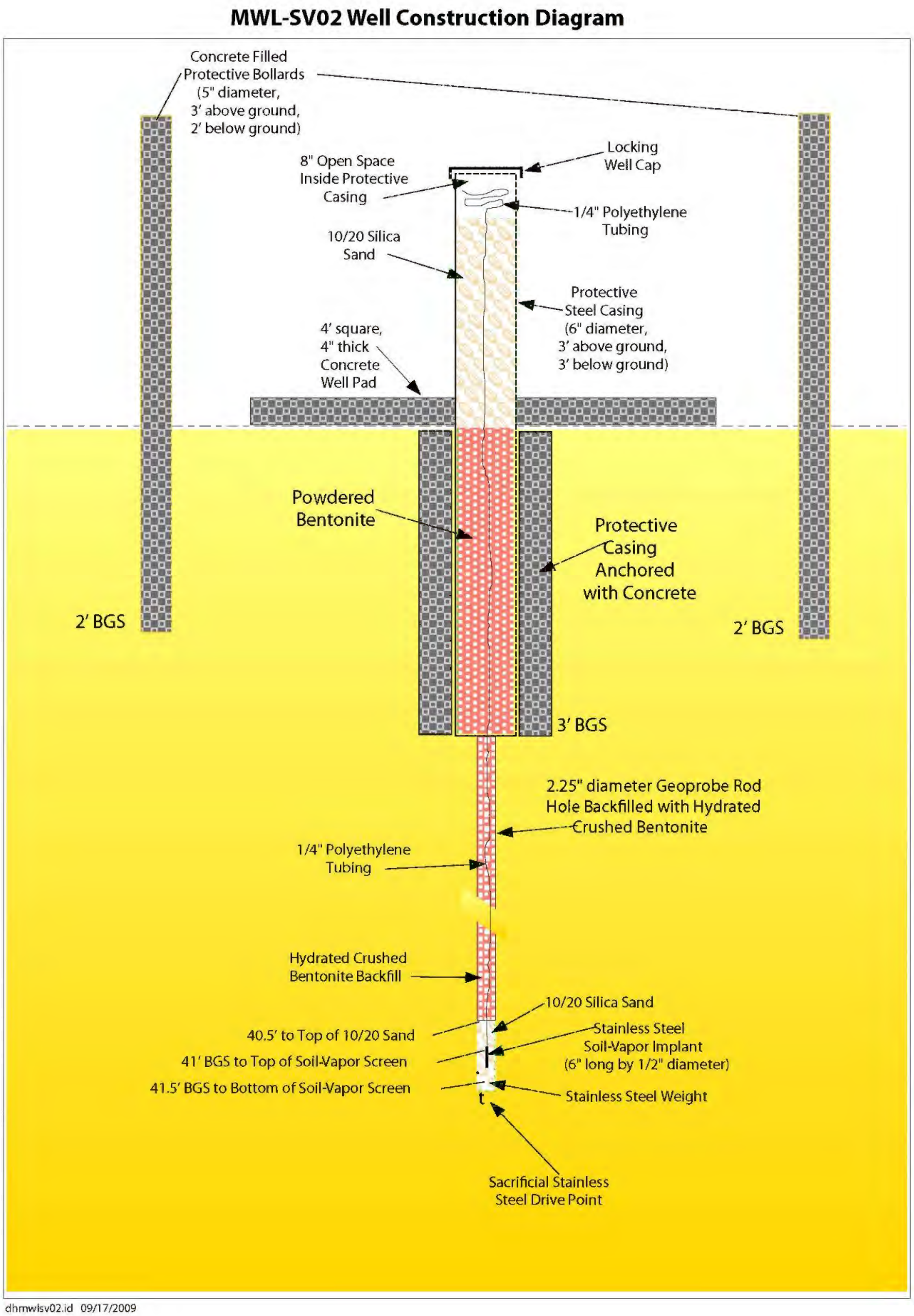

Figure 2-5
Soil-Vapor Well MWL-SV02 Construction Diagram

3.0 REFERENCES

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Sandia National Laboratories/New Mexico (SNL/NM), August 2008. "Investigation Report on the Soil-Vapor Volatile Organic Compounds, Tritium, and Radon Sampling at the Mixed Waste Landfill," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

ATTACHMENT 1
Soil Vapor Sampling Implants Operation Procedures from Geoprobe Systems®

Implants Operation

from Geoprobe Systems®

www.geoprobe.com
1-800-436-7762

Attaching polyethylene tubing to the sampling implant.

Sampling Implants – Operation

Installation Instructions for Soil Gas Implants

1. Drive probe rods to the desired depth using a Point Holder (AT-13B) and an Implant Anchor/Drive Point (PR-14). DO NOT disengage the drive point when depth has been reached.

2. Attach appropriate tubing to the implant **(Figure 1)**. If tubing is pre-cut, allow it to be approximately 48 in. (1219 mm) longer than the required depth of the implant. Cover or plug the open end of the tubing.

3. Remove pull cap and lower the implant and tubing down inside the diameter of the probe rods until the implant hits the top of the Anchor/Drive Point. Note the length of the tubing to assure that proper depth has been reached.

4. Rotate tubing counterclockwise while exerting a gentle downward force to engage the PRT threads **(Figure 2)**. Pull up on the tubing lightly to test the connection. DO NOT cut excess tubing.

5. Position a Probe Rod Pull Plate or Manual Probe Rod Jack on the top probe rod. Exert downward pressure on the tubing while pulling the probe rods up. Pull up about 12 in. (305 mm).

6. If using 1/4-in. (6,4 mm) O.D. tubing or smaller, thread the excess tubing through the Implant Funnel and position it over the top probe rod. If using larger tubing, it may not be possible to install the glass beads.

Figure 1. Attaching tubing to the sampling implant.

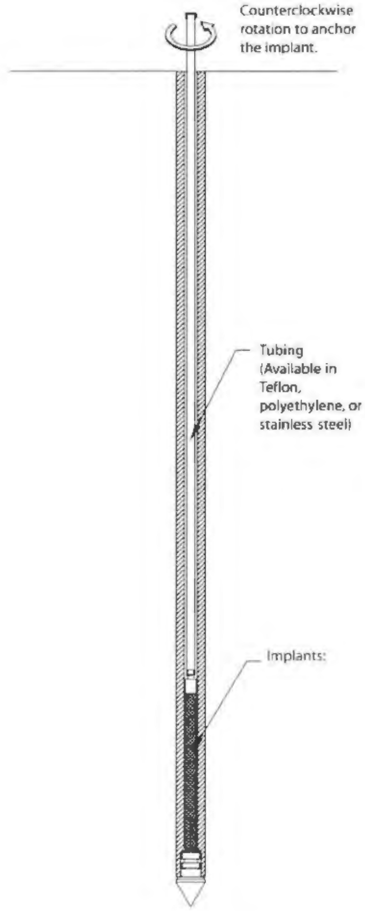


Figure 2. Once depth is achieved, the selected implant and tubing are inserted through the rods. The tubing is rotated to lock the implant into the drive point.

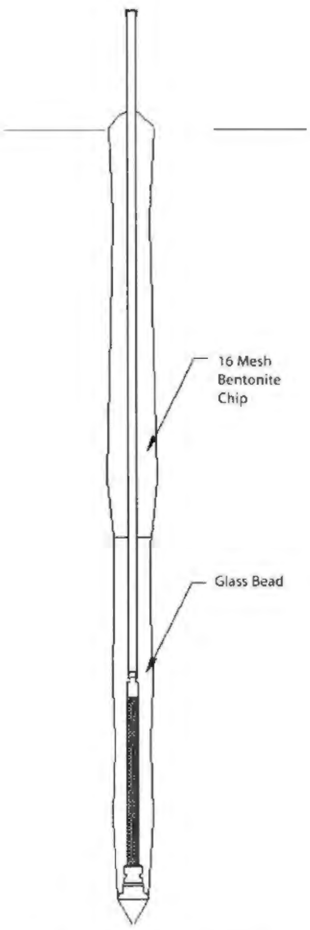


Figure 4. After the implant has been secured, the rods are removed and the annulus backfilled as appropriate.

7. Pour glass beads down the inside diameter of the probe rods around the outside of the tubing. Use the tubing to "stir" the glass beads into place around the implant. Do not lift up on tubing. It should take less than 150 mL of glass beads to fill the space around the implant.

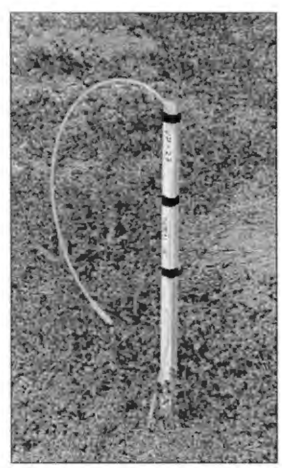
   NOTE: Backfilling through the rods with glass beads or glass beads/bentonite mixes can only be performed in the Vadose Zone, not below the water table.

8. Lift up an additional 18 to 24 in. (457 to 610 mm) and pour the bentonite seal mixture into place as in Step 7. The volume to be filled is about 154 mL per foot. It may be necessary to "chase" the seal mixture with distilled water to initiate the seal.

9. Pull the remaining rods out of the hole as in Step 5. Backfilling with sackcrete (cement/sand) or bentonite/sand may be done while removing the rods **(Figure 4)**. If the PR-14 Implant Anchor is used, the tubing may be cut flush with the top probe rod and a regular pull cap may be used to remove the remaining probe rods after Step 8.

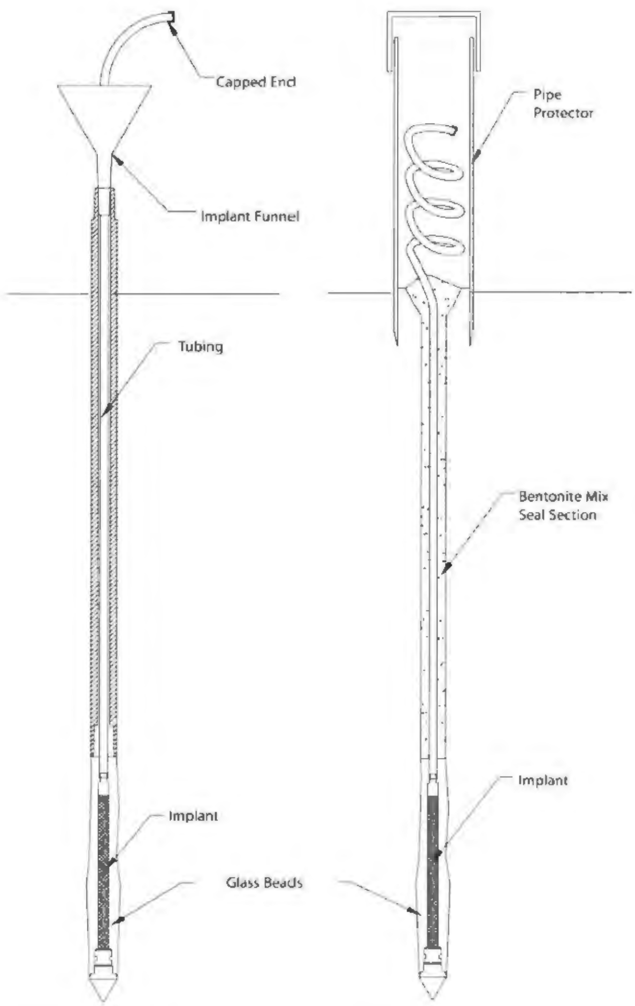
10. After the probe rods have been removed, cut the tubing at the surface, attach a connector or plug, and mark the location with a pin flag or stake. The point is ready for sampling now.

Figure 3. Glass Beads create a permeable layer around vapor sample implants.



A vapor implant location.

Sampling Implants – Operation



Backfill materials include glass beads and bentonite sealants.

Example of completed permanent soil gas monitoring point.

APPENDIX B
Summary of Cover Maintenance and Supplemental Watering Activities for the Mixed Waste Landfill Evapotranspirative Cover Calendar Years 2009 through 2011

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1.0 INTRODUCTION

Maintenance of the Mixed Waste Landfill (MWL) evapotranspirative (ET) cover (hereinafter referred to as the ET Cover) has been performed since completion of construction activities in September 2009. The following represent the primary objectives of the ET Cover maintenance efforts:

- Comply with Condition 2 of the New Mexico Environment Department (NMED) Conditional Approval of the MWL Corrective Measures Implementation (CMI) Plan (Bearzi December 2008)
  - Remove/manage Russian thistle (i.e., tumbleweed growth)
  - Implement supplemental watering as a means to help establish a mature plant community
- Promote the growth of native grass seedlings to mature, healthy plants
- Establish a self-sustaining native grass community on the ET Cover (including side slopes)

Establishing a self-sustaining native plant community that is compatible with the local east mesa ecosystem is important to long-term ET Cover performance. Native plants are ideally suited to the climate of the arid southwest. The root systems not only stabilize the ET Cover surface and minimize erosion but also take up moisture stored in the upper part of the ET Cover and transfer it to the atmosphere through transpiration. Transpiration, in combination with evaporation, prevents deeper percolation of surface water/precipitation into the subsurface where the waste is buried. Thus, native vegetation is an important component that ensures the ET Cover performs as intended.

Weed removal (Russian thistle and other invasive annual weedy species) and supplemental watering have been performed in accordance with NMED requirements and have produced positive results. ET Cover revegetation success is defined in Section 4.1 of this MWL Long-Term Monitoring and Maintenance Plan (LTMMP) as the ET Cover vegetation meeting or exceeding criteria based on the surrounding Technical Area III natural conditions for foliar coverage and percentage of native perennial grass species versus invasive annual species.

The MWL currently has a young community of native grasses established on the cover. With short term assistance these native grasses should permanently out-compete the invasive species, reducing the amount of cover maintenance required to meet successful revegetation criteria as defined in this LTMMP. Weed removal, supplemental watering, spot reseeding, and cover repair work may be required during subsequent growing seasons to maintain and enhance the current foliar coverage and balance of native grass species versus invasive annual species.

The remainder of this appendix presents the cover maintenance activities performed by calendar year (CY). For CY 2009 through CY 2011, the majority of the maintenance has been performed during the growing season (March through September).

2.0 COVER MAINTENANCE ACTIVITIES, CALENDAR YEAR 2009

During construction of the MWL ET Cover in 2009, revegetation activities were initiated on August 12, 2009, with the installation of a temporary, aboveground, sprinkler, irrigation system that covered the entire landfill surface. The temporary irrigation system was installed to provide optimal soil moisture conditions for seed germination and plant growth by maintaining moderate moisture levels within the top 3 inches of soil. Tilling, seeding, and crimping operations are detailed in the NMED-approved MWL CMI Report (SNL/NM January 2010, Revision 1) and were completed on September 2, 2009.

2.1 Temporary Irrigation System Installation

The temporary irrigation system was installed aboveground over the 4.1-acre MWL ET Cover and over approximately 2.6 additional acres of seeded area surrounding the site on August 12 and August 13, 2009. The layout of the irrigation system and the revegetated areas are depicted in Figure B-1. Prior to seeding activities, a subcontractor, Rain for Rent, Inc., installed the temporary irrigation system utilizing aluminum pipes with o-rings to seal pipe joints and hooks to connect the pipes to minimize compaction of the soil and possible seed disturbance. The main line of the system was 6 inches in diameter and each of the 17 parallel branch lines were approximately 40 feet apart. Each branch line contained between 10 and 12 sprinklers. The branch lines measured 3 inches in diameter with each sprinkler spaced 30 feet apart. Each sprinkler consisted of a nozzle with a 5/64-inch opening allowing water spray up to 33 feet (horizontal distance).

The irrigation system was connected via the 6-inch main line that extended approximately 1,000 feet to a pair of 2-inch ports on a fire hydrant located northeast of the site. The ports were connected with 2-inch backflow preventers and water meters.

2.2 Supplemental Watering Activities

According to the watering plan discussed with NMED (Wagner September 2009), the total water to be applied to the site using the supplemental irrigation system plus the naturally occurring precipitation was not to exceed an annual precipitation total of 16.5 inches for CY 2009. This annual rainfall amount (16.5 inches) is the quantity modeled as the maximum annual precipitation in the MWL CMI Plan (SNL/NM November 2005). The volume of water applied using the irrigation system was measured using the water meters and tracked in the same units as natural precipitation (i.e., inches of water on the ET Cover surface).

Based on the initial supplemental watering plan, the irrigation system was to be operated for 48 days according to the schedule provided in Table B-1. This watering schedule was previously developed for the Chemical Waste Landfill At-Grade ET Cover (SNL/NM June 2009) and approved by the NMED (Bearzi July 2009). This schedule was implemented as the starting point; the actual frequency and duration of watering was modified based upon observed field conditions and natural precipitation and to ensure the overall water budget was not exceeded.

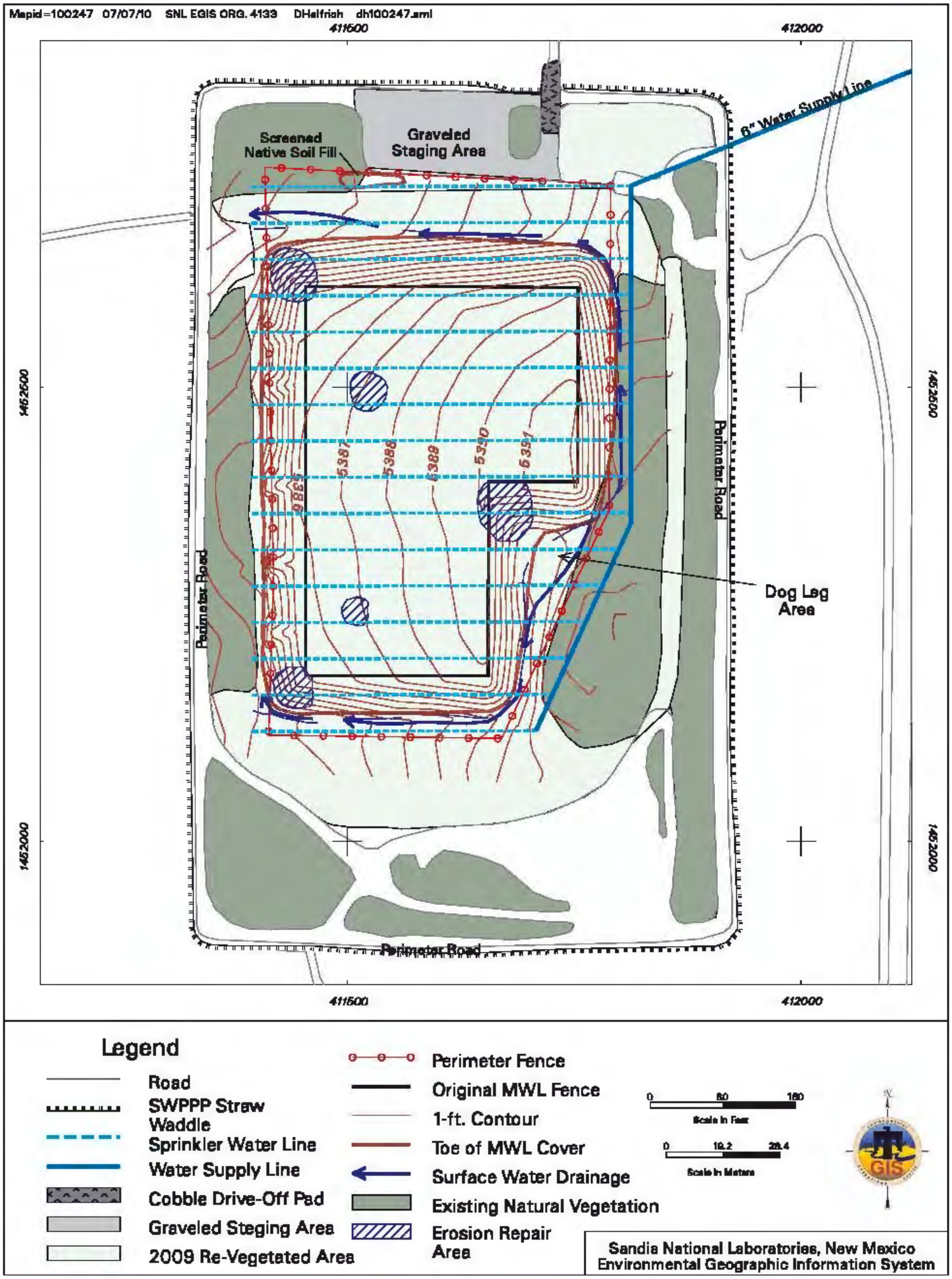

Figure B-1
MWL Temporary Irrigation System, 2009

Table B-1
Supplemental Watering Schedule
Mixed Waste Landfill Evapotranspirative Cover
Calendar Year 2009

Date Range	Watering Frequency	Time of Watering	Application Time (Hours)
Days 1-24	Daily	Morning	2
Days 25-36	Every other day	Morning	2
Days 37-48	Every third day	Morning	2.5

Supplemental watering of the MWL ET Cover vegetation was conducted from September 3 through October 20, 2009. The watering was monitored by the Sandia National Laboratories, New Mexico (SNL/NM) Staff Biologist and involved significantly less frequent daily applications. By late October, significant natural precipitation had occurred, and the cooler average temperatures indicated the end of the 2009 growing season; the supplemental watering effort was subsequently terminated.

Table B-2 summarizes the CY 2009 supplemental watering performed with the Rain-For-Rent, Inc. temporary irrigation system along with the natural precipitation monitored at both the site (during supplemental watering activities) and a nearby permanent SNL/NM meteorological monitoring station. The total for supplemental watering is conservative in that it does not factor in evaporative loss that occurred during application of the water. As shown in Table B-2, the total combined supplemental watering and natural precipitation for CY 2009 was 14.97 inches, which is 1.53 inches less than the 16.5 inches CY limit. The temporary irrigation system was removed from the site on November 3 and November 4, 2009.

Table B-2
Supplemental Watering and Natural Precipitation Summary
Mixed Waste Landfill Evapotranspirative Cover
Calendar Year 2009

Supplemental Watering Period	Number of Days Supplemental Watering Conducted	Total Monthly Gallons	Range of Daily Watering Totals (inches)	Monthly Watering Totals (inches)	Natural Precipitation (inches)
—	—	—	—	—	4.27[a]
September 3 – 30	19 out of 28 days	909,563	0.18 – 0.39	5.13	2.20
October 1 – 20	6 out of 20 days	276,907	0.21 – 0.32	1.56	0.98
—	—	—-	—	—	0.83[b]
GRAND TOTALS		**1,186,470**	—	**6.69**	**8.28**
Total Supplemental + Natural Precipitation for Calendar Year 2009				**14.97**	

[a]Total natural precipitation for pre-supplemental watering period of January 1 – September 2, 2009.
[b]Total natural precipitation for post-supplemental watering period of October 21 – December 31, 2009.

3.0 COVER MAINTENANCE ACTIVITIES, CALENDAR YEAR 2010

The silt fence around the perimeter of the site established in May 2009 prior to construction of the ET Cover was replaced with straw wattles from January 5 through January 11, 2010. The perimeter site road used for routine security patrols is located inside of the straw wattles.

To reduce invasive annual weedy species competing with native vegetation for space and resources on the ET Cover, EDi Team personnel performed a final sweep of the surface to remove invasive annual plant species (i.e., weeds) from March 26 to March 31, 2010. Weed removal was done by hand and, when possible, roots were also removed. Weeds were stockpiled at the site and later transported to the Kirtland Air Force Base Landfill for disposal.

During the CY 2009 supplemental watering activities, some segments of the irrigation pipe occasionally separated and released high pressure water spray in isolated areas. This caused limited, localized erosion of the topsoil in several areas on the ET Cover. From November 17 through November 20, 2010, these areas were repaired. Also during this time frame, approximately 200 cubic yards of screened native soil remaining from cover construction operations was hauled from the MWL Borrow Area to a staging pile north of the MWL (Figure B-1). This soil was tested during 2009 cover construction and met CMI Plan specifications for use as both native and topsoil. A total of approximately 5 cubic yards of this native soil material were used for the erosion repairs. The remainder of the material was left for future cover maintenance activities. The location of the straw wattles, native soil material pile, and perimeter security road are shown in Figure B-1.

4.0 COVER MAINTENANCE ACTIVITIES, CALENDAR YEAR 2011

Cover maintenance activities conducted during CY 2011 included both supplemental watering and weed removal.

4.1 Supplemental Watering Activities

On April 1, 2011, a request to conduct supplemental watering and cover maintenance activities at the MWL (Wagner March 2011) in lieu of an approved LTMMP was approved by the NMED (Bearzi April 2011). Requirements for watering limits, tracking, and documentation are detailed in the approved letter request and are summarized as follows:

- Supplemental watering will be applied to augment natural precipitation.
- The amount of supplemental water applied and the duration of each watering event must be tracked as a precipitation event (i.e., inches of water applied) along with natural precipitation.

- No more than 3 inches of supplemental water will be applied over a 30-day period, and no more than 0.5 inches will be applied during any one-day event.
- The total water applied to any portion of the ET Cover during the CY (combination of natural and supplemental water) shall not exceed 16.5 inches.

A water meter was installed at the hydrant and used to track the volume of water applied during each watering event. The "inches of precipitation" measurement was calculated by applying the volume of water over the ET Cover surface area impacted by the watering event. The first two supplemental watering events of CY 2011 were performed in June and July using one large sprinkler operated at 16 locations to simulate 0.5 inches of rainfall across the cover (Figure B-2). A total of 56,000 gallons of water were applied per event during the morning hours to minimize evaporative loss across the 4.1-acre ET Cover (cover and side slopes). The sprinkler locations were determined by measuring the distance (i.e., radius) of the sprinkler output and then spacing the locations across the cover area to ensure complete coverage. Due to pressure loss in the sprinkler hose at the southern end of the ET Cover, the 10 southern locations were more closely spaced than the 6 northern locations (50- versus 70-foot radius) and less water was applied for each southern location (2,600 versus 5,000 gallons).

A temporary supplemental watering system (TSWS) was installed from July 19 through August 2, 2011, to allow for more efficient as-needed supplemental watering of the ET Cover. The system configuration is shown in Figure B-3 and was designed to cover approximately 80 to 90 percent of the entire ET Cover. Prior to system startup, approximately 12,600 gallons of water were used to flush the system and perform pressure and zone testing, equivalent to applying 0.11 inches of rain over the ET Cover. Seven additional supplemental 0.5-inch watering events were conducted using this system in CY 2011, a year with a dry growing season that was preceded by a very dry winter. The TSWS is comprised of seven zones and due to the size, layout, and distance from the hydrant, only one half the TSWS could be operated at one time. CY 2011 supplemental watering events were completed by September 22 and are summarized in Table B-3. The TSWS was not drained after each use; it was drained on October 5, 2011, for the winter, and the flexible fire hose, back flow preventers, and water meter were removed from the hydrant and moved to the Environmental Restoration Field Office for storage.

4.2 Weed Removal Activities

Two weed removal events were conducted at the MWL during CY 2011. The first event was conducted from August 23 through September 1, 2011, and the second event was conducted from September 20 through October 3, 2011. Weed removal was performed prior to the plants going to seed and was facilitated by supplemental watering to soften the ground that allowed for complete removal of the root system in most cases. After removal, the plants were loaded into a trailer (capacity of approximately 8 cubic yards), compressed, and transported off site to the Kirtland Air Force Base Landfill for disposal. A total of nine trailer-loads of plant material were removed during the two events.

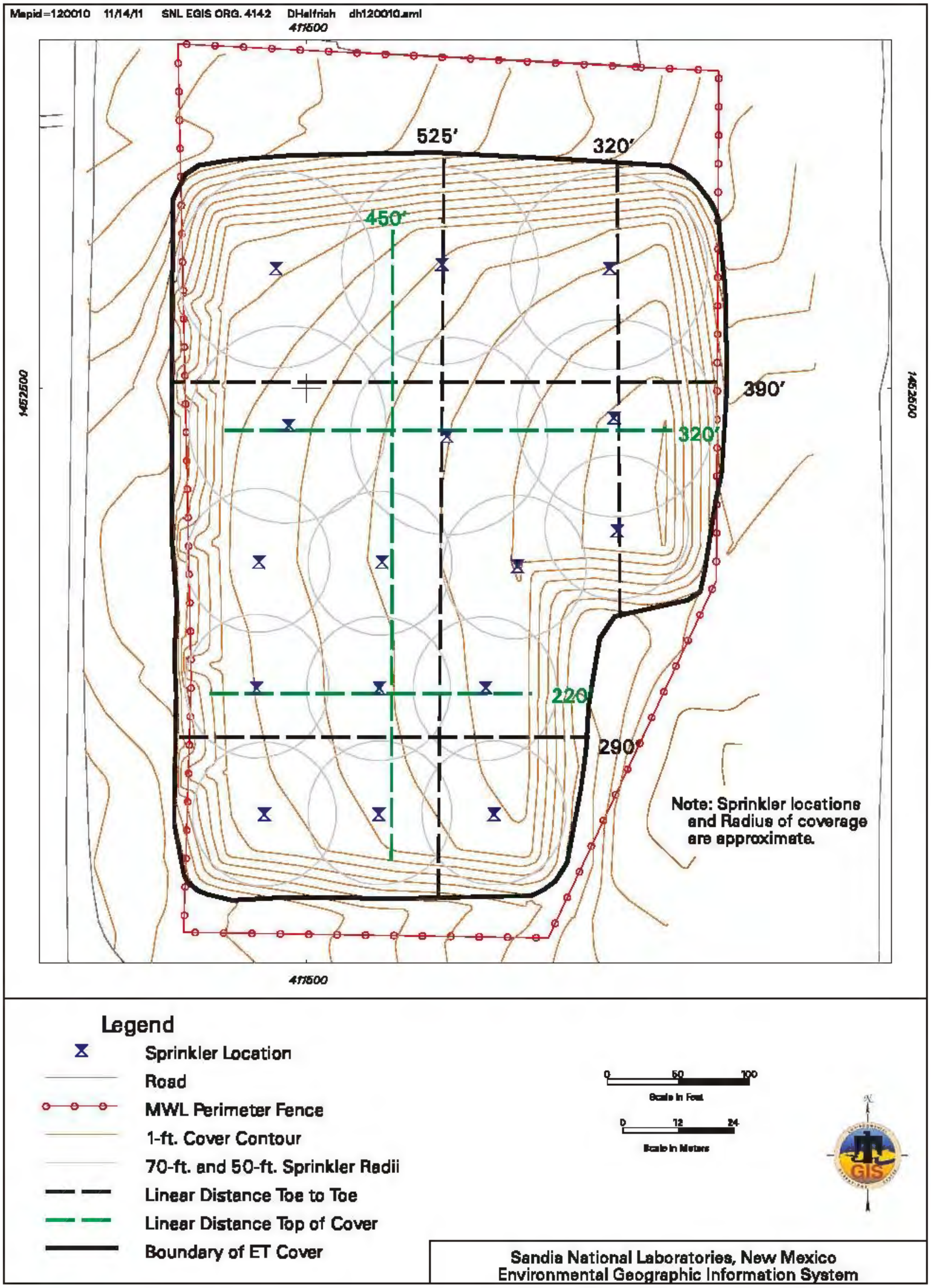

Figure B-2
Large Sprinkler Locations Used During Supplemental Watering in 2011 for the Mixed Waste Landfill

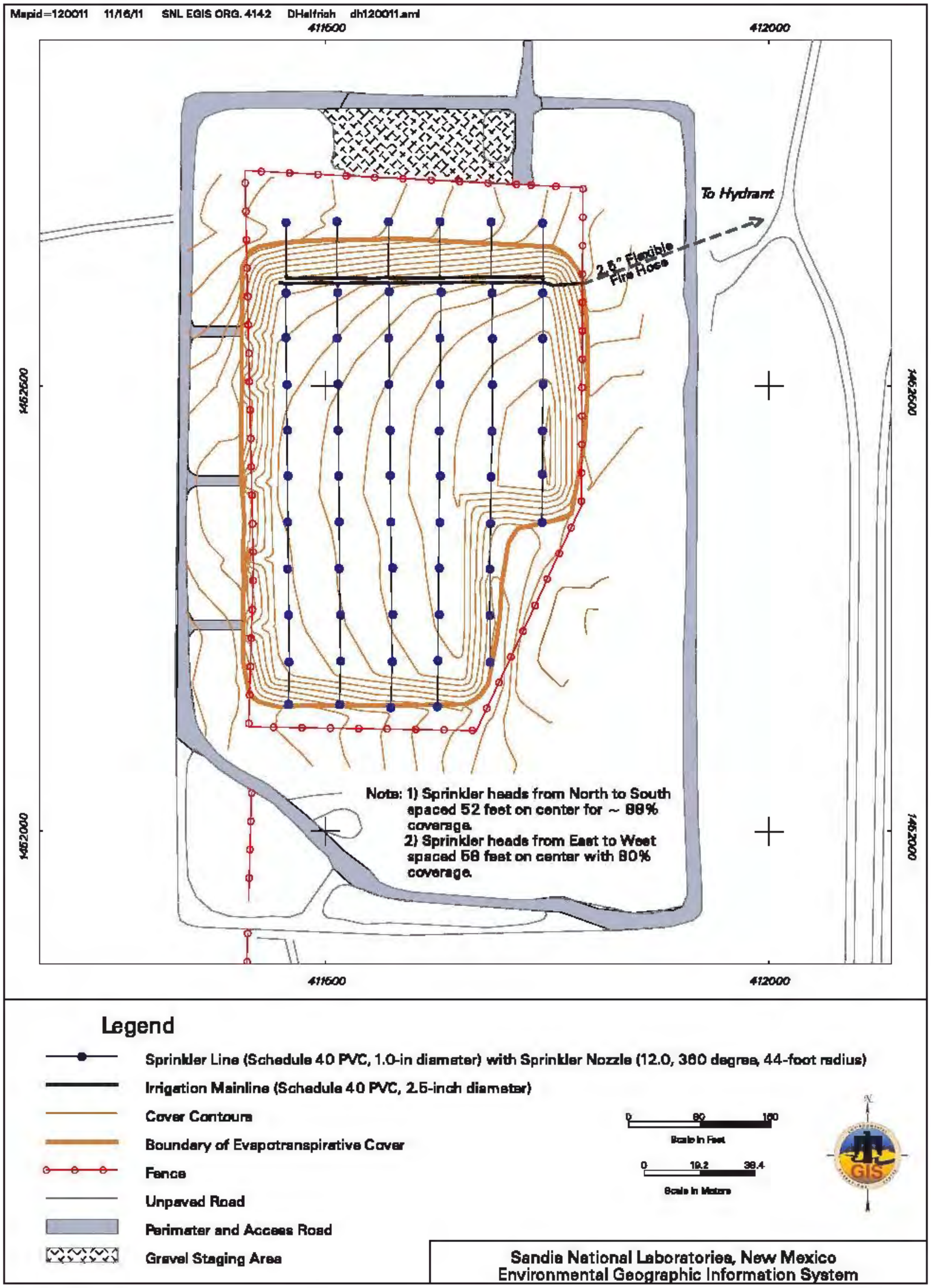

Figure B-3
Temporary Supplemental Watering System at the Mixed Waste Landfill

Table B-3
Supplemental Watering and Natural Precipitation Summary
Mixed Waste Landfill Evapotranspirative Cover
Calendar Year 2011

Supplemental Watering Event	Dates	Total Gallons Applied	Method	Total Monthly Gallons	Precipitation Equivalent (inches)	Natural Precipitation (inches)[a]
1	June 23-30	56,000	Large Sprinkler	56,000	0.5	0.21[b]
2	July 7-14	56,000	Large Sprinkler	56,000	0.5	0.71
3	August 1 and 3	12,600	TSWS	292,600	0.1	1.98
4	August 10-11	56,000	TSWS		0.5	
5	August 15-17	56,000	TSWS		0.5	
6	August 22-23	56,000	TSWS		0.5	
7	August 25-29	56,000	TSWS		0.5	
8	August 30-31	56,000	TSWS		0.5	
9	September 19-20	56,000	TSWS	112,000	1.0	0.70
10	September 21-22	56,000	TSWS			
11	October	--	--	--	--	1.35
12	November	--	--	--	--	0.22
13	December	--	--	--	--	1.70
GRAND TOTALS		**516,000**	**--**	**--**	**4.6**	**6.87**
Supplemental + Natural Precipitation for Calendar Year 2011					**11.47**	

[a]Value reflects the total natural precipitation for the entire month.
[b]Total for January through June 2011.
TSWS = Temporary supplemental watering system.

5.0 REFERENCES

Bearzi, J.P. (New Mexico Environment Department), December 2008. Letter to K. Davis (U.S. Department of Energy) and F. Nimick (Sandia Corporation), “Conditional Approval, Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005, Sandia National Laboratories NM5890110518, SNL-05-025.” December 22, 2008.

Bearzi, J.P. (New Mexico Environment Department), July 2009. Letter to K. Davis (U.S. Department of Energy) and F. Nimick (Sandia Corporation), “Approval: Chemical Waste Landfill Evapotranspirative Cover Plan, June 2009, Sandia National Laboratories NM5890110518, HWB-SNL-09-010.” July 31, 2009.

Bearzi, J.P. (New Mexico Environment Department), April 2011. Letter to P. Wagner (U.S. Department of Energy NNSA/Sandia Site Office) and S. Andrew Orrell (Sandia National Laboratories/New Mexico), “Request to Conduct Supplemental Watering and Cover Maintenance Activities, Mixed Waste Landfill, Sandia National Laboratories, EPA ID# NM5890110518 HWB-SNL-MISC. April 1, 2011.

Sandia National Laboratories/New Mexico (SNL/NM), November 2005. “Mixed Waste Landfill Corrective Measures Implementation Plan,” Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2009. “Chemical Waste Landfill Evapotranspirative Cover Plan,” Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2010, Revision 1. “Mixed Waste Landfill Corrective Measures Implementation Report,” Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Wagner, P. (U.S. Department of Energy), September 2009. Letter to J. Bearzi (New Mexico Environment Department) documenting the schedule and approach for supplemental watering at the Mixed Waste Landfill Evapotranspirative Cover. September 4, 2009.

Wagner, P. (U.S. Department of Energy), March 2011. Letter to J. Bearzi (New Mexico Environment Department), requesting approval to implement supplemental watering and cover maintenance activities for the Mixed Waste Landfill Evapotranspirative Cover. March 23, 2011.

APPENDIX C
Air Sampling and Analysis Plan for the Mixed Waste Landfill

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1.0 INTRODUCTION

Requirements for monitoring at the Mixed Waste Landfill (MWL) are defined in the Long-Term Monitoring and Maintenance Plan (LTMMP). The U.S. Department of Energy and National Technology & Engineering Solutions of Sandia, LLC are hereinafter referred to as the Permittees throughout this appendix. This Air Sampling and Analysis Plan (SAP) was developed in response to a request by the New Mexico Environment Department (NMED) to monitor for potential radon emissions at the MWL, Technical Area III (TA-III), Sandia National Laboratories, New Mexico (SNL/NM).

Radon air monitoring requirements, including background information, field and analytical methods, frequency, sampling locations, and sampling rationale, are presented in the MWL LTMMP, Section 3.2.1. The trigger evaluation process and trigger level for radon in air are presented Sections 5.1 and 5.2.1, respectively of the MWL LTMMP. This Air SAP provides detailed supporting information for the long-term monitoring of radon concentrations in the air at the MWL using commercially-available radon detectors (referred to as detectors).

1.1 Monitoring Objective

The monitoring objective of this SAP is to characterize radon emissions at the MWL over long exposure periods of three months to one year in a variety of locations at the site. In addition to establishing monitoring and data quality objectives (DQOs), this SAP presents specifications for the use of radon detectors, laboratory analysis, data evaluation, records management, and reporting. This document provides sampling personnel with the necessary information to perform radon sampling in air. The results will be compared to the proposed trigger level of 4 picocuries per liter, as presented in Section 5.2.1 of the MWL LTMMP.

1.2 Scope

Upon implementation of the MWL LTMMP, monitoring (sampling) of radon emissions at the MWL will be conducted on a routine basis throughout the long-term monitoring and maintenance period for the MWL.

2.0 BACKGROUND INFORMATION

Radon studies conducted at the MWL in 1997 (Haaker January 1998) and 2008 (SNL/NM August 2008) summarized in Section 3.2.1 of the MWL LTMMP used four-inch-diameter activated charcoal radon canisters across the MWL surface to evaluate radon surface fluxes in the vicinity of the MWL and at background locations. Results showed that the measured radon fluxes above the MWL were not significantly different than the background values and have not significantly changed between 1997 and 2008.

The MWL fate and transport model predicts no potential for release of radon-222 into the atmosphere in excess of regulatory standards, as long as the sealed sources containing radium-226 within the MWL inventory remain intact (Ho et al. January 2007). However, the MWL fate and transport model also predicts that if the sealed sources containing radium-226 degrade over time, there is some potential for radon to be emitted to the atmosphere in concentrations above regulatory standards.

Because there is a potential for radon to be emitted from the MWL wastes in excess of regulatory standards, the Permittees will conduct radon monitoring at the MWL surface to verify that the sealed sources remain intact, and that MWL conditions with the Evapotranspirative (ET) Cover in place continue to be protective of human health and the environment.

As described in the “Responses to the NMED Notice of Disapproval” (SNL/NM January 2007), radon will be monitored above ground surface along the MWL perimeter using alpha track (also referred to as track-etch), electret ion chamber, or equivalent radon detectors capable of accurately measuring radon in air over three-month to one-year exposure periods. Additional radon sampling locations overlie pits and trenches in which radium-226 was disposed, and which have a potential for generating radon in the future. The alpha track and electret ion chamber techniques are two radon long exposure measurement methods utilized for time-integrated analysis of radon air concentration (unit concentration per unit air volume), and will provide more useful information than time-discrete samples collected from soil-vapor samples or from using charcoal canisters. Radon has not been detected above background (natural environmental) levels in soils at the MWL. Any significant releases of radon in the near future are unlikely due to the nature of the radium-226 sealed sources.

3.0 DATA QUALITY OBJECTIVES

This SAP is designed to ensure that radon measurement procedures are consistent and can be used to establish radon emission trends. The DQO is to produce representative, accurate, defensible, and comparable analytical results to support the monitoring objective (i.e., provide radon emission data). This DQO will be accomplished through the implementation and use of standard operating procedures, analytical procedures/methods, quality assurance (QA) measures, quality control (QC) samples, and data evaluation protocols. Guidance on sampling protocols was also taken from the U.S. Environmental Protection Agency (EPA) (EPA July 1992).

3.1 Measurement of Radon in Air

Radon concentrations will be measured by alpha-track, electret ion chamber, or equivalent detectors designed to monitor radon exposure for three months to one year to obtain a representative long-term average concentration over time.

3.2 Detector Locations and Sampling Frequency

Each sampling event requires the placement of radon detectors at designated locations for each exposure period. Radon detectors will be collected and analyzed at the end of the sampling period. Radon levels around the perimeter of the MWL will be measured using alpha track, electret ion chamber, or equivalent radon detectors (hereinafter referred to as the detectors). A total of 10 detectors will be placed at corners and midpoints of the perimeter fence, five detectors will be placed within the boundaries of the completed ET Cover at locations overlying pits and trenches containing the highest activities of radium-226 in their disposal inventory, and two detectors will be placed in areas determined to represent background conditions as detailed in Section 3.2.1 and Figure 3.2.1-2 of the MWL LTMMP. A field control sample (serving as a QC sample) will be prepared during each sampling event.

Table C-3.2-1 gives the sampling (detector exchange) frequency for the 5 years following implementation of the MWL LTMMP. The detectors will be placed in the field for the duration of the time period to be monitored as determined by the monitoring frequency (e.g., quarterly monitoring will be accomplished by leaving the detectors in the field for 3 months and annual monitoring will involve leaving the detectors in the field for 12 months). Detector exchange will occur at the end of the monitoring period and consist of removing the exposed detector and replacing it at the same location with an unexposed detector. The exposed detector will be sent to an off-site analytical laboratory (referred to as the laboratory) for analyses.

3.3 Data Accuracy

Proper sampling procedures and use of QC samples will help reduce random and systematic sampling error or bias. Accurate estimates of radon concentration can be made reliably through the use of a qualified laboratory, appropriate methodologies, and effective QA/QC procedures. These measures along with consistent implementation of the LTMMP and this SAP will satisfy the DQO for accuracy.

Table C-3.2-1
Sampling Frequency

Time Period	Sample Frequency[a]	Sample Locations[b]	Quality Control Samples	Number Samples Per Year
Year 1	4 events (quarterly basis)	10 perimeter 2 background 5 on site	4 trip blanks (1 per event)	72
Year 2	4 events (quarterly basis)	10 perimeter 2 background 5 on site	4 trip blanks (1 per event)	72
Year 3	2 events (semi-annual basis)	10 perimeter 2 background 5 on site	2 trip blanks (1 per event)	36
Year 4	2 events (semi-annual basis)	10 perimeter 2 background 5 on site	2 trip blanks (1 per event)	36
Year 5 and subsequent years	1 event (annual basis thereafter)	10 perimeter 2 background 5 on site	1 trip blank	18

[a]Refers to the frequency in which the detectors are exchanged.
[b]Refer to Figure 3.2.1-2 of the MWL LTMMP for sample locations.

3.4 Data Consistency and Comparability

Data consistency and comparability will be achieved through implementation of this SAP, which defines field and laboratory procedures designed for this purpose. Consistency in methods and procedures will be maintained in the following areas to ensure radon emission data are consistent and that the data sets are comparable.

- Field sample collection and management
- Use of an off-site contract laboratory

After radon emission results are received from the laboratory, SNL/NM personnel will review the laboratory report for completeness and conformance to the monitoring objective and DQOs. If problems are noted that require corrective action during these reviews, the laboratory will be contacted for further information.

Each set of time-period results (quarter, semi-annual, annual) will be compared to the previous set, as well as the field background. This evaluation process will aid in characterization and allow analysis of trends, but will also help identify outliers or other potential indicators of error and inconsistency.

3.5 Quality Control

The QC measures ensure that data are scientifically sound and of known precision and accuracy. QC samples will be collected to help reduce random and systematic sampling error or bias. Section 3.5.3 presents the samples needed to meet the QC requirements for radon monitoring at the MWL.

3.5.1 Calibration Measures

Calibration measurements are the responsibility of the laboratory supplying/analyzing the detectors. Calibration measurements determine the response or reading of an instrument relative to a series of known values; results are used to develop correction or calibration factors. These factors are determined for a range of concentrations and exposure times, and for a range of other exposure and/or analysis conditions pertinent to the detector.

3.5.2 Laboratory Background Measures

Laboratory background measurements are made in the laboratory by analyzing unexposed detectors (laboratory blanks). The results are subtracted from the actual field measurements before calculating the reported concentration. Laboratory background levels may be due to electronic noise of the analysis system, leakage of radon into the detector, or other causes. The laboratory is responsible for routinely measuring the background of a statistically significant number of unexposed detectors from each batch or lot to establish the laboratory background for the batch and the entire measurement system.

3.5.3 Field Control Measures

Two types of field control measures will be employed for QC; a field control sample (field/trip blank) and a field background sample (natural environmental). These samples are specified in Table C-3.2-1.

A field control sample (field/trip blank) will be prepared during each sampling event. An unexposed detector will be set aside from each detector shipment, kept sealed and in a low radon environment, labeled in the same manner as the field samples to preclude special processing, and returned to the analysis laboratory along with each shipment. These field/trip blanks measure the background exposure that may accumulate during shipment and storage.

Two field (natural environmental) background samples will be collected during each sampling event at areas outside of the MWL, but within TA-III. This will allow the measurement of background radiation that is always present due to natural radon concentrations. The average of the two field background sample values will be compared to (subtracted from) the sample detectors that are placed on and around the MWL.

4.0 SAMPLING ACTIVITIES

This section describes the field and laboratory measures to be taken in providing radon measurements in air.

4.1 Field Activities

Field activities include the preparation, deployment, collection, and shipping of the detectors and the methods and procedures governing these activities. Adherence to this protocol will help ensure uniformity among measurements, and allow comparison of the results. Activities that will be conducted in preparation for or during radon emission monitoring include the following:

- Health and Safety
- Pre-Field Preparations
- Detector Deployment and Collection
- Sample Labeling
- Sample Custody Documentation
- Sample Handling and Shipment
- Waste Management

The SNL/NM Administrative Operating Procedure (AOP) and Laboratory Operating Procedure (LOP) for these activities are listed in Table C-4.1-1. This SAP represents the Field Operating Procedure. All personnel directly involved in radon emission monitoring field activities will review and abide by these procedures, this SAP, and the MWL LTMMP.

Table C-4.1-1
Reference Documentation[a]
MWL Radon Monitoring

Document[a]	Title
AOP 95-16	Sample Management and Custody
LOP 94-03	Sample Handling, Packaging, and Shipping, SMO

[a]The most current version will be used.
AOP = Administrative operating procedure.
LOP = Laboratory operating procedure.
MWL = Mixed Waste Landfill.
SMO = Sample Management Office.

The Permittees will provide to the NMED within 60 days of the effective date of the MWL LTMMP in hard copy and electronic format the current versions of the AOP and LOP listed in Table C-4.1-1. The Permittees shall provide NMED with any updated versions of the AOP/LOP within 30 days of their effective date. If any requirement or procedure in the AOP or LOP is found by NMED to be unacceptable for reasons including, but not limited to, the requirement or procedure will or could prevent the acquisition of representative and reliable monitoring results, the requirement or procedure shall be replaced by the Permittees with a different requirement or procedure that is acceptable to NMED.

4.1.1 Health and Safety

Field operations will be conducted in an approach that prioritizes the health and safety of field personnel above all other objectives. Every team member has the authority and responsibility to stop operations if an unsafe condition develops or is observed. All sampling personnel will perform field activities in accordance with the applicable SNL/NM safety documentation.

4.1.2 Pre-Field Preparations

Sampling locations will be identified, marked, and numbered. Only the number of detectors needed for each sampling event should be ordered as close as possible to the deployment time in order to minimize chances of background exposure. All pertinent information regarding detectors, dates, and locations will be maintained on project forms or in a log book.

4.1.3 Detector Deployment and Collection

The detector and the radon-proof container will be inspected to make sure that they are intact and have not been physically damaged in shipment or handling. The sampling period (i.e., monitoring period) begins when the protective cover or bag is removed and will be noted on project forms or in a log book along with the detector number and sample location. On the same day the detectors are removed from the protective cover or bag, they will be inspected and placed in the field, starting the monitoring period. The detector will be sealed in a protective bag when collected at the end of the monitoring period.

At the end of the sampling period (Table C-3.2-1), each detector will be inspected for damage or deviation from the conditions noted at the time of deployment. The time and date of removal and any observable changes to the detector will be noted on project forms or in a log book. The detectors will be resealed in the original container or another appropriate container following the instructions provided by the supplier. The detectors will be stored in a low radon environment and returned as soon as possible to the laboratory for processing.

4.1.4 Sample Labeling

Each detector is identified by a unique serial number. A unique SNL/NM Sample Management Office (SMO) issued sample identification number will be assigned to each detector. The SMO sample number will be affixed to each detector, and will be noted on the analysis request/chain-of-custody (AR/COC) form along with the manufacturer's serial number and the detector field location (i.e., "MWL-RN" number).

A SNL/NM sample label will be completed with indelible ink and affixed to each sample container. Each completed sample label should include the following information:

- SNL/NM SMO sample number
- Sample location
- Date and time of sample collection

A field log will be maintained documenting the collection of all samples.

4.1.5 Sample Custody Documentation

To ensure the integrity of samples from the time of collection through the reporting of analytical results, sample collection, handling, and custody will be documented. The continuous record of documented sample possession is referred to as the chain of custody. Primary elements in the documentation of samples are: sample identification number, sample labels, custody tape, and the AR/COC form. SNL/NM AR/COC forms will be used to document sample information. Sample custody and documentation procedures for sampling activities are outlined in AOP 95-16 (most current revision).

4.1.6 Sample Handling and Shipment

The exposed detectors will be packaged in either the original bag or in new bags to prevent further exposure. No preservation is needed. Detector numbers, SMO sample numbers, and sample location identification will be recorded on an AR/COC form that will accompany the detectors to the laboratory.

Samples will be shipped to the analytical laboratory in accordance with SMO procedures detailed in LOP 94-03. Prior to shipment, the sample collection documentation will be verified. Any error will be noted and corrected as required by SNL/NM SMO protocols.

4.1.7 Waste Management

There will not be any waste generated during these activities.

4.2 Analytical Methods

The detectors measure the average radon concentration at the location of the detector during the sampling period. The alpha-track detector consists of a plastic housing and a radiosensitive element that records submicroscopic damage tracks as the alpha particle emissions (alpha track) from the natural decay of radon and alpha-emitting radon decay products striking the detector. At the end of the sampling period, the alpha track detectors are returned to the laboratory. The detectors are placed in a caustic solution that accentuates the damage tracks so they can be counted using an automated counting system. The number of tracks per unit area is correlated to the radon concentration in air, using a conversion factor derived from data generated at the calibration facility. The number of tracks per unit of analyzed detector area produced per unit of time is proportional to the radon concentration. For electret ion chamber detectors, an electrostatically charged disk detector (i.e., electret) is situated within a small container (ion chamber). During the measurement period, radon diffuses through a filter-covered opening in the chamber, where the ionization resulting from the decay of radon and its progeny reduces the voltage on the electret. A calibration factor relates the measured drop in voltage to the radon concentration. The electret design for detectors used at the MWL will be appropriate for making long-term measurements. Both detector types function as true integrators and measure the average concentration over the exposure period.

4.3 Records Management and Reporting

Records associated with the radon emission sampling activities include the MWL LTMMP, this SAP, the applicable AOP and LOP, AR/COC forms, personnel training, field documentation, laboratory analytical results, and technical data evaluations. These records will be maintained at the SNL/NM Records Center and comply with the record-keeping provisions of 20.4.1.500 New Mexico Administrative Code, incorporating Title 40 Code of Federal Regulations Section 264.74, concerning the availability, retention, and disposition of records.

Reports will be prepared and submitted to the NMED as part of the annual MWL long-term monitoring reports according to the schedule defined in the LTMMP.

5.0 REFERENCES

Haaker, R. (Sandia National Laboratories, New Mexico), January 1998. Memorandum to H. Oldewage (Sandia National Laboratories, Albuquerque, New Mexico), "Radon Flux Testing at the Mixed Waste and the Adjacent Classified Waste Landfills, Technical Area III, SNL/NM." January 19, 1998.

Ho, C.H., T.J. Goering, J.L. Peace, M.L. Miller, January 2007. "Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories (2nd Ed.)," SAND2007-0170, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2007. "Reponses to the NMED's Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005 Comment Set 2," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), August 2008. "Investigation Report on the Soil-Vapor Volatile Organic Compounds, Tritium, and Radon Sampling at the Mixed Waste Landfill," Environmental Restoration Project, Sandia National Laboratories, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2011. "Sample Management and Custody, Administrative Operating Procedure," AOP 95-16, Revision 04, Sandia National Laboratories, Albuquerque, New Mexico.

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U.S. Environmental Protection Agency (EPA), July 1992. "Indoor Radon and Radon Decay Product Measurement Device Protocols," Office of Air and Radiation, Washington D.C.

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APPENDIX D
Soil-Vapor Sampling and Analysis Plan for the Mixed Waste Landfill

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1.0 INTRODUCTION

Requirements for monitoring at the Mixed Waste Landfill (MWL) are defined in the Long-Term Monitoring and Maintenance Plan (LTMMP). The U.S. Department of Energy and National Technology & Engineering Solutions of Sandia, LLC are hereinafter referred to as the Permittees throughout this appendix. This Sampling and Analysis Plan (SAP) provides requirements that shall be followed for collecting and analyzing volatile organic compound (VOC) soil-vapor samples from soil-vapor monitoring wells located at the MWL, Technical Area III (TA-III), Sandia National Laboratories, New Mexico (SNL/NM), during the long-term monitoring period. The long-term soil-vapor monitoring program, including the monitoring network, parameters, frequency, and reporting requirements, are detailed in Section 3.4.1 of the MWL LTMMP. The trigger evaluation process and soil-vapor trigger levels are presented in Sections 5.1 and 5.2.3 of the MWL LTMMP, respectively.

The purpose of this SAP is to document procedures for the collection and reporting of consistent, reliable, defensible, and comparable soil-vapor sampling results to be used to determine if soil vapor has the potential to contaminate groundwater. In addition to establishing data quality objectives (DQOs), this SAP presents requirements for field sampling, laboratory analysis, data validation and evaluation, and reporting. Other instructions are provided in SNL/NM Field Operating Procedures (FOPs), SNL/NM Laboratory Operating Procedures (LOPs), and SNL/NM Administrative Operating Procedures (AOPs); however, the requirements of this SAP and the MWL LTMMP shall take precedence over any FOPs, LOPs, and AOPs. Table D-1-1 summarizes documents that are referenced in this SAP, which can be obtained from the SNL/NM Records Center. The most current versions of these documents shall be consulted for the purpose of conducting groundwater sampling.

Table D-1-1
Reference Documentation[a]
Mixed Waste Landfill Soil-Vapor Monitoring

Document Number	Document Title
FOP 08-22	Soil Vapor Sampling
AOP 95-16	Sample Management and Custody
AOP 00-03	Data Validation Procedure for Chemical and Radiochemical Data
LOP 94-03	Sample Handling, Packaging, and Shipping
SMO 05-03	Procedure for Completing the Contract Verification

[a]The most current version will be used.
AOP = Administrative operating procedure.
FOP = Field operating procedure.
LOP = Laboratory operating procedure.
SMO = Sample Management Office.

The Permittees shall provide to the New Mexico Environment Department (NMED) within 60 days of the effective date of the MWL LTMMP in hard copy and electronic format the current versions of the FOPs, LOPs, and AOPs listed in Table D-1-1. The Permittees shall provide

NMED with any updated versions of the FOPs, LOPs, or AOPs within 30 days of their effective date. If any requirement or procedure in the FOPs, LOPs, or AOPs is found by NMED to be unacceptable for reasons including, but not limited to, the requirement or procedure will or could prevent the acquisition of representative and reliable groundwater sampling results, the requirement or procedure shall be replaced by the Permittees with a different requirement or procedure that is acceptable to NMED.

2.0 DATA QUALITY OBJECTIVES

Soil-vapor monitoring is required to provide spatial and temporal soil-vapor concentration data for the approximately 500-foot-thick vadose zone beneath the MWL. The DQO is to produce representative, accurate, defensible, and comparable soil-vapor analytical results. This SAP is designed to ensure the DQO is met by establishing standard field methods, analytical procedures/methods, quality control measures, and data review/validation protocols for the collection, analysis, and evaluation of soil-vapor data. Results from the deepest sampling ports of the deepest soil-vapor wells will be compared to trigger levels as described in Section 5.2.3 of the MWL LTMMP.

2.1 Sampling Locations and Frequency

VOC concentrations in the vadose zone will be monitored using two existing single-port soil-vapor monitoring wells installed through the MWL evapotranspirative Cover and three proposed Flexible Liner Underground Technologies (FLUTe™) or equivalent multi-port soil-vapor monitoring wells. The three multi-port FLUTe™ or equivalent wells will provide VOC concentration data at various depths beneath the MWL, whereas the single-port soil-vapor monitoring wells will monitor VOC concentrations immediately beneath the disposal areas. Soil-vapor sampling ports are planned to be installed in each FLUTe™ or equivalent well at depths of 50, 100, 200, 300, and 400 feet below ground surface. The soil-vapor monitoring system will be sampled semiannually for the first three years and annually thereafter. The soil-vapor monitoring network is presented in detail in Section 3.4.1 and Appendix A of the MWL LTMMP.

2.2 Data Accuracy and Reproducibility

The Permittees shall follow proper sampling procedures, including purging, preparation of sampling containers, and use of quality assurance (QA)/quality control (QC) samples. Accurate estimates of contaminant concentrations shall be obtained through use of qualified laboratories, appropriate analytical methods, and effective QA/QC procedures. These measures along with consistent implementation of the LTMMP and this SAP will satisfy the DQO for accuracy.

Accuracy shall be maintained and evaluated through referenced calibration standards and various laboratory control samples (typically matrix spike samples, and surrogate spike samples). A range in deviation from actual (true) concentration (percent recovered or %REC) that meets the EPA analytical method quality control requirement for each detected VOC shall be considered acceptable. The Permittees shall take corrective action for any sample results where the %REC quality control targets are not met.

At least two field duplicate samples shall be collected and analyzed during each sampling event. These samples will document the precision of the sampling and analysis process. A relative percent difference (RPD) of 50% or less for each detected VOC is considered satisfactory. An RPD will only be calculated when results for both the environmental and duplicate samples are greater than or equal to five times the laboratory reporting limit. Sampling and analysis may be repeated for any sample results where the RPD requirement is not met.

3.0 MONITORING ACTIVITIES

This section describes the field and laboratory procedures that shall be followed to produce soil-vapor analytical results that meet the requirements of this SAP.

3.1 Field Sampling

The methods and procedures used to obtain soil-vapor samples for laboratory analysis are described below in Sections 3.2 through 3.4.

Activities that shall be conducted by the Permittees in preparation for or during soil-vapor sampling include:

- Pre-field work planning;
- Vacuum check of SUMMA® canisters;
- Visual inspection of all MWL soil-vapor wells and sampling ports;
- Purging and field estimation of purge volume and total VOC concentration;
- Sample acquisition;
- Sample container documentation and packaging; and
- Sample delivery to laboratory within the method holding time.

The FOP covering these activities, as well as SMO procedures, guidance, and laboratory procedures that apply to the long-term soil-vapor monitoring program are listed in Table D-1-1 and Section 3.4.1 of the MWL LTMMP. All personnel directly involved in field activities related to soil-vapor monitoring shall review and abide by these procedures.

3.2 Pre-Field Sampling Preparations

Prior to initiating soil-vapor sampling, field personnel shall ensure that all necessary equipment is ready and properly functioning in accordance with applicable FOPs and this SAP and that the necessary arrangements have been made with the SMO and off-site analytical laboratory for sample shipment and analysis. As appropriate, operating procedures shall be reviewed and support personnel notified.

3.3 Purging and Field Estimation of Total Concentration of VOCs

At the wellhead, a vacuum pump connected to the sample tubing via a Swagelok® or equivalent fitting shall be used to purge stagnant and/or pre-existing soil vapor from the monitoring ports and sample tubing. Sample collection shall commence after at least three tubing volumes have been removed.

3.4 Sample Collection

Soil-vapor samples shall be collected in 6-liter SUMMA® canisters for off-site laboratory analysis of VOCs by EPA Compendium Method TO-15 (EPA January 1999) or equivalent. The SUMMA® canisters shall be shipped from the laboratory under vacuum and connected directly to the sampling ports by Swagelok® fittings or equivalents. Soil vapor shall be drawn into the sample container by the pressure differential between the atmosphere and the container interior. After sample collection, the valve shall be closed, and the canister shall be shipped back to the laboratory with field and analysis request/chain-of-custody (AR/COC) forms containing the sample identification number, sample location, date and time, elevation, and ambient pressure. Field sample management shall follow AOP 95-16 and the requirements of this SAP. A Swagelok® plug or equivalent fitting shall be fastened to the canister opening to ensure that the canister remains airtight during shipment to the laboratory. The canisters require no special preservation during transport and storage.

4.0 LABORATORY ANALYSIS AND DATA REVIEW

All samples shall be submitted to an off-site analytical laboratory. The samples shall be analyzed using EPA Compendium Method TO-15 (EPA January 1999) or equivalent. The Permittees shall ensure that the off-site laboratory implements the requirements of the method, including analytical method, target analytes for quantification, and internal QA/QC procedures. The target analytes are listed in Table D-4-1.

4.1 Data Verification

After soil-vapor analytical results are received from the laboratory, the Permittees shall review the laboratory report for completeness and conformance to the performance criteria of the contract according to the “Procedure for Completing the Contract Verification,” SMO 05-03 and the requirements of this SAP. If problems are noted that require corrective action, the appropriate corrective action shall be implemented.

Table D-4-1
Mixed Waste Landfill Soil-Vapor Analyte List[a]
Mixed Waste Landfill Long-Term Monitoring Program

Compound	Compound
Acetone	1,2-Dichloropropane
Benzene	cis-1,3-Dichloropropene
Benzyl chloride	trans-1,3-Dichloropropene
Bromodichloromethane	Ethyl benzene
Bromoform	4-Ethyltoluene
Bromomethane	Hexachlorobutadiene
2-Butanone	2-Hexanone
Carbon disulfide	Methylene chloride
Carbon tetrachloride	4-Methyl-2-pentanone
Chlorobenzene	Styrene
Chloroethane	1,1,2,2-Tetrachloroethane
Chloroform	Tetrachloroethene
Chloromethane	Toluene
Dibromochloromethane	1,1,2-Trichloro-1,2,2-trifluoroethane
1,2-Dibromoethane	1,2,4-Trichlorobenzene
1,2-Dichloro-1,1,2,2-tetrafluoroethane	1,1,1-Trichloroethane
1,2-Dichlorobenzene	1,1,2-Trichloroethane
1,3-Dichlorobenzene	Trichloroethene
1,4-Dichlorobenzene	Trichlorofluoromethane
Dichlorodifluoromethane	1,2,4-Trimethylbenzene
1,1-Dichloroethane	1,3,5-Trimethylbenzene
1,2-Dichloroethane	Vinyl acetate
1,1-Dichloroethene	Vinyl chloride
cis-1,2-Dichloroethene	m-, p-Xylene
trans-1,2-Dichloroethene	o-Xylene

[a]EPA Method TO-14 analyte list that was used for the 1994 and 2008 Soil-Vapor Surveys (SNL/NM August 2008).

4.2 Data Validation

After the data verification review is completed, the Permittees shall arrange for the validation of the data. The data validation process shall address field sample management and custody requirements, as well as adherence to the analytical method and internal laboratory QA/QC requirements by the off-site laboratory performing the analyses. Data qualification is based upon review of field QC data, laboratory-supplied QC data, the specific QC criteria, and the DQOs identified in the analytical method (EPA Compendium Method TO-15 procedure [EPA January 1999] or equivalent), the DQO in Section 2.0 of this SAP, and the requirements of the MWL LTMMP. Data validation shall be conducted according to the requirements of this SAP and AOP 00-03, “Data Validation Procedure for Chemical and Radiochemical Data.” All associated data validation reports shall be submitted to NMED along with the results for each monitoring event in the annual MWL long-term monitoring reports.

5.0 DATA MANAGEMENT AND REPORTING

The following activities comprise data management and reporting tasks, and shall be conducted by the Permittees:

- Technical evaluation and reporting; and
- Records management

5.1 Technical Evaluation and Reporting

The following specific data evaluation and reporting steps shall be followed and documented as part of the annual MWL long-term monitoring report for soil-vapor monitoring activities. Data interpretation and evaluation shall follow the procedures outlined below.

1. Show results (VOC soil-vapor concentrations) for trichloroethene (TCE), tetrachloroethene (PCE), and total VOCs in a tabulated summary;

2. As appropriate add the data to graphs to illustrate concentration versus time trends for specified monitoring ports and VOCs;

3. Compare TCE, PCE, and total VOCs concentrations for the deepest sampling ports of the deep multi-port wells to the trigger levels for TCE (20 parts per million by volume basis [ppmv]), PCE (20 ppmv), and total VOCs (25 ppmv) using the procedure discussed in Sections 5.1 and 5.2.3 of the MWL LTMMP; and

4. Provide a brief summary discussion of the soil-vapor results, and how these results relate to the potential for groundwater to be contaminated by soil vapor.

Reports will be prepared and submitted to the NMED as part of the annual MWL long-term monitoring reports according to the schedule defined in the LTMMP.

5.2 Records Management

Records associated with soil-vapor monitoring include the MWL LTMMP and this SAP, the applicable AOPs, LOPs, and FOPs, personnel training, field documentation, AR/COC forms, laboratory analytical results, data validation reports, and annual MWL long-term monitoring reports and technical data evaluations. These records will be maintained at the SNL/NM Records Center and comply with the record-keeping provisions of 20.4.1.500 New Mexico Administrative Code, incorporating Title 40 Code of Federal Regulations Section 264.74, concerning the availability, retention, and disposition of records.

6.0 REFERENCES

Sandia National Laboratories/New Mexico (SNL/NM), August 2008. "Investigation Report on the Soil-Vapor Volatile Organic Compounds, Tritium, and Radon Sampling at the Mixed Waste Landfill," Environmental Restoration Project, Sandia National Laboratories, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), May 2010. "Procedure for Completing the Contract Verification," SMO 05-03, Revision 04, Sample Management Office, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), May 2011. "Data Validation Procedure for Chemical and Radiochemical Data," AOP 00-03, Revision 03, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2011. "Field Operating Procedure FOP 08-22, Soil Vapor Sampling," Sandia National Laboratories, Long Term Stewardship Department, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2011. "Sample Management and Custody, Administrative Operating Procedure," AOP 95-16, Revision 04, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2011. "Sample Handling, Packaging, and Shipping," Sample Management Office (SMO) LOP 94-03, Revision 05, Sandia National Laboratories, Albuquerque, New Mexico.

U. S. Environmental Protection Agency (EPA) January 1999. "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method TO-15," EPA/625/R-96/010b, Center for Environmental Research Information, Office of Research and Development, US EPA, Cincinnati, Ohio.

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APPENDIX E
Soil-Moisture Monitoring Plan for the Mixed Waste Landfill

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1.0 INTRODUCTION

Requirements for monitoring at the Mixed Waste Landfill (MWL) are defined in the Long-Term Monitoring and Maintenance Plan (LTMMP). The U.S. Department of Energy and National Technology & Engineering Solutions of Sandia, LLC are hereinafter referred to as the Permittees throughout this appendix. This Soil-Moisture Monitoring Plan (MP) was developed for use during long-term monitoring of the vadose zone for soil moisture at the MWL, Technical Area III, Sandia National Laboratories, New Mexico (SNL/NM).

Vadose zone soil moisture monitoring requirements, including background information, field methods, frequency, sampling locations, and sampling rationale, are presented in the MWL LTMMP, Section 3.4.2. The trigger evaluation process and soil moisture trigger level are presented Sections 5.1 and 5.2.3.2 of the MWL LTMMP, respectively. This MP provides detailed supporting information for the long-term monitoring of soil moisture in the vadose zone beneath the MWL Evapotranspirative (ET) Cover using three soil moisture access tubes drilled at a 30-degree angle (from vertical) directly below waste disposal cells.

1.1 Objective

The objective of this MP is to provide soil-moisture monitoring results for the vadose zone at the MWL to evaluate the integrity and performance of the ET Cover over time. In addition to establishing monitoring and data quality objectives (DQOs), this MP presents specifications for the use and handling of the CPN 503 DR Hydroprobe® Moisture Depth Gauge (neutron probe), data evaluation, records management, and reporting. This document provides monitoring personnel with the necessary information to perform vadose zone soil moisture monitoring. The results will be compared to the soil moisture trigger level of 23 percent by volume as presented in Section 5.2.3.2 of the MWL LTMMP.

1.2 Scope

Monitoring for soil moisture in the vadose zone will be conducted on a routine basis throughout the long-term monitoring and maintenance period to assess the hydrologic performance of the ET Cover. Semi-annual monitoring is planned for the first two years after implementation of the MWL LTMMP, followed by annual monitoring thereafter. Each monitoring event requires the deployment of the neutron probe in the current monitoring system consisting of three angled access tubes. The locations of the access tubes and construction information are provided in Section 3.4.2 of the MWL LTMMP.

2.0 BACKGROUND INFORMATION

The MWL Corrective Measures Implementation Work Plan was written and submitted to the New Mexico Environment Department (NMED) in November 2005 (SNL/NM November 2005). NMED reviewed the document, and responded with a “Notice of Disapproval” (NOD) letter dated November 20, 2006 (NMED November 2006). This letter described a number of deficiencies related to the MWL cover, construction plans, performance and fate and transport modeling, and monitoring triggers. The letter also included a requirement for soil-moisture monitoring in the vadose zone, as follows:

> "The NMED expects the vadose zone to be monitored for volatile organic compounds, tritium, and radon, in addition to soil moisture." (NMED November 2006).

In the "Responses to the NMED Notice of Disapproval" (SNL/NM December 2006), the Permittees proposed soil-moisture monitoring via the current monitoring system. The soil-moisture monitoring will serve as an early-warning system for the potential migration of contaminants. Additional information regarding the proposed monitoring, including the trigger levels and depths to be monitored, were included in the Permittees' responses to the second set of comments within the NOD (Part 2) (SNL/NM January 2007).

3.0 DATA QUALITY OBJECTIVES

This MP is designed to ensure that procedures are consistent and can be used to detect soil moisture beneath the ET Cover. The DQO is to produce representative, accurate, defensible, and comparable results to support the monitoring objective (i.e., provide soil-moisture data from the vadose zone beneath the ET Cover). This DQO will be accomplished through the implementation of standard operating procedures and the use of quality assurance and quality control (QA/QC) measures and data evaluation protocols.

3.1 Monitoring System

The soil-moisture monitoring system was installed in 2003, and is comprised of three boreholes drilled on a 30-degree angle from vertical to a depth of 200 linear feet and a vertical depth of 173 feet below ground surface. Each borehole was cased with drill string used to advance the borehole. The drill string is approximately 4.5 inches in diameter and is made of steel. The borehole is open to the soil in the bottom (no end cap). These are referred to as the access tubes.

During long term monitoring at the MWL, moisture readings will be taken within each access tube at intervals given in Table E-3.1-1.

Table E-3.1-1
Soil-Moisture Monitoring Frequency

Time Period	Monitoring Frequency	Access Tubes	Depths (ft bgs)
Year 1 Year 2	Semi-annual (2 events per year)	3	4-25, at 1 ft intervals
			25-200, 5 ft intervals
Year 3 and subsequent years	Annually (1 event per year)	3	4-25, at 1 ft intervals
			25-200, 5 ft intervals

Note: The 23-percent trigger applies to linear depths of 10 and 100 feet (vertical depths of 8.7 to 86.6 feet) along the neutron probe access tubes.
bgs = Below ground surface.
ft = Foot (feet).

3.2 Neutron Probe

The primary moisture sensor will be a CPN 503DR neutron moisture probe, or an equivalent soil moisture probe. The CPN 503DR is a geophysical means of measuring soil moisture content. The probe uses a 50.0 millicurie Americium-241:Beryllium neutron source for moisture content measurements. The probe is self-contained and includes the radioactive sources, and detectors. A neutron probe uses the absorption of emitted neutrons to calculate soil moisture content. The assumption is made that the hydrogen in soil moisture is the dominant absorber of the emitted neutrons. In the MWL soil, the calibration and QA/QC procedures to be used for the neutron probe associated with this monitoring system have not been confirmed; therefore, the following calibration and QA/QC checks are required.

3.2.1 Calibration and Correlation

The CPN 503DR neutron probe is returned to the manufacturer annually for calibration. It is adjusted to account for the decay of the Americium-241 source.

In order to convert neutron count readings measured with the calibrated CPN 503DR neutron probe to volumetric water content, a correlation study was performed in a controlled environment that duplicates as close as possible the in situ characteristics of the MWL field monitoring location. The probe is inserted into the access tube and count readings are taken as the soil moisture content in the repacked native soil is varied. The resulting count/soil moisture content relationship is used to develop a correlation curve for the instrument, which associates a neutron count to a known soil moisture content (as measured in the laboratory for the test soil layers). Technically this process is a correlation, because the probe electronics are not actually being adjusted or tuned to a known moisture content. Rather a mathematical formula is developed that correlates a neutron count to a known moisture content.

The CPN 503DR neutron probe was field-calibrated in August 2001 at the Infiltration Pilot Test Site, located approximately 500 feet west of the MWL (SNL/NM September 2001). A calibration study was conducted during which the relationship between neutron count readings measured with the CPN 503DR neutron probe and volumetric water content was determined. The results of this study determined that the relationship between volumetric water content and the neutron count ratio can be expressed as follows:

$$\theta = 17.784 R - 2.0801$$

Where

θ = the volumetric water content, and
R = count ratio (neutron probe counts divided by the standard count)

Using this formula, measurements made with the properly calibrated CPN 503DR neutron probe can be converted to the desired units of volumetric water content for comparison to the soil moisture trigger level as discussed in Section 5.2.3.2 of the MWL LTMMP.

3.2.2 Quality Assurance and Quality Control

The CPN 503DR neutron probe is operated in accordance with the Field Operating Procedure (FOP) 10-07. A standard count will be taken once daily during each monitoring event prior to the moisture logging to ensure the highest measurement of accuracy. The standard count measures the proper function of the gauge electronics and also compensates for the source decay. This measurement shall be performed daily when used as described in the FOP 10-07.

Each new set of soil-moisture data will be compared to historical data collected. This evaluation process will be used to identify trends and help identify outliers or other potential indicators of error and inconsistency.

4.0 MONITORING ACTIVITIES

Monitoring activities include preparation for monitoring and monitoring methods and procedures governing these activities. Adherence to this protocol will help ensure uniformity among measurements, and allow comparison of the results over time. Activities that will be conducted in preparation for or during monitoring include the following:

- Safety documentation review
- Pre-monitoring activities
- Perform standard count
- Visual inspection of access tube entry point

The SNL/NM managing document for this monitoring activity is listed in Table E-4-1. This MP and the FOP integrates safety, training, field operations, data collection, and documentation requirements. All personnel directly involved in field activities will review and abide by these plans/procedures.

Table E-4-1
Reference Documentation[a]
MWL Vadose Zone Soil-Moisture Monitoring

Document[a]	Title
FOP 10-07	Field Operating Procedure for Soil Moisture Determination at the Mixed Waste Landfill Utilizing Neutron Logging

[a]The most current version will be used.
FOP = Field operating procedure.
MWL = Mixed Waste Landfill.

The Permittees shall provide to the NMED within 60 days of the effective date of the MWL LTMMP in hard copy and electronic format the current version of FOP 10-07. The Permittees shall provide NMED with any updated versions of this FOP within 30 days of its effective date. If any requirement or procedure in the FOP is found by NMED to be unacceptable for reasons including, but not limited to, the requirement or procedure will or could prevent the acquisition of representative and reliable monitoring results, the requirement or procedure shall be replaced by the Permittees with a different requirement or procedure that is acceptable to NMED.

4.1 Health and Safety

Field operations will be conducted in an approach that prioritizes the health and safety of field personnel above all other objectives. Every team member has the authority and responsibility to stop operations if an unsafe condition develops or is observed. All personnel will perform field activities in accordance with the applicable SNL/NM safety documentation.

4.2 Data Acquisition

A standard count will be taken and the results recorded on the FOP form or in the field logbook. After assembly of the probe and necessary cables, the probe will be lowered to each predetermined location (Table E-3.1-1) in the access tube. At each monitoring location, the neutron counts will be logged and recorded on the FOP form or in the field logbook.

The data will be transferred from the probe and to a tabular spreadsheet for data evaluation and analysis.

4.3 Waste Management

There are no hazardous wastes generated from these monitoring activities.

5.0 DATA REVIEW AND REPORTING

Review of data and field documentation will be performed for completeness and conformance to the procedures established for this activity. The data will be reviewed for representativeness of quality and comparability to determine whether the specified DQOs have been met.

5.1 Data Review

Completed field documentation will be reviewed and verified for accuracy, completeness, and conformance with established procedures. The review will occur at the end of each day in the field to allow verification, correction, and retrieval of missing information as appropriate.

5.2 Reporting

A summary report for will be prepared documenting the monitoring events and results for each annual reporting period. The summary report will include graphs that portray the results. The report will be included as part of the annual MWL long-term monitoring reports submitted to the NMED.

5.3 Records Management

Records associated with the soil-moisture monitoring, including field documentation, logging results, reports, and data evaluations, will be maintained at the SNL/NM Records Center and comply with the record-keeping provisions of 20.4.1.500 New Mexico Administrative Code, incorporating Title 40 Code of Federal Regulations Section 264.74, concerning the availability, retention, and disposition of records.

6.0 REFERENCES

New Mexico Environment Department (NMED), November 2006. “Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Work Plan, November 2005, and Requirement for Soil-Vapor Sampling and Analysis Plan, Sandia National Laboratories, EPA ID NM5890110518, HWB-05-025,” November 20, 2006.

Sandia National Laboratories/New Mexico (SNL/NM), September 2001. “Neutron-Probe Calibration Project, Infiltration Pilot Site, Mixed Waste Landfill Area, July & August 2001,” Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), November 2005. “Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005,” Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), December 2006. “DOE/Sandia Responses to NMED’s Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Work Plan November 2005, Comment Set 1” Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2007. “Reponses to the NMED’s Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005 Comment Set 2,” Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 2011 (or most current version). “Field Operating Procedure for Field Operating Procedure for Soil Moisture Determination at the Mixed Waste Landfill Utilizing Neutron Logging,” FOP 10-07, Revision 00, Sandia National Laboratories, Albuquerque, New Mexico.

APPENDIX F
Groundwater Sampling and Analysis Plan for the Mixed Waste Landfill

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1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) provides additional requirements and specific information for the collection and analysis of samples from groundwater monitoring wells located at the Mixed Waste Landfill (MWL) during the long-term monitoring period. The long-term groundwater monitoring program is described in Section 3.5 of the MWL Long-Term Monitoring and Maintenance Plan (LTMMP). Groundwater monitoring parameters, frequency, and reporting requirements are detailed in Section 3.5.4. The trigger evaluation process and groundwater trigger levels are presented Sections 5.1 and 5.2.4 of the MWL LTMMP, respectively.

The purpose of this SAP is to document procedures for the collection and reporting of consistent, reliable, defensible, and comparable groundwater sampling results. This SAP provides additional instructions for sample collection, data management, and reporting of data that shall be followed during the long-term monitoring period. Other instructions are provided in Sandia National Laboratories/New Mexico (SNL/NM) Field Operating Procedures (FOPs), SNL/NM Laboratory Operating Procedures (LOPs), and SNL/NM Administrative Operating Procedures (AOPs); however, the requirements of this SAP and the MWL LTMMP will take precedence over any FOPs, LOPs, and AOPs. Table F-1-1 summarizes documents that are referenced in this SAP, which can be obtained from the SNL/NM Records Center. The most current versions of these documents shall be consulted for the purpose of conducting groundwater sampling.

The U.S. Department of Energy and National Technology & Engineering Solutions of Sandia, LLC (NTESS), hereinafter referred to as the Permittees, shall provide to the New Mexico Environment Department (NMED) within 60 days of the effective date of the MWL LTMMP in hard copy and electronic format the current versions of the FOPs and AOPs listed in Table F-1-1. The Permittees shall provide NMED with any updated versions of the FOPs, LOPs, or AOPs within 30 days of their effective date. If any requirement or procedure in the FOPs, LOPs, or AOPs is found by NMED to be unacceptable for reasons including, but not limited to, the requirement or procedure will or could prevent the acquisition of representative and reliable groundwater sampling results, the requirement or procedure shall be replaced by the Permittees with a different requirement or procedure that is acceptable to NMED.

2.0 DATA QUALITY OBJECTIVES AND QUALITY CONTROL

The data quality objective (DQO) for groundwater monitoring is to collect representative, accurate, defensible, and comparable data to assess the concentrations of hazardous constituents in the groundwater in the uppermost aquifer underlying the MWL such that they can be compared to the trigger levels in concentration limits in Table 5.2.4-1 of the MWL LTMMP. The Permittees shall evaluate accuracy, precision, representativeness, completeness, and comparability of the groundwater data to verify that data are of high quality and ensure that the DQO is met. Quality control (QC) procedures discussed in Section 4.2 of this SAP shall also be used to determine whether the DQO has been attained. QC samples generated in both the field and the laboratory shall be analyzed and evaluated.

Table F-1-1
Reference Documentation[a]
MWL Groundwater Monitoring

Document Number	Document Title
AOP 00-03	Data Validation Procedure for Chemical and Radiochemical Data
AOP 95-16	Sample Management and Custody
FOP 05-01	Groundwater Monitoring Well Sampling and Field Analytical Measurements
FOP 05-02	Groundwater Monitoring Equipment Field Check For Water Quality Measurements
FOP 05-03	Groundwater Monitoring Equipment Decontamination
FOP 05-04	Groundwater Monitoring Waste Management
LOP 94-03	Sample Handling, Packaging, and Shipping
SMO 05-03	Procedure for Completing the Contract Verification

[a]The most current version will be used.
AOP = Administrative operating procedure.
FOP = Field operating procedure.
LOP = Laboratory operating procedure.
MWL = Mixed Waste Landfill.
SMO = Sample Management Office.

Laboratory measurements shall comply with SNL/NM Sample Management Office (SMO) procedures and protocols listed in Table F-1-1, including qualification or validation of laboratory analytical data, and requirements in this SAP. The data validation review for determining the quality and usability of analytical data acquired during groundwater sampling shall be summarized in data validation reports regarding the overall quality of the data and the resulting data qualifiers. All associated data validation reports shall be submitted to NMED in the annual MWL long-term monitoring report along with the results for each monitoring event. Data not meeting DQO requirements are subject to corrective action(s) as discussed in SNL/NM SMO procedures and protocol and as discussed in Section 6.0 of this SAP.

2.1 Accuracy

Accuracy is the agreement between a measured value and an accepted reference value. When applied to a set of observed values, accuracy is influenced by a combination of a random component and a systematic bias. Accuracy shall be maintained and evaluated through referenced calibration standards, laboratory control samples (LCS), matrix spike (MS) samples, and surrogate spike samples. The bias component shall be evaluated and expressed as percent recovery (%R), as indicated in the equation below:

$$\%R = \frac{(measure\,sample\,concentration)}{true\,concentration} x100\%$$

The acceptable range for %R shall meet the quality control requirements of the EPA analytical method. Corrective action shall be taken for any sample results where the %R requirement is not met.

2.2 Precision

Precision is the agreement among a set of replicate measurements. Precision data shall be derived from field and laboratory duplicate samples. Precision shall be reported as relative percent difference (RPD), which is calculated as follows.

$$RPD = \frac{\left|(measured\ value\ sample\ 1 - measured\ value\ sample\ 2)\right|}{average\ of\ samples\ 1\ and\ 2} x100\%$$

For field environmental and environmental duplicate sample pairs, RPD results shall only be calculated for detected parameters (i.e. results greater than the method detection limit) and the acceptable range is less or equal to 20 for VOCs and less than or equal to 35 for metals. The acceptable RPD range for laboratory quality control samples shall meet the requirements specified in the EPA analytical methods. Corrective action is required for RPD results that fall outside the acceptable range and may include reanalysis and/or resampling.

2.3 Completeness

Completeness is defined as a measure of the amount of usable data compared to the total amount of data required. Examples of events that reduce the amount of usable data include improperly collected and preserved samples, missed holding times, sample container breakage, and operating outside prescribed QC limits. The completeness objective is 100% for compliance data. If the completeness objective is not met and sufficient sample material remains for re-analysis, and if still appropriate, the laboratory shall repeat the analysis. Otherwise, the incomplete portion of the sampling shall be made complete by repeating the sampling and analysis as necessary. Percent completeness is expressed in the equation below:

$$\%Completeness = \frac{number\ of\ useable\ data\ points}{total\ number\ of\ samples\ required} x100\%$$

2.4 Data Representativeness

Data representativeness is the degree to which samples represent the media they are intended to represent. To help ensure that samples are representative of formation water, the Permittees shall implement the procedures in this SAP for groundwater purging and sampling. Monitoring wells shall be adequately purged and stability of field parameters achieved prior to the collection of water samples.

2.5 Comparability

Comparability is the extent to which one data set or value can be related to another. Comparability between data sets shall be achieved through the collection and analysis of samples using consistent methods and QC criteria.

2.6 Sampling Locations and Frequency

The long-term groundwater monitoring network at the MWL is described in Section 3.5.1 and groundwater monitoring well replacement is described in Section 3.5.3 of the MWL LTMMP.

Table F-2.6-1 summarizes the groundwater parameters, methods, and frequency. Aqueous samples shall be reported in units of milligrams per liter (mg/L), micrograms (µg)/L, or picocuries per liter (pCi/L). Well completion diagrams for these wells are provided in Appendix H of the MWL LTMMP.

Table F-2.6-1
Groundwater Monitoring Parameters, Test Methods, and Monitoring Frequency
Mixed Waste Landfill Long-Term Monitoring Program

Parameter	EPA Method[a]	Monitoring Frequency
Volatile Organic Compounds	SW846-8260 or Equivalent	Semi-annual for all parameters from the MWL Groundwater Monitoring Compliance Network
Metals: total uranium, total chromium, cadmium, and nickel	SW846-6020 or Equivalent	
Tritium	EPA 906.0 or Equivalent	
Radon	SM 7500 series	
Gamma Spectroscopy (short list)	EPA 901.1 or Equivalent	
Gross Alpha/Beta activity	EPA 900.0 or Equivalent	

[a]EPA November 1986.
EPA = U.S. Environmental Protection Agency.
MWL = Mixed Waste Landfill.
SM = Standard Methods.
SW = Solid waste.

3.0 FIELD OPERATIONS

Groundwater sampling shall be conducted in accordance with this SAP and the MWL LTMMP to ensure accurate, precise, representative, complete, and comparable groundwater sampling results. Other groundwater monitoring activities shall include the measurement of water levels and calculating the direction, flow rate, and gradient of groundwater flow, the decontamination of equipment, inspection of monitoring equipment, monitoring field water quality parameters, collecting and handling samples, and managing waste.

3.1 Safety

Field operations shall be conducted in a manner that protects the health and safety of field personnel. Every team member has the authority and responsibility to stop operations if an unsafe condition develops or is observed. All groundwater monitoring personnel shall perform field activities safely in accordance with the SNL/NM Groundwater Monitoring Health and Safety Plan.

3.2 Water Level Measurements

Water level information is used to calculate the volume of water in a well casing and the minimum amount required for purging. It is also used to determine the direction and gradient of groundwater flow. Measurements shall be referenced to a surveyed mark of known elevation at the top of each well casing. The static water level shall be measured in each well prior to purging or obtaining a sample, and measurements shall be taken to the nearest 0.01-foot using a water level indicator. Other requirements for water level measurements are provided in SNL/NM FOP 05-01. Water levels in all compliance wells shall be measured during every sampling event.

3.3 Field Water Quality Parameters

Field water quality parameters shall be collected during purging in accordance with SNL/NM FOP 05-01 and this SAP. Measurements taken shall include potential of hydrogen (pH), specific conductance (SC), temperature, and turbidity. Additional field water quality parameters shall include dissolved oxygen (DO) and oxidation-reduction potential (ORP). Field water quality parameters are as follows.

DO – The DO content of the water in percent saturation or in mg/L.

SC – The ability of a cubic centimeter of water to conduct electricity. It varies directly with the amount of ionized minerals in the water and is measured in micro-mhos per centimeter at 25 degrees Celsius (ºC).

pH – A measure of the acidity or alkalinity of a solution. Numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity.

ORP – Potential for an oxidation (loss of electrons to another atom or molecule) or reduction (gain of electrons from another atom or molecule) reaction in millivolts.

Temperature – The temperature of the water in °C.

Turbidity (nephelometric) – The cloudiness in water due to suspended and colloidal organic and inorganic material. Water turbidity is measured in Nephelometric Turbidity Units (NTUs).

3.4 Sample Collection

Sample collection procedures are provided in SNL/NM FOP 05-01 and this SAP. Groundwater monitoring shall be performed using conventional sampling methods. The Permittees shall purge monitoring wells with a portable Bennett™ submersible pump system or equivalent. The pump intake shall be set at or near the bottom of the screened interval. In an effort to lower the rate of discharge for wells that purge dry, the Bennett pump system used at the MWL shall be equipped with a flow meter valve located along the water discharge line, and with small-diameter tubing for both the water discharge and air (or other drive gas) intake lines. These actions represent best faith efforts that shall be employed by the Permittees to attain a pumping rate of 0.3 liters per minute (L/min) or less. If the desired pumping rate of 0.3 L/min is not achieved during a particular sampling event for a particular well that purges dry, the Permittees will document in the annual MWL long-term monitoring reports their attempts to achieve the desired pumping rate that failed.

Regardless of the desired pumping rate mentioned above, the maximum pumping rate in any case shall not exceed 12 L/min, and groundwater samples collected for VOC analyses shall be collected by filling the sample containers at a flow rate not to exceed 0.1 L/min. The Permittees may modify the sampling system in order to split the flow of water, such that the flow of water through one side can be reduced to a rate of 0.1 L/min or less to facilitate the filling of sample containers. The flow rate through the other side shall be the minimum rate that is reasonably achievable. Each monitoring well shall be purged a minimum of one saturated casing volume (a saturated casing volume is the volume of all static water in the well screen interval plus the volume of water in the primary and secondary filter packs adjacent to the well screen interval). Prior to the collection of groundwater samples, purging shall continue beyond one saturated casing volume until four stable measurements are obtained for turbidity, pH, temperature, and SC. Groundwater stability shall be considered acceptable when measurements are less than 5 NTU for turbidity, ± 0.1 pH units for pH, ± 1.0 °C for temperature, and ± 5% for SC. If any of the turbidity measurements are greater than 5 NTU after completing the purging a saturated casing volume, stability shall be considered acceptable when the lowest and highest of four consecutive measurements are within plus or minus 10%. If a monitoring well is purged dry prior to meeting the above purging and stability requirements, then sampling shall be conducted once the well has recovered such that the volume of water available in the well is the minimum necessary to collect the required water samples.

Samples shall be placed into clean laboratory-supplied containers. Groundwater samples shall be collected for VOC, metals, and radionuclide analyses, in that order, from each well. Samples shall not be filtered. Sample documentation and custody shall be performed in accordance with SNL/NM SMO procedures and protocols (AOP 95-16 and LOP 94-03) and this SAP. Samples shall be delivered to the shipping facility for repackaging in shipping coolers in accordance with appropriate U.S. Department of Transportation shipping regulations (Title 49 Code of Federal Regulations Parts 170–179).

3.5 Monitoring Equipment Field Checks

Monitoring instruments used to measure field water quality parameters shall be calibrated where appropriate or function-checked prior to sampling activities. Calibration and field-check instructions are presented in FOP 05-02.

3.6 Equipment Decontamination

All equipment that would come into contact with a sample, the interior of a well, or groundwater shall be decontaminated prior to entering any well or contacting any sample to prevent cross-contamination. Equipment and materials (including chemicals and protective clothing), decontamination procedures, and waste management procedures are presented in the FOPs 05-01, 05-02, 05-3, and 05-04.

3.7 Waste Management

All waste generated during groundwater sampling activities shall be managed in accordance with federal, state, and local regulations. All purge and decontamination water shall be assumed to be non-hazardous waste based upon historical analytical data. Analytical data from sampling events shall be compared to discharge and disposal criteria. The anticipated disposal path for purge water and decontamination water is discharge to the sanitary sewer. If the Albuquerque Bernalillo County Water Utility Authority discharge standards are not met, purge and decontamination water shall be managed appropriately through the SNL/NM waste management process and facilities. Personal protective equipment that comes into contact with groundwater shall be managed and disposed of as solid waste. Waste management activities associated with groundwater monitoring are discussed in FOP 05-04.

3.8 Sample Documentation and Custody

To ensure the integrity of samples from the time of collection through the reporting of analytical results, sample collection, handling, and custody shall be documented in writing. Primary elements in the documentation of samples are: sample identification numbers, sample labels, custody tape, and Analysis Request/Chain-of-Custody forms. Standardized forms shall be used to document sample information. Sample custody and documentation procedures for sampling activities are outlined in SNL/NM AOP 95-16 and LOP 94-03. These procedures, and the procedures in this SAP, shall be followed throughout each groundwater-sampling event.

3.9 Sample Shipment

Samples shall be packaged and shipped to the analytical laboratory in accordance with SMO procedures detailed in LOP 94-03. Prior to shipment, sample collection documentation shall be verified. Any error shall be noted in writing and corrected.

4.0 LABORATORY PROCEDURES AND QUALITY CONTROL SAMPLES

The Permittees shall ensure that the analytical laboratory analyzes samples using U.S. Environmental Protection Agency- (EPA) approved analytical methods. The analytical laboratory shall provide appropriate sample containers prepared with the required preservative. The analytical laboratory shall prepare and submit to the Permittees an analysis data report as required by the conditions of the MWL LTMMP and this SAP. Container types and preservation methods applicable to groundwater sampling at the MWL shall be consistent with the EPA Methods used; however, the Permittees may use other appropriate test methods, container types, and preservation methods that meet the data quality requirements of MWL LTMMP and this SAP.

4.1 Analytical Laboratory

The Permittees shall ensure that the analytical laboratory performs the analyses in accordance with this SAP, the MWL LTMMP, and regulatory requirements. The laboratory shall maintain written documentation of sample handling and custody, analytical results, and internal QC data. The laboratory shall analyze QC samples in accordance with this SAP and its own internal QC program. The Permittees shall direct the laboratory to investigate and if necessary conduct corrective action where data are found to be outside quality acceptance limits.

4.2 Quality Control

QC samples shall be collected in the field and prepared in the laboratory to ensure that the data generated meet the DQO. QC shall be achieved through adherence to requirements and procedures listed and described in Section 2.0 of this SAP. Mandatory QC samples are identified in the following sections.

4.2.1 Field Quality Control

Field QC samples are used to document data quality and identify errors that may be introduced by field conditions, in sample collection, storage, transportation, and equipment decontamination. Field QC samples submitted to the analytical laboratory shall be handled and analyzed in an identical manner as environmental samples. The Permittees shall collect and analyze the following Field QC sample types: equipment blanks, duplicates, field blanks, and trip blanks.

Equipment blanks demonstrate the effectiveness of equipment decontamination and monitor the cleanliness of the sampling system. After sampling equipment decontamination has been completed, an equipment blank is produced by passing de-ionized water through the sampling system and collecting a sample of this water. Equipment blanks shall be collected at a frequency of 10 percent (minimum of one per MWL sampling event) and shall be analyzed for all of the constituents required by this SAP.

Duplicate environmental samples are collected in the field and analyzed to document the precision of the sampling and analysis process. The duplicate samples shall be collected immediately after the original environmental sample in order to reduce variability caused by time and/or the sampling process. Duplicates shall be collected and analyzed at a frequency of at least 10 percent. At least one duplicate groundwater sample shall be collected and analyzed per sampling event for each of the constituents required by this SAP.

Field blanks are collected for VOCs to assess whether any contamination of the samples was caused by ambient field conditions. The field blanks shall be prepared by pouring deionized water into sample containers at wellheads to simulate the transfer of environmental samples from the sampling system to the sample container. Field blank samples shall be collected and analyzed at a frequency of 10 percent (minimum of one per sampling event).

Trip blanks (TBs) are used to assess the potential for cross-contamination between environmental samples during sample handling and shipping activities. The TBs are to be analyzed for VOCs only. Each batch of groundwater samples to be analyzed for VOCs shall be accompanied by at least one TB during shipping. The analytical laboratory shall prepare the TB by filling a VOC-sample vial with deionized water and using the same sample preservation method designated for VOC environmental samples. Each vial shall be sealed with custody tape and dated when it is prepared. The TBs shall accompany the empty sample containers when they are shipped to the field supervisor prior to the start of sample collection. The TBs shall be taken into the field during sample collection and shall be included in the shipment of environmental samples to the laboratory. The TBs must remain sealed during this entire cycle and may be opened only for analysis on return to the analytical laboratory.

4.2.2 Laboratory Quality Control

The analytical laboratory must have established procedures that demonstrate the analytical process is in control during each sample analysis step. The procedures include LCSs, method blank samples, and MS samples.

A LCS consists of a control matrix (e.g., deionized water) spiked with known concentrations of analytes representative of the target analytes. LCSs shall be prepared and analyzed for each analytical procedure performed. LCSs shall be analyzed with each analytical batch containing environmental samples to determine accuracy of the data. The laboratory shall also evaluate the precision of the data by analyzing twice either the environmental samples, LCSs, or MS samples and calculating the RPD between corresponding results.

Method blank samples shall be used to check for contamination in the laboratory during sample preparation and analysis. Method blank samples shall be concurrently prepared and analyzed with each analytical batch. Method blanks shall be reported in the same units as corresponding environmental samples, and the results shall be included with each analytical report.

Surrogate spike analysis shall be performed for all samples analyzed by Gas Chromatography/ Mass Spectroscopy. The surrogate compounds added to the sample shall be those specified in the applicable EPA analytical method procedure (EPA November 1986). Recovery values for surrogate compounds that are outside specified control limits shall require corrective action in accordance with the data validation process described in Section 5.2.

The analytical process shall be systematically evaluated for the effects of indigenous constituents present in the environmental sample matrix. MS/matrix spike duplicate analyses shall be performed in accordance with the specified analytical procedures.

5.0 DATA REVIEW, VALIDATION, AND REPORTING

Data validation and review of analytical and field documentation shall be performed. Field and analytical QC data shall be reviewed for conformance to QC acceptance criteria. The entire data package shall be reviewed for completeness, comparability, representativeness, precision, and accuracy to determine whether the DQO has been met. All groundwater monitoring data shall be reported in the annual MWL long-term monitoring reports for the year for which the data were obtained.

5.1 Field Documentation Review

Completed field documentation shall be reviewed and checked for errors, completeness, and conformance with the procedures required by this SAP. The review shall occur at the end of each day in the field to allow verification, correction, and retrieval of missing information as appropriate. Field documentation found to be incomplete or to contain questionable data shall be corrected prior to finalizing the field reports. If necessary, measurements of field water quality parameters shall be repeated.

5.2 Laboratory Data Verification and Validation

The Permittees shall review laboratory reports for completeness and conformance to the requirements of this SAP and to the performance criteria of the laboratory contract according to the "Procedure for Completing the Contract Verification," SMO 05-03.

Upon receipt of the analytical results from the analytical laboratory, the Permittees shall arrange for the validation of the data. The purpose of the validation is to determine the usability and establish the defensibility of the results in support of environmental and waste management activities. Data qualification shall be based upon review of field and laboratory-supplied QC data, the specific QC criteria identified in the procedures for the EPA-approved analytical methods, and the QC criteria for meeting the DQO identified in this SAP. Data validation shall be conducted according to the requirements of this SAP and AOP 00-03, "Data Validation Procedure for Chemical and Radiochemical Data." All associated data validation reports shall be submitted in the annual MWL long-term monitoring report.

5.3 Data Reporting

All groundwater monitoring data shall be reported in the annual MWL long-term monitoring reports for the year for which the data were obtained. This report shall include a description of sampling activities, field water quality data, laboratory analytical results, a discussion of QC evaluations and data reviews, a description of any project variance or nonconformance, and data validation summaries. The control charts and statistical analysis shall be included, if appropriate, to show data trends over time and provide supporting information for data evaluation. Additional reporting requirements are found in Section 3.5.4 of the MWL LTMMP.

5.4 Records Management

Records associated with groundwater monitoring, including field documentation, chains of custody, laboratory analytical results, data validation reports, long-term monitoring reports, and technical data evaluations, shall be maintained at the SNL/NM Records Center and comply with the record-keeping provisions of 20.4.1.500 New Mexico Administrative Code, incorporating

Title 40 Code of Federal Regulations Section 264.74, concerning the availability, retention, and disposition of records.

6.0 NON-CONFORMANCES AND VARIANCES

Corrective actions must be taken to rectify or prevent a nonconformance or variance that could adversely affect the quality of data generated. Corrective actions must be documented in writing by the persons identifying the need for action.

Any purposeful change to or deviation from the requirements of this SAP and MWL LTMMP shall take effect only after approval by NMED.

A nonconformance is any action or condition that does not meet the requirements of this SAP. The analytical laboratory, SMO, groundwater monitoring team members, or the Project Leader may identify a nonconformance. The person noting a nonconformance shall document the nonconformance in writing and suggest an appropriate corrective action. Resolution of the nonconformance shall be documented in writing and acknowledged by the Permittees.

The Permittees and the analytical laboratories shall have systems in place to identify QC issues and initiate corrective actions. In accordance with SMO procedures, the laboratories are required to notify the SMO of QC problems that may affect data quality. The Permittees shall evaluate and determine whether data are comparable to historical values and whether or not corrective action is required based upon the specific issue. Corrective action may include documentation of QC issues in an analytical laboratory report, data qualifiers, and/or sample re-analysis. In all cases, the DQO in Section 2.0 of this SAP shall be met.

7.0 REFERENCES

EPA, see U.S. Environmental Protection Agency.

Sandia National Laboratories/New Mexico (SNL/NM), May 2010. “Procedure for Completing the Contract Verification,” SMO 05-03, Revision 04, Sample Management Office, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), May 2011. “Data Validation Procedure for Chemical and Radiochemical Data,” AOP 00-03, Revision 03, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2011. “Sample Management and Custody, Administrative Operating Procedure,” AOP 95-16, Revision 04, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2011. “Sample Handling, Packaging, and Shipping,” Sample Management Office (SMO) LOP 94-03, Revision 05, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2012. "Groundwater Monitoring Well Sampling and Field Analytical Measurements," FOP 05-01, Revision 04, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2012. "Groundwater Monitoring Equipment Field Check for Water Quality Measurements," FOP 05-02, Revision 04, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2012. "Groundwater Monitoring Equipment Decontamination," FOP 05-03, Revision 04, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2012. "Groundwater Monitoring Waste Management," FOP 05-04, Revision 04, Sandia National Laboratories, Albuquerque, New Mexico.

U.S. Environmental Protection Agency (EPA), November 1986. "Test Methods for Evaluating Solid Waste," 3rd ed., and all updates, SW-846, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

APPENDIX G
Tritium and Biota Sampling and Analysis Plan for the Mixed Waste Landfill

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1.0 INTRODUCTION

Requirements for monitoring at the Mixed Waste Landfill (MWL) are defined in the Long-Term Monitoring and Maintenance Plan (LTMMP). The U.S. Department of Energy and National Technology & Engineering Solutions of Sandia, LLC are hereinafter referred to as the Permittees throughout this appendix. This Tritium and Biota Sampling and Analysis Plan (SAP) was developed in response to a request by the New Mexico Environment Department (NMED) to monitor for tritium in surface soil and potential biotic mobilization of contaminants at the MWL, Technical Area III, Sandia National Laboratories, New Mexico (SNL/NM) (Bearzi November 2006).

The SNL/NM Terrestrial Surveillance Program has monitored concentrations of tritium in surface soil at the MWL on an annual basis since 1985. Biotic mobilization of contaminants that is of concern at the MWL is defined as the migration of contaminants by burrowing insects and animals (ants and rodents), and uptake by vegetation. The collection of soil samples from ant hills and/or animal burrows, and potentially deep-rooted vegetation samples can determine if contaminant mobilization has occurred via these mechanisms.

Tritium and biota monitoring requirements, including background information, field and analytical methods, frequency, sampling locations, and sampling rationale, are presented in the MWL LTMMP Sections 3.3 and 3.6, respectively. The trigger evaluation process is presented in Section 5.1 of the MWL LTMMP, and trigger levels for tritium in surface soil (collected at the four corners of the Evapotranspirative [ET] Cover) and metals in surface soil from biota sampling locations (collected from animal burrows and ant hills) are presented Section 5.2.2 of the MWL LTMMP. This SAP provides detailed supporting information for the long-term monitoring of tritium, gamma-emitting radionuclides (short list), and metals in surface soil and vegetation at the MWL.

1.1 Monitoring Objective

The LTMMP, including this SAP, is designed to ensure the monitoring of specified parameters over a period of time. The monitoring objective of this SAP is to provide analytical data in order to characterize tritium levels in the surface soil and biotic mobilization of contaminants at the MWL. In addition to establishing monitoring and data quality objectives (DQOs), this SAP presents specifications for the locations of sample collection points, sample collection procedures, laboratory analysis, data evaluation, records management, and reporting. This document provides sampling personnel with the necessary information to perform sampling of soil from the four corners of the ET Cover (tritium), burrows or nests (gamma-emitting radionuclides and metals), and vegetation (gamma-emitting radionuclides). The results for tritium and metals will be compared to the proposed trigger levels presented in the Section 5.2.2 of the MWL LTMMP. The gamma-emitting radionuclide results will be compared to background activities (biota surface soil samples) and evaluated over time to determine trends (biota surface soil and vegetation samples).

1.2 Scope

Tritium sample locations at the four corners of the ET Cover have been previously defined and are detailed in Section 3.3 of the LTMMP. These locations will continue to be sampled annually for the long-term monitoring period to allow future data to be compared to historic results.

As described in Section 4.2 of the MWL LTMMP, inspections of the ET Cover will be conducted quarterly to determine the presence of burrowing animals and/or insects and the types of vegetation present. If animal burrows, ant hills/nests, and/or potentially deep-rooted plants are identified on the ET Cover near the end of the growing season (i.e., August or September), biota sampling will occur. Biota surface soil samples will be collected from the identified locations and submitted for laboratory analysis of specific metals and radionuclides by gamma spectroscopy (short list of radionuclides). Vegetation samples will be submitted for laboratory analysis of radionuclides by gamma spectroscopy (short list of radionuclides) only.

2.0 DATA QUALITY OBJECTIVES

This SAP is designed to ensure that procedures are consistent and can be used to establish contaminant trends, if present. The DQO is to produce representative, accurate, defensible, and comparable analytical results to support the monitoring objective (i.e., provide analytical data to evaluate tritium levels in surface soil and biotic mobilization of contaminants). This DQO will be accomplished through the implementation of standard operating procedures and analytical procedures/methods through the use of quality assurance measures, quality control (QC) samples, and data evaluation protocols.

2.1 Sample Locations and Sampling Frequency

All sampling will be performed annually as required by NMED (Bearzi October 2008). The sampling locations for tritium surface soil have been previously surveyed and remain consistent with past sampling locations, as described in Section 3.3 of the MWL LTMMP.

Biota sampling locations (up to 6 total per year) will be identified during the quarterly ET Cover inspections as described in Section 4.2 of the MWL LTMMP. The number of available sampling locations is variable, depending on the presence and distribution of the insects, animals, and vegetation. Up to two animal burrows and up to two ant hills/nests will be sampled each year (i.e., annually) at the peak of the growing season (August or September) if features are identified. Up to 2 potentially deep-rooted plants will also be sampled annually in August or September if they are present on the ET Cover overlying former disposal areas. If no burrows, ant hills/nests, and potentially deep-rooted vegetation are identified during ET Cover inspections, no biota sampling will be performed. Sampling is dependent upon the presence of these features/plants.

Animal burrow, ant hill/nest, and deep-rooted vegetation sampling locations will be surveyed with a Global Positioning Satellite (GPS) unit, recorded in the SNL/NM geographic information system (GIS) database, and flagged for sampling.

2.2 Data Accuracy

Proper sampling procedures and use of QC samples such as environmental sample duplicates will help reduce random and systematic sampling error or bias. Accurate measurements can be made reliably through the use of a qualified laboratory, appropriate methodologies, and effective QC procedures. These measures along with consistent implementation of the LTMMP and this SAP will satisfy the DQO for accuracy.

Accuracy is the agreement between a measured value and an accepted reference value. When applied to a set of observed values, accuracy is a combination of a random component and a systematic bias. Accuracy will be maintained and evaluated through referenced calibration standards, laboratory control samples (LCS), matrix spike (MS) samples, and surrogate spike samples. The bias component will be evaluated and expressed as a percent recovery (% R) which is calculated as follows:

$$\%R = \frac{(measure\,sample\,concentration)}{true\,concentration} x100\%$$

Acceptance criteria are defined in the U.S. Environmental Protection Agency (EPA) analytical method and verified as part of the data validation process. Corrective action shall be taken for any sample results where the %R requirement is not met.

2.3 Precision

Precision is the agreement among a set of replicate measurements. Precision data will be derived from environmental and laboratory duplicate samples. Precision will be reported as the relative percent difference (RPD) which is calculated as follows:

$$RPD = \frac{|R_1 - R_2|}{[(R_1 + R_2)/2]} \times 100$$

RPD = Relative percent difference (rounded to nearest whole number)

R_1 = analysis result

R_2 = duplicate analysis result

For field environmental and environmental duplicate sample pairs, RPD results shall only be calculated for detected parameters (i.e., results greater than the method detection limit). An RPD less than or equal to 35 percent is considered satisfactory. Natural variation in soils is common, so an RPD greater than 35 percent in an environmental sample and duplicate pair is not necessarily indicative of a problem with data precision. Duplicate samples will not be collected for vegetation due to the difficulty in collecting a representative duplicate sample and the anticipated very low activity results. The acceptable RPD range for laboratory quality control samples shall meet the requirements specified in the EPA analytical method. Corrective action is required for RPD results that fall outside the acceptable range and may include reanalysis and/or resampling.

2.4 Data Consistency and Comparability

Data consistency and comparability will be achieved through implementation of this SAP, which defines field and laboratory procedures designed for this purpose. Consistency in methods and procedures will be maintained in the following areas to ensure tritium and biota data are consistent and that the data sets are comparable.

- Field sample collection and management
- Use of an off-site contract laboratory and approved analytical methods

After analytical results are received from the laboratory, the Permittees will review the laboratory report for completeness and conformance to the sampling and data quality objectives. If problems are noted that require corrective action during these reviews, the laboratory will be contacted for further information.

Surface soil results will be compared to the trigger levels (tritium and metals), to established soil background levels (gamma emitting radionuclides and metals), and to previous results. This evaluation process will aid in characterization, allow analysis of trends, and help identify outliers or other potential indicators of error and inconsistency. Vegetation results will be tabulated and compared to other vegetation results. There are no established trigger levels or background activities for radionuclides in vegetation.

2.5 Quality Control

QC measures ensure that data are scientifically sound and of known precision and accuracy. QC samples will be collected to help reduce random and systematic sampling error or bias. Section 4.2 presents the samples needed to meet the QC requirements for tritium and biota sampling at the MWL.

3.0 SAMPLING ACTIVITIES

This section describes the field and laboratory measures to be taken in providing tritium and biota data.

3.1 Field Activities

Field activities include the preparation, identification, collection, and shipping of the samples and the methods and procedures used for these activities. Adherence to this protocol will help ensure uniformity, and allow comparison of the results. Activities that will be conducted in preparation for or during sampling include the following:

- Pre-field work planning

- Health and safety considerations

- Sample location verification (tritium sampling locations)

- ET Cover surface inspections for the presence of burrows, ant hills/nests, and vegetation (biota sampling locations)
- GPS survey/enter locations into GIS database

- Sample acquisition

- Sample documentation, handling, and shipping

- Waste management

The SNL/NM Administrative Operating Procedure (AOPs), Laboratory Operating Procedures (LOPs), and Field Operating Procedure (FOPs) for these activities are listed in Table G-3.1-1 , as well as Sample Management Office (SMO) procedures and guidance. All personnel directly involved in survey and sampling field activities will review and abide by these procedures. The most current versions of these documents will be used.

Table G-3.1-1
Reference Documentation[a]
MWL Tritium and Biota Sampling

Document Number	Document Title
AOP 95-16	Sample Management and Custody
LOP 94-03	Sample Handling, Packaging, and Shipping
AOP 00-03	Data Validation Procedure for Chemical and Radiochemical Data
SMO 05-03	Procedure for Completing the Contract Verification

[a]The most current version will be used.
AOP = Administrative Operating Procedure.
LOP = Laboratory Operating Procedure.
MWL = Mixed Waste Landfill.
SMO = Sample Management Office.

The Permittees shall provide to the NMED within 60 days of the effective date of the MWL LTMMP in hard copy and electronic format the current versions of the documents listed in Table G-3.1-1. The Permittees shall provide NMED with any updated versions of the documents within 30 days of their effective date. If any requirement or procedure in the documents is found by NMED to be unacceptable for reasons including, but not limited to, the requirement or procedure will or could prevent the acquisition of representative and reliable monitoring results, the requirement or procedure shall be replaced by the Permittees with a different requirement or procedure that is acceptable to NMED.

3.2 Health and Safety

Field operations will be conducted in an approach that prioritizes the health and safety of field personnel above all other objectives. Every team member has the authority and responsibility to stop operations if an unsafe condition develops or is observed. All sampling personnel will perform field activities in accordance with the applicable SNL/NM safety documentation.

3.3 Surface Survey

The tritium sampling locations have been previously established and are marked in the field. Biota sampling locations will depend upon the identification of features (burrows, ant hills/nests, potentially deep-rooted vegetation) during quarterly ET Cover inspections as described in Section 2.1. All information regarding dates, locations, and species type (if available) will be maintained on sampling forms or in a log book. All sampling locations will be surveyed with a GPS unit recorded in the GIS database.

3.4 Sample Acquisition and Labeling

Samples will be collected from the designated locations following this SAP. Soil and vegetation will be placed in appropriate containers and labeled with sample identification information.

Tritium Surface Soil Sample Acquisition

To ensure a representative soil sample for tritium analysis, composite approximately 3 kilograms (kg) of soil into appropriate containers provided by the laboratory from an undisturbed area at each sampling location. Use a clean scoop, trowel, or other sampling device to collect the 3.0 kg of soil to a depth of approximately 15 centimeters (cm). Make sure the containers are full of soil, and then seal and label the containers. Samples for analysis by gamma spectroscopy and for metals analysis may also be collected, but are not required by this SAP.

Animal Burrow and Ant Hill/Nest Sample Acquisition

At the location of the burrow or ant hill/nest, collect a grab sample of surface soil from the area immediately surrounding the burrow or hill/nest entrance using a clean scoop, trowel or other sampling device. Place the soil directly into containers provided by the laboratory for metals and gamma spectroscopy analyses. Completely fill the container to ensure adequate volume for analysis. Seal and label the container.

Vegetation Sample Acquisition

At the location of the potentially deep-rooted plant that was previously identified and marked for sampling, remove the surface portion of the plant and as much of the root system as possible. Remove as much soil as possible from the roots and lower plant. Use clippers or other cutting tools to cut the entire plant into small pieces, and place all cut plant materials into a large Ziplock bag. The grab sample should only contain plant material from a discrete plant(s) with the potential for a deep-rooted root system. Native grasses and other plants with shallow root systems should not be sampled.

A unique SNL/NM SMO-issued sample identification number is assigned to each sample. The sample number will be affixed to or noted on the container sample label and the analysis request/chain–of-custody (AR/COC) form.

A SNL/NM sample label should be completed with indelible ink and affixed to each sample container prior to or during sampling. Each completed sample label will include the following information:

- SNL/NM SMO sample number (with sample fraction designation)
- Sample matrix type
- Sample location
- Date and time of sample collection

A field log will be maintained documenting the collection of all samples. The field log for biota sampling locations will include information on the animal or insect species, size and description of the feature, the plant species, size, condition, and description, and any other pertinent information. See Section 4.0 below for sample container information.

3.5 Equipment Decontamination

All nondisposable equipment that comes into contact with the sample will be decontaminated prior to and following the collection of each sample to prevent cross-contamination. All visible material, such as embedded soil or grass clippings, must be removed from the sampling tools by spraying with Alconox or equivalent, followed by a rinse with deionized water if they are to be used again. The fluid may be allowed to run onto the ground at the sampling site. A clean paper towel or similar adsorbent material will be used to wipe equipment after the final rinse. .

3.6 Sample Custody Documentation

To ensure the integrity of samples from the time of collection through the reporting of analytical results, sample collection, handling, and custody will be documented. The continuous record of documented sample possession is referred to as the chain of custody. Primary elements in the documentation of samples are: sample identification number, sample labels, custody tape, and the AR/COC form. Standardized forms will be used to document sample information. Sample custody and documentation procedures for sampling activities are outlined in AOP 95-16.

3.7 Sample Shipment

Samples will be shipped to the analytical laboratory in accordance with LOP 94-03. Prior to shipment, the sample collection documentation will be verified. Any error will be noted and corrected as required by SNL/NM SMO protocols.

3.8 Waste Management

Waste generated during sampling activities will be minimal and may include used personal protective equipment (i.e., gloves) and decontamination wipes. All waste generated will be managed in accordance with federal, state, and city regulations, and applicable SNL/NM requirements. Analytical data collected from the sampling event will be used to characterize any waste generated.

4.0 ANALYTICAL METHODS

The analytical laboratory will analyze samples using EPA-approved analytical methods and specified performance criteria. The analytical laboratory will provide appropriate sample containers. The analytical laboratory will prepare and submit to SNL/NM SMO an analysis data report as required by the MWL LTMMP and this SAP. Table G-4-1 summarizes analytical requirements and EPA Methods (EPA November 1986) applicable to biota monitoring at the MWL.

Table G-4-1
Laboratory Analytical Methods
MWL Tritium and Biota Sampling

Parameter	EPA Method[a]	Container Size/Type x Number
Tritium in soil moisture using liquid scintillation	EPA 906.0 or equivalent	1-liter/poly or equivalent x 2
RCRA[b] Metals plus copper, nickel, vanadium, zinc, cobalt, and beryllium	SW846-6020/7470 or equivalent	500 milliliter/glass or equivalent x 1
Gamma Spectroscopy (short list)	EPA 901.1 or equivalent	Soil: 250 milliliter poly or equivalent x 1 Vegetation: 1-gallon Ziplock bag or equivalent x 1

[a]U.S. Environmental Protection Agency, 1986 (and updates), "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd Edition, U.S. Environmental Protection Agency, Washington, D.C.
[b]RCRA metals = arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.
EPA = U.S. Environmental Protection Agency.
MWL = Mixed Waste Landfill.
RCRA = Resource Conservation and Recovery Act.
SW = Solid waste.

4.1 Analytical Laboratory

The analytical laboratory is responsible for performing analyses in accordance with this SAP, the EPA analytical method, and regulatory requirements. The laboratory will maintain documentation of sample handling and custody, analytical data, and internal QC data. The laboratory will analyze QC samples in accordance with this SAP, the EPA analytical method, and its own internal QC program for indicators of analytical accuracy and precision. The SNL/NM SMO will direct the laboratory activity, including investigation and corrective action, if necessary, for data generated outside laboratory acceptance limits.

4.2 Quality Control Samples

QC samples will be analyzed in conjunction with the soil samples to ensure that the data generated meet the DQO of this SAP. QC for the entire activity will be achieved through adherence to requirements and procedures listed and described in Section 2.0 of this SAP. Mandatory QC samples are identified in the following sections.

4.2.1 Field Quality Control Samples

Field QC samples are used to document data quality and evaluate consistency in sample collection. Field QC samples submitted to the analytical laboratory will be handled and analyzed in the same manner as environmental samples. For this limited sampling effort field QC samples include duplicate environmental samples (Table G-4.2-1).

Table G-4.2-1
Field Quality Control Samples

Sample Type	Purpose of Sample	Frequency	Acceptance Criteria	Matrix
Duplicate Samples	To evaluate the overall precision of the sampling and analysis system.	1 with each sample batch sent to the laboratory or 1 per 20 samples.	RPD less than or equal to 20 percent (guidance only)	Soil

RPD = Relative percent difference.

Duplicate environmental samples are collected in the field and analyzed to establish and document the precision of the sampling and analysis process. The duplicate samples will be collected immediately after the original environmental sample in order to reduce variability caused by time and/or sampling mechanics and are typically collected at a frequency of 5 percent (minimum of one per MWL sampling event). An RPD of 20 percent or less will be considered satisfactory. An RPD exceeding 20 percent does not require corrective action because these sample results will reflect natural variability in the sampled media (i.e., surface soil and vegetation), and for low concentrations of naturally occurring constituents significant variability is expected. Duplicate samples of vegetation may not be possible if there is not enough plant material for two samples.

4.2.2 Laboratory Quality Control Samples

The analytical laboratory must have established procedures that demonstrate the analytical process is always in control during each sample analysis step. The procedures include LCSs, method blank samples, and MS samples. Laboratories must operate in conformance with the EPA analytical methods, and their own internal QC process. The laboratory QC sample results will be documented in a complete data report along with the results of environmental and field QC samples. This report will be submitted to the SNL/NM SMO for review and validation as discussed in Sections 5.2 and 5.3, respectively.

5.0 DATA VALIDATION, REVIEW, AND REPORTING

Data validation and review of analytical and field documentation will be performed for completeness and conformance to the procedures established for the various activities. Field and analytical QC data will be reviewed for conformance to QC acceptance criteria. The entire data package will be reviewed for representativeness of quality and comparability to determine whether the specified DQO has been met.

5.1 Field Measurement Data and Documentation Review

Completed field documentation will be reviewed and verified for accuracy, completeness, and conformance with established procedures. The review will occur at the end of each day in the field to allow verification, correction, and retrieval of missing information as appropriate.

5.2 Laboratory Data Verification and Validation

The SNL/NM SMO will review the laboratory report for completeness and conformance to the performance criteria of the contract with the laboratory according to the SMO 05-03.

Upon receipt of the analytical results from the laboratory, the SNL/NM SMO will arrange for the validation of the data. The purpose of validation is to determine the data usability and establish the defensibility of the numerical results. Data qualification is based upon review of laboratory-supplied QC data, the specific QC criteria identified in the procedures for the EPA-approved analytical methods, and the DQO identified in this SAP. Data validation will be conducted according to the requirements of AOP 00-03.

5.3 Reporting

A report of each annual tritium and biota sampling event will be submitted to the NMED as part of the annual MWL long-term monitoring report according to the schedule in Section 4.8.1 of the MWL LTMMP. The report will include a description of sampling locations and activities, a summary of laboratory analytical results, a discussion of QC analyses and data reviews, a description of any project variance or nonconformance, and data validation summaries. In addition, tritium and metals results for surface soil samples will be compared with trigger levels.

5.4 Records Management

Records associated with the tritium and biota sampling effort, including field documentation, laboratory analytical results, data validation reports, long-term monitoring reports, and technical data evaluations, will be maintained at the SNL/NM Records Center and comply with the record-keeping provisions of 20.4.1.500 New Mexico Administrative Code, incorporating Title 40 Code of Federal Regulations Section 264.74, concerning the availability, retention, and disposition of records.

6.0 REFERENCES

Bearzi J.P. (New Mexico Environment Department), November 2006. Letter to P. Wagner (U.S. Department of Energy) and L. Shepherd (Sandia Corporation), "Notice of Disapproval, Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005, and Requirement for Soil-Vapor Sampling and Analysis Plan, Sandia National Laboratories EPA ID NM5890110518, HWB-SNL-05-025." November 20, 2006

Bearzi J.P. (New Mexico Environment Department), October 2008. Letter to P. Wagner (U.S. Department of Energy) and F. Nimick (Sandia Corporation), "Notice of Disapproval, Mixed Waste Landfill Corrective Measures Implementation Plan, November 2005, Sandia National Laboratories NM5890110518, SNL-05-025." October 10, 2008.

Sandia National Laboratories/New Mexico (SNL/NM), May 2010. "Procedure for Completing the Contract Verification," SMO 05-03, Revision 04, Sample Management Office, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), May 2011. "Data Validation Procedure for Chemical and Radiochemical Data," AOP 00-03, Revision 03, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2011. "Sample Management and Custody, Administrative Operating Procedure," AOP 95-16, Revision 04, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), June 2011. "Sample Handling, Packaging, and Shipping," Sample Management Office (SMO) LOP 94-03, Revision 05, Sandia National Laboratories, Albuquerque, New Mexico.

U.S. Environmental Protection Agency (EPA), November 1986. "Test Methods for Evaluating Solid Waste," 3rd ed., and all updates, SW-846, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

APPENDIX H
Mixed Waste Landfill Well Database Summary Sheets

Compliance Groundwater Monitoring Wells
MWL-BW2
MWL-MW7
MWL-MW8
MWL-MW9

Information Only Groundwater Monitoring Wells
MWL-MW4
MWL-MW5
MWL-MW6

APPENDIX I
Mixed Waste Landfill
Long-Term Monitoring Inspection Checklists/Forms

Note: the inspection forms are provided in a specific format; however, alternate formats may be used to detail the information

Mixed Waste Landfill
Biology Inspection Checklist/Form

Mixed Waste Landfill
Biology Inspection Checklist/Form for the MWL Cover

Approximate vegetative coverage (actively photosynthesizing): ________ %

Approximate percent native vegetation of the total vegetative cover: ________ %

Listed below are the main plant species identified as growing on the MWL cover and the percentage of the cover populated by each species.

Scientific Name	Common Name (optional)	% of Cover[1]

Note: [1] Percentage of total MWL Cover populated by actively-photosynthesizing plants of this species

Mixed Waste Landfill
Biology Inspection Checklist/Form for the MWL Cover
(continued)

Are there any contiguous areas of no vegetation greater than 200 square feet? (approximately 14 x 14 ft)? ________

If "Yes," mark such areas on a map and attach to this checklist. Address actions and schedule to improve such area(s) in the notes section below.

Are there any very deeply rooted (roots greater than 8 feet deep at maturity) plant species present on the cover? ________

If "Yes," describe the plant(s) and their general distribution. Address actions and schedule to remove plant(s) from the cover in the notes section below.

Notes: ____

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Inspection for Animal and Insect Intrusion into MWL Cover

Are any burrows present on the cover? ______

Do any of the burrows appear to be active? ______

Any ant hills/nests? ______

Describe below observations regarding animal and insect features. If burrows with an entrance diameter of 4 inches or greater are present or appear to be that of a species that is able to burrow 6 feet deep or greater, indicate the location(s) on a map and attach to this checklist. Address actions and schedule to repair cover damage that exceeds prescribed limits. As appropriate, identify animal and insect features and have them surveyed and marked for biota sampling.

Notes: ____

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Mixed Waste Landfill
Biology Inspection Checklist/Form for the MWL Cover
(Continued)

Notes (continued):

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Biological Aspects Map -- [note: sketch map to locate specific features described above will be attached as appropriate]

Inspector's Signature: ______________________________ Date: ______________

Original to: Mixed Waste Landfill Operating Record

Copy to: SNL/NM Records Center

Mixed Waste Landfill
Cover Inspection Checklist/Form

Mixed Waste Landfill
Cover Inspection Checklist/Form

1. Date of Inspection ___________________________
2. Time of Inspection ___________________________
3. Name of Inspector ___________________________

Provide explanatory notes for each parameter not inspected or each action required. Include any maintenance or repair required in notes section at the end of this form.

I. COVER SYSTEM [Quarterly]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
A. Visible settlement of the soil cover in excess of 6 inches.			
B. Erosion of the soil cover in excess of 6 inches deep.			
C. Evidence of water ponding on the MWL cover surface in excess of 100 square feet.			
D. Animal intrusion burrows in excess of 4 inches in diameter. Note: During period when the Biology Inspection is occurring quarterly, this inspection requirement will be covered on the Biology Inspection Checklist/Form.			
E. Contiguous areas of no vegetation greater than 200 ft^2. Note: During period when the Biology Inspection is occurring quarterly, this inspection requirement will be covered on the Biology Inspection Checklist/Form.			
F. Potentially deep-rooted plants present. Note: During period when the Biology Inspection is occurring quarterly, this inspection requirement will be covered on the Biology Inspection Checklist/Form.			
II. SURFACE-WATER (STORM-WATER) DIVERSION STRUCTURES [Quarterly]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
A. Channel or sidewall erosion in excess of 6 inches deep.			
B. Channel sediment accumulation in excess of 6 inches deep.			
C. Debris that blocks more than 1/3 of the channel width.			

Mixed Waste Landfill
Cover Inspection Checklist/Form (continued)

III. SECURITY FENCE [Quarterly]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
A. Accumulation of wind-blown plants and debris.			
B. Fence wires and posts in need of repair/maintenance.			
C. Gates in need of oiling/repair/maintenance.			
D. Locks in need of cleaning or replacement.			
E. Warning signs in need of repair or replacement.			
F. Survey monuments in vicinity of MWL visible.			
IV. PREVIOUS DEFICIENCIES			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
Uncorrected/undocumented previous deficiencies.			

Mixed Waste Landfill
Cover Inspection Checklist/Form (continued)

NOTES

Note Number	Description

Mixed Waste Landfill
Cover Inspection Checklist/Form (continued)

Action (Note Number) ______ assigned to __________________Date action completed______________

Action (Note Number) ______ assigned to __________________Date action completed______________

Action (Note Number) ______ assigned to __________________Date action completed______________

Action (Note Number) ______ assigned to __________________Date action completed______________

Action (Note Number) ______ assigned to __________________Date action completed______________

Additional Comments:

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Inspector's Signature ___________________________

Original to: Mixed Waste Landfill Operating Record

Copy to: SNL/NM Records Center

Mixed Waste Landfill
Groundwater Monitoring Network Checklist/Form

Mixed Waste Landfill
Groundwater Monitoring Network Checklist/Form

1. Date of Inspection ____________________________
2. Time of Inspection ____________________________
3. Name of Inspector ____________________________

Provide explanatory notes for each parameter not inspected or each action required. Include any maintenance or repair required.

I. GROUNDWATER MONITORING LOCATIONS [Semiannually]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
A. Concrete pads, bollards, and protective casings in need of repair/maintenance.			
B. Well cover caps in need of repair/maintenance.			
C. Well casing in need of repair/maintenance.			
D. Monitoring well properly labeled.			
E. Locks in need of cleaning or replacement.			
II. GROUNDWATER SAMPLING EQUIPMENT [Semiannually]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
A. Sampling pump in need of repair/maintenance.			
B. Sampling assembly (e.g., tubing, gauges, and valves) in need of repair/maintenance.			
III. PREVIOUS DEFICIENCIES			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
Uncorrected/undocumented previous deficiencies.			

Mixed Waste Landfill
Groundwater Monitoring Network Checklist/Form (Continued)

NOTES

Note Number	Description

Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________

Additional Comments:

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Inspector's Signature ____________________________

Original to: Mixed Waste Landfill Operating Record

Copy to: SNL/NM Records Center

Mixed Waste Landfill
Soil-Vapor Monitoring Network Checklist/Form

Mixed Waste Landfill
Soil-Vapor Monitoring Network Checklist/Form

1. Date of Inspection ____________________________
2. Time of Inspection ____________________________
3. Name of Inspector ____________________________

Provide explanatory notes for each parameter not inspected or each action required. Include any maintenance or repair required.

I. SOIL–VAPOR MONITORING LOCATIONS [Semiannually or Annually]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
A. Concrete pads, bollards, and protective casings in need of repair/maintenance.			
B. Well cover caps in need of repair/maintenance.			
C. Well casing or sampling ports in need of repair/maintenance.			
D. Monitoring location and sampling ports properly labeled.			
E. Locks in need of cleaning or replacement.			
II. SAMPLING EQUIPMENT [Semiannually or Annually]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
A. Sampling pump in need of repair/maintenance.			
B. Sampling assembly (e.g., tubing, gauges, and valves) in need of repair/maintenance.			
III. PREVIOUS DEFICIENCIES			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
Uncorrected/undocumented previous deficiencies.			

Mixed Waste Landfill
Soil-Vapor Monitoring Network Checklist/Form (Continued)

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Note Number	Description

Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________

Additional Comments:

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Inspector's Signature ______________________________

Original to: Mixed Waste Landfill Operating Record

Copy to: SNL/NM Records Center

Mixed Waste Landfill
Soil-Moisture Monitoring Network Checklist/Form

Mixed Waste Landfill
Soil-Moisture Monitoring Network Checklist/Form

1. Date of Inspection ____________________________
2. Time of Inspection ____________________________
3. Name of Inspector ____________________________

Provide explanatory notes for each parameter not inspected or each action required. Include any maintenance or repair required.

I. SOIL–MOSITURE MONITORING LOCATIONS [Semiannually or Annually]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
F. Concrete pads, bollards, and protective casings in need of repair/maintenance.			
G. Access tube cover caps in need of repair/maintenance.			
H. Access tube casing in need of repair/maintenance.			
I. Monitoring location properly labeled.			
J. Locks in need of cleaning or replacement.			
II. SAMPLING EQUIPMENT [Semiannually or Annually]			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
A. Neutron probe in need of repair/maintenance.			
B. Cable reel or cable in need of repair/maintenance.			
III. PREVIOUS DEFICIENCIES			
Inspection Parameter	***Parameter Inspected (Yes or No)***	***Action Required (Yes or No)***	***Note Number***
Uncorrected/undocumented previous deficiencies.			

Mixed Waste Landfill
Soil-Moisture Monitoring Network Checklist/Form (Continued)

NOTES

Note Number	Description

Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________
Action (Note Number) ______ assigned to __________________Date action completed______________

Additional Comments:

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Inspector's Signature ____________________________

Original to: Mixed Waste Landfill Operating Record

Copy to: SNL/NM Records Center