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NNSA-2023-008933

National Nuclear Security Administration

Department of Energy
National Nuclear Security Administration
Sandia Field Office
P.O. Box 5400
Albuquerque, NM 87185

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Received
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NMED Hazardous Waste Bureau

Mr. Ricardo Maestas
Acting Chief, Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6313

Subject: Submittal of Mixed Waste Landfill (MWL) Second Five-Year Report, January 2024 for Sandia National Laboratories, New Mexico, U.S. Environmental Protection Agency Identification Number NM5890110518

Dear Mr. Maestas:

The U.S. Department of Energy, National Nuclear Security Administration, Sandia Field Office and National Technology & Engineering Solutions of Sandia, LLC submit the subject report dated January 2024. The subject report fulfills the reporting requirements set forth in the New Mexico Environment Department (NMED) May 2005 Final Order, Section 4.8.2 of the MWL Long-Term Monitoring and Maintenance Plan, and the NMED approval letter for the January 2019 MWL Five-Year Report.

If you have any questions, please contact me at (505) 845-6036 or Dr. Adria Bodour of our staff at (505) 845-6930 or adria.bodour@nnsa.doe.gov.

Sincerely,

Daryl J. Hauck, PhD
Manager

cc: See page 2

DEC 0 1 2023

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Mixed Waste Landfill Second Five-Year Report
January 2024

Sandia National Laboratories
Albuquerque, New Mexico
EPA ID No. NM5890110518

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

Gregory T. Roselle Digitally signed by Gregory T. Roselle Date: 2023.11.08 10:15:58 -07'00'

Signature Date

Gregory T. Roselle, Ph.D., P.G.
Senior Manager, Defense Waste Management Programs Group
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Operator

and

Signature 12/11/2023
Date

Daryl J. Hauck, Ph.D., Manager
U.S. Department of Energy
National Nuclear Security Administration
Sandia Field Office
Owner

This form is derived from AOP F 95-45-3 (6-2017).

MIXED WASTE LANDFILL
SECOND FIVE-YEAR REPORT

SANDIA NATIONAL LABORATORIES, NEW MEXICO
LONG-TERM STEWARDSHIP

JANUARY 2024

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.

MIXED WASTE LANDFILL
SECOND FIVE-YEAR REPORT

Facility: Mixed Waste Landfill

Location: Sandia National Laboratories
Albuquerque, New Mexico

EPA ID No.: NM5890110518

Permit Basis: SNL/NM RCRA Facility Operating Permit, Attachment M
New Mexico Environment Department 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) (May 2005)

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EXECUTIVE SUMMARY

In the May 2005 Final Order, the New Mexico Environment Department (NMED) selected a vegetative soil cover with a biointrusion barrier (i.e., evapotranspirative [ET] cover) as the remedy for solid waste management unit (SWMU) 76, Mixed Waste Landfill (MWL), and established the requirement for a five-year report. The May 2005 Final Order on remedy selection (NMED May 2005) and Section 4.8.2 of the *Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill* (LTMMP) (SNL/NM March 2012) establish and delineate five-year report requirements. As determined by the NMED (Kieling October 2011), the first five-year evaluation period began on January 8, 2014, when NMED approved the LTMMP (Blaine January 2014) and included the first four calendar years under the LTMMP (i.e., January 2014 through December 2017). The evaluation period for this *Mixed Waste Landfill Second Five-Year Report* (Report) is January 2018 through December 2022.

The MWL is a 2.6-acre SWMU located in the north-central portion of Technical Area-III approximately four miles south of Sandia National Laboratories/New Mexico (SNL/NM) central facilities and five miles southeast of the Albuquerque International Sunport. The MWL was used as a disposal area for low-level radioactive waste, hazardous waste, and mixed waste generated at SNL/NM research facilities and offsite locations from March 1959 to December 1988. The MWL has undergone corrective action and as effective on March 13, 2016, is Corrective Action Complete with Controls (NMED February 2016). All remedy and controls required for the MWL are defined in the LTMMP, which is included in Attachment M of the SNL/NM Resource Conservation and Recovery Act Facility Operating Permit (Permit) (NMED January 2015, with all approved modifications and Kieling February 2016). Long-term monitoring, inspection, and maintenance/repair activities are conducted in accordance with the Permit and detailed in MWL Annual Long-Term Monitoring and Maintenance Reports.

The scope of this Report includes addressing all requirements specified in the May 2005 Final Order (NMED May 2005) and Section 4.8.2 of the LTMMP (SNL/NM March 2012). The primary purpose of the five-year report is to analyze the effectiveness of the selected remedy (i.e., the ET Cover and remedy controls) through review of multi-media monitoring, inspection, and maintenance results collected over the five-year evaluation period. The measure of effectiveness is the protection of human health and the environment. The Report also presents an evaluation of the likelihood of contaminants reaching groundwater and a reevaluation of the feasibility of the excavation remedial alternative.

The NMED approval letter for the first Five-Year Report (Catechis July 2021) included two additional requirements for this Report: 1) evaluation of 13 toxic pollutants added to the New Mexico Administrative Code since January 2014, and 2) evaluation of current and future land use in areas surrounding Kirtland Air Force Base. In addition, a review of the multi-media monitoring trigger levels was performed and documented in this Report.

Multi-media monitoring, inspection, and maintenance results presented in this Report establish site conditions and provide the empirical data to determine the effectiveness of the ET Cover and all remedy controls. Results from this second five-year evaluation period were compared with historical investigation, characterization, and previous monitoring and fate and transport modeling results to determine if conditions are changing in a way that could increase risk to human health and the environment and to reevaluate the likelihood of contaminants reaching groundwater. The inspection and maintenance results provide information on the physical

condition of the ET Cover and controls, including the storm-water diversion swale, perimeter security fence and signage, survey monuments, monitoring networks, and associated sampling equipment. This information is used to evaluate the performance of the ET Cover and controls in accordance with design, as well as verify implementation of land-use restrictions.

Based upon nine years of monitoring, inspection, and maintenance under the LTMMP, MWL site conditions have improved and are protective of human health and the environment. The ET Cover and all remedy controls are in good condition and are performing as designed. The multi-media monitoring results for the 2018 through 2022 evaluation period are consistent with historical data and confirm protective conditions; no trigger levels were exceeded. There are no indications of changing conditions that would increase the risk to site workers, the public, or indicate an increase in the likelihood of contaminants reaching groundwater. Inspection and maintenance results from the 2018 through 2022 evaluation period, combined with multi-media monitoring results, confirm the ET Cover and controls conform with design requirements, are in good condition, and are performing as designed. Industrial land use is being maintained and the ET Cover has not been disturbed.

Routine and best-practice maintenance summarized in this Report have improved site conditions. The ET Cover native vegetation is established and serving its design functions of surface stabilization and minimizing the percolation and infiltration of surface water into the disposal area. Best-practice weed control activities conducted during this evaluation period helped the native vegetation by minimizing weed growth on the ET Cover, thereby minimizing competition with invasive annual weeds for limited moisture and nutrients. Site erosion controls and surface-water drainage improvements completed during the first five-year evaluation period continue to be inspected and maintained and are performing as designed. Overall ET Cover and site maintenance and repairs have decreased as a result of successful revegetation efforts, routine and best-practice maintenance, and best-practice site improvements.

Results of additional evaluation and monitoring performed to address the two new NMED requirements specific to this Report (Catechis July 2021) confirm the Regional Aquifer beneath the MWL has not been impacted and the MWL will not limit the development of land surrounding Kirtland Air Force Base, including Mesa del Sol and the Pueblo of Isleta. Of the 13 new compounds that were evaluated, five are already included as part of the multi-media monitoring program. For the other eight compounds there are no anticipated impacts based on groundwater monitoring results, historical investigation data, and/or process knowledge. No changes to monitoring parameters and/or frequencies are necessary for the protection of human health and the environment based upon the information presented in this Report.

A review of monitoring trigger levels that are based upon published regulatory standards and risk-based screening levels, as defined in Section 5.2 of the LTMMP, was also performed. Current trigger levels were approved by the NMED in 2014 (Blaine January 2014) and continue to be protective of human health and the environment. More recent changes to the regulatory standards and risk-based screening levels since 2014 are documented in this Report and will be addressed in a future Permit modification request in accordance with Section 5.2 of the LTMMP.

Fate and transport modeling updates were not required for this Report based upon a comparison of the 2018 through 2022 monitoring results to the 2005 model (SNL/NM November 2005, Ho et al. November 2005 and January 2007) and the 2018 updated tetrachloroethene (PCE) soil-vapor transport model presented in the first Five-Year Report (SNL/NM January 2019). All monitoring results reflect conditions that are consistent with those previously modeled

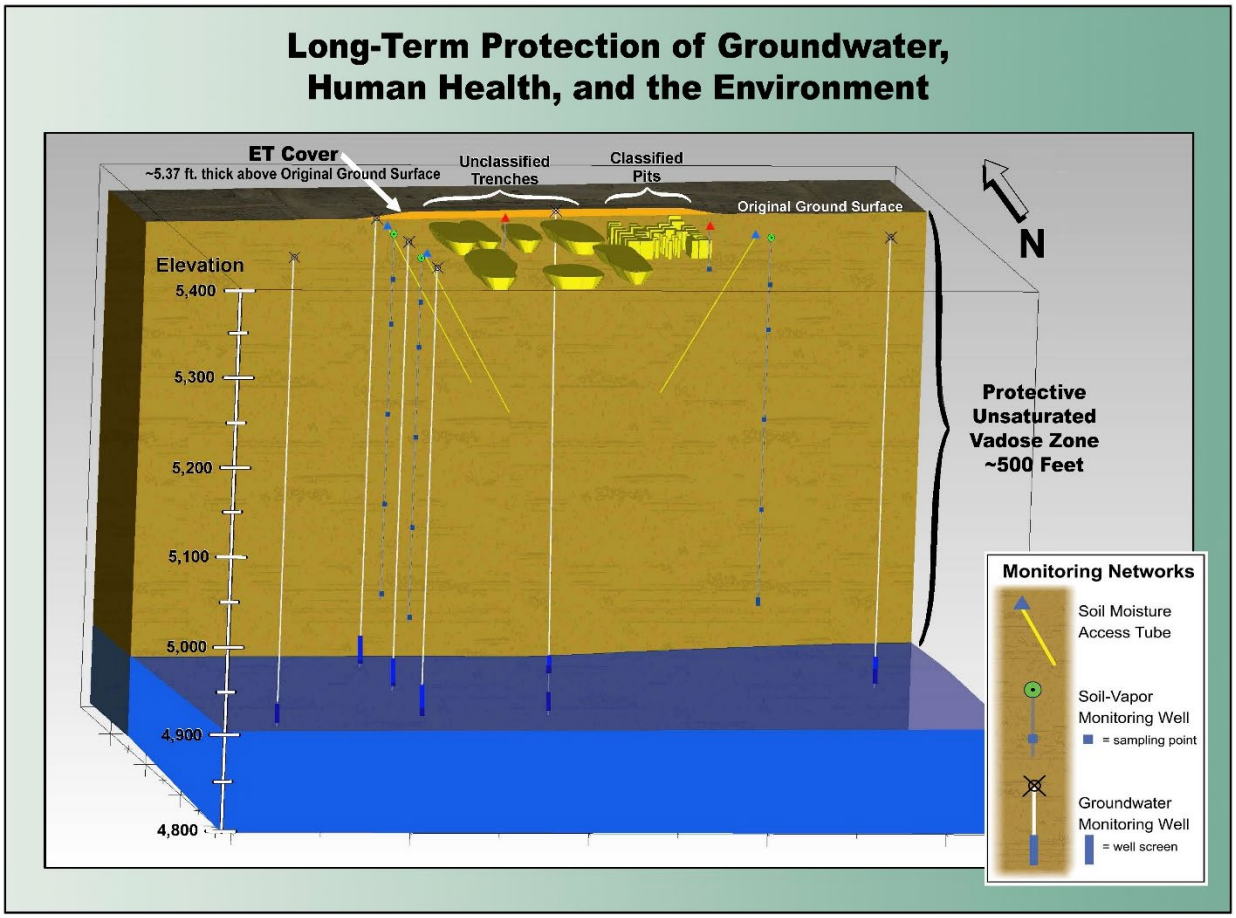
and that are protective of human health and the environment. The PCE soil-vapor concentrations for the 2018 through 2022 evaluation period were similar to, or lower than, concentrations for the 2014 through 2017 evaluation period, which is consistent with the 2018 updated model predictions. Volatile organic compound (VOC) soil-vapor results since monitoring began under the LTMMP in 2014 indicate there are no new sources contributing to the MWL VOC soil-vapor plume and the plume is not a threat to groundwater.

The 2023 reevaluation of the *Complete Excavation with Offsite Disposal* remedial alternative presented in this Report updates the comprehensive 2018 reevaluation presented in the first Five-Year Report (SNL/NM January 2019). The excavation and waste management technical approach, waste disposal pathways, and risk to site workers and the public have not changed. The estimated cost is anticipated to be higher than the 2018 cost estimate due to recent higher rates of inflation and generally higher costs for materials, equipment, and labor.

The NMED requirement to reevaluate the feasibility of the *Complete Excavation with Offsite Disposal* remedial alternative has been fulfilled in both the first Five-Year Report (SNL/NM January 2019) and in this Report. Both reevaluations concluded that *Complete Excavation with Offsite Disposal* is a remedial alternative that could be implemented, if necessary, for the protection of human health and the environment. Considering all available information, the ET Cover with controls remedy continues to be the preferred remedy because it protects human health and the environment without increasing risk to site workers and the public.

The ET Cover with controls remedy is effective and performing as designed as confirmed by ongoing multi-media monitoring, inspection, maintenance, and repair results. The multi-media monitoring program is focused on the most mobile contaminants and exposure pathways. Consistent with the May 2005 Final Order and the LTMMP requirements, the associated Trigger Evaluation Process ensures any future releases or movement of contaminants are detected and addressed in a timely manner (Figure ES-1). The contingency procedures presented in Chapter 7 of the LTMMP address the highest potential failure scenarios and possible corrective actions that would be implemented in accordance with the Trigger Evaluation Process. Complete excavation is not an anticipated corrective action that would be required for any of the evaluated failure scenarios.

The regulatory requirements associated with this Report have been met. No changes to the remedy or controls are needed for the protection of human health and the environment. Best-practice measures, follow-up field investigations, and evaluation of new and emerging contaminants are part of the protective approach for the MWL that is established in the Permit through incorporation of the LTMMP in Attachment M. Annual Long-Term Monitoring and Maintenance and five-year reporting requirements will continue and ensure all MWL monitoring, inspection, maintenance, and repair information is provided to the NMED and made available to the public in a timely manner.



- **Evapotranspirative Cover (ET Cover) provides a barrier preventing human and animal intrusion and protects the disposal area from the percolation and infiltration of surface water/moisture, thereby minimizing the potential for waste mobilization and migration.**
  - **~500-foot-thick unsaturated vadose zone also provides protection of the Regional Aquifer beneath the disposal area.**

- **Multi-media monitoring program provides an early warning detection system, and the Trigger Evaluation Process ensures timely follow up if any Trigger Levels are exceeded.**

- **The ET Cover with controls remedy, including multi-media monitoring and the Trigger Evaluation Process, ensure the long-term protection of human health and the environment *without the additional risk to site workers and the public associated with excavation and offsite disposal*.**

Figure ES-1
Long-Term Protection of Human Health and the Environment at the Mixed Waste Landfill

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ACRONYMS AND ABBREVIATIONS

%	percent
bgs	below ground surface
CADD	Computer Assisted Design Drawings
CFR	Code of Federal Regulations
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ET	evapotranspirative
LTMM	Long-Term Monitoring and Maintenance
LTMMP	*Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill*
µg/L	micrograms per liter
MDA	minimum detectable activity
MWL	Mixed Waste Landfill
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
PCE	tetrachloroethene
pCi/L	picocuries per liter
PFAS	perfluoroalkyl and/or polyfluoroalkyl substances
PFHxS	perfluorohexane sulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
ppmv	parts per million by volume
Permit	RCRA Facility Operating Permit for Sandia National Laboratories, EPA ID No. NM5890110518
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAP	Sampling and Analysis Plan
SNL/NM	Sandia National Laboratories, New Mexico
SWMU	solid waste management unit
TCE	trichloroethene
VOC	volatile organic compound
WERC	A Consortium for Environmental Education and Technology Development

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1.0 INTRODUCTION AND BACKGROUND

This is the second Five-Year Report for solid waste management unit (SWMU) 76, Mixed Waste Landfill (MWL), as required by the New Mexico Environment Department (NMED) May 2005 Final Order (NMED May 2005) that selected the remedy. The five-year reporting requirement began with NMED-approval of the *Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill* (LTMMP) in January 2014 (Blaine January 2014). The primary purpose of the five-year report is to evaluate the effectiveness of the selected remedy (i.e., the Evapotranspirative [ET] Cover). This Report also evaluates the likelihood of contaminants reaching groundwater and revaluates the feasibility of the excavation remedial alternative.

The MWL is a 2.6-acre SWMU located in the north-central portion of Technical Area-III at Sandia National Laboratories, New Mexico (SNL/NM). This location is approximately four miles south of SNL/NM central facilities and five miles southeast of Albuquerque International Sunport (Figure 1-1). The MWL was used as a disposal area for low-level radioactive waste, hazardous waste, and mixed waste generated at SNL/NM research facilities and offsite locations from March 1959 to December 1988. The MWL consists of two distinct disposal areas: the Classified Area (occupying 0.6 acres) and the Unclassified Area (occupying 2.0 acres). MWL operational history, including a detailed waste inventory summary by pit and trench, is presented in the following documents.

- *Responses to New Mexico Environment Department Technical Comments on the Report of the Mixed Waste Landfill Phase 2 Resource Conservation and Recovery Act Facility Investigation Dated September 1996* (SNL/NM June 1998)

- *Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation* (Peace et al. September 2002, SAND2002-2997)

The MWL is situated between the Manzanita Mountains to the east and the Rio Grande to the west. The ground surface is generally flat with a gentle slope towards the Rio Grande. The regional climate is semi-arid with an average annual rainfall of approximately eight inches per year. Annual net potential evapotranspiration, the amount of water that could evaporate and/or be transpired from the surface and shallow subsurface soils to the atmosphere, is approximately 75 inches per year. In other words, the rate of evaporation and transpiration is approximately nine times greater than the annual precipitation. Groundwater occurs in fine-grained Santa Fe Group alluvial fan sediments approximately 500 feet below the ground surface. Recharge to the Regional Aquifer occurs primarily in the Manzanita Mountains approximately five miles east of the MWL.

1.1 Purpose and Scope

The primary purpose of the five-year report is to analyze the effectiveness of the remedy through a review of monitoring, inspection, and maintenance results collected over the five-year evaluation period. The measure of effectiveness is the protection of human health and the environment. The evaluation period for this *Mixed Waste Landfill Second Five-Year Report* (Report) is January 2018 through December 2022. The evaluation period for the first Five-Year

Report (SNL/NM January 2019) was January 2014 through December 2017. The evaluation periods represent calendar years and are hereafter referred to as 2014 through 2017 and 2018 through 2022.

Other five-year report requirements include evaluation of the likelihood of contaminants reaching groundwater through a review of multi-media monitoring results collected over the five-year evaluation period and updating the fate and transport model, if necessary. If recent monitoring results differ from the range of conditions previously modeled in 2005 (SNL/NM November 2005, Ho et al. November 2005 and January 2007) or the model for tetrachloroethene (PCE) soil-vapor transport in the vadose zone updated in 2018 and presented in the first Five-Year Report (SNL/NM January 2019), the fate and transport model will be updated to determine the likelihood of contaminants reaching groundwater. Reevaluation of the feasibility of MWL excavation is also required. A comprehensive feasibility evaluation was presented in Chapter 5 of the first Five-Year Report and included both onsite and offsite waste disposal alternatives as required by the NMED February 2016 Final Order (NMED February 2016). The evaluation of the onsite waste disposal alternative was only required for the first Five-Year Report.

The scope of this Report includes addressing all requirements specified in the two Final Orders (NMED May 2005 and February 2016), Section 4.8.2 of the LTMMP (SNL/NM March 2012), and the NMED approval letter for the first Five-Year Report (Catechis July 2021). More specific information on the NMED requirements is provided in Section 1.4 of this Report.

1.2 Regulatory History

The MWL is a Resource Conservation and Recovery Act (RCRA) SWMU that underwent 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)

- SNL/NM RCRA Permit
    - Module IV of RCRA Permit No. NM5890110518 (U.S. Environmental Protection Agency [EPA] August 1993)

    - Facility Operating Permit EPA Identification Number NM5890110518 (Permit) (NMED January 2015)

- *Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act* § *74- 4- 10* (Compliance Order on Consent) (NMED April 2004)

- 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 Sandia National Laboratories EPA ID No. NM5890110518,* No. HWB 04-11(M) (NMED May 2005)

In October 2014, U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) and SNL/NM personnel submitted a request to the NMED for a Class 3 Permit Modification for Corrective Action Complete at the MWL (Beausoleil October 2014). The associated regulatory process included two public comment periods, a public meeting held by DOE/NNSA and SNL/NM personnel in November 2014, and a four-day public hearing held by the NMED in July 2015. On February 12, 2016, the NMED issued the *Final Order In the Matter of Proposed Permit Modification for Sandia National Laboratories EPA ID No. NM5890110518 to Determine Corrective Action Complete with Controls at the Mixed Waste Landfill*, No. HWB 15-18 (P) (NMED February 2016). The February 2016 Final Order became effective on March 13, 2016, granting the Class 3 Permit Modification to reflect that the MWL is Corrective Action Complete with Controls. All remedy controls (i.e., ET Cover System controls or controls) required for the MWL are defined in the LTMMP (SNL/NM March 2012, with all approved modifications) and incorporated through reference in Attachment M of the Permit (Kieling February 2016). Long-term monitoring, inspection, maintenance, and reporting are conducted in accordance with the Permit (NMED January 2015, with all approved modifications). The first Permit modification request for the LTMMP (Hauck December 2021) was approved by the NMED (Shean February 2022) and became effective on February 16, 2022. Details are provided in Section 2.4.1 of this Report.

A more comprehensive summary of the MWL operational and regulatory history is provided in Appendix A of this Report.

1.3 Remedy and Controls

As part of the RCRA corrective action process for the MWL, the NMED selected a vegetative soil cover with a biointrusion barrier (i.e., an ET cover) as the remedy (NMED May 2005). The ET Cover and associated storm-water controls (also referred to as surface-water controls) limit water infiltration into the disposal areas preventing future migration of contaminants. The ET Cover design and construction specifications were presented in the Corrective Measures Implementation (CMI) Plan (SNL/NM November 2005) along with performance modeling based on site-specific field testing that demonstrated the effectiveness of the design. The ET Cover was constructed in accordance with the CMI Plan in 2009. The construction was documented in the CMI Report (SNL/NM January 2010, Revision 1) that was approved by the NMED (Kieling October 2011).

The ET Cover consists of four main layers: Compacted Subgrade, Biointrusion, Compacted Native Soil, and Topsoil. A schematic profile of the ET Cover and its design function is provided in Figure 1-2. Site surface-water controls were incorporated into the design to control surface-water run-on from hydraulically up-gradient areas and runoff from the ET Cover, as shown in Figure 1-3.

The May 2005 Final Order also required the development of a fate and transport model to assess long-term contaminant migration and the development of a protective multi-media monitoring plan with media-specific trigger levels to identify changing conditions that would require further investigation and timely follow-up actions. The fate and transport model was presented in the CMI Plan along with proposed long-term monitoring and associated trigger levels for identified contaminants of concern in various environmental media (SNL/NM November 2005). Monitoring and specific trigger levels, maintenance, inspection, and reporting

requirements were finalized in the LTMMP (SNL/NM March 2012), which was approved by the NMED (Blaine January 2014). The trigger levels and evaluation process specified in the LTMMP ensure that if conditions change in a manner that could increase the risk to human health and the environment, timely follow-up actions will be taken, including the implementation of an additional or different remedy, if necessary.

In addition to the ET Cover, remedy controls are implemented and maintained to provide the information needed to determine if the ET Cover is performing as designed and confirm that site conditions remain protective of human health and the environment. MWL remedy controls, which include all physical, active, and administrative controls associated with the MWL, are defined in the LTMMP that was implemented upon approval in January 2014. Remedy controls discussed in this Report include the ET Cover and slope; storm-water diversion swale; perimeter security fence and signage; survey monuments; multi-media monitoring and trigger level requirements; inspection, maintenance, and repair requirements; and land-use restrictions (i.e., maintain industrial land use and do not allow disturbance of the ET Cover). These remedy controls are implemented in an integrated and layered approach to enhance their effectiveness and protectiveness over time.

1.4 Report Requirements and Organization

Table 1-1 lists the regulatory documents that specify requirements for this Report. Appendix B provides copies of pages from each document, along with a requirements verification matrix (i.e., cross-referenced table) that maps requirements from each document to corresponding chapters and sections of this Report. Table 1-2, found at the end of this chapter, provides a crosswalk of the Report content to the Report requirements.

Table 1-1
Mixed Waste Landfill Second Five-Year Report Requirements Documents

Document Date	Document Source	Document Name
May 2005	New Mexico Environment Department	*Final Order In the Matter of Request for a Class 3 Permit Modification for Corrective Measures for the Mixed Waste Landfill Sandia National Laboratories EPA ID No. NM5890110518*, No. HWB-SNL-04-11(M) (NMED May 2005)
March 2012	Sandia National Laboratories	*Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill* (SNL/NM March 2012)
February 2016	New Mexico Environment Department	*Final Order In the Matter of Proposed Permit Modification for Sandia National Laboratories EPA ID No. NM5890110518 to Determine Corrective Action Complete with Controls at the Mixed Waste Landfill*, HWB-SNL-15-18(P) (NMED February 2016)
July 2021	New Mexico Environment Department	*Approval, Mixed Waste Landfill Five-Year Report, January 2019 EPA ID#NM5890110518,* HWB-SNL-19-001 (Catechis July 2021)

Section 4.8.2 of the LTMMP provides additional details regarding the required elements to be addressed in this Report. These are summarized below.

- Summarize monitoring and inspection results used to evaluate ET Cover performance. The 2018 through 2022 monitoring, inspection, and maintenance results are presented in Chapter 2 of this Report along with site improvements.

- Update the fate and transport model originally presented in the CMI Plan (SNL/NM November 2005) if 2018 through 2022 monitoring results are different from the conditions previously modeled. Volatile organic compound (VOC) soil-vapor plume modeling was updated in the first Five-Year Report (SNL/NM January 2019). This requirement is addressed in Chapter 3 of this Report.

- Evaluate effectiveness of the remedy. The measure of effectiveness for the ET Cover is the protection of human health and the environment. An assessment of current site conditions and the performance of the ET Cover System and controls are documented in Chapter 4 of this Report.

- Reevaluate the feasibility of excavation. This requirement is defined as an update to the *Complete Excavation with Offsite Disposal* remedial alternative originally evaluated in the MWL Corrective Measures Study (CMS) Final Report, Appendix H (SNL/NM May 2003). This requirement was established in the May 2005 Final Order (NMED May 2005) and expanded by the February 2016 Final Order to include an evaluation of onsite disposal in a modern landfill that includes a RCRA Subtitle C liner system. The requirement for evaluation of onsite disposal was specific to the first Five-Year Report (SNL/NM January 2019) and is not addressed in this Report. The feasibility of *Complete Excavation with Offsite Disposal* is addressed in Chapter 5 of this Report.

Two new requirements were added in the NMED approval letter for the first Five-Year Report (Catechis July 2021). The new requirements, listed below, apply to this Report.

- Evaluate groundwater quality for all toxic pollutants added to the Ground Water and Surface Water Protection regulations at 20.6.2 NMAC, since January 2014. This evaluation is included in Chapter 2 of this Report.

- Evaluate current and future planned land-use activities in previously undeveloped areas around Kirtland Air Force Base, including Mesa del Sol. This evaluation is included in Chapter 4 of this Report.

1.5 Public Process and Regulatory Review and Approval

SNL/NM and DOE/NNSA personnel are responsible for submitting this Report to the NMED and making the Report and supporting information available to the public prior to approval by the NMED. Supporting information is included in the appendices of this Report. After the NMED performs a preliminary review and determines it is complete, the Report will be available through the federal repository at the University of New Mexico, Main Campus, Albuquerque, Zimmerman Library in the Course Reserves section (two printed copies) and the SNL/NM Technical Reports Collection under the “Facilities-Units” page of the digital repository at the following link: *http://digitalrepository.unm.edu/snl_fu/* (electronic copy).

The NMED is responsible for review and approval of this Report and providing a process whereby members of the public may comment on the Report and its conclusions. The NMED is also responsible for responding to public comments submitted during the specified public comment period.

1.6 Public Access for Supporting Information

Much of the information evaluated and summarized in this Report is detailed in MWL Annual Long-Term Monitoring and Maintenance (LTMM) Reports. Annual LTMM Reports are submitted to the NMED in June of each year and provide details of all required multi-media monitoring, inspections, and maintenance/repair activities performed during the annual reporting period. MWL remedy controls and five-year report requirements are defined in the LTMMP. The documents listed below were reviewed and approved by the NMED, and are accessible to the public through the federal repository at the University of New Mexico, Main Campus, Albuquerque, Zimmerman Library (hardcopy) and the SNL/NM Technical Reports Collection under the "Facilities-Units" page of the digital repository at the following link: *http://digitalrepository.unm.edu/snl_fu/* (electronic copy).

Document	Reference
Regulatory Requirements Plan	
Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill, March 2012	SNL/NM March 2012
Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill, March 2012, Revision 1 December 2021	Shean February 2022[a]
Permit Modification Requests	
Request for Modification 21-019 to RCRA Facility Operating Permit	Hauck December 2021
Five-Year Reports	
Mixed Waste Landfill Five-Year Report, January 2019	SNL/NM January 2019
Annual Reports	
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, January – March 2014	SNL/NM June 2014
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2014 – March 2015	SNL/NM June 2015
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2015 – March 2016	SNL/NM June 2016
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2016 – March 2017	SNL/NM June 2017
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2017 – March 2018	SNL/NM June 2018
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2018 – March 2019	SNL/NM June 2019
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2019 – March 2020	SNL/NM June 2020
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2020 – March 2021	SNL/NM June 2021
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2021 – March 2022	SNL/NM June 2022
Mixed Waste Landfill Annual Long-Term Monitoring & Maintenance Report, April 2022 – March 2023	SNL/NM June 2023

Notes:
[a]The first request for modification of the *Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill* (LTMMP) was submitted in December 2021 (Request Modification 21-2019) and was approved by the New Mexico Environment Department in February 2022.
RCRA = Resource Conservation and Recovery Act.
SNL/NM = Sandia National Laboratories, New Mexico.

Table 1-2
Mixed Waste Landfill Second Five-Year Report – Table of Contents Crosswalk to Requirements

Chapter & Main Sections	Content Explanation	Requirements[a]
1.0 Introduction and Background 1.1 Purpose and Scope 1.2 Regulatory History 1.3 Remedy and Controls 1.4 Report Requirements and Organization 1.5 Public Process and Regulatory Review and Approval 1.6 Public Access for Supporting Information	Set Context and Regulatory Process for the Report; define Report requirements and how/where requirements are addressed.	1, 5, 6, 7, 15, 16, 18, 19, 23, 24
2.0 Monitoring and Inspections Summary 2.1 Monitoring and Inspection Requirements 2.2 Monitoring Results Summary 2.3 Inspection and Maintenance Summary 2.4 Other Pertinent Data and Information	Address requirement to include a review of monitoring reports and other pertinent data for the purpose of evaluating remedy effectiveness. This information is used in Chapter 4 to assess remedy effectiveness and detail all efforts to ensure future releases or movement of contaminants are detected and addressed before any effect on groundwater or increased risk to public health. Section 2.4 includes a requirement added in the first Five Year Report approval letter for this Report to evaluate groundwater quality for toxic pollutants added to Ground Water and Surface Water Protection regulations at 20.6.2 NMAC since January 2014.	1, 2, 7, 8, 14, 23
3.0 Fate and Transport Model Review 3.1 Requirement for Update 3.2 Comparison of Monitoring Results to 2005 and 2018 Modeling Data 3.3 Discussion and Conclusions	Address requirement to update the 2005 fate and transport model with newer monitoring results, if necessary, and reevaluate the likelihood of contaminants reaching groundwater.	1, 3, 7, 10, 11, 13, 14
4.0 Evaluate Effectiveness of the Remedy 4.1 Site Conditions 4.2 Evapotranspirative Cover System 4.3 Evapotranspirative Cover System Controls 4.4 Future Releases and Contaminant Migration 4.5 Evaluation of Land Use in the Vicinity of the Mixed Waste Landfill 4.6 Remedy Effectiveness Summary and Conclusions	Address requirement to: 1) analyze the effectiveness of the remedy and 2) detail all efforts to ensure future releases or movement of contaminants are detected and addressed before any effect on groundwater or increased risk to public health. Use monitoring, inspection, and modeling results presented in Chapters 2 and 3. Section 4.5 added to meet the requirement in the first Five-Year Report approval letter for this Report to evaluate current and future planned land-use activities around Kirtland Air Force Base, including Mesa del Sol.	1, 4, 7, 10, 14, 24
5.0 Reevaluate Feasibility of Excavation 5.1 Background 5.2 Changes and Updates to the 2018 Reevaluation 5.3 Reevaluation of Excavation 5.4 Summary and Conclusions	Address requirement to reevaluate the feasibility of excavation.	1, 7, 9
6.0 Final Summary and Conclusions	Summarize how requirements have been met and main conclusions.	Not Applicable
7.0 References	Provide references for Report.	Not Applicable

Note: [a]Requirement number from Appendix B, Requirements Verification Matrix.

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CHAPTER 1 FIGURES

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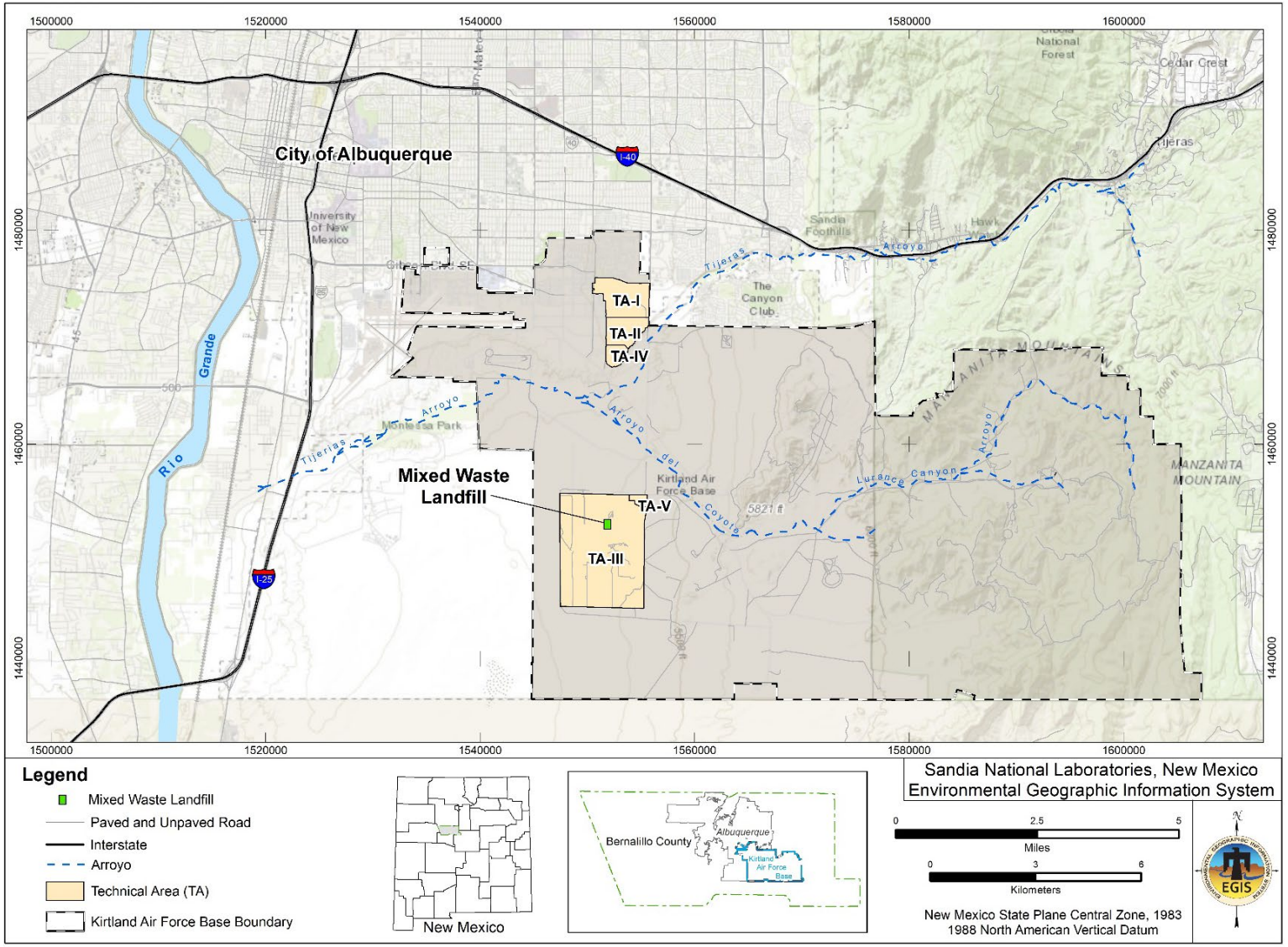

Figure 1-1
Location of the Mixed Waste Landfill with Respect to Kirtland Air Force Base and the City of Albuquerque

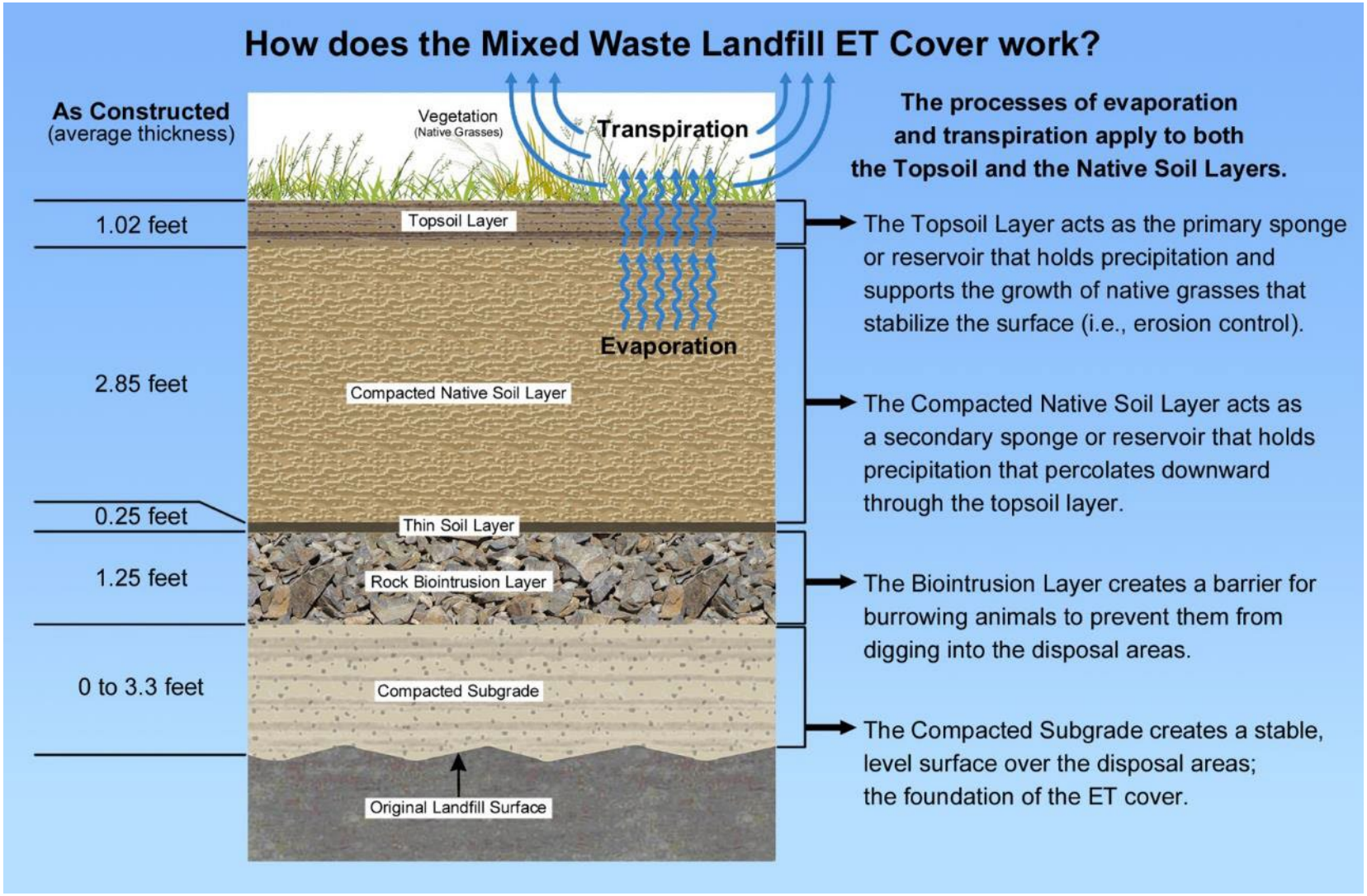

Figure 1-2
Schematic Profile of the Mixed Waste Landfill Evapotranspirative Cover and How it Works

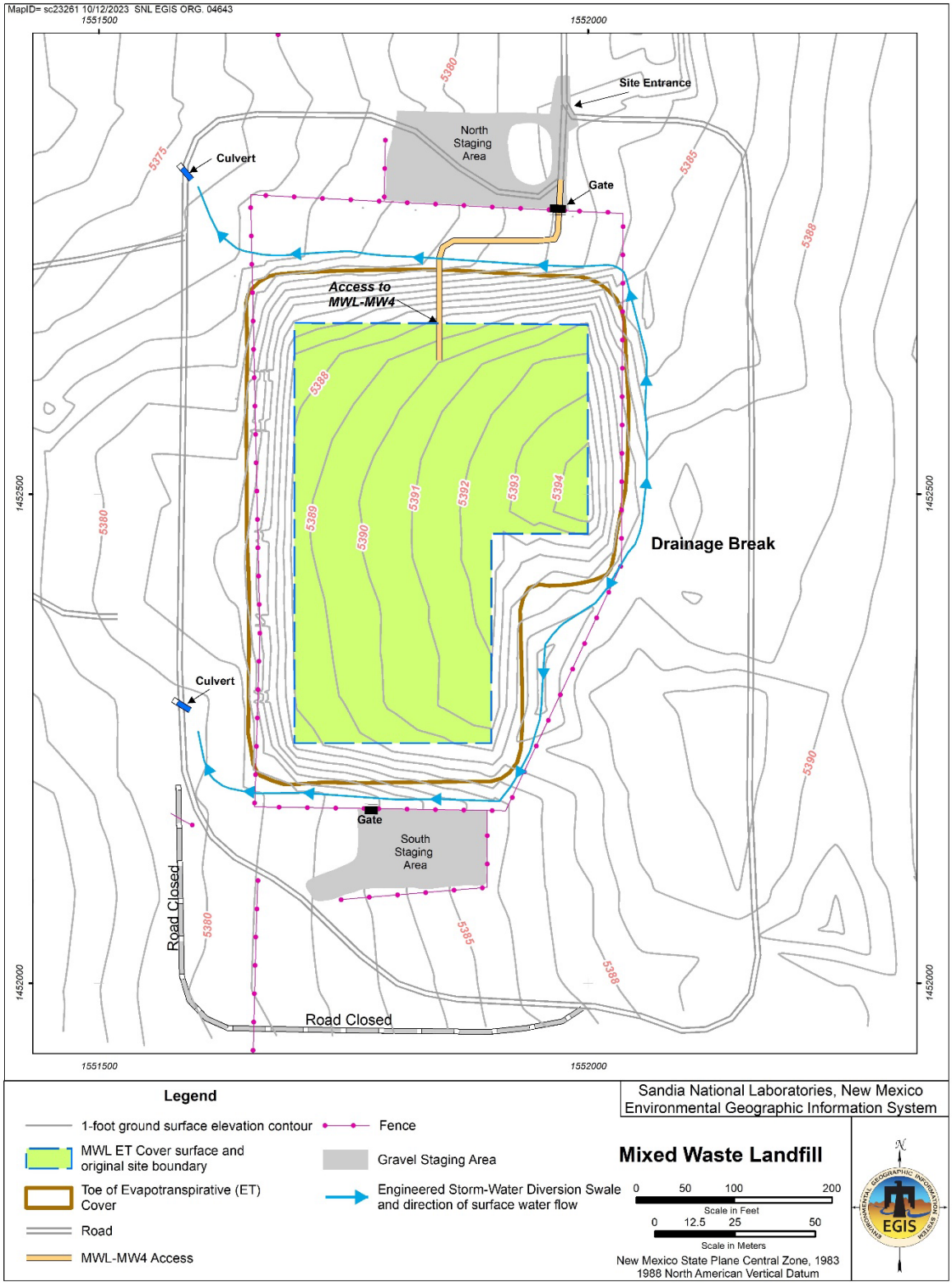

Figure 1-3
Mixed Waste Landfill Engineered Storm-Water Diversion Swale

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2.0 MONITORING AND INSPECTIONS SUMMARY

The primary objectives of monitoring, inspection, maintenance, and repair activities at the MWL are to ensure site conditions are protective of human health and the environment and that the ET Cover and remedy controls, including the monitoring networks, perform as designed. The monitoring networks provide the information needed to assess site conditions and ET Cover performance through multi-media monitoring focused on the most mobile contaminants. The inspection, maintenance, and repair process provides the information needed to verify the ET Cover and remedy controls are implemented, in good physical condition, and are operating as designed.

Section 2.1 of this Report briefly summarizes the monitoring and inspection programs and associated requirements. Section 2.2 and 2.3 of this Report summarize monitoring and inspection results for the 2018 through 2022 evaluation period, respectively. Section 2.4 presents other pertinent information for this evaluation period, including an assessment of new groundwater contaminants and review of regulatory standards and risk-based screening levels used to develop trigger levels.

2.1 Monitoring and Inspection Requirements

This section summarizes background information and requirements for the MWL monitoring and inspection programs. A detailed description of MWL monitoring and inspection, maintenance, and repair requirements are in Chapters 3 and 4 of the LTMMP, respectively (SNL/NM March 2012).

2.1.1 Monitoring Program Requirements

The routine monitoring of air, surface soil, vadose zone (soil moisture and soil vapor), groundwater, and biota (soil and plants) provides an early warning detection system for changing conditions and empirical data to evaluate site conditions and ET Cover performance. The multi-media monitoring program established in the LTMMP ensures long-term protection through:

- multi-media monitoring focused on the most mobile contaminants and most likely exposure pathways, and
- a Trigger Evaluation Process that requires timely follow-up if changing conditions are indicated by exceedance of a monitoring trigger level, including additional investigation and implementation of an additional or different remedy, if necessary, as determined by the NMED.

Monitoring is performed following the procedures and requirements stipulated in Chapter 3 and Sampling and Analysis Plans (SAPs) in Appendices C through G of the LTMMP. Sampling media, monitoring parameters (i.e., contaminants of concern), frequencies, locations and number of samples, and monitoring methods are summarized in Table 3.1-1 of the LTMMP and

Table 2-1 of Annual LTMM Reports. Monitoring results are compared to parameter-specific trigger levels defined in Section 5.2 of the LTMMP and historical MWL monitoring results. All monitoring results are reported along with supporting information (e.g., field forms, data validation reports, subject matter expert evaluation reports) in the Annual LTMM Reports.

2.1.2 Inspection Program Requirements

Inspections of the ET Cover, storm-water diversion swale, perimeter security fence and signage, survey monuments, and all monitoring networks and sampling equipment are performed following the processes and requirements specified in the Chapter 4 of the LTMMP to ensure controls are performing as designed. These inspections also verify land-use restrictions are being implemented (i.e., industrial land use and no disturbance to the ET Cover).

Information detailing the MWL systems and networks that are inspected, the frequency of inspections, inspection parameters and specifications, and maintenance/repair requirements are provided in Table 4.6-1 of the LTMMP and Table 2-2 of Annual LTMM Reports. All inspection-maintenance-repair activities are documented on respective checklists/forms and tracked through completion. Example inspection checklists/forms are provided in the Appendix I of the LTMMP. All inspection, maintenance, and repair results are reported along with supporting documentation (e.g., checklists/forms) in the Annual LTMM Reports.

2.2 Monitoring Results Summary

Results for monitoring activities conducted during the 2018 through 2022 evaluation period are presented in Sections 2.2.1 through 2.2.6. Associated trigger levels and results from the first Five-Year Report (SNL/NM January 2019), representing the 2014 through 2017 evaluation period, are included in the Section 2.2 tables for comparison. The two five-year evaluation periods represent nine years of multi-media monitoring conducted under the LTMMP and cover all monitoring results since implementation of the LTMMP in January 2014.

A more detailed presentation of monitoring results for each of the annual reporting periods can be found in the corresponding Annual LTMM Reports, which are reviewed and approved by the NMED. Refer to Section 1.6 of this Report for a list of the Annual LTMM Reports and information on how to access them.

2.2.1 Air Monitoring for Radon

The objective of air monitoring for radon is to collect data to evaluate radon gas flux (i.e., movement) to the atmosphere from the MWL. Based on fate and transport modeling (Ho et al. November 2005 and January 2007), radon gas (radon-222) could exceed the applied indoor regulatory standard of 4 picocuries per liter (pCi/L) if sealed radium-226 sources disposed in the MWL degrade or breach.

Air monitoring activities and data evaluation are performed in accordance with Section 3.2.1 and Appendix C *Air SAP* of the LTMMP (SNL/NM March 2012). Monitoring results are compared to the 4 pCi/L trigger level defined in Section 5.2.1 of the LTMMP. The monitoring duration for the

2018 through 2022 evaluation period was semiannual, fulfilling the LTMMP minimum requirement of annual monitoring. The radon air measurements were obtained using alpha-track radon gas detectors manufactured by Radonova (formerly Landauer® Nordic). Radtrak2® detectors were used from January 2018 through July 2022. Radonova introduced the Radtrak3® detectors in 2022, which were used during the second 2022 six-month monitoring event. Radtrak3® detectors replaced the Radtrak2® detectors and are as or more sensitive (i.e., equal or lower detection limit) than the Radtrak2® detectors.

A total of 17 radon detectors are deployed at sampling locations shown in Figure 2-1. Detectors are deployed at the start of the semiannual monitoring period and are collected/exchanged for new detectors at the end of the six-month monitoring period. Locations RN1 through RN10 are on the perimeter fence. The trigger level of 4 pCi/L (time-weighted average) is based on the EPA-recommended action level for radon in households and only applies to these perimeter fence locations. Locations RN11 through RN15 are located on the ET Cover surface directly above the pits and trenches with known sealed radium-226 sources. RN16 and RN17 are background sample locations, located away from the MWL but in the general vicinity. Table 2-1 summarizes the radon monitoring results for the 2018 through 2022 evaluation period representing 10 semiannual monitoring periods.

Table 2-1
Summary of Mixed Waste Landfill Radon Air Monitoring Results
2014 through 2022

Monitoring Location[a]	Trigger Level (pCi/L)	Radon Air Activity Results Range (pCi/L)	
		2014 – 2017	2018 – 2022[b]
RN1	4	0.14 – 0.9	<0.2 – <0.4[c]
RN2	4	0.11 – 1.4	<0.2 – 0.4
RN3	4	0.14 – 0.9	<0.2 – 0.4
RN4	4	<0.08 – 1.2	<0.2 – 0.4
RN5	4	0.16 – 1.1	<0.2 – 0.5
RN6	4	0.11 – 0.8	<0.2 – 0.4
RN7	4	0.14 – 1.3	<0.2 – 0.4
RN8	4	0.08 – 0.9	<0.2 – 0.5
RN9	4	0.14 – 1.1	<0.2 – 0.5
RN10	4	<0.08 – 0.8	<0.2 – 0.4
RN11	NA	<0.08 – 1.0	<0.2 – 0.4
RN12	NA	0.11 – 0.8	<0.2 – 0.8
RN13	NA	0.11 – 1.0	<0.2 – 0.6
RN14	NA	0.11 – 0.9	<0.2 – 0.5
RN15	NA	0.14 – 0.8	<0.2 – 0.4
RN16	NA	0.11 – 0.8	<0.2 – 0.4
RN17	NA	0.11 – 1.0	<0.2 – 0.4

Notes:
[a]Bolded locations are the monitoring locations where the trigger level applies.
[b]Radtrak2® radon detectors were used from 2018 through 2021. Radonova introduced Radtrak3® detectors in 2022 that replaced the older model Radtrak2® detectors. Radtrak3® detectors were used for the second six-month monitoring event in 2022.
[c]For the highest value in the range, the highest minimum detectable activity was used because it was higher than the highest detected value, which was 0.3 pCi/L.
< = Less than; indicates result is less than the minimum detectable activity.
NA = Trigger level not applicable to locations RN11 through RN17.
pCi/L = Picocuries per liter.

Validated results from all locations are below the 4 pCi/L trigger level and show radon activities that are equivalent to background activities. The maximum radon activity was 0.8 pCi/L at location RN12 on the ET Cover from the 2021 data set. All radon monitoring results for the current evaluation period are consistent with historical results and indicate radon flux at the MWL, as measured in pCi/L, is not significantly different than background values. A more detailed presentation of radon monitoring for each annual reporting period can be found in Chapter 3 of the Annual LTMM Reports.

2.2.2 Tritium in Surface Soil

The objective of monitoring tritium in surface soil is to determine and evaluate tritium flux to the atmosphere from moisture in surface soil at the four corners of the ET Cover. This monitoring provides an early warning for new releases of tritium or changing conditions that would warrant additional investigation.

The monitoring of tritium in surface soil is performed in accordance with Section 3.3 and Appendix G *Tritium and Biota SAP* of the LTMMP (SNL/NM March 2012). Samples are collected annually from four ET Cover corner monitoring locations shown in Figure 2-2. Monitoring results are compared to the trigger level of 20,000 pCi/L defined in Section 5.2.2.1 of the LTMMP.

Table 2-2 summarizes tritium results for the 2018 through 2022 evaluation period representing five annual monitoring events. Tritium activities have decreased during the current evaluation period, with no results over the minimum detectable activity (MDA). This is expected because of the relatively short half-life of tritium (12.30 years) and the low activity of tritium in the near-surface soils. However, other factors also impact the analytical results (e.g., amount of soil moisture, barometric pressure), which are subject to variation. The results are consistent with historical results, reflect very low levels of tritium activity below MDAs, and indicate no new releases from the disposal area. A more detailed presentation of tritium monitoring for each annual reporting period can be found in Chapter 4 of the Annual LTMM Reports.

Table 2-2
Summary of Tritium Results
Mixed Waste Landfill Surface Soil Monitoring
2014 through 2022

Sample Location	Trigger Level (pCi/L)	Tritium in Soil Results Range (pCi/L)	
		2014 – 2017[a]	2018 – 2022[b]
MWL TS-2NW	20,000	ND (183) – 1,210	No Detections
MWL TS-2SW	20,000	ND (179) – 1,660	No Detections
MWL TS-2NE	20,000	ND (182) – 1,370	No Detections
MWL TS-2SE	20,000	ND (182) – 1,830	No Detections

Notes:
Results for both environmental and environmental duplicate samples were used in minimum to maximum ranges.
[a]Analyzed for but not detected above the MDA shown in parentheses.
[b]Tritium activities for the 2018 through 2022 evaluation period were all below the MDA.
MDA = Minimum detectable activity.
ND = Non-detection.
pCi/L = Picocuries per liter.

2.2.3 Soil Vapor

VOCs in soil vapor are the most mobile hazardous constituents detected in the vadose zone alluvial sediments beneath the MWL. The objective of soil-vapor monitoring is to provide spatial and temporal concentration data for VOCs at various depths throughout the approximately 500-foot-thick vadose zone (i.e., unsaturated soil and sediments above the Regional Aquifer) beneath the MWL. Concentration trends in shallow sampling ports (41.5 to 100 feet below ground surface [bgs]) provide an early warning for any new releases of VOCs from the disposal areas. Concentrations from deeper sampling ports provide early warning for potential impact to groundwater. Vadose zone VOC monitoring and trigger levels are designed to provide early detection of changing conditions throughout the vadose zone for the long-term protection of groundwater.

Soil-vapor monitoring activities, analytical results, and data evaluation are performed in accordance with Section 3.4.1 and Appendix D *Soil-Vapor SAP* of the LTMMP (SNL/NM March 2012). Samples are collected from the two single-sampling-port soil-vapor monitoring wells (MWL-SV01 and MWL-SV02, sampling ports at 42.5 and 41.5 feet bgs, respectively) and the three multi-sampling-port soil-vapor monitoring wells (MWL-SV03 through MWL-SV05, sampling ports at 50, 100, 200, 300, and 400 feet bgs); well locations are shown in Figure 2-3. A more detailed description of the soil-vapor monitoring well network can be found in Section 3.4.1 of the LTMMP.

Results from the deepest sampling ports of the multi-sampling-port soil-vapor monitoring wells (MWL-SV03, MWL-SV04, and MWL-SV05), located at 400 feet bgs, are compared to trigger levels defined in Section 5.2.3.1 of the LTMMP and provided below.

- 20 parts per million by volume (ppmv) for PCE
- 20 ppmv for Trichloroethene (TCE)
- 25 ppmv for Total VOCs (i.e., the sum of detected, validated VOC concentrations)

Tables 2-3, 2-4, and 2-5 summarize results for PCE, TCE, and Total VOCs, respectively, for all soil-vapor sampling ports for the 2018 through 2022 evaluation period representing eight semiannual monitoring events and one annual monitoring event. A semiannual frequency was maintained from 2014 through 2021 (eight years of semiannual events) to ensure all sampling ports remained open and capable of providing representative samples. In accordance with Table 3.1-1 of the LTMMP, three years of semiannual sampling are required prior to transitioning to annual sampling. This requirement has been met and the transition to annual sampling occurred in 2022. Table 2-3 through 2-5 summarize results for a total of 16 semiannual events and one annual event.

Table 2-3
Summary of PCE Concentrations
Mixed Waste Landfill Soil-Vapor Monitoring
2014 through 2022

Well ID & Sample Port Depth[a]	Trigger Level (ppmv)	2014 – 2017 Results Range[b] (ppmv)	2018 – 2022 Results Range[b] (ppmv)
MWL-SV01-42.5	NA	0.30 – 0.56	0.21 – 0.47
MWL-SV02-41.5	NA	0.065 – 0.086	0.034 – 0.090
MWL-SV03-50	NA	0.10 – 0.17	0.10 – 0.21
MWL-SV03-100	NA	0.16 – 0.24	0.12 – 0.28
MWL-SV03-200	NA	0.21 – 0.32	0.15 – 0.28
MWL-SV03-300	NA	0.22 – 0.37	0.18 – 0.31
MWL-SV03-400	20	0.31 – 0.45	0.14 – 0.45
MWL-SV04-50	NA	0.052 – 0.078	0.020 – 0.076
MWL-SV04-100	NA	0.089 – 0.13	0.065 – 0.12
MWL-SV04-200	NA	0.11 – 0.18	0.094 – 0.13
MWL-SV04-300	NA	0.095 – 0.13	0.085 – 0.13
MWL-SV04-400	20	0.10 – 0.15	0.074 – 0.15
MWL-SV05-50	NA	0.021 – 0.060	0.035 – 0.050
MWL-SV05-100	NA	0.070 – 0.10	0.065 – 0.091
MWL-SV05-200	NA	0.10 – 0.17	0.11 – 0.15
MWL-SV05-300	NA	0.090 – 0.12	0.077 – 0.11
MWL-SV05-400	20	0.080 – 0.12	0.063 – 0.11

Notes:
All concentrations are reported to two significant digits as reported by the laboratory.
[a]Port depth is the last number in the Well ID and is in feet below ground surface.
[b]Results for both environmental and environmental duplicate samples were used in minimum to maximum ranges.
ID = Identification.
NA = Not applicable.
PCE = Tetrachloroethene.
ppmv = Parts per million by volume.

Table 2-4
Summary of TCE Concentrations
Mixed Waste Landfill Soil-Vapor Monitoring
2014 through 2022

Well ID & Sample Port Depth[a]	Trigger Level (ppmv)	2014 – 2017 Results Range[b] (ppmv)	2018 – 2022 Results Range[b] (ppmv)
MWL-SV01-42.5	NA	0.071 – 0.11	0.042 – 0.10
MWL-SV02-41.5	NA	0.058 – 0.075	0.027 – 0.073
MWL-SV03-50	NA	0.080 – 0.14	0.090 – 0.17
MWL-SV03-100	NA	0.13 – 0.21	0.11 – 0.24
MWL-SV03-200	NA	0.23 – 0.31	0.14 – 0.26
MWL-SV03-300	NA	0.17 – 0.26	0.13 – 0.19
MWL-SV03-400	20	0.23 – 0.35	0.12 – 0.33
MWL-SV04-50	NA	0.054 – 0.070	0.033 – 0.062
MWL-SV04-100	NA	0.12 – 0.15	0.069 – 0.12
MWL-SV04-200	NA	0.17 – 0.22	0.12 – 0.17
MWL-SV04-300	NA	0.044 – 0.097	0.056 – 0.091
MWL-SV04-400	20	0.058 – 0.097	0.045 – 0.11
MWL-SV05-50	NA	0.042 – 0.074	0.043 – 0.059
MWL-SV05-100	NA	0.10 – 0.14	0.084 – 0.12
MWL-SV05-200	NA	0.15 – 0.24	0.16 – 0.22
MWL-SV05-300	NA	0.082 – 0.13	0.071 – 0.13
MWL-SV05-400	20	0.060 – 0.12	0.053 – 0.10

Notes:
All concentrations are reported to two significant digits as reported by the laboratory.
[a]Port depth is the last number in the Well ID and is in feet below ground surface.
[b]Results for both environmental and environmental duplicate samples were used in minimum to maximum ranges.
ID = Identification.
NA = Not applicable.
ppmv = Parts per million by volume.
TCE = Trichloroethene.

Table 2-5
Summary of Total VOCs Concentrations
Mixed Waste Landfill Soil-Vapor Monitoring
2014 through 2022

Well ID & Sample Port Depth[a]	Trigger Level (ppmv)	2014 – 2017 Results Range[b] (ppmv)	2018 – 2022 Results Range[b] (ppmv)
MWL-SV01-42.5	NA	0.74 – 1.1	0.52 – 0.99
MWL-SV02-41.5	NA	0.63 – 0.76	0.37 – 0.74
MWL-SV03-50	NA	0.31 – 0.48	0.31 – 0.55
MWL-SV03-100	NA	0.53 – 0.74	0.37 – 0.79
MWL-SV03-200	NA	0.79 – 0.99	0.46 – 0.83
MWL-SV03-300	NA	0.60 – 0.83	0.47 – 0.69
MWL-SV03-400	25	0.63 – 0.96	0.30 – 0.96
MWL-SV04-50	NA	0.23 – 0.30	0.19 – 0.27
MWL-SV04-100	NA	0.41 – 0.54	0.29 – 0.43
MWL-SV04-200	NA	0.56 – 0.73	0.43 – 0.58
MWL-SV04-300	NA	0.27 – 0.37	0.27 – 0.35
MWL-SV04-400	25	0.25 – 0.38	0.23 – 0.41
MWL-SV05-50	NA	0.26 – 0.38	0.27 – 0.32
MWL-SV05-100	NA	0.51 – 0.62	0.44 – 0.53
MWL-SV05-200	NA	0.57 – 0.82	0.55 – 0.74
MWL-SV05-300	NA	0.34 – 0.48	0.35 – 0.47
MWL-SV05-400	25	0.25 – 0.54	0.24 – 0.36

Notes:
All calculated Total VOC concentrations (sum of validated detected VOCs) are rounded to two significant digits to maintain level of certainty reported by the laboratory.
[a]Port depth is the last number in the Well ID and is in feet below ground surface.
[b]Results for both environmental and environmental duplicate samples were used in minimum to maximum ranges.
ID = Identification.
NA = Not applicable.
ppmv = Parts per million by volume.
VOCs = Volatile organic compounds.

Key points from the 2018 through 2022 evaluation period are summarized below.

- The total number of validated VOCs, including TCE and PCE, detected in soil-vapor samples ranged from 14 (2022) to 42 (2018) compounds. The higher number of compounds detected during several monitoring events largely reflects very low concentration detections at one or more sampling ports. Total VOCs are the sum of these detected, validated VOC results.

- Results for individual VOCs and Total VOCs from all soil-vapor monitoring well sampling ports are low concentrations (i.e., less than 0.50 and 1.0 ppmv, respectively) and are well below the trigger levels.

- Concentrations throughout the 500-foot-thick vadose zone are relatively consistent and indicate stable conditions (i.e., results for each sampling port show only minor variability).

- The soil-vapor monitoring results indicate an old source (i.e., disposal period of 1958 through 1988) that has slowly dissipated by the process of diffusion throughout the vadose zone.

- The distribution of VOC concentrations in the vadose zone indicates the VOC soil-vapor plume is stable with no new releases from the disposal area.

- Results reflect lower concentrations than were measured during the Phase 2 RCRA Facility Investigation (RFI) in 1994 (Peace et al. September 2002) and 2008 VOC Soil-Vapor Investigation (SNL/NM August 2008).

- PCE is the primary soil-vapor contaminant of concern and the range of concentrations for the 2018 through 2022 evaluation period are generally stable or decreasing relative to the concentrations measured during the 2014 through 2017 evaluation period.

- The VOC concentrations are generally stable or decreasing over time and indicate the VOC soil-vapor plume is not a threat to groundwater.

The variation in PCE and TCE concentrations over the nine sampling events conducted from 2018 to 2022 is less than 0.20 ppmv for all sampling ports except MWL-SV01-42.5 and MWL-SV03-400; concentrations do not vary significantly from the 2014 through 2017 data sets (Tables 2-3 through 2-5). The MWL-SV01 (42.5 feet bgs sampling port) and the MWL-SV03 (400 feet bgs sampling port) locations have consistently shown the highest individual VOC concentrations (PCE ranging from 0.14 to 0.47 ppmv; TCE ranging from 0.042 to 0.33 ppmv) and Total VOCs concentrations (ranging from 0.30 to 0.99 ppmv). The 2018 through 2022 data sets are similar to the 2014 through 2017 data sets indicating stable VOC concentrations throughout the 500-foot-thick vadose zone. The variability shown in the data is expected given the very low concentrations and heterogeneous vadose zone geology, which is laterally and vertically discontinuous, comprised of interfingering, unconsolidated, alluvial-fan deposits ranging in grain size from clay to poorly sorted coarse gravels. A more detailed presentation of soil-vapor monitoring for each annual reporting period can be found in Chapter 5 of the Annual LTMM Reports, including concentration trend graphs showing measured PCE, TCE, and Total VOCs for each soil-vapor monitoring well location versus time.

2.2.4 Soil Moisture

Soil-moisture monitoring is conducted to establish soil-moisture trends in the vadose zone beneath the MWL to evaluate ET Cover performance. The soil-moisture monitoring network functions as a detection system for water percolation and infiltration through the ET Cover and disposal area.

Soil-moisture monitoring activities are conducted in accordance with, Section 3.4.2 and Appendix E *Soil-Moisture Monitoring Plan* of the LTMMP (SNL/NM March 2012). Soil-moisture is monitored annually from three soil-moisture monitoring access tubes, which are angled

boreholes oriented 60 degrees from the horizontal ground surface that extend below the MWL (Figure 2-4). Monitoring results are compared to the baseline soil-moisture profile established for each soil-moisture monitoring access tube prior to construction of the ET Cover subgrade in late 2006, and to the trigger level of 23 percent (%) moisture by volume defined in Section 5.2.3.2 of the LTMMP. The trigger level applies to the results for the vertical depth range of 8.7 to 86.6 feet bgs for each soil-moisture access tube, which corresponds to the monitoring interval directly beneath the ET Cover and disposal area.

Table 2-6 summarizes the 2018 through 2022 evaluation period soil-moisture monitoring results for the vertical depth range of 8.7 to 86.6 feet bgs for each soil-moisture access tube representing five annual monitoring events.

Table 2-6
Summary of Mixed Waste Landfill Soil-Moisture Monitoring Results
2014 through 2022

Sample Location	Trigger Level	Baseline Range	2014 – 2017 Results Range	2018 – 2022 Results Range
MWL-VZ-1	23	1.7 – 5.6	1.4 – 5.2	1.8 – 5.3
MWL-VZ-2	23	2.1 – 5.5	1.3 – 4.8	2.1 – 4.9
MWL-VZ-3	23	1.8 – 4.5	1.3 – 5.1	1.2 – 5.2

Notes:
Results summarized are for the vertical depth range of 8.7 to 86.6 feet bgs for each soil-moisture access tube.
All numeric values are % moisture by volume.
% = Percent.
bgs = Below ground surface.

Soil-moisture measurements have remained consistent for the three monitoring locations over the past five years, are well below the trigger level of 23%, and track closely with the baseline soil-moisture content (Table 2-6). The results indicate the ET Cover is performing as designed, and confirm a dry vadose zone (i.e., soil-moisture content generally less than 5% by volume) beneath the ET Cover. A more detailed presentation of soil-moisture monitoring for each annual reporting period can be found in Chapter 6 of the Annual LTMM Reports.

2.2.5 Groundwater

The objective of groundwater monitoring under the LTMMP is to obtain analytical results representative of groundwater in the uppermost part of the Regional Aquifer beneath the MWL. This, combined with soil-vapor monitoring, functions as an early warning detection system for the protection of groundwater.

Groundwater monitoring activities, sample analyses, and data evaluation are performed in accordance with Section 3.5.1 and Appendix F *Groundwater SAP* of the LTMMP (SNL/NM March 2012). Samples are collected on a semiannual basis from the four compliance groundwater monitoring wells (MWL-BW2, MWL-MW7, MWL-MW8, and MWL-MW9) shown in Figure 2-5. A detailed description of the groundwater monitoring well network can be found in Section 3.5.1 of the LTMMP, and Section 7.1 of the Annual LTMM Reports. Results are compared to trigger levels defined in Section 5.2.4 of the LTMMP. Table 2-7 summarizes groundwater monitoring results for the 2018 through 2022 evaluation period representing 10 semiannual monitoring events.

Table 2-7
Summary of Mixed Waste Landfill Groundwater Monitoring
2014 through 2022

Analyte	Trigger Level	2014 – 2017 Results Range	2018 – 2022 Results Range
VOCs (µg/L)[a]			
Tetrachloroethene	2.50	ND (0.300) – 0.450J	No Detections
Toluene	1,000	No Detections	ND (0.300) - 0.880J
Trichloroethene	2.50	ND (0.300) – 0.380J	No Detections
Metals (mg/L)[a]			
Cadmium	0.0025	No Detections	No Detections
Chromium	0.043	ND (0.002) – 0.00208	ND (0.003) – 0.00319J
Nickel	0.050	ND (0.0005) – 0.00173	ND (0.0006) – 0.00298J+
Uranium	0.015	0.00652 – 0.00978	0.00657 – 0.00960
Radiological Constituents (pCi/L)[b]			
Americium-241	NE	No Detections	No Detections
Cesium-137	NE	No Detections	No Detections
Cobalt-60	NE	No Detections	No Detections
Gross Alpha[c]	15	-0.10 – 12.06	0.38 – 12.8
Gross Beta	4 millirem per year[d]	4.13 – 12.2	ND (1.26) – 12.7
Tritium	4 millirem per year[e]	No Detections	No Detections
Radon-222	1,000	80.2J – 509	81.1 – 559

Notes:
[a]For ND values, the MDL is shown in parentheses.
[b]For ND values, the MDA is shown in parentheses.
[c]Gross alpha activity measurements were corrected by subtracting the total uranium activity from the total gross alpha result (40 Code of Federal Regulations 141).
[d]Trigger level is a dose rate that only applies if a gross beta result exceeds the background range. No results exceeded the background range for gross beta activity. See Annual LTMM Reports, Section 7.2.1 for a more detailed explanation.
[e]The equivalent activity for 4 millirem per year for tritium is 20,000 pCi/L assuming an onsite receptor. See Annual LTMM Reports, Section 7.2.1 for a more detailed explanation.
J = Laboratory qualifier; estimated value greater than the method detection limit, but less than the practical quantitation limit.
J+ = Estimated value with a suspected high bias.
LTMM = Long-Term Monitoring and Maintenance.
MDA = Minimum detectable activity.
MDL = Method detection limit. The minimum concentration that can be measured and reported with 99 percent confidence that the analyte is greater than zero.
µg/L = Micrograms per liter.
mg/L = Milligrams per liter.
ND = Analyte was not detected above the MDL/MDA shown in parenthesis.
NE = Not established.
pCi/L = Picocuries per liter.
VOCs = Volatile organic compounds.

Results include VOCs; the metals cadmium, chromium, nickel, and uranium; the gamma emitting radionuclides americium-241, cesium-137, and cobalt-60; gross alpha and gross beta activity; tritium; and radon-222. At the request of the NMED (Kieling September 2019 and Catechis July 2021), supplemental analyses were performed for 1,4-dioxane and three perfluoroalkyl and polyfluoroalkyl substances (PFAS) during the 2018 through 2022 evaluation period. Results for the supplemental analyses are discussed in Section 2.4.3.

Toluene was the only validated VOC detection in groundwater samples collected during the 2018 through 2022 evaluation period. Toluene was detected in three groundwater monitoring wells during the October 2022 monitoring event with concentrations ranging from 0.840J to 0.880J micrograms per liter (µg/L). Toluene was also reported by the laboratory in additional samples from the October 2018 and 2022 monitoring events but was qualified during data validation as not detected due to field blank contamination (i.e., field quality control sample results). Toluene is a ubiquitous chemical and common laboratory contaminant that has been sporadically detected at very low concentrations in groundwater samples from the MWL and other SNL/NM sites. A comprehensive toluene investigation (SNL/NM October 2010) performed by SNL/NM personnel and approved by the NMED (Bearzi January 2011) indicated the MWL and other SNL/NM sites were not the source of the toluene detected in groundwater samples.

Methylene chloride and acetone, which are common laboratory contaminants, were also reported by the laboratory in various samples from the 2018, 2019, 2021, and 2022 monitoring events, but were qualified during data validation as non-detections due to field blank contamination. VOCs were not reported by the laboratory in any samples from the April and October 2020 monitoring events. VOCs were not detected above respective trigger levels.

Cadmium was not detected above the method detection limit in any groundwater sample collected during the current evaluation period. Detections of chromium and nickel were reported at very low concentrations below the laboratory practical quantitation limit (i.e., J-qualified or estimated result). Uranium was detected in all groundwater samples collected during the 2018 through 2022 evaluation period with a maximum concentration of 0.00960 milligrams per liter. All metal results for the 2018 through 2022 evaluation period were consistent with historical results and were below respective trigger levels.

All gamma-emitting radionuclides and tritium results were below the MDA (i.e., non-detections). Gross beta activities were within the background range and consistent with historical results. Gross alpha and radon-222 results were consistent with historical results and below respective trigger levels. All radiological results were reviewed by an SNL/NM Health Physics subject matter expert to screen for potential indications of radiological contamination; there were no indications of radiological anomalies in the groundwater sample results.

A more detailed presentation of groundwater monitoring for each annual reporting period can be found in Chapter 7 of the Annual LTMM Reports, including concentration and activity trend graphs for nickel, uranium, and gross alpha for each groundwater monitoring well location versus time.

Hydrogeologic Assessment

A detailed conceptual site model is provided in the *MWL Phase 2 RCRA Facility Investigation Report* (Peace et al. September 2002) and the *Mixed Waste Landfill Groundwater Report, 1990 through 2001* (Goering et al. December 2002). An update to the conceptual site model integrating the findings from the current groundwater monitoring well network installed in 2008 is presented in the *Mixed Waste Landfill Annual Groundwater Monitoring Report, Calendar Year 2009* (SNL/NM June 2010). A potentiometric surface map based upon October groundwater elevation data, groundwater elevation changes and trends, and estimates of the hydraulic gradient and groundwater velocity are provided in each Annual LTMM Report.

The upper surface of the Regional Aquifer at the MWL is contained within the interfingering, unconsolidated, fine-grained alluvial-fan deposits of the Santa Fe Group. The more transmissive, coarser-grained Ancestral Rio Grande sediments underlie the fine-grained alluvial deposits beneath the MWL. The depth to water is approximately 500 feet bgs and groundwater flows generally westward, away from the Manzanita Mountains and towards the Rio Grande. Several water-supply wells operated by Kirtland Air Force Base and the Albuquerque Bernalillo County Water Utility Authority have profoundly modified the natural groundwater flow regime near the MWL by creating a trough in the water table in the western and northern portions of Kirtland Air Force Base. As a result, water levels at the MWL have historically declined since monitoring began in 1990.

Since about 2010, the rate of groundwater elevation decline in all groundwater monitoring wells except MWL-BW2 has been relatively slow and constant, and less than 2 feet overall. The rate of groundwater elevation decline in the upper screen interval of MWL-MW4 (north central part of the MWL) has stabilized since April 2010; this monitoring well shows more variation due to the strong downward gradient in the Regional Aquifer beneath the MWL and the presence of an inflatable packer between the upper (across the water table) and lower (at least partially within the Ancestral Rio Grande sediments) screen intervals. A Class 2 Permit Modification request to decommission groundwater monitoring well MWL-MW4 will be submitted in 2023 (Section 2.4.2 of this Report). The overall decline in MWL-BW2 (east of the MWL) since 2009 has been approximately 5 feet, reflecting a slightly higher rate of decline than observed in the other groundwater monitoring wells.

Since 2017, the groundwater monitoring wells located west of the MWL have stable to slightly increasing or slightly decreasing groundwater elevations. Monitoring wells MWL-MW5, MWL-MW6, and MWL-MW9 have shown increases in groundwater elevation from October 2018 to October 2022, while MWL-BW2, MWL-MW4, MWL-MW7, and MWL-MW8 have declined. Changes in groundwater elevation during the 2018 through 2022 evaluation period ranged from -1.13 (MW-BW2) to 0.36 (MWL-MW6) feet. In 2020, all groundwater monitoring wells located west of the MWL (i.e., all wells except MWL-BW2 and MWL-MW4) showed an increase in groundwater elevation from the previous year; however, those wells have been gradually declining since 2020.

The recent subtle water table rebound measured in the groundwater monitoring wells on the west side of the MWL has been observed in wells located farther north on Kirtland Air Force Base and is most likely related to a decrease in groundwater removal from the Regional Aquifer by the Albuquerque Bernalillo County Water Utility Authority. Recharge from infiltration of precipitation at the MWL is negligible due to high evapotranspiration, low precipitation, the thick sequence of unsaturated Santa Fe Group deposits above the water table, and the presence of the ET Cover. Groundwater recharge of the Regional Aquifer occurs by the infiltration of precipitation in the Manzanita Mountains located five miles to the east. Regional recharge has been affected by extended drought conditions that continued throughout the 2018 through 2022 evaluation period.

Figure 2-6 shows the October 2022 potentiometric surface of the Regional Aquifer beneath the MWL, which has remained consistent over the 2018 through 2022 evaluation period. Groundwater flows towards the west and northwest. Measured orthogonally from the potentiometric surface contours, the horizontal gradient for October 2022 ranges from approximately 0.03 to 0.08 feet per foot. Groundwater velocities in the alluvial-fan sediments were calculated using the current potentiometric surface gradient, the average hydraulic

conductivity obtained from slug testing of the four compliance groundwater monitoring wells, and an effective porosity of 25%. The calculated 2022 groundwater velocity remains consistent with previous years and ranges from 0.02 to 0.06 feet per day; the average is 0.04 feet per day. These very low values and the general position of the groundwater elevation contours have not changed over the past five years and are consistent with previous estimates for horizontal groundwater flow at the water table in the MWL vicinity.

2.2.6 Biota

The objective for biota monitoring is to provide data to evaluate mobilization of contaminants (e.g., metals and radionuclides) from the subsurface to surface by animals and plants. Biota monitoring functions as a detection system to determine if this type of contaminant mobilization is occurring, and if so, timely action can be taken to address this contaminant transport process.

Biota monitoring activities are performed in accordance with Section 3.6 and Appendix G *Tritium and Biota SAP* of the LTMMP (SNL/NM March 2012). In accordance with the LTMMP, biota samples are collected on an annual basis. During the annual ET Cover Biology Inspection performed in August or early September (i.e., peak of the New Mexico growing season) animal burrows, ant hills, and potentially deep-rooted plants are identified, if present, and flagged for sampling. Up to two animal burrows and/or ant hills (maximum of four total samples) and up to two potentially deep-rooted plants are then sampled and analyzed for metals and gamma-emitting radionuclides (plants only analyzed for gamma-emitting radionuclides).

In accordance with Section 5.2.2 of the LTMMP, monitoring results are compared to the trigger levels for metals and NMED-approved background activities for radionuclides in surface soil (Dinwiddie September 1997). There are no trigger levels established for radionuclides; background activities for radionuclides are used for comparison and evaluation.

Tables 2-8 and 2-9 summarize the biota metals and gamma-emitting radionuclide results, respectively, for the 2018 through 2022 evaluation period representing five annual monitoring events. NMED-approved background levels for metals and radionuclides and details on the number of samples collected for each year are also provided in Tables 2-8 and 2-9. There were no animal burrows or potentially deep-rooted plants identified on the ET Cover during the Biology Inspections, so no related samples were collected during the 2018 through 2022 evaluation period (i.e., only ant hill samples were collected). Therefore, animal burrow and potentially deep-root plant results from the 2014 through 2017 evaluation period are not included for comparison.

No surface soil metals results from ant hills exceeded the trigger levels. All metal results were also below or close to NMED-approved background levels. Only barium and selenium results slightly exceeded background levels and vanadium was detected at the background level of 240 milligrams per kilogram. All metals results were several orders of magnitude below the associated trigger levels. Based on historical sampling results, these slight exceedances of background levels represent natural variation in surface soil. No surface soil radionuclide results exceeded NMED-approved background activities. A more detailed presentation of biota monitoring for each annual reporting period can be found in Chapter 8 of the Annual LTMM Reports.

Table 2-8
Summary of Metals Results
Mixed Waste Landfill Biota Monitoring
2014 through 2022

Sample Type	Parameter	Trigger Level (mg/kg)	NMED Background[a] (mg/kg)	2014 – 2017 Results Range (mg/kg)	2018 – 2022 Results Range (mg/kg)
Ant Hill Soil Samples 2018 – 2 samples + duplicate 2019 – 2 samples + duplicate 2020 – 2 samples + duplicate 2021 – 2 samples + duplicate 2022 – 2 samples + duplicate	Arsenic	17.7	5.6	2.18 – 4.94	0.968J – 4.37
	Barium	100,000	130	66.1J – 101J	20.6J – 166J
	Beryllium	2,260	0.65	0.328J – 0.509	0.136J – 0.625
	Cadmium	897	<1	0.0903J – 0.125J	0.0831J – 0.161J
	Chromium	63.1	17.3	4.90 – 10.1J	1.46J – 8.01J
	Cobalt	20,500	5.2	2.14 – 3.63	0.272J- – 3.43
	Copper	45,400	15.4	4.96 – 7.63	1.26J – 7.20J
	Lead	800	21.4	3.32 – 7.92	2.70J+ – 6.99
	Mercury	73.6	<0.25	0.00383J – 0.016	0.0041J – 0.00815J
	Nickel	22,500	11.5	4.55 – 7.87	1.05J – 6.23
	Selenium	5,680	<1	0.399J – 1.43J	ND (0.454) – 1.15
	Silver	5,680	<1	ND (0.0988) – 0.136J	No Detections
	Vanadium	5,680	20.4	13.7 – 20.9J	2.61J – 20.4
	Zinc	100,000	62	15.9 – 30.8	6.69J – 23.3J

Notes:
[a]Dinwiddie September 1997, Letter from R.S. Dinwiddie (NMED) to M.J. Zamorski (DOE), "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB," dated September 24, 1997.
< = Less than.
DOE = U.S. Department of Energy.
J = Laboratory and/or validation qualifier; the result is an estimated value.
J- = The associated numerical value is an estimated quantity with a suspected negative bias.
KAFB = Kirtland Air Force Base.
mg/kg = Milligram(s) per kilogram.
ND = Analyte was not detected above the Reporting Limit, shown in parentheses.
NMED = New Mexico Environment Department.
SNL = Sandia National Laboratories.

Table 2-9
Summary of Gamma Spectroscopy Results
Mixed Waste Landfill Biota Monitoring
2014 through 2022

Sample Type	Parameter	NMED Background[a] (pCi/g)	2014 – 2017 Results Range (pCi/g)	2018 – 2022 Results Range (pCi/g)
Ant Hill Soil Samples 2018 – 2 samples + duplicate 2019 – 2 samples + duplicate 2020 – 2 samples + duplicate 2021 – 2 samples + duplicate 2022 – 2 samples + duplicate	Cesium-137	1.5	0.0465J – 0.108	0.0337J – 0.562
	Cobalt-60	NA	No Detections	No Detections
	Radium-226	2.7	0.604 – 0.734	0.482 – 0.789
	Thorium-232[b]	1.5	0.841 – 0.979	0.767 – 0.991
	Uranium-235	0.18	No Detections	No Detections
	Uranium-238	2.3	ND (0.259) – 1.20J	ND (0.495) – 1.76J

Notes:
[a]Dinwiddie September 1997, Letter from R.S. Dinwiddie (NMED) to M.J. Zamorski (DOE), "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB," dated September 24, 1997. Cobalt-60 is not naturally occurring; therefore, it does not have a listed background activity.
[b]Thorium-232 activity is quantified using the daughter isotope Lead-212 results.
DOE = U.S. Department of Energy.
J = Validation qualifier; the result is an estimated value.
KAFB = Kirtland Air Force Base.
NA = Not applicable.
ND = Analyte was not detected.
NMED = New Mexico Environment Department.
pCi/g = Picocuries per gram.
SNL = Sandia National Laboratories.

2.3 Inspection and Maintenance Summary

A summary of inspection and maintenance results for the 2018 through 2022 evaluation period is provided in the sections that follow. A more detailed presentation of inspection and maintenance results for each of the annual reporting periods can be found in the corresponding Annual LTMM Reports, which are reviewed and approved by the NMED. Refer to Section 1.6 of this Report for a list of the Annual LTMM Reports and information on how to access them. Inspection, maintenance, and repair activities are conducted in accordance with requirements in Chapter 4 of the LTMMP (SNL/NM March 2012). Table 2-10 lists the inspections performed, the inspection frequency, and the month when inspections are typically performed. Detailed information for each annual reporting period can be found in Chapter 9 of the Annual LTMM Reports.

Table 2-10
Mixed Waste Landfill Inspection Types, Frequency, and Months Performed
2018 through 2022

Inspection Type	Frequency[a]	Checklist/Form[b]	Month Performed
ET Cover Biology	Annual	Biology Inspection	August or September
ET Cover Surface	Quarterly	Cover Inspection	March
			June
			September
			December
Storm-Water Diversion Structure[c]	Quarterly	Cover Inspection	March
			June
			September
			December
Soil-Vapor Monitoring Network	Semiannually[d,e]	Soil-Vapor Monitoring Network	April or May
			October or November
Soil Moisture Monitoring Network	Annually[d]	Soil-Moisture Monitoring Network	April-May
Groundwater Monitoring Network	Semiannually[d]	Groundwater Monitoring Network	April or May
			October or November
Security Fence[c]	Quarterly	Cover Inspection	March
			June
			September
			December

Notes:
[a]Frequency requirements for some inspection types have transitioned to a less-frequent basis since the inception of the LTMMP, based upon meeting time and/or performance requirements. Unless otherwise noted, the frequency shown in this table is the most current for each type.
[b]Completed inspection forms for each annual reporting period are provided in Annex F of respective Annual LTMM Reports.
[c]These inspections are conducted at the same time as the ET Cover Surface Inspection and documented on the same inspection form.
[d]Monitoring network inspections are performed at the same frequency and at the same time as the associated monitoring.
[e]Soil-vapor monitoring transitioned to annual frequency in 2022 and is typically performed in October.
ET = Evapotranspirative.
LTMM = Long-Term Monitoring and Maintenance.
LTMMP = *Long-Term Monitoring and Maintenance Plan for the MWL*.

2.3.1 Cover System

The cover system includes the ET Cover vegetation and ET Cover surface (note the term ET Cover includes the top surface and side slopes). ET Cover vegetation is inspected annually by an SNL/NM staff biologist and documented on the *Biology Inspection Form/Checklist*. The ET Cover surface is inspected quarterly by a field technician and documented on the *Cover Inspection Checklist/Form*. During the quarterly inspections, the field technician also inspects the storm-water diversion swale, security fence and signage, and survey monuments. Cover system inspection results are summarized below.

Biology

In accordance with the LTMMP (SNL/NM March 2012), Biology Inspections have been on an annual frequency since the August 2014 growing season inspection confirmed the ET Cover met all successful revegetation criteria (SNL/NM June 2015). Although only the annual Biology Inspection is required, the staff biologist also performs verification inspections as a best practice to support the quarterly ET Cover surface inspections, which are performed by a field technician. Section 2.4.2 has additional information on this ET Cover vegetation best practice.

Throughout the 2018 through 2022 evaluation period, the ET Cover vegetation met or exceeded all LTMMP criteria for successful revegetation. Based on the most recent Biology Inspection conducted on August 22, 2022, the approximate foliar coverage on the ET Cover was 43%, with 99% of this coverage composed of native vegetation. The foliar coverage is dominated by native grasses, with Galleta grass (native clump grass species) continuing as the dominant grass species at approximately 35% of the total foliar coverage and black grama as the next most prominent native grass at 5%. The continued propagation of black grama across the ET Cover is significant because black grama is a final successional species in New Mexico grassland development. Overall, the ET Cover vegetation and surface is in good condition and the species complexity, spacing, and appearance of the native vegetation is similar to the surrounding vegetation in Technical Area-III (Figure 2-7).

In the 2018 through 2022 evaluation period, no action or repairs were required based on the Biology Inspections. Despite ongoing severe drought conditions, supplemental watering of the ET Cover vegetation was not needed. There were no contiguous areas of 200 or more square feet without vegetation and no plants capable of developing deep root systems were identified. During all annual Biology Inspections ant hills were observed distributed evenly across the ET Cover surface and side slopes. There were no small animal burrows or other diggings observed on the ET Cover surface and side slopes. Butterflies, grasshoppers, dragonflies, and lizards were observed during inspections performed in this evaluation period, which is an indication that wildlife recognizes the ET Cover as native habitat.

Additional detailed information is provided in Annual LTMM Reports, including the *Biology Inspection Form/Checklist* (Annex F) and the Annual Biology Report (Annex G). The Biology Report summarizes ET Cover background information, local climate trends, best-practice maintenance performed to support the vegetation, and recommendations for ongoing ET Cover maintenance based on inspections performed during the annual reporting period.

ET Cover System/Surface

Quarterly inspections of the ET Cover surface were performed by a field technician during the 2018 through 2022 evaluation period, fulfilling the LTMMP inspection requirement. There were no signs of subsidence, ponding water on the ET Cover surface, or erosion. No repairs were required for the ET Cover during this evaluation period.

Storm-Water Diversion Structure

Storm-water diversion structure inspections were combined with the quarterly ET Cover System/Surface Inspections during this evaluation period, fulfilling the LTMMP inspection requirement. These inspections addressed the engineered storm-water diversion swale on the north, east, and south sides of the ET Cover just beyond the toe of the cover side slopes (Figure 1-3) and were documented on the *Cover Inspection Checklist/Form*. No inspection items required follow-up actions, although windblown weeds and debris were periodically removed from the swale as a best practice. There were no observations of ponded water in the swale after storm events; the swale continues to operate as designed.

Security Fence

Perimeter security fence inspections were combined with the quarterly ET Cover System/Surface Inspections during this evaluation period, fulfilling the LTMMP inspection requirement. The inspections addressed the security fence, access controls (gates, locks, signs), and survey monuments, and were documented on the *Cover Inspection Checklist/Form*.

Periodic maintenance of the gate locks and replacement of faded/damaged signs was performed at the time of inspection or within 60 days. Clearing the perimeter fence of dead, windblown weeds was the most common required maintenance for this evaluation period. From March 2018 through March 2022, live and dead weeds were removed from the ET Cover and site perimeter 15 times by the field technician at the time of inspection. In March 2018 and March 2019, the fence was cleared of dead windblown weeds by the ET Cover maintenance contractor.

2.3.2 Monitoring Networks and Equipment

Inspections of the soil-vapor, soil-moisture, and groundwater monitoring networks and sampling equipment were performed concurrently with monitoring events during each annual reporting period, fulfilling the LTMMP inspection requirement. Routine maintenance was performed as needed, including replacing the soil-moisture monitoring cable reel system prior to sampling in April-May 2018. No other inspection parameters required repairs for the three monitoring networks during the 2018 through 2022 evaluation period. Routine inspections of monitoring wells and sampling/monitoring equipment, in addition to the requirements of Section 4.0 of the LTMMP, are performed by SNL/NM field personnel as best practice. Maintenance and/or repairs are performed as needed during these best-practice inspections.

2.4 Other Pertinent Data and Information

As part of the LTMM effort at the MWL, process and site improvements were made during the 2018 through 2022 and the previous 2014 through 2017 evaluation periods. The following sections summarize these improvements, or best practices, that are not explicitly required by LTMMP or Permit conditions. Process improvements are designed to facilitate monitoring network performance and data quality and enhance the protection of human health and the environment. The site improvements are designed to augment ET Cover long-term effectiveness and minimize required maintenance.

2.4.1 Process Improvements

Installation of Passive Venting BaroBalls™ on Groundwater Monitoring Wellheads

After a review of the September 2014 soil-vapor monitoring results that showed low detections (i.e., less than 1.0 ppmv) of VOC soil-vapor concentrations at 400 feet bgs, passive soil-vapor venting devices (BaroBalls™) were installed on groundwater monitoring wellheads at MWL-BW2, MWL-MW7, MWL-MW8, and MWL-MW9 (i.e., the compliance groundwater monitoring wells, Figures 2-5 and 2-8). The devices, installed in February 2015, allow soil-vapor that diffuses into groundwater monitoring wells to move toward the surface and vent during periods of low atmospheric pressure and prevent the downward movement (i.e., barometric pumping) of soil vapor in the well during periods of high barometric pressure. Installation of BaroBalls™ on all compliance groundwater monitoring wells was a best practice to address the potential for diffusion of VOC soil vapor into the wells and in particular MWL-MW8 (see discussion below). The passive soil-venting devices were inspected and maintained during the 2018 through 2022 evaluation period.

Passive Soil-Vapor Investigation

As addressed in Sections 2.2.5 and 2.4.1 of the first Five-Year Report (SNL/NM January 2019) and Section 7.4 of the Annual LTMM Report (SNL/NM June 2019), historical groundwater samples from MWL-MW8 have shown sporadic, very low concentration detections of PCE and TCE. In April 2018 a soil-vapor investigation was conducted inside the MWL-MW8 well casing; passive soil-vapor sampling devices were placed at various locations above the groundwater surface. This study was detailed in the Annual LTMM Report (SNL/NM June 2019); results confirmed PCE and TCE soil vapor had diffused into the well casing with the highest detectable concentrations occurring approximately 90 feet above the groundwater surface in the well. Based on this investigation, the most likely cause of the historical PCE and TCE detections in MWL-MW8 groundwater samples is VOC soil-vapor intrusion into the groundwater monitoring well casing, with barometric pumping pushing the VOC soil vapor downward to the groundwater surface. As summarized in Section 2.2.5 of this Report, there were no detections of PCE or TCE in groundwater samples from MWL-MW8 or the other compliance groundwater monitoring wells during the 2018 through 2022 evaluation period, indicating the BaroBalls™ continue to be effective.

Removal of Photoionization Detector Readings & Laboratory Quality Control Improvements

A Class 1 Permit Modification revising the LTMMP (Hauck December 2021) was approved by the NMED on February 16, 2022 (Shean February 2022). This was the first modification to the LTMMP and included the removal of photoionization detector readings to determine stabilization during the soil-vapor purging and sampling process. This streamlined and improved the process to minimize the potential for over-purging the sampling ports, consistent with current industry standards. This Permit modification also changed all laboratory quality control requirements for all LTMMP-required monitoring to those specified in the associated EPA analytical methods. This modification improved data consistency and quality while allowing flexibility as the EPA analytical methods are improved and revised.

Improvements were also incorporated into the various inspection forms during the current evaluation period, building upon experience and feedback from SNL/NM project personnel. Also consistent with LTMMP requirements, referenced SNL/NM operating procedures were routinely updated and submitted to the NMED within 30 days of the new effective date to keep these procedures current with industry standards and incorporate improvements.

2.4.2 Site Improvements and Best Practices

Two site improvement projects were implemented in the 2014 through 2017 evaluation period. In 2016, a significant upgrade was made to the perimeter road to improve site drainage and minimize erosion. In 2017, animal burrow and erosion control features were installed to protect the 10 perimeter monitoring wells from small burrowing mammals, erosion around the wellhead and pad areas, and erosion of the ET Cover western side slope during large storm events. Inspection and maintenance performed over the course of the 2018 through 2022 evaluation period confirmed the two site improvements continue to perform as designed.

Weed control activities were conducted during the 2018 through 2022 evaluation period to maintain and improve the ET Cover vegetation (Figure 2-9). These activities included one- to three-day manual weed removal efforts, 16 total, performed at a frequency of 2 to 4 events per calendar year. In April and December 2019 and April 2020, a pre-emergent herbicide was applied to the perimeter monitoring well locations, the area between the north toe of the ET Cover and the north fence, and the three-foot area outside the perimeter fence. In addition, the December 2019 and April 2020 events included pre-emergent herbicide application to the western side slope and western portion of the ET Cover. Annual application of an herbicide sterilant to the North and South Staging Areas was also conducted in March 2019, April 2020, May 2021, and April 2022. These best-practice weed control activities help the native grasses by minimizing weed growth on the ET Cover and perimeter areas that are more prone to invasive annual weed growth, and thereby minimizing competition with invasive annual weeds for limited moisture and nutrients.

Quarterly inspections of the ET Cover are further supported by the staff biologist, who performs best-practice Biology Inspections during the three quarters that do not coincide with the annual Biology Inspection (i.e., typically March, June, and December). This ensures the staff biologist observes the ET Cover in all four seasons, rather than just once a year at the end of monsoon season (August/September) when the Biology Inspection is typically performed. The biologist

prepares a memo with observations of current ET Cover conditions and recommendations for proactive steps to maintain healthy native vegetation. This best practice is an important component of the strategy to sustain ET Cover native vegetation during the extended, severe drought that has been impacting New Mexico for the past decade. SNL/NM quarterly biology memos are included in Annex F of Annual LTMM Reports.

During the 2014 monitoring period, one of the detectors used to measure radon in air was dislodged from the protective housing and found on the ground when the detectors were being collected at the end of the monitoring period. Because of this situation, the results for that detector were not representative and were determined to be unusable. The corrective action for this incident was implementation of a best-practice supplemental monthly inspection to ensure all the detectors remain in place. The housing, the clamps that secure the detector housing to the fence posts, and the internal area where the detectors are located are checked each month. There have been no other occurrences of detectors being dislodged from the protective housing since the 2014 incident. This best-practice inspection has been in effect since January 2015 but was not noted in the first Five-Year Report (SNL/NM January 2019); therefore, documentation is included in this Report. Radon inspection forms are included in Annex A of Annual LTMM Reports.

The second Permit modification revising the LTMMP will be submitted to the NMED in 2023. This will be a Class 2 Permit Modification and will request NMED-approval to decommission groundwater monitoring well MWL-MW4 that was installed in 1993 at an angled orientation (six degrees from vertical) with two screen intervals. Monitoring well MWL-MW4 is not part of the LTMMP compliance monitoring network and was retained for informational purposes only (i.e., groundwater elevation measurements). MWL-MW4 is being proposed for decommissioning because of its age, unique construction, and concerns it could act as a potential conduit for contaminant migration (e.g., VOC soil-vapor plume migration). It is not needed for compliance monitoring or the measurement of groundwater elevation to prepare groundwater potentiometric surface maps. Nine years under the LTMMP have shown that the compliance groundwater monitoring network is adequate for establishing the potentiometric surface of the Regional Aquifer in the vicinity of the MWL.

2.4.3 Evaluation of New Groundwater Contaminants

The first new requirement for this Report that was added through the NMED July 9, 2021, approval letter relates to continuing advances in science and associated regulatory changes regarding emerging contaminants of concern, such as PFAS, that have occurred since NMED approved the LTMMP in 2014 (Blaine January 2014). Per the NMED letter:

NMED requires Sandia National Laboratories next Five-Year Report, due to NMED no later than January 8, 2024, to evaluate:

1. *Groundwater quality for all toxic pollutants added to the Ground Water and Surface Water Protection regulations at 20.6.2 NMAC, since January 8, 2014 (enclosure provided listing 13 toxic pollutants added to Subsection T of 20.6.2.7 NMAC).*

The NMED made changes to 20.6.2.3103 NMAC, Standards for Groundwater and added 13 toxic pollutants to Subsection T of 20.6.2.7 NMAC; both of which became effective on

December 21, 2018. The revisions to existing standards are addressed in Section 2.4.4 and the 13 toxic pollutants (hereafter referred to as the 13 compounds) that were added to Subsection T are addressed in this section and listed below.

Toxic Pollutants Added as of December 21, 2018	
styrene (ethenylbenzene)	1,4-dioxane (1,4-D)
1,2-dichlorobenzene (ortho-dichlorobenzene)	sulfolane (thiolane 1,1-dioxide)
1,4-dichlorobenzene (para-dichlorobenzene)	perfluorohexane sulfonic acid (PFHxS)
1,2,4-trichlorobenzene	perfluorooctane sulfonate (PFOS)
pentachlorophenol (PCP)	perfluorooctanoic acid (PFOA)
1,2-dichloropropane (propylene dichloride, PDC)	atrazine
	prometon

Table 2-11 summarizes the evaluation process for the 13 compounds and presents the compound name, the Chemical Abstracts Service Registry Number (or CAS #), a description of the compound including historical use, whether existing data are available, and an evaluation summary. The evaluation of MWL groundwater quality for the 13 compounds was performed by SNL/NM personnel according to the following process. The first step was to determine if recent and/or historical data (i.e., before LTMMP implementation in 2014) were available. If results were available, they were sorted for each compound by data type/medium (i.e., groundwater data, soil-vapor data, soil data) and then reviewed. Soil sample and soil-vapor sample results provide information on whether a compound is present and may have the potential to impact groundwater. All environmental samples, including duplicate samples, were included in the sample counts presented in Table 2-11. Related quality assurance/quality control and waste management samples were not included.

Based upon the review, a determination was made regarding the potential for that compound to impact groundwater beneath the MWL. In all cases where previous sampling and analysis data were available, the results were conclusive and additional sampling and analysis was not necessary. If there were no analytical results available for a compound, the historical use of that compound was researched and compared to MWL operation information and disposal history (i.e., MWL process knowledge) to determine if sampling and analysis of MWL groundwater was warranted. If SNL/NM personnel conducting the review determined there was uncertainty, then additional groundwater sampling and analysis was performed.

For 7 of the 13 compounds (styrene; 1,2-dichlorobenzene; 1,4-dichlorobenzene; 1,2,4-trichlorobenzene; pentachlorophenol; 1,2-dichloropropane; and 1,4-dioxane) there are existing groundwater data. Based upon a review of these data, there is no need for additional groundwater sampling and analysis (Table 2-11). However, the compounds styrene and 1,2-dichloropropane are part of the ongoing LTMMP groundwater monitoring program and will continue to be monitored in MWL groundwater in accordance with LTMMP requirements. In addition, styrene; 1,2-dichloropropane; 1,2-dichlorobenzene; 1,4-dichlorobenzene; and 1,2,4-trichlorobenzene are part of the ongoing LTMMP soil-vapor monitoring program and will also continue to be monitored in MWL vadose zone soil vapor in accordance with LTMMP requirements.

Table 2-11
Evaluation of Toxic Pollutants Added to 20.6.2.7 NMAC as of December 2018

Compound[a]	CAS #[b]	Description & Historical Use[c]	Existing Data[d]?	Evaluation Summary
styrene (ethenylbenzene)	100-42-5	A colorless, oily liquid that is a derivative of benzene and evaporates easily. It is used to make latex, synthetic rubber, and polystyrene resins. It is also produced naturally in some plants.	Yes	~311 groundwater results April 1995 – October 2022, all non-detections. ~103 soil results April 1995 - November 2006, all non-detections. ~355 soil-vapor results April 2008 – October 2022, 2 detections, both less than 1 ppbv. Will continue to be monitored in groundwater and soil vapor per LTMMP requirements.
1,2-dichlorobenzene (ortho-dichlorobenzene)	95-50-1	A non-polar colorless liquid derivative of benzene that is used as a precursor for agrochemicals, a solvent for fullerenes, an insecticide, and an agent to remove carbon-based contamination from metal.	Yes	~93 groundwater results October 1995 – February 2013, all non-detections. ~103 soil results April 1995 – November 2006, all non-detections. ~363 soil-vapor results April 2008 – October 2022, 2 detections, both less than 1.2 ppbv. Will continue to be monitored in soil vapor per LTMMP requirements – no additional groundwater sampling and analysis needed.
1,4-dichlorobenzene (para-dichlorobenzene)	106-46-7	A synthetic, white crystalline solid that is practically insoluble in water. It is used primarily as a space deodorant in products such as room deodorizers, urinal and toilet bowl blocks, and as an insecticide fumigant for moth control.	Yes	~93 groundwater results October 1995 – February 2013, all non-detections. ~103 soil results April 1995 - May 2008, all non-detections. ~363 soil-vapor results April 2008 – October 2022, 2 detections, both less than 1.3 ppbv. Will continue to be monitored in soil vapor per LTMMP requirements – no additional groundwater sampling and analysis needed.
1,2,4-trichlorobenzene	120-82-1	A colorless liquid or white solid with a sharp chlorobenzene odor. Used as a dye carrier, an herbicide intermediate, a heat-transfer medium, a dielectric fluid in transformers, a degreaser, a lubricant, a component in synthetic transformer oils, and as a solvent in chemical manufacturing. It was formerly used as an insecticide.	Yes	~93 groundwater results October 1995 – February 2013, all non-detections. ~103 soil results April 1995 - November 2006, all non-detections. ~355 soil-vapor results April 2008 – October 2022, all non-detections. Will continue to be monitored in soil vapor per LTMMP requirements – no additional groundwater sampling and analysis needed.

Refer to footnotes at end of table.

Table 2-11 (Continued)
Evaluation of Toxic Pollutants Added to 20.6.2.7 NMAC as of December 2018

Constituent[a]	CAS #[b]	Description & Historical Use[c]	Existing Data[d]?	Evaluation Summary
1,2-dichloropropane (propylene dichloride, [PDC])	78-87-5	A colorless, flammable liquid with a chloroform-like odor, moderately soluble in water and readily evaporates into air. It does not occur naturally in the environment and production in the United States has declined over the past 20 years. It was used in the past as a soil fumigant, chemical intermediate and industrial solvent, and was found in paint strippers, varnishes, and furniture finish removers but most of these uses were discontinued. Almost all the current use is as a chemical intermediate to make perchloroethylene and several other related chlorinated chemicals.	Yes	~313 groundwater results April 1995 – October 2022, all non-detections. ~103 soil results April 1995 - November 2006, all non-detections. ~355 soil-vapor results April 2008 – October 2022, 7 detections, all less than 0.4 ppbv. Will continue to be monitored in groundwater and soil vapor per LTMMP requirements.
1,4-dioxane (1,4-D)	123-91-1	A synthetic, volatile, colorless liquid that is miscible with water, most organic solvents, aromatic hydrocarbons, and oils. It is used primarily as a stabilizer in chlorinated solvents. It is also used as a solvent for numerous commercial products and as a wetting/dispersing agent in textile processing.	Yes	~10 groundwater results from the May 2020 and November 2020 semiannual groundwater monitoring events, all non-detections. No soil or soil-vapor results. As requested previously by NMED in September 2019, two consecutive semiannual groundwater sampling events were completed in 2020 with no detections. No additional groundwater results needed.
sulfolane (thiolane 1,1-dioxide)	126-33-0	A colorless oily liquid with a weak oily odor that is miscible with both water and hydrocarbons. It is used as an industrial solvent, plasticizer, curing agent (epoxy resins) and therapeutic (antibacterial, convulsant, and radiation-protective agent). Also used for acid gas purification, fractionation (wood tars, tall oil, and other fatty acids), and textile finishing. Used in electronic applications, pharmaceutical manufacturing (solvent), jet printing inks (solvent), and medicines.	No	Based on the historical use of this chemical and process knowledge of the MWL operational history, no groundwater sampling and analysis is needed.

Refer to footnotes at end of table.

Table 2-11 (Continued)
Evaluation of Toxic Pollutants Added to 20.6.2.7 NMAC as of December 2018

Constituent[a]	CAS #[b]	Description & Historical Use[c]	Existing Data[d]?	Evaluation Summary
atrazine	1912-24-9	An herbicide that does not occur naturally. An odorless, white powder that is not very volatile, reactive, or flammable and that will dissolve in water. Atrazine is used to kill weeds, primarily on farms, but has also been used on highway and railroad rights-of-way. The EPA now restricts how atrazine can be used and applied.	No	Based on the historical use of this chemical and process knowledge of the MWL operational history, no groundwater sampling and analysis is needed.
pentachlorophenol (PCP)	87-86-5	A manufactured chemical that does not occur naturally. In pure form occurs as colorless crystals; impure form is dark gray to brown dust, beads, or flakes. Was widely used as a pesticide and wood preservative. Since 1984, no longer registered for use as a pesticide (termiticide), fungicide, herbicide, molluscicide, disinfectant, or paint anti-fouling agent; the purchase and use was restricted to certified applicators (no longer available to the general public). PCP is manufactured at only one facility in the United States (Wichita, Kansas) and is still used as a wood preservative for utility poles, railroad ties, and wharf pilings. Non-wood uses account for less than 2 percent of United States consumption.	Yes	~76 groundwater results October 1995 – April 2010, all non-detections. ~73 soil sample results April 1995 – November 2006, all non-detections. No additional groundwater sampling and analysis is needed.
prometon	1610-18-0	A colorless powder or white crystalline solid used as non-selective pre- and post-emergent herbicide for non-crop land. Used to control grasses and broad-leaved weeds in cotton and celery crops.	No	Based on the historical use of this chemical and process knowledge of the MWL, no groundwater sampling and analysis is needed.

Refer to footnotes at end of table.

Table 2-11 (Concluded)
Evaluation of Toxic Pollutants Added to 20.6.2.7 NMAC as of December 2018

Constituent[a]	CAS #[b]	Description & Historical Use[c]	Existing Data[d]?	Evaluation Summary
perfluorohexane sulfonic acid (PFHxS)	355-46-4	A compound in the perfluoroalkyl family of chemicals with a six-carbon-long molecular chain (C6) historically used in a variety of consumer and industrial applications, including firefighting foams, carpet treatment solutions, and as a stain and water repellent.	No	Groundwater sampling and analysis conducted to evaluate these PFAS due to their ubiquitous nature and longevity in the environment. ~10 groundwater results October 2022 and May/June 2023, all results were non-detections with the laboratory detection limit ranging from 0.566 to 0.771 nanograms per liter (equivalent to 0.566 to 0.771 parts per trillion). May/June 2023 PFAS groundwater results were included for completeness with regards to addressing this NMED request. Used same approach as the NMED request related to 1,4-dioxane; two consecutive semiannual groundwater sampling events were conducted. No additional groundwater sampling and analysis is needed.
perfluorooctane sulfonate (PFOS)	1763-23-1	A compound in the perfluoroalkyl family of chemicals with an eight-carbon-long molecular chain (C8), PFOS is a fluorosurfactant that has been used in a variety of applications, including as protective surface coatings (i.e., carpets, fabrics, and food packaging, including Scotchgard™ stain and water repellent products) and in specialty chemicals (i.e., fire-fighting foams, hydraulic fluids, mining and oil-well surfactants, and consumer products). It has also been used as an acid catalyst for photoresists, the active ingredient for ant bait traps, and as a surfactant in alkaline cleaners, floor polishes, metal plating baths, and etching acids for circuit boards.	No	
perfluorooctanoic acid (PFOA)	335-67-1	A compound in the perfluoroalkyl family of chemicals with an eight-carbon-long molecular chain (C8), PFOA is a surfactant that has been used in a variety of consumer and industrial applications, including in fire-fighting foams and various industrial processes.	No	

Notes:
[a]Toxic Pollutants Added to 20.6.2.7 NMAC as of December 2018.
[b]The Chemical Abstracts Service Registry Number (CAS#) is a unique number assigned to every chemical substance described in the open scientific literature by the Chemical Abstracts Service located in Columbus, Ohio.
[c]Chemical descriptions summarized from the PubChem database, which is an open chemistry database at the National Institutes of Health.
[d]Existing data refers to sampling and analysis results that were collected prior to the July 2021 NMED request.

~ = approximately.
EPA = U.S. Environmental Protection Agency.
LTMMP = *Long-Term Monitoring and Maintenance Plan for the MWL*.
MWL = Mixed Waste Landfill.
NMED = New Mexico Environment Department.
NMAC = New Mexico Administrative Code.
PFAS = perfluoroalkyl and/or polyfluoroalkyl substances.
ppbv = parts per billion by volume basis.

For the remaining six compounds (sulfolane, atrazine, prometon, PFHxS, PFOS, and PFOA) there were no groundwater, soil-vapor, or soil sample analytical results prior to the July 2021 NMED request. The historical use for sulfolane, atrazine, and prometon does not suggest they would be present at the MWL based upon MWL process knowledge (Table 2-11). Therefore, no groundwater sampling and analysis is proposed for these compounds.

While not anticipated to be present based upon MWL process knowledge, PFHxS, PFOS, and PFOA were included in the October 2022 and May/June 2023 groundwater monitoring events since these emerging contaminants are ubiquitous and persistent in the environment. The environmental groundwater samples collected from the four compliance groundwater monitoring wells in October 2022 and May/June 2023 were analyzed for these three PFAS and all results were reported as non-detections with very low detection limits ranging from 0.566 to 0.771 nanograms per liter (equivalent to 0.566 to 0.771 parts per trillion). Similar to the sampling requirements specified by the NMED for 1,4-dioxane (Kieling September 2019), two consecutive sampling events for the three PFAS were conducted and will be reported. The October 2022 PFAS results were presented in the April 2022-March 2023 Annual LTMM Report (SNL/NM June 2023), and the May/June 2023 groundwater monitoring results will be presented in the June 2024 MWL Annual LTMM Report. The May/June 2023 PFAS results are only summarized in this section of the Report for completeness to address the NMED July 2021 request. No additional groundwater sampling and analysis is planned to address this NMED requirement.

2.4.4 Trigger Levels Review

The Trigger Evaluation Process and media-specific monitoring trigger levels are documented in Chapter 5 of the LTMMP and were approved and implemented in 2014. Conservative, media-specific trigger levels provide early detection of potentially changing conditions at the surface (air and soil), in the vadose zone, and in the groundwater at the MWL. The Trigger Evaluation Process ensures MWL site conditions continue to be protective by requiring timely action if any trigger levels are exceeded. This approach ensures the protection of human health and the environment based on monitoring the most mobile contaminants and likely exposure pathways at the MWL.

2.4.4.1 Development and Implementation of Current LTMMP Trigger Levels

Monitoring trigger levels for the air, surface soil, vadose zone, and groundwater at the MWL were developed through the CMI Plan (SNL/NM November 2005) approval process. Additional information related to the final media-specific trigger levels is presented in Section 5.2 of the LTMMP (SNL/NM March 2012).

2.4.4.2 Periodic Review Requirement

Section 5.2 of the LTMMP includes a requirement for periodic review of the regulatory standards and risk-based screening levels that were used to develop the media-specific triggers. The review is performed annually to determine if any changes to the reference EPA and NMED regulatory standards and risk-based screening level guidance that form the basis for the trigger levels have occurred. Changes that affect a trigger level are to be documented and submitted to

the NMED as a Class 1 Permit modification with prior approval (SNL/NM March 2012) before any changes take effect.

Informal annual reviews of regulatory standards and risk-based screening levels performed prior to 2022 did not result in significant revisions to LTMMP trigger levels. Revisions to NMED risk-based screening levels released in the Soil Screening Guidance for Human Health Risk Assessments (NMED June 2022 and November 2022) prompted a comprehensive, formal review of the updated regulatory standards and risk-based screening levels. Results are documented in the following sections.

2.4.4.3 Review Process

The first step in the review process was to review the sources used to establish the trigger levels presented in Section 5.2 of the LTMMP (SNL/NM March 2012) and search the most current NMED and EPA regulatory standards and risk-based screening levels for each contaminant. The 2012 trigger levels and 2022 sources were then loaded into a spreadsheet for comparison and to generate the tables in this section. The same regulatory sources used for the 2012 trigger levels were used for the 2023 trigger level review; however, these sources were updated and in some cases the source name was changed by the EPA or the NMED. Where updated trigger levels were calculated as a percentage of a regulatory standard or risk-based screening level, the same formulas for each contaminant used to calculate the 2012 LTMMP trigger levels were used to calculate the 2023 trigger level. For a given contaminant, if a cancer and non-cancer risk level was provided, the more conservative of the two was selected. While this process was initially completed in 2022, a final review was completed in 2023. The updated trigger levels presented in the next section are therefore referred to as the 2023 trigger levels.

2.4.4.4 Review Results

Tables 2-12 through 2-15 display the 2012 LTMMP trigger levels and the updated 2023 trigger levels for the multi-media monitoring program. The tables also include the regulatory sources used to determine the 2012 and 2023 trigger levels.

The 2012 trigger levels approved by the NMED in 2014 continue to be protective of human health and the environment. Of the 64 total multi-media monitoring trigger levels, most either stay the same (32) or increase (28); only four trigger levels will decrease (i.e., become more conservative) based upon this review. All changes to the media-specific trigger levels are based on EPA and NMED changes to their published regulatory standards and risk-based screening levels that were the basis for the NMED-approved 2012 trigger levels.

As required in Section 5.2 of the LTMMP (SNL/NM March 2012), a Class I Permit Modification request will be submitted to the NMED to complete the process. The 2023 updated trigger levels will not take effect until the NMED approves the modification request.

Table 2-12
Mixed Waste Landfill Surface Soil Trigger Levels Review

Parameter	Trigger Level (mg/kg) 2012[a]	Trigger Level (mg/kg) 2023[b]
Arsenic	17.7	35.9
Barium	100,000[c]	100,000[c]
Cadmium	897	1,110
Chromium (as Chromium VI)	63.1	72.1
Lead	800	800
Mercury	73.6	112
Selenium	5,680	6,490
Silver	5,680	6,490
Copper	45,400	51,900
Nickel	22,500	25,700
Vanadium	5,680	6,530
Zinc	100,000[c]	100,000[c]
Cobalt	20,500[d]	388
Beryllium	2,260	2,580
Tritium in soil moisture	20,000 pCi/L[e]	20,000 pCi/L[e]

Notes:
[a]Source of the 2012 trigger levels is NMED Industrial/Occupational Soil Screening Levels (NMED February 2012).
[b]Source of the 2023 trigger levels is NMED Industrial/Occupational Soil Screening Levels (NMED November 2022) except where noted. Lead trigger level adopted by the NMED from U.S. Environmental Protection Agency, May 2023, "Regional Screening Levels."
[c] The theoretical ceiling limit of 100,000 mg/kg was applied as the maximum concentration for a surface soil trigger level per 2012 NMED Risk Assessment Guidance (NMED February 2012). This value was maintained for the 2023 trigger level evaluation.
[d]Source of the 2012 cobalt trigger level is Bearzi October 2008.
[e]Tritum trigger level is measured in soil moisture and based on modeling a human receptor being exposed via the air pathway (Ho et al. January 2007, 2nd Edition, SAND2007-0170).
mg/kg = Milligram(s) per kilogram(s).
NMED= New Mexico Environment Department.
pCi/L = Picocurie(s) per liter.

Table 2-13
Mixed Waste Landfill Radon-in-Air Trigger Level Review

Parameter	Trigger Level 2012[a]	Trigger Level 2023[a]
Radon concentration in air	4 pCi/L	4 pCi/L

Notes:
[a]The source for the radon trigger level is the EPA Action Threshold for Radon in Household Air (EPA September 2005).
EPA = U.S. Environmental Protection Agency.
pCi/L = Picocurie(s) per liter.

Table 2-14
Mixed Waste Landfill Vadose Zone Trigger Levels Review

Parameter	Trigger Level 2012	Trigger Level 2023
Soil Vapor Volatile Organic Compounds – Deepest 3 Ports of MWL-SV03 through SV05[a]		
Tricholorethene (TCE)	20 ppmv	20 ppmv
Tetrachloroethene (PCE)	20 ppmv	20 ppmv
Total Volatile Organic Compounds	25 ppmv	25 ppmv
Soil Moisture as Measured in Vadose Zone Boreholes using a Neutron Probe[b]		
Total soil moisture by volume	23%	23%

Notes:
No changes proposed to the vadose zone monitoring trigger levels.
[a]The listed vadose zone monitoring trigger levels are from the *Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill* (SNL/NM March 2012); they were established through modeling to be protective of groundwater as documented in the Mixed Waste Landfill Corrective Measures Implementation Plan, Appendix E, Probabilistic Performance Assessment Modeling of the MWL (Ho et al. January 2007, 2nd Edition, SAND2007-0170) and in the Chemical Waste Landfill Corrective Measures Study Report, Appendix J, Supporting Information for the Development of a TCE Soil-Gas Trigger Level (SNL/NM December 2004).
[b]The established trigger level is the moisture content by volume that corresponds to an unsaturated hydraulic conductivity equal to the EPA-prescribed technical equivalence criteria of 10E-7 centimeters per second (31.5 millimeters per year) for Resource Conservation Recovery Act landfills (EPA July 1989, 1991, 1994).
% = Percent.
EPA = U.S. Environmental Protection Agency.
MWL = Mixed Waste Landfill.
ppmv = Parts per million by volume.

Table 2-15
Mixed Waste Landfill Groundwater Trigger Levels Review

Parameter	Source[a]	Trigger Level 2012[b]	2012 Reference	Trigger Level 2023[c]	2023 Reference[d]
EPA Method 8260 Volatile Organic Compounds		(µg/L)		(µg/L)	
1,1,1-Trichloroethane (1,1,1-TCA)	25% NMED WQCC MAC	15	NMED WQCC MAC for Tap Water (2002)	50	20.6.2.3103 NMAC (2018)
1,1,2,2-Tetrachloroethane	50% NMED WQCC MAC	5	NMED WQCC MAC for Tap Water (2002)	5	20.6.2.3103 NMAC (2018)
1,1,2-Trichloroethane	50% EPA MCL	2.5	EPA MCL (May 2009)	2.5	EPA National Primary Drinking Water Regulations
1,1-Dichloroethane	50% NMED WQCC MAC	12.5	NMED WQCC MAC for Tap Water (2002)	12.5	20.6.2.3103 NMAC (2018)
1,1-Dichloroethene	50% NMED WQCC MAC	2.5	NMED WQCC MAC for Tap Water (2002)	3.5	20.6.2.3103 NMAC (2018)
1,2-Dichloroethane	50% EPA MCL	2.5	EPA MCL (May 2009)	2.5	EPA National Primary Drinking Water Regulations
1,2-Dichloropropane	50% EPA MCL	2.5	EPA MCL (May 2009)	2.5	EPA National Primary Drinking Water Regulations
2-Butanone (methyl ethyl ketone)	25% EPA RSL	1,225	EPA RSL for Tap Water (November 2011)	1,400	EPA RSL Summary Table (May 2023)
2-Hexanone	50% EPA RSL	17	EPA RSL for Tap Water (November 2011)	19	EPA RSL Summary Table (May 2023)
4-methyl-, 2-Pentanone (Methyl isobutyl ketone)	25% EPA RSL	250	EPA RSL for Tap Water (November 2011)	1,575	EPA RSL Summary Table (May 2023)
Acetone	25% EPA RSL	3,000	EPA RSL for Tap Water (November 2011)	4,500	EPA RSL Summary Table (May 2023)
Benzene	50% EPA MCL	2.5	EPA MCL (May 2009)	2.5	EPA National Primary Drinking Water Regulations
Bromodichloromethane	50% NMED SL	0.6	NMED SL for Tap Water (February 2012)	0.67	NMED Risk Assessment Guidance Volume 1 (Nov 2022)
Bromoform	25% EPA MCL[e]	4	EPA RSL for Tap Water (November 2011)	20	EPA RSL Summary Table (May 2023)
Bromomethane	50% EPA RSL	3.5	EPA RSL for Tap Water (November 2011)	3.8	EPA RSL Summary Table (May 2023)

Refer to footnotes at end of table.

Table 2-15 (Continued)
Mixed Waste Landfill Groundwater Trigger Levels Review

Parameter	Source[a]	Trigger Level 2012[b]	2012 Reference	Trigger Level 2023[c]	2023 Reference[d]
Carbon disulfide	25% EPA RSL	180	EPA RSL for Tap Water (November 2011)	203	EPA RSL Summary Table (May 2023)
Carbon tetrachloride	50% EPA MCL	2.5	EPA MCL (May 2009)	2.5	EPA National Primary Drinking Water Regulations
Chlorobenzene	25% EPA MCL	25	EPA MCL (May 2009)	25	EPA National Primary Drinking Water Regulations
Chloroethane (ethyl chloride)	25% EPA RSL	5,250	EPA RSL for Tap Water (November 2011)	2,075	EPA RSL Summary Table (May 2023)
Chloroform	25% NMED WQCC MAC	25	NMED WQCC MAC for Tap Water (2002)	25	20.6.2.3103 NMAC (2018)
Chloromethane	25% NMED SL	47[f]	NMED SL for Tap Water (February 2012)	5.1[f]	NMED Risk Assessment Guidance Volume 1 (Nov 2022)
Dibromochloromethane	50% NMED SL	0.75	NMED SL for Tap Water (February 2012)	0.84	NMED Risk Assessment Guidance Volume 1 (Nov 2022)
Ethyl benzene	25% EPA MCL	175	EPA MCL May 2009)	175	EPA National Primary Drinking Water Regulations
Methylene chloride	50% EPA MCL[g]	3	EPA MCL (May 2009)	2.5	EPA National Primary Drinking Water Regulations
Styrene	25% EPA MCL	25	EPA MCL (May 2009)	25	EPA National Primary Drinking Water Regulations
Tetrachloroethene (PCE)	50% EPA MCL	2.5	EPA MCL (May 2009)	2.5	EPA National Primary Drinking Water Regulations
Toluene	25% NMED WQCC MAC	187.5	NMED WQCC MAC for Tap Water (2002)	250	NMAC 20.6.2.3103 (2018)
Trichloroethene (TCE)	50% EPA MCL	2.5	EPA MCL (May 2009)	2.5	EPA National Primary Drinking Water Regulations
Vinyl acetate	25% EPA RSL	103	EPA RSL for Tap Water (November 2011)	103	EPA RSL Summary Table (May 2023)
Vinyl chloride	50% NMED WQCC MAC	0.5	NMED WQCC MAC for Tap Water (2002)	1.0	20.6.2.3103 NMAC (2018)

Refer to footnotes at end of table.

Table 2-15 (Continued)
Mixed Waste Landfill Groundwater Trigger Levels Review

Parameter	Source[a]	Trigger Level 2012[b]	2012 Reference	Trigger Level 2023[c]	2023 Reference[d]
Xylene (total xylenes)	25% NMED WQCC MAC	155	NMED WQCC MAC for Tap Water (2002)	155	20.6.2.3103 NMAC (2018)
cis-1,2-Dichloroethene	25% EPA MCL	17.5	EPA MCL (May 2009)	17.5	EPA National Primary Drinking Water Regulations
cis-1,3-Dichloropropene (1,3-Dichloropropene)	50% NMED SL	2.2	NMED SL for Tap Water (February 2012)	2.4	NMED Risk Assessment Guidance Volume 1 (Nov 2022)
trans-1,2-Dichloroethene	25% EPA MCL	25	EPA MCL (May 2009)	25	EPA National Primary Drinking Water Regulations
trans-1,3-Dichloropropene (1,3-Dichloropropene)	50% NMED SL	2.2	NMED SL for Tap Water (February 2012)	2.4	NMED Risk Assessment Guidance Volume 1 (Nov 2022)
Dichlorodifluoromethane	25% EPA RSL	47.5	EPA RSL for Tap Water (November 2011)	50	EPA RSL Summary Table (May 2023)
Metals with Trigger Levels		(µg/L)		(µg/L)	
Uranium (total)	50% EPA MCL	15	EPA MCL (May 2009)	15	EPA National Primary Drinking Water Regulations
Chromium (total)	NMED Background Concentration	43	NMED Background Concentration (Dinwiddie September 1997)	43	Dinwiddie (September 1997)
Cadmium	50% EPA MCL	2.5	EPA MCLs (May 2009)	2.5	EPA National Primary Drinking Water Regulations
Nickel	25% of NMED WQCC standard of 0.2 mg/L	50	NMED Guidance (Bearzi October 2008)	50	20.6.2.3103 NMAC (2018)
Radiological Constituents with Trigger Levels		(pCi/L)		(pCi/L)	
Tritium	EPA MCL	4 mrem/yr	EPA MCL (May 2009) 20,000 pCi/L Trigger Level value determined assuming a dose of 4 mrem/yr	4 mrem/yr 20,000 pCi/L	EPA National Primary Drinking Water Regulations and EPA Tritium Fact Sheet
Radon	MWL LTMMP	1,000	MWL LTMMP (March 2012)	1,000	MWL LTMMP (March 2012)
Gross Alpha Activity	EPA MCL	15[h]	EPA MCL (May 2009)	15[h]	EPA National Primary Drinking Water Regulations

Refer to footnotes at end of table.

Table 2-15 (Concluded)
Mixed Waste Landfill Groundwater Trigger Levels Review

Parameter	Source[a]	Trigger Level 2012[b]	2012 Reference	Trigger Level 2023[c]	2023 Reference[d]
Gross Beta Activity	EPA MCL	4 mrem/yr	EPA MCL (May 2009)	4 mrem/yr	EPA National Primary Drinking Water Regulations

Notes:
[a]From Table 5.2.4-1 of the *Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill*, SNL/NM March 2012, approved by NMED (Blaine January 2014) unless otherwise noted.
[b]From the *Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill*, SNL/NM March 2012 approved by the NMED (Blaine January 2014).
[c]Proposed MWL trigger level based upon the same regulatory guidance as was used to establish the 2012 trigger level, except where noted.
[d] EPA National Primary Drinking Water Regulations website accessed in September 2023. 20.6.2.3103 NMAC updated in December 2018 (New Mexico Commission of Public Records, NMAC, 2018).
[e]2012 trigger level determined using 50% of the EPA Risk Screening Level. An EPA MCL is listed in the EPA May 2023 Risk Screening Level Guidance (EPA May 2023); the proposed 2023 trigger level is 25% of the MCL.
[f]The 2012 trigger level used the non-cancer value, the 2023 trigger level uses the cancer value that is more conservative.
[g]60% of the EPA MCL was used in 2012 due to the 50% value being less than the analytical laboratory detection limit at that time. The minimum detection limit is now lower than the 50% value so the 2023 proposed trigger level was determined using 50% of the EPA MCL; the MCL has not changed.
[h]Gross alpha activity data corrected for naturally occurring uranium in accordance with 40 CFR Parts 9, 141, and 142, Table I-4.
% = Percent.
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(s) per year.
MWL = Mixed Waste Landfill.
NMAC = New Mexico Administrative Code.
NMED = New Mexico Environment Department.
pCi/L = Picocurie(s) per liter.
RSL = Regional Screening Level.
SL = Screening Level.
SNL/NM = Sandia National Laboratories, New Mexico.
WQCC = Water Quality Control Commission.

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CHAPTER 2 FIGURES

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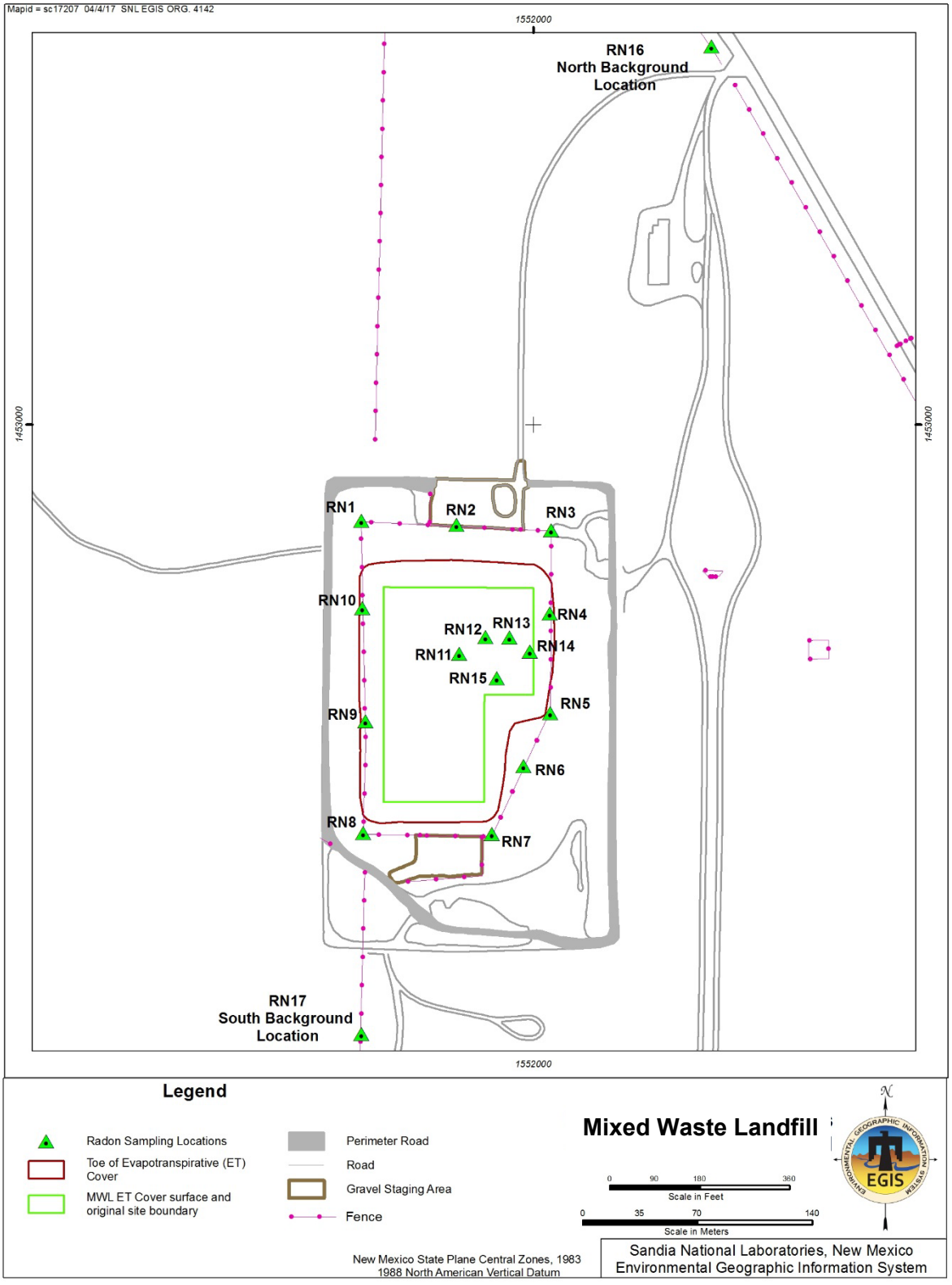

Figure 2-1
Mixed Waste Landfill Radon Detector Locations

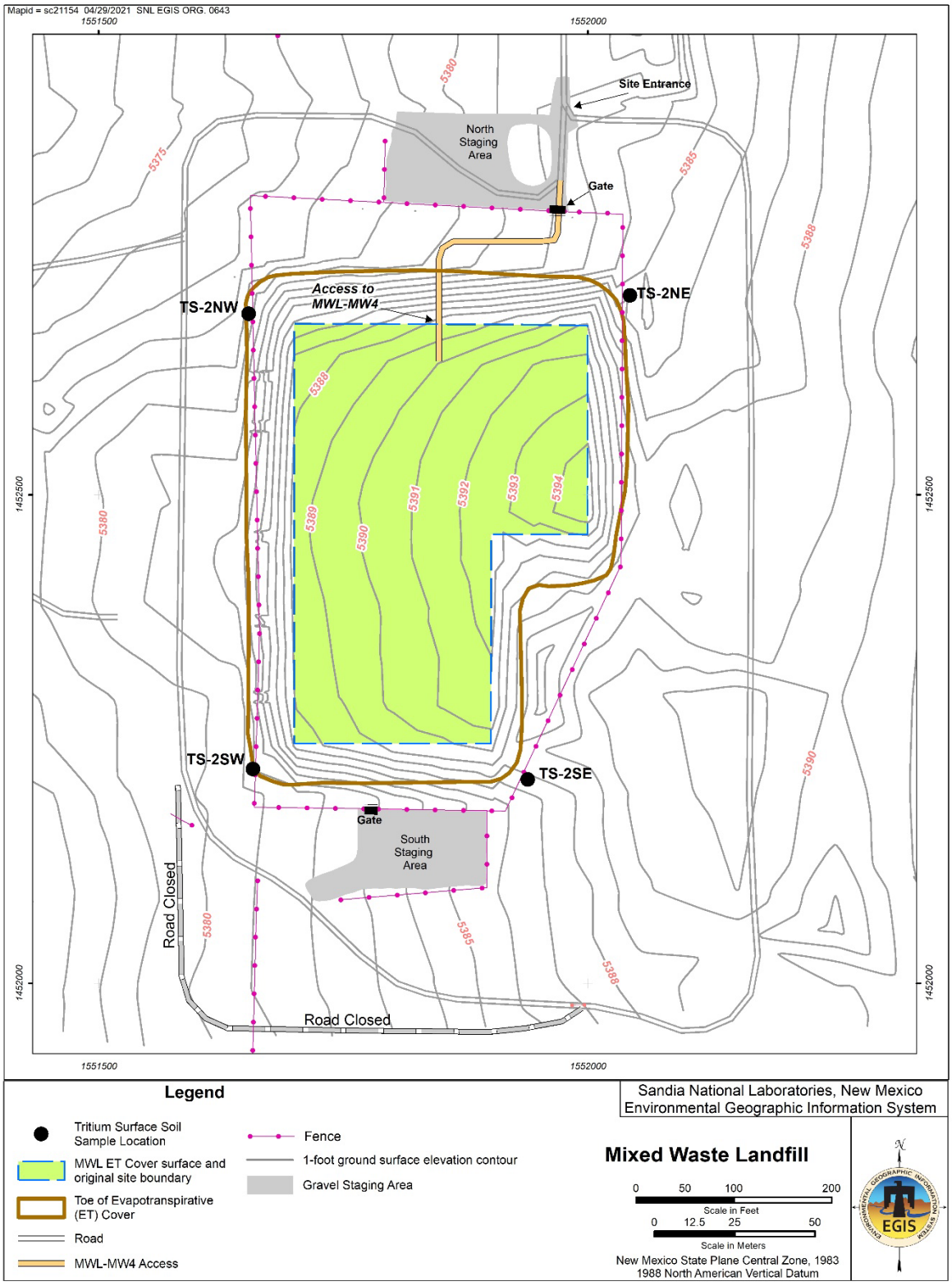

Figure 2-2
Mixed Waste Landfill Tritium Surface Soil Sampling Locations

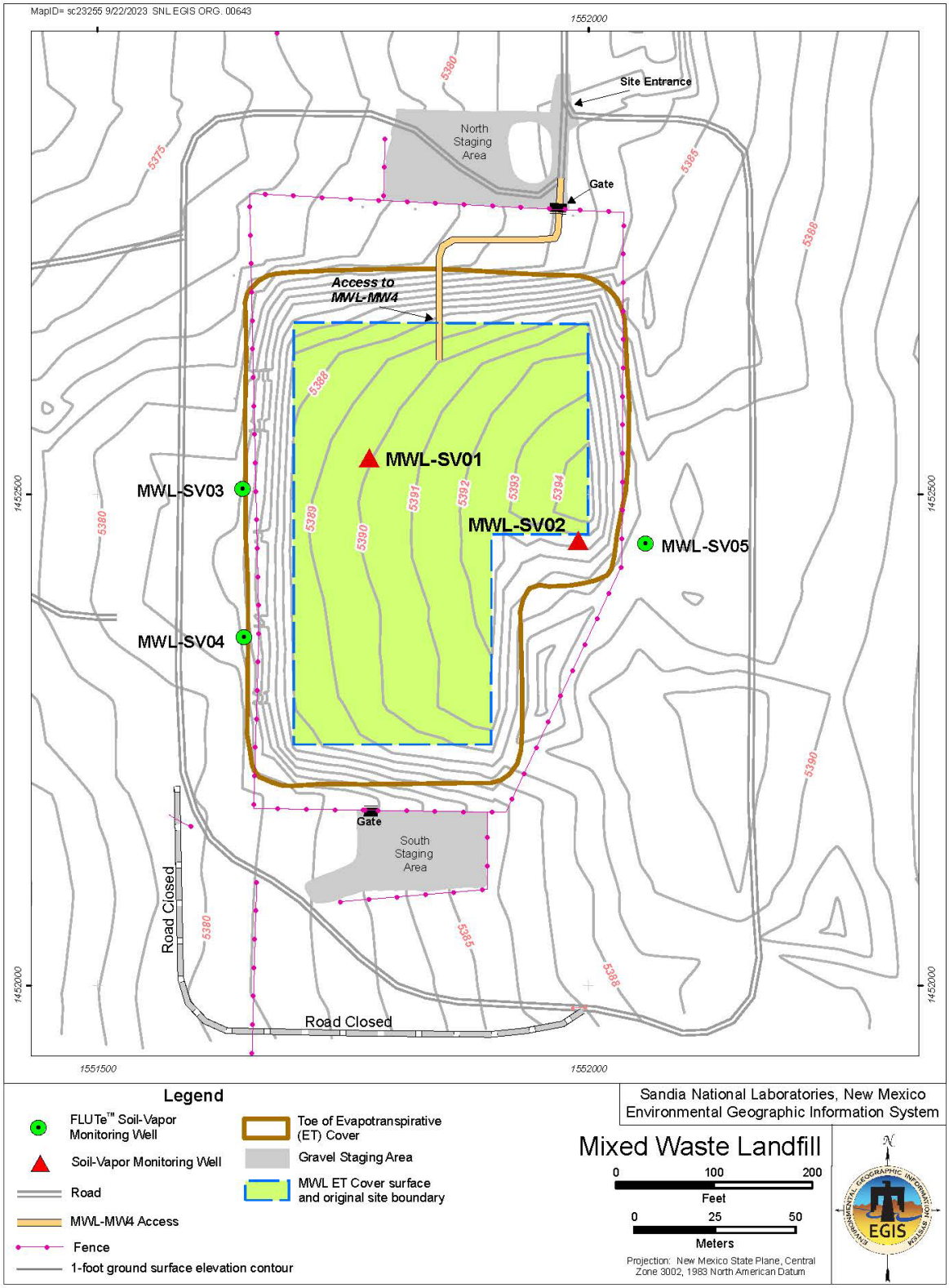

Figure 2-3
Mixed Waste Landfill Soil-Vapor Monitoring Well Locations

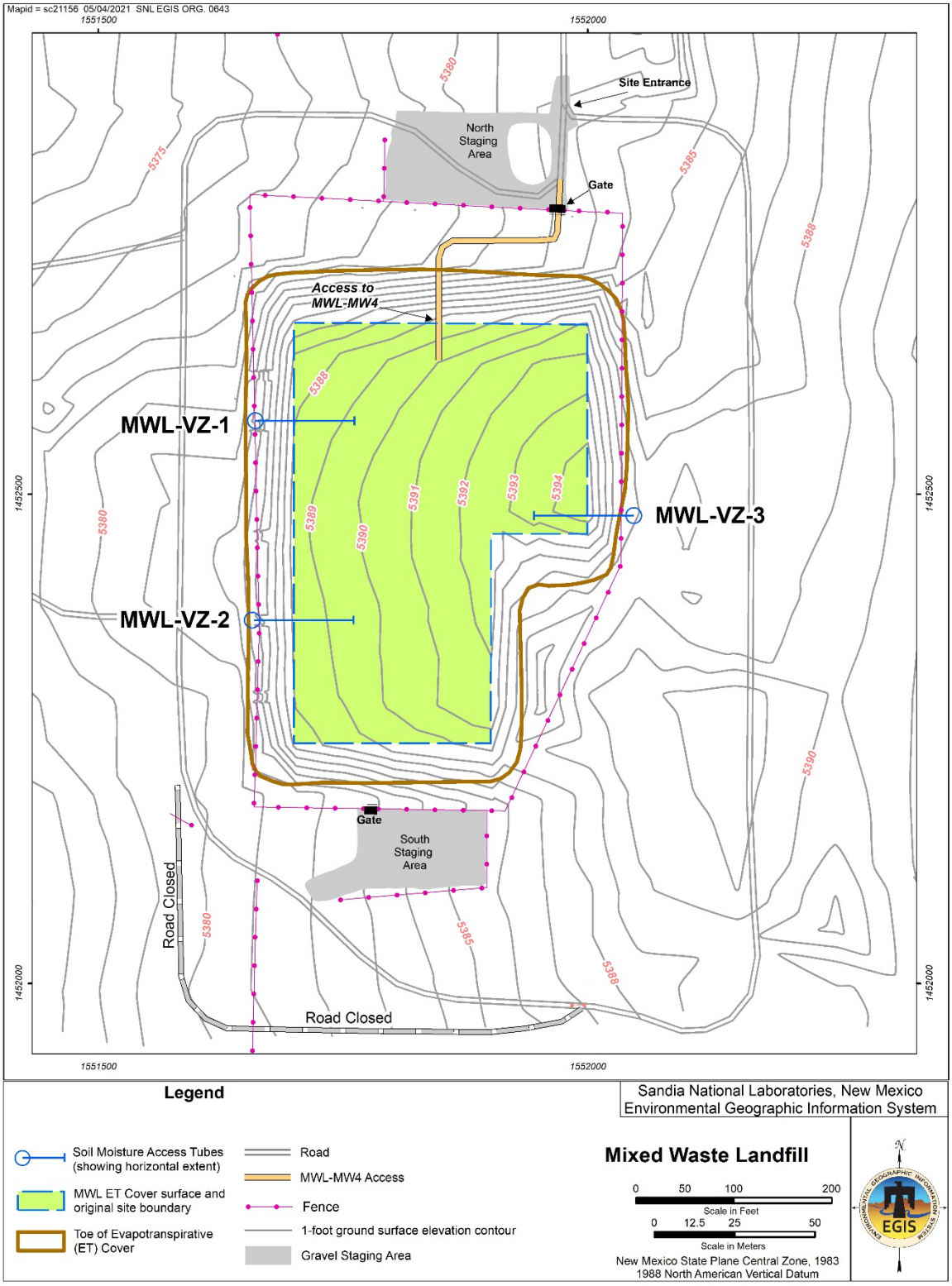

Figure 2-4
Mixed Waste Landfill Soil-Moisture Monitoring Locations

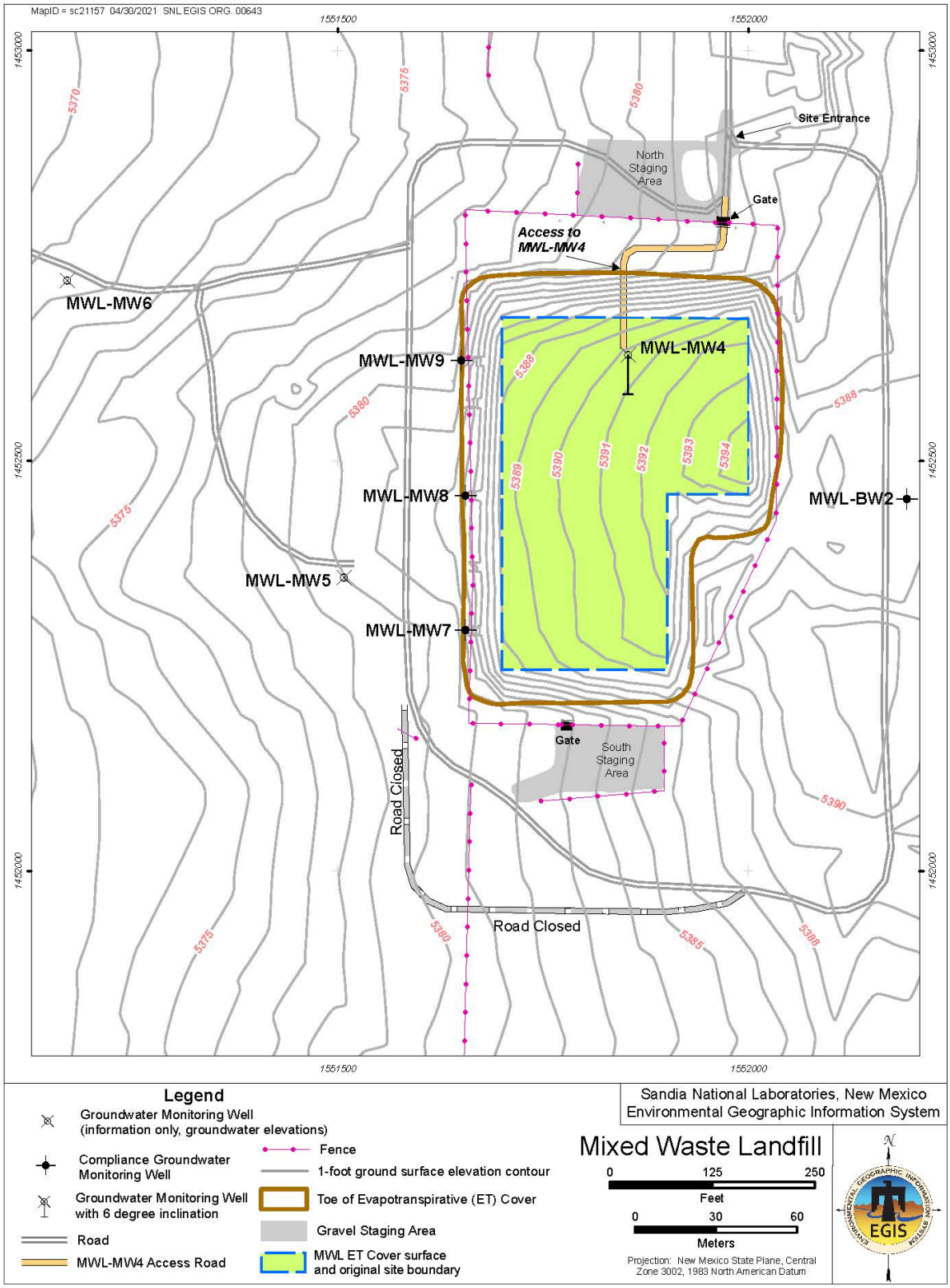

Figure 2-5
Mixed Waste Landfill Groundwater Monitoring Well Locations

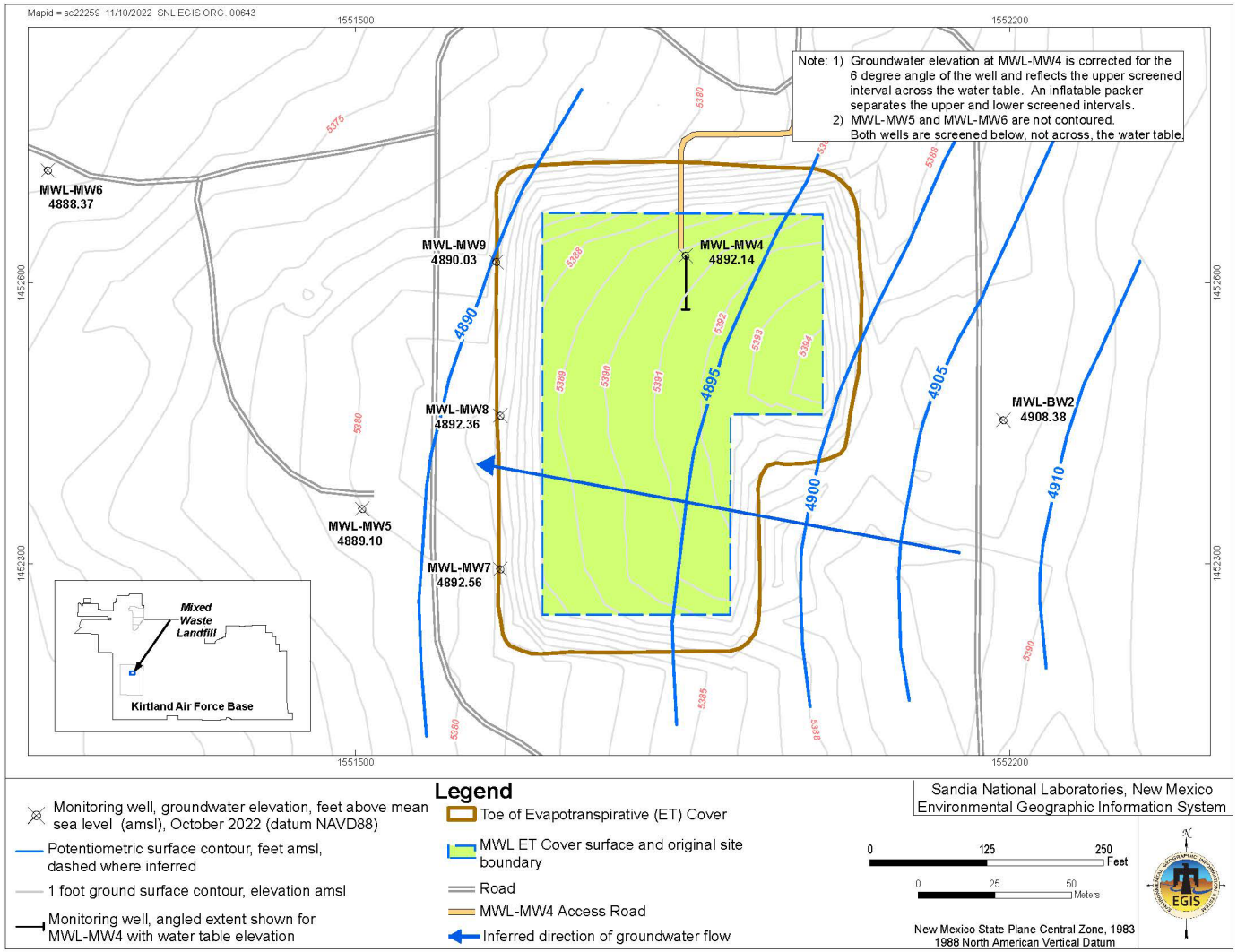

Figure 2-6
Localized Potentiometric Surface of the Regional Aquifer at the Mixed Waste Landfill, October 2022

Figure 2-7
Mixed Waste Landfill Evapotranspirative Cover in September 2023
View Looking West

Figure 2-8
Photograph of a BaroBall™ Passive Venting Device on Groundwater Monitoring Well MWL-MW9 on the Western Perimeter of the Mixed Waste Landfill

Figure 2-9
Routine Best-Practice Weed Removal Maintenance at the Mixed Waste Landfill on the Northern Slope of the Evapotranspirative Cover

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3.0 FATE AND TRANSPORT MODEL REVIEW

This Chapter addresses the requirement to update the fate and transport model originally presented in the CMI Plan (SNL/NM November 2005, Ho et al. November 2005 and January 2007). This model is hereafter referred to as the 2005 model.

The 2005 model included a probabilistic performance assessment that provided a comprehensive evaluation of the fate and transport of radionuclides, heavy metals, and VOCs at the MWL. The two pathways of concern included transport of volatile or gas-phase contaminants from the MWL to the atmosphere, and migration of aqueous-phase or vapor-phase contaminants through the vadose zone to the groundwater (i.e., Regional Aquifer). Various models were used to evaluate contaminant transport for each of these pathways that represent the most likely releases of contaminants from the MWL based on available inventory information, contaminant properties, and previous investigations (i.e., Phase 1 and Phase 2 RCRA Facility Investigations) and monitoring results. The 2005 modeling results and sensitivity analyses were used to assess the overall site performance and identify media-specific trigger levels for long-term monitoring requirements designed to ensure regulatory compliance and the protection of human health and the environment.

3.1 Requirement for Update

The May 2005 Final Order states "*In each 5-year report, Sandia shall update the fate and transport model for the site with current data, and re-evaluate any likelihood of contaminants reaching groundwater*." In accordance with clarifying guidance in Section 4.8.2 of the LTMMP, if the monitoring results reflect conditions that are consistent with the previous modeling inputs and results, the fate and transport model does not need to be updated.

Section 3.2 provides a summary of the 2018 fate and transport model update presented in the first Five-Year Report (SNL/NM January 2019) along with a comparison of the 2018 through 2022 monitoring results to the 2005 and 2018 modeling data. A brief discussion and final conclusions are provided in Section 3.3.

3.2 Comparison of Monitoring Results to 2005 and 2018 Modeling Data

The 2005 fate and transport model for PCE soil-vapor transport in the vadose zone (hereafter referred to as the PCE soil-vapor transport model) was updated in 2018. This update was performed because new monitoring results from the LTMMP soil-vapor monitoring network completed in 2014 (Figure 2-3) provided a broader spatial distribution of VOC concentrations throughout the 500-foot-thick vadose zone than previously available. The sampling port depths of the five LTMMP soil-vapor monitoring wells range from 41.5 to 400 feet bgs beneath the MWL. Modeling inputs for the 2005 PCE soil-vapor transport model included the 1994 Phase 2 RFI results that extended to a depth of 30 feet bgs (Peace et al. September 2002). The 2018 modeling update integrated LTMMP soil-vapor monitoring results for the 2014 through 2017 evaluation period and provided a more comprehensive understanding of VOC soil-vapor plume migration, which was used to reevaluate the likelihood of contaminants reaching groundwater. No other updates were made to the 2005 model in 2018.

Section 2.2 presents a detailed summary of the 2018 through 2022 monitoring results. All multi-media monitoring results for air, surface soil, vadose zone soil moisture and soil vapor, and groundwater are consistent with previous monitoring results collected and evaluated under the LTMMP and reflect conditions that are consistent with the 2005 and 2018 (for PCE soil-vapor transport only) modeling inputs and results. Specific to the 2018 update for the PCE soil-vapor transport model, the PCE soil-vapor concentrations for the 2018 through 2022 evaluation period ranged from 0.020 to 0.47 ppmv. These results were generally similar to or lower than PCE soil-vapor concentrations for the 2014 through 2017 evaluation period, which ranged from 0.021 to 0.56 ppmv (Section 2.2.3).

3.3 Discussion and Conclusions

Based on a comparison of the 2018 through 2022 multi-media monitoring results to the 2005 and 2018 modeling inputs and results, no updates to the 2005 model or the 2018 PCE soil-vapor transport model update are required for the 2018 through 2022 evaluation period. The 2018 updated PCE soil-vapor transport model results (SNL/NM January 2019) validates the conservative one-dimensional analytical model of PCE transport through the vadose zone originally presented in the CMI Plan (SNL/NM November 2005; Ho et al. November 2005 and January 2007). The spatial-temporal trends in the 2014 through 2017 and the 2018 through 2022 VOC soil-vapor monitoring results were captured by the model with a high degree of confidence (i.e., 95% confidence). Consistent with the 2005 modeling results, the probability of exceeding the EPA maximum contaminant level of 5 µg/L for PCE in groundwater remains very low even with the assumption of one-dimensional transport, which maximizes VOC transport to groundwater and does not consider other protective factors. The 2018 PCE soil-vapor transport model update confirms that PCE soil-vapor is not likely to contaminate groundwater. The first Five-Year Report (SNL/NM January 2019) contains a detailed presentation of the 2018 PCE soil-vapor transport model update.

As predicted by the 2018 PCE soil-vapor transport model update, PCE soil-vapor concentrations are decreasing when compared to measurements made in 1994 (Peace et al. September 2002) and 2008 (SNL/NM August 2008). Also consistent with the 2018 updated model results, PCE soil-vapor concentrations for the 2018 through 2022 evaluation period are similar to, or slightly lower than, PCE soil-vapor concentrations from the first five-year evaluation period of 2014 through 2017. The updated model showed that PCE and other VOC soil-vapor concentrations are stable and will slowly decrease as the low-concentration VOC soil-vapor plume diffuses throughout the vadose zone. VOC soil-vapor results since monitoring began under the LTMMP in 2014 indicate there are no new sources contributing to the MWL VOC soil-vapor plume and the plume is not a threat to groundwater.

Conclusions

No updates to the 2005 model or the 2018 PCE soil-vapor transport model update are required for this second five-year evaluation period of 2018 through 2022. Multi-media monitoring results for the 2018 through 2022 evaluation period are presented in Section 2.2 of this Report and were compared to the modeling performed in 2005 and the 2018 PCE soil-vapor transport modeling update. All monitoring results reflect conditions that are consistent with those previously modeled and that are protective of human health and the environment.

4.0 EVALUATE EFFECTIVENESS OF THE REMEDY

The primary purpose of the five-year report is to evaluate the effectiveness of the ET Cover and the likelihood of contaminants reaching groundwater. In accordance with Section 4.8.2 of the LTMMP, the effectiveness of the ET Cover is based upon monitoring, inspection, and maintenance results, which are summarized in Chapter 2 and detailed in Annual LTMM Reports listed in Section 1.6 of this Report. Multi-media monitoring, inspection, and maintenance results establish site conditions and provide the empirical data to determine if the ET Cover and remedy controls are performing as designed.

Multi-media monitoring and the Trigger Evaluation Process, defined in Sections 5.1 and 5.2 of the LTMMP, establish an early warning detection system for changing conditions that ensures any releases or movement of contaminants are detected and addressed in a timely manner. The Multi-media monitoring program is summarized in Table 3.1-1 of the LTMMP (SNL/NM March 2012) and results for this evaluation period are presented in Section 2.2 of this Report.

The inspection and maintenance process provides information on the physical condition of the ET Cover and controls, including the storm-water diversion swale, perimeter security fence and signage, survey monuments, all monitoring networks and sampling equipment. This information is used to evaluate the physical condition and performance of the ET Cover and controls in accordance with design, as well as verify implementation of land-use restrictions. The inspection and maintenance program is summarized in Table 4.6- 1 of the LTMMP and results for this evaluation period are presented in Section 2.3 of this Report.

An assessment of current site conditions, ET Cover System performance, and ET Cover System controls is presented in Sections 4.1, 4.2, and 4.3, respectively. Future releases and contaminant migration are addressed in Section 4.4. Section 4.5 presents an evaluation of land use in the vicinity of the MWL (requirement from the NMED approval letter for the first Five-Year Report) and an overall remedy evaluation summary is presented in Section 4.6.

4.1 Site Conditions

Current site conditions are established based upon the monitoring, inspection, and maintenance results for the 2018 through 2022 evaluation period. The monitoring results are compared with historical investigation, characterization, and monitoring results to determine if conditions are changing in a way that could represent increased risk to human health and the environment.

Multi-media monitoring results for this evaluation period are consistent with historical results and indicate site conditions continue to be protective of human health and the environment. No trigger levels were exceeded and there were no indications of changing conditions that would increase the risk to site workers or the public.

Inspection and maintenance results confirm the good physical condition of the site. The ET Cover, storm-water diversion swale, perimeter security fence and signage, survey monuments, and all monitoring networks and sampling equipment were inspected at regular intervals and determined to be in good condition. Routine maintenance and repairs were performed and documented. Additionally, best-practice ET Cover vegetation maintenance was implemented to

help keep the established native vegetation healthy. Erosion and surface-water drainage controls implemented during the previous 2014 through 2017 evaluation period to improve site conditions were inspected and maintained during the 2018 through 2022 evaluation period. These best-practice measures are intended to minimize long-term maintenance and improve long-term ET Cover performance (Section 2.4.2 of this Report).

An evaluation of 13 new groundwater contaminants added to the New Mexico Ground Water and Surface Water Protection regulations at 20.6.2.7 NMAC in December 2018, after NMED approval of the LTMMP in 2014 (Blaine January 2014), is presented in Section 2.4.3 of this Report as requested by the NMED in the approval letter (Catechis July 2021) for the first Five-Year Report (SNL/NM January 2019). The results of this evaluation indicate the Regional Aquifer beneath the MWL has not been impacted by these 13 contaminants.

Based upon nine years of monitoring, inspection, and maintenance under the LTMMP, MWL site conditions have improved and remain protective of human health and the environment.

4.2 Evapotranspirative Cover System

The primary design function of the ET Cover is to limit the downward movement of soil moisture from the surface into and through the disposal area, thereby limiting the potential for contaminant migration out of the disposal area (Figure 1-2). The ET Cover includes a biointrusion layer and is also a physical barrier between the surface and the buried waste that prevents human and animal intrusion.

Monitoring, inspection, and maintenance results indicate the ET Cover conforms with design requirements, is in good condition, and is performing as designed. Soil moisture monitoring results are consistent with the pre-ET Cover construction baseline data and are well below the soil moisture trigger level. There are no indications of increasing soil moisture beneath the ET Cover and disposal area.

The inspection and maintenance results confirm the physical integrity of the ET Cover and the good condition of the vegetation. No evidence of surface subsidence, ponding water, significant erosion, or any type of cracks or fissures in the ET Cover surface was observed during this evaluation period. The native grass vegetation serves two ET Cover design functions; it stabilizes the ET Cover surface, minimizing erosion loss, and helps minimize percolation and infiltration of surface water into the ET Cover (and waste disposal area beneath the cover) through the process of transpiration (Figure 1-2). Best-practice maintenance was performed to ensure the establishment and long-term health of the ET Cover native grass vegetation, which is in good condition and exceeds LTMMP successful revegetation criteria. In other words, the foliar coverage of perennial native grasses on the ET Cover is greater than the minimum LTMMP requirement for successful revegetation.

Based upon nine years of monitoring, inspection, and maintenance under the LTMMP, the ET Cover is in good condition and performing as designed. Overall maintenance and repairs have decreased as a result of successful revegetation efforts, best-practice maintenance, and best-practice ET Cover/site improvements.

4.3 Evapotranspirative Cover System Controls

ET Cover System controls, or remedy controls, that are defined in the LTMMP include the perimeter storm-water diversion swale, perimeter security fence and signage, survey monuments, all monitoring networks and sampling equipment, and land-use restrictions (i.e., industrial land use and no disturbance of the ET Cover). The perimeter road provides additional surface-water drainage control for the site and ET Cover with the established road ditches and culverts that move surface water away from the site (Figure 1-3).

Inspection and maintenance results confirm the good physical condition of the ET Cover System controls and that land-use restrictions are being maintained. The storm-water diversion swale, perimeter security fence and signage, and all monitoring networks and sampling equipment were inspected at regular intervals and determined to be in good condition. Routine maintenance and repairs were performed and documented.

Perimeter road improvements continue to provide additional protection for the ET Cover and storm-water diversion swale by intercepting upgradient surface-water flow and catching surface water flowing off the ET Cover and side slopes, diverting it around and away from the site in the road ditches and through culverts. Perimeter monitoring well erosion and burrow control measures continue to provide extra protection from erosion and small animal burrows, especially on the western side slope, which is important as this area receives surface water that flows off the gently sloping ET Cover surface during stronger precipitation events (Figure 1-3). These best-practice improvements continue to enhance performance and minimize long-term maintenance of the ET Cover and perimeter monitoring wells.

4.4 Future Releases and Contaminant Migration

The multi-media monitoring program detailed in Chapter 3 of the LTMMP (SNL/NM March 2012) is designed based upon MWL process knowledge, the results of extensive site characterization and monitoring conducted from 1989 through 2008, and the results of fate and transport modeling (SNL/NM November 2005; Ho et al. November 2005 and January 2007). The multi-media monitoring program is focused on the most mobile contaminants and exposure pathways and ensures that any future releases or movement of contaminants are detected and addressed before any detrimental effect on groundwater or increased risk to human health and the environment.

Based upon historical investigation and monitoring data, monitoring results from 2014 through 2022 under the LTMMP and fate and transport modeling, PCE soil vapor is the primary MWL contaminant of concern that could impact groundwater. Updated fate and transport modeling for the VOC soil-vapor plume presented in Chapter 3 of the first Five-Year Report (SNL/NM January 2019) incorporated the 2014 through 2017 monitoring results performed under the LTMMP that provided VOC soil-vapor concentration data for depths of 41.5 to 400 feet bgs. Previous modeling included investigation results to a depth of only 30 feet bgs. The updated one-dimensional modeling results for PCE soil vapor indicate that impact to groundwater is unlikely.

Conservative, protective trigger levels for PCE, TCE, and Total VOCs were established in the LTMMP and apply to the 400-foot bgs sampling ports of soil-vapor monitoring wells MWL-SV03,

MWL-SV04, and MWL-SV05. All monitoring results for these sampling ports for the current evaluation period are well below the respective trigger levels. Monitoring results for 2018 through 2022 show the VOC soil-vapor plume remains stable and the range of PCE concentrations show a slight decrease from historical levels.

As presented in Section 2.4.1 of this Report, passive venting soil-vapor devices (i.e., BaroBalls™) were installed on all the MWL groundwater monitoring wells in February 2015. These devices are designed to prevent downward movement of soil vapor in groundwater monitoring wells during periods of high atmospheric barometric pressure. Since the installation of the BaroBalls™, PCE has been detected in one groundwater sample collected from MWL-MW8 (April 2016). The passive venting BaroBalls™ are performing effectively based on semiannual inspections of the monitoring wells and passive venting devices, groundwater monitoring results, and results of the MWL-MW8 Soil-Vapor Investigation conducted in 2018. The MWL-MW8 Soil-Vapor Investigation was conducted to evaluate the movement of contaminants in the VOC soil-vapor plume and to ensure the protection of groundwater in accordance with NMED requirements found in Section 1.4 and Appendix B of this Report. Information on the investigation is provided in Section 2.4.1.

4.5 Evaluation of Land Use in the Vicinity of the Mixed Waste Landfill

The second new requirement for this Report that was added through the NMED July 9, 2021 approval letter relates to land use and evaluating potential MWL impact on the continued residential and commercial growth west of Technical Area-III and the Kirtland Air Force Base boundary. Per the NMED letter:

NMED requires Sandia National Laboratories next Five-Year Report, due to NMED no later than January 8, 2024, to evaluate:

2. *Current and future planned land use activities in previously undeveloped areas around Kirtland Air Force Base, including Mesa del Sol.*

Mesa del Sol is a developing area that borders the western side of Kirtland Air Force Base and Technical Area-III, approximately 2.2 miles west of the MWL. Although there is currently minimal development in the area adjacent to the western base boundary, commercial and residential development is anticipated in this area in the future. The MWL is located approximately 0.8 miles east of the western edge of Technical Area-III and 2.2 miles east of the Kirtland Air Force Base western buffer zone boundary (Figure 4-1). The Pueblo of Isleta is located approximately 3.0 miles to the south of the MWL. Technical Area-III includes other active test sites that surround the MWL. Figure 4-1 shows these features and the distances from the MWL, and Figure 4-2 is a photograph looking west from the MWL toward Mesa del Sol.

The current and future land-use designation for Technical Area-III and the MWL is industrial (DOE and USAF September 1995). Kirtland Air Force Base and Technical Area-III are fenced with controlled access. The MWL has a perimeter security fence with two locked gates that is inspected and maintained, as needed, on a quarterly frequency.

4.5.1 Risk Assessment Results for the Mixed Waste Landfill

To evaluate the potential impact of the MWL on commercial and residential development approximately 2.2 miles west of the site, it is helpful to understand the potential risk to a human receptor at the site.

As part of the MWL CMS Final Report (Peace and Goering March 2004), a comprehensive human health and ecological risk evaluation was performed for proposed remedial alternatives, including “no further action with no institutional controls” as the baseline scenario. Although the designated land use is industrial, a more restrictive residential land-use scenario was also included in the CMS risk assessment to provide perspective. A conservative approach was used to address uncertainty in the environmental data and risk process in accordance with EPA Risk Assessment Guidance for Superfund (EPA December 1989) to ensure the risk was not underestimated. As part of this approach, the maximum concentration or activity of each detected contaminant for the entire site was used. The assessment did not consider risk posed by the waste constituents in the pits and trenches that have not been released into the environment.

Risk to potential human receptors only occurs if there are exposure pathways that allow receptor uptake to occur (i.e., for a human to be exposed to the waste or contamination released from the waste). For the industrial land-use scenario, the human receptor modeled is an industrial site worker. For the residential land-use scenario, the human receptor is a person living at the site. The potential uptake of chemical and radiological contamination from the MWL by a human receptor includes two exposure routes or pathways: (1) ingestion (i.e., eating) of contaminated soil, and (2) inhalation (i.e., breathing) of contaminated soil particulates and/or vapor-phase contaminants (i.e., VOCs, tritium, radon). For residential land use, plant uptake and consumption of home-grown produce was also considered. For radionuclides, the additional exposure route of external gamma radiation was also considered (i.e., the human receptor is close enough to radioactive contamination and/or radiological sources to be exposed to gamma radiation).

The exposure pathway of drinking groundwater from beneath the site was not evaluated because groundwater concentrations and activities are at background levels based upon monitoring results collected since 1990. In addition, the high evapotranspiration rate and the 500-foot depth to the Regional Aquifer makes groundwater an unlikely pathway for contaminant transport in the future.

The results of the CMS risk assessment demonstrate the MWL presents minimal risk (i.e., below guidelines established by the EPA) under industrial land use for all the remedial alternatives evaluated. In other words, the MWL will not adversely affect the health of a human receptor who works at the site on a regular basis. Under the more restrictive residential land-use scenario, the MWL remedial alternatives of no further action with institutional controls, a vegetative soil cover (i.e., ET cover), and a vegetative soil cover with a biointrusion barrier also present minimal risk to a residential human receptor.

The assessment of the vegetative soil cover alternative with a biointrustion rock layer incorporated the additional safeguards provided by the ET Cover constructed in 2009, which are summarized below.

1. An additional barrier of clean rock and compacted soil, on average 5.37 feet thick, above the clean surface soil fill that overlies the buried subsurface waste and contamination.
2. The biointrusion rock layer, on average 1.25 feet thick, that protects against animal and human intrusion into the MWL disposal areas and potential mobilization of contaminants to the surface.
3. Reduction in the potential for contaminant transport and movement downward towards the Regional Aquifer by minimizing percolation and infiltration of surface water.

With the ET Cover barrier in place, the exposure pathways are eliminated for nonradiological contaminants (i.e., organic and inorganic contaminants) for both land-use scenarios. In other words, the risk to an industrial or residential human receptor goes to zero. Radiological risks that were well below guidelines without the addition of the ET Cover are further decreased with the addition of the ET Cover. The potential transport of both nonradiological and radiological contaminants from the disposal area downward to the Regional Aquifer is further minimized. Disturbance of the ET Cover is prohibited by the Permit, enforced through internal administrative controls, and verified through quarterly inspections.

4.5.2 Mixed Waste Landfill Impacts to Undeveloped Areas Around Kirtland Air Force Base

The MWL risk assessment results summarized in the previous section indicate the MWL, with the protective ET Cover and controls in place, presents minimal to no risk to human receptors at the site under both industrial and residential land use. Therefore, the MWL will not impact the public living and/or working more than 2 miles from the site at Mesa del Sol, more than 3 miles from the site on Pueblo of Isleta land, or any other areas surrounding Kirtland Air Force Base. Nor will it limit the residential, commercial, and/or industrial development of any land surrounding Kirtland Air Force Base.

SNL/NM personnel will continue monitoring the most mobile contaminants and the most likely exposure pathways. The comprehensive LTMMP multi-media monitoring, inspection, maintenance/repair, and reporting requirements are implemented and enforceable through the Permit and do not have a time limit. They collectively address uncertainty and ensure protective, safe conditions are maintained and verified at the MWL now and in the future. This multi-layered, regulatory approach makes certain the MWL is monitored for changing conditions and that timely action is taken if conditions change in a way that could increase risk to any human receptors or increase the likelihood of contaminants reaching groundwater. They also provide ongoing verification that the MWL will not impact development of Mesa del Sol, the Pueblo of Isleta, or any other property outside the Kirtland Air Force Base boundary.

4.6 Remedy Effectiveness Summary and Conclusions

Based upon nine years of monitoring, inspection, and maintenance under the LTMMP, MWL site conditions have improved and continue to be protective of human health and the

environment. Multi-media monitoring results are consistent with historical results, no trigger levels were exceeded, and there are no indications of changing conditions that would increase risk to site workers or the public.

The ET Cover System with controls remains an effective remedy that is protective of human health and the environment (Figure 4-3). The ET Cover is in good condition and performing as designed as verified by multi-media monitoring, inspection, and maintenance results. Maintenance and repairs have decreased over the 2018 through 2022 evaluation period as a result of successful revegetation efforts, routine and best-practice maintenance, and best-practice ET Cover and site improvements. The inspection and maintenance results confirm the good physical condition of the ET Cover and controls and verify that land-use restrictions are being maintained.

The multi-media monitoring program is focused on the most mobile contaminants and exposure pathways. Consistent with the LTMMP and the May 2005 Final Order requirements, the associated Trigger Evaluation Process ensures any future releases or movement of contaminants are detected and addressed in a timely manner. Best-practice actions and follow-up field investigations are being used to augment LTMMP requirements, better understand site conditions, and plan future actions as necessary. Figure 4-3 summarizes how the current remedy ensures the protection of human health and the environment.

Monitoring parameters and frequencies have been evaluated as part of this Report; no changes are needed for the protection of human health and the environment. In addition, 13 new contaminants added to the New Mexico Ground Water and Surface Water Protection regulations in December 2018 were evaluated and all media-specific monitoring trigger levels have been reviewed and updated in accordance with changes to the EPA and NMED regulatory standards and risk-based screening levels. Based upon this evaluation and review, groundwater beneath the MWL is not impacted and updates to the trigger levels will be proposed in accordance with the requirements in Section 5.2 of the LTMMP.

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CHAPTER 4 FIGURES

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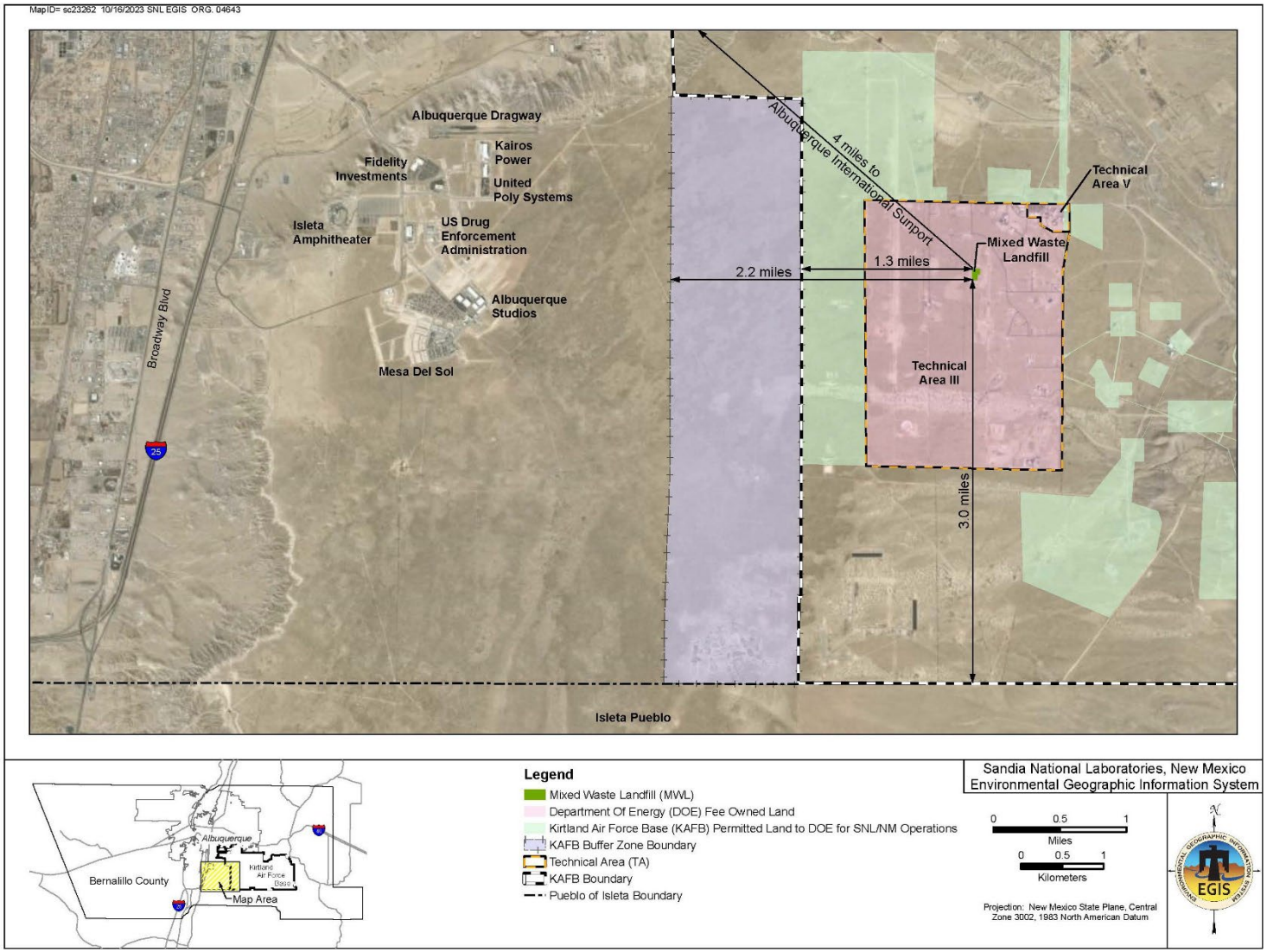


Figure 4-1
Location of the Mixed Waste Landfill Relative to Areas Surrounding Kirtland Air Force Base

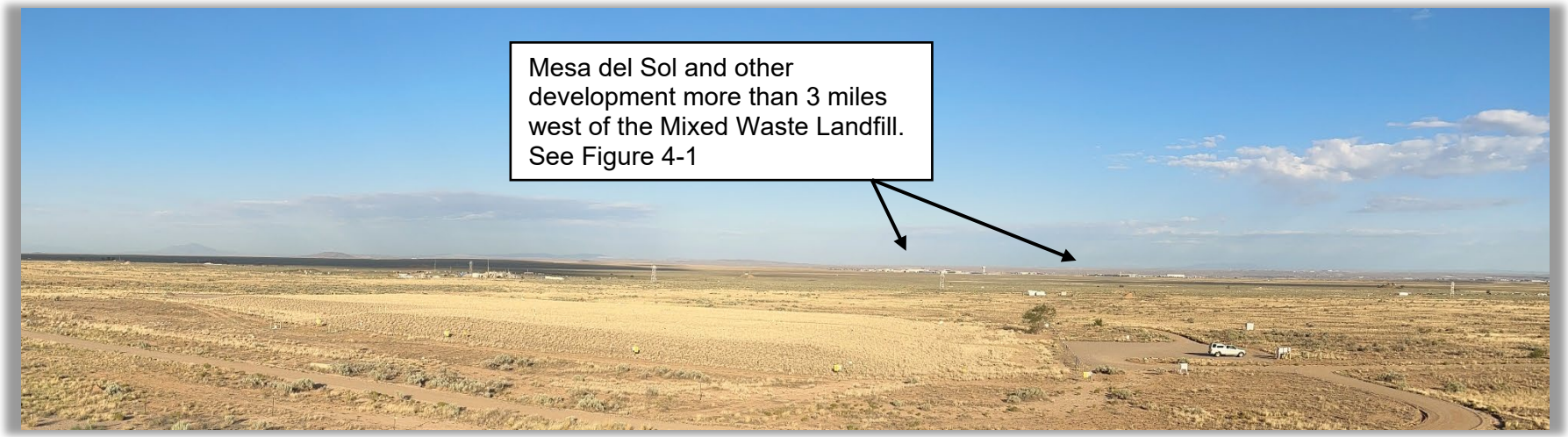
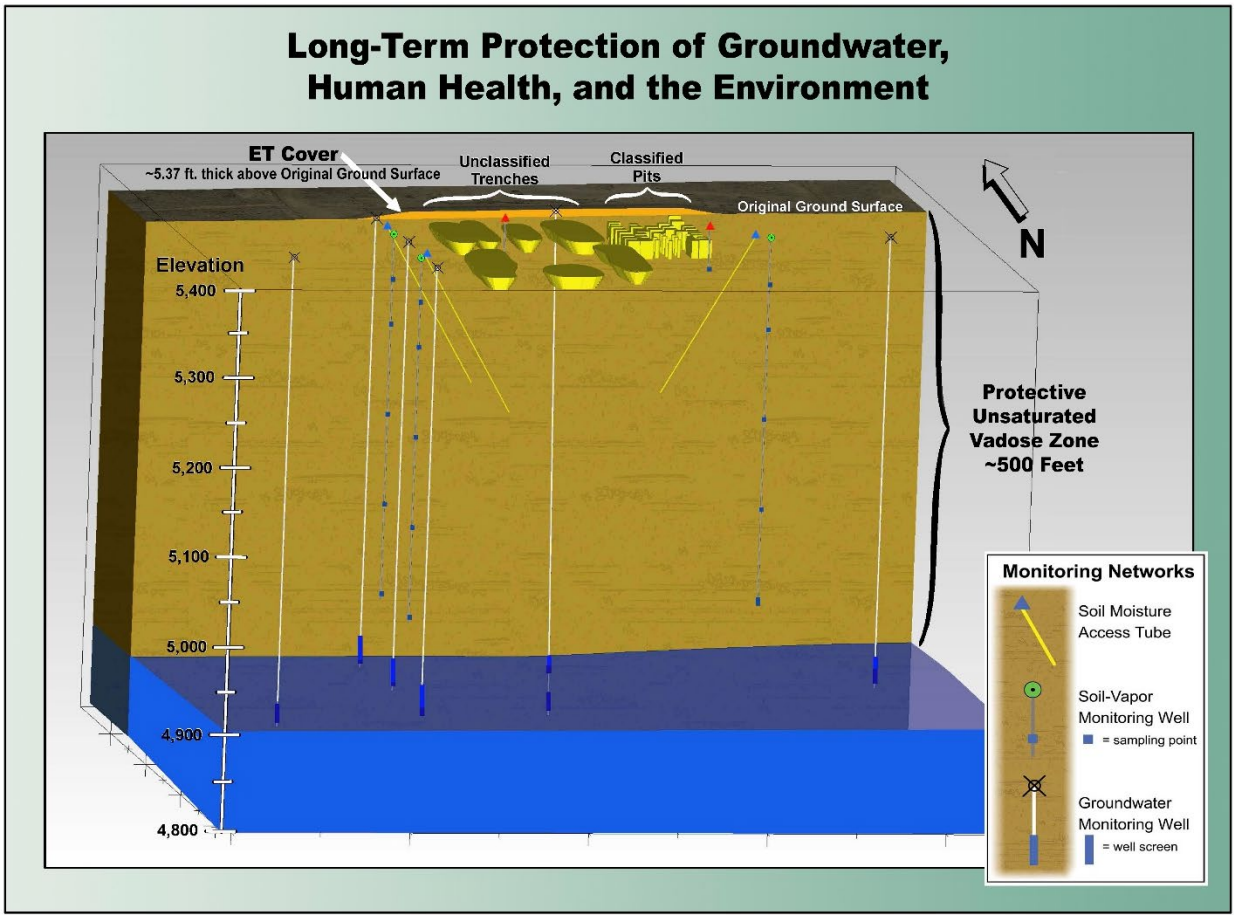


Figure 4-2
View of the Evapotranspirative Cover Looking West Toward Mesa del Sol from the Mixed Waste Landfill



- **Evapotranspirative Cover (ET Cover) provides a barrier preventing human and animal intrusion and protects the disposal area from the percolation and infiltration of surface water/moisture, thereby minimizing the potential for waste mobilization and migration.**
  - **~500-foot-thick unsaturated vadose zone also provides protection of the Regional Aquifer beneath the disposal area.**

- **Multi-media monitoring program provides an early warning detection system, and the Trigger Evaluation Process ensures timely follow up if any Trigger Levels are exceeded.**

- **The ET Cover with controls remedy, including multi-media monitoring and the Trigger Evaluation Process, ensure the long-term protection of human health and the environment *without the additional risk to site workers and the public associated with excavation and offsite disposal*.**

Figure 4-3
Long-Term Protection of Human Health and the Environment at the Mixed Waste Landfill

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5.0 REEVALUATE FEASIBILITY OF EXCAVATION

This chapter addresses the May 2005 Final Order (NMED May 2005) requirement to reevaluate the feasibility of MWL excavation with offsite disposal. In accordance with Section 4.8.2 of the LTMMP, reevaluation of excavation feasibility is modeled after and updates the evaluation of the *Complete Excavation with Offsite Disposal* remedial alternative presented in Appendix H of the MWL CMS Final Report (SNL/NM May 2003), hereafter referred to as the 2003 evaluation.

In accordance with the May 2005 Final Order and the LTMMP, the 2003 evaluation was comprehensively reevaluated and updated in the first Five-Year Report (SNL/NM January 2019), hereafter referred to as the 2018 reevaluation. The February 2016 Final Order (NMED February 2016) requirement to evaluate excavation with onsite disposal in an engineered cell that includes a RCRA Subtitle C liner system (i.e., a modern landfill) was specific to, and addressed in, the 2018 reevaluation (SNL/NM January 2019).

Section 5.1 presents background information and a summary of the 2018 reevaluation. Section 5.2 presents a summary of the minor changes and updates since the 2018 reevaluation. The reevaluation for this Report (hereafter referred to as the 2023 reevaluation) is presented in Section 5.3 and a final summary and conclusions is provided in Section 5.4.

5.1 Background

In January 2001, the U.S. Congress requested that WERC (a Consortium for Environmental Education and Technology Development) perform an independent peer review of the performance of the MWL. This review focused on historical operational information and the Phase 1 and 2 RFIs. WERC held MWL public meetings in March and May of 2001. After responding to public comments, WERC completed their Independent Peer Review of the MWL and issued their final report on August 31, 2001 (WERC August 2001).

In the fall of 2002, DOE requested WERC perform a second independent technical peer review. This review addressed the Draft MWL CMS Report completed in November 2002 and included additional public meetings in December 2002 and January 2003. WERC issued their Independent Technical Peer Review of the Draft MWL CMS (i.e., issued their final report) on January 31, 2003 (WERC January 2003). DOE and SNL/NM personnel submitted the CMS Final Report to the NMED in May 2003 after reviewing and addressing the WERC Report (WERC January 2003). NMED completed their review and public process and issued their comments in November 2003. DOE and SNL/NM personnel submitted responses to the NMED comments in December 2003, which were accepted without further comments by the NMED. The MWL investigation data and the CMS Final Report went through an extensive public, independent peer, technical, and regulatory review process (including a four-day public hearing) prior to the NMED remedy selection of an ET cover with biointrusion layer as documented in the May 2005 Final Order.

Complete Excavation with Offsite Disposal was one of several remedial alternatives evaluated in the May 2003 CMS Final Report (SNL/NM May 2003). This alternative was considered acceptable as a viable approach in the initial screening evaluation of potential corrective measures, but it was eliminated from further consideration due to other alternatives providing

the same protection with substantially less risk to site workers and the public related to construction, excavation, waste management, and waste transportation activities. However, the *Future Excavation* alternative was carried through the full 2003 CMS evaluation process. Due to community interest, a detailed evaluation of the *Complete Excavation with Offsite Disposal* remedial alternative was requested by the NMED and was included as Appendix H of the CMS Final Report. The feasibility evaluation and associated cost estimate followed the criteria established in Chapter 4 of the CMS Final Report. The Hazardous and Solid Waste Amendments and EPA guidance were considered and incorporated in the evaluation approach (SNL/NM May 2003), along with the Corrective Measures Evaluation approach outlined in the Compliance Order on Consent (NMED April 2004).

As presented in Chapter 4 of the CMS Final Report, EPA and NMED consider five main criteria for evaluating corrective measures alternatives that address technical measures and management controls for environmental issues at the site. The criteria are listed below and formed the structure of Section 5.3 of the first Five-Year Report (SNL/NM January 2019)

1. Long-term reliability and effectiveness
2. Reduction of toxicity, mobility, or volume of wastes
3. Short-term effectiveness
4. Implementability
5. Cost

Summary of the 2018 Reevaluation

The 2018 reevaluation updated the 2003 evaluation and included both the offsite and onsite disposal alternatives (SNL/NM January 2019). The 2018 reevaluation was comprehensive and was based on all available MWL waste inventory information, including over 5,200 disposal records and approximately 570 pages of supporting records that document the entire operational history (1959 through 1988). Using 30-plus years of RCRA corrective action experience at SNL/NM including the five-year excavation of the Chemical Waste Landfill in Technical Area-III (1998 through 2002), the SNL/NM project team developed a detailed conceptual excavation and waste management approach divided into six main phases of work listed below.

1. Planning & Permitting
2. Support Facility Construction
3. Excavation & Waste Management
4. Closure
5. Closure Reporting – Toxic Substances Control Act & RCRA
6. Long-Term Monitoring & Maintenance

The level and duration of effort, required resources (including support facilities, equipment, and personnel), and rough order of magnitude cost were estimated for each phase using project team experience and RACER®, Version 11.4 software for consistency with the 2003 evaluation. The technical approach was described in Section 5.3.4 and resource-loaded, summary-level project schedules (one for each disposal alternative) were presented in Figures 5-3 and 5-4 of the first Five-Year Report (SNL/NM January 2019).

Detailed supporting documentation (approximately 450 pages) was provided in Appendix D, *Supporting Documentation for Evaluations of Mixed Waste Landfill Excavation with Offsite and Onsite Disposal Alternatives,* of the first Five-Year Report, including the following:

- Appendix D-1: Inventory Waste Distribution, Soil Volumes, and Excavation Site Plan (including 3-Dimensional Computer Assisted Design Drawings [CADD] Drawings depicting excavation plan & volumes for each pit and trench).
- Appendix D-2: Radiological, Construction, & Transportation Risk Assessment.
- Appendix D-3: MWL Technical & Costing Assumptions, Onsite and Offsite Disposal Alternatives (including CADD Drawings for Onsite Cell Design).
- Appendix D-4: RACER® Cost Reports for both Disposal Alternatives.

Advances in technology since 2003 did not fundamentally change the excavation and waste management approach used for the 2018 reevaluation. The factors that had the most significant impact were radiological decay (especially relevant to cobalt-60 sources and tritium) and the identification of disposal pathways for all anticipated waste streams. Radiological decay allowed for a more conventional excavation approach and less reliance on remotely operated equipment. The identification of disposal pathways for all anticipated waste streams eliminated long-term onsite storage of excavated waste and a more streamlined waste management approach relative to the 2003 evaluation. Together, these two factors enabled a more compressed project schedule and a decrease in the rough order of magnitude cost of $527,446,809 (Net Present Value for 2018) compared to the 2003 evaluation cost ($618,000,000) as presented in Chapter 5 and Appendix D of the first Five-Year Report (SNL/NM January 2019).

The 2018 reevaluation of the *Complete Excavation with Offsite Disposal* remedial alternative demonstrated that this remedial alternative is feasible and could be implemented, if necessary, for the protection of human health and the environment. Consistent with the 2003 evaluation, construction (including excavation and waste management activities) and transportation risks to site workers and the public were identified as a primary concern with this remedial alternative.

5.2 Changes and Updates to the 2018 Reevaluation

Changes and updates to the *Complete Excavation with Offsite Disposal* remedial alternative reevaluation presented in the first Five-Year Report (SNL/NM January 2019) are minor and are summarized below.

In general, the same technical approach developed and detailed in the 2018 reevaluation remains viable. The six work phases would be executed in the same sequence, with many activities occurring in parallel to ensure a streamlined schedule and efficient workflow. The shift to a more conventional excavation approach for the Classified Area would likely continue with less dependence on remotely operated and specialized equipment. This is not a major change as the 2018 reevaluation already accounted for a transition in this direction based upon radiological decay of cobalt-60 and tritium waste. Although the excavation and waste management production rates may slightly increase as a result of this shift, the production rates used in the 2018 reevaluation were reasonably aggressive based upon experience and any increase would likely be negligible.

Radiological decay since the 2018 reevaluation is relatively minor but continues to reduce the exposure risk associated with cobalt-60 and tritium waste. The decay over the past five years would have little impact on overall worker safety and the excavation waste management approach. Health and safety concerns related to internal exposure to airborne radioactive particulates (i.e., inhalation and ingestion pathways) generated during excavation and waste management activities remain the same. Therefore, most excavation and waste management work would still need to be performed in Level B personal protective equipment.

Of the five main criteria for evaluating corrective measures alternatives listed previously, the most significant change is anticipated to be cost. Given recent inflation rates (2020 through 2023) and supply chain issues that linger from the global pandemic, the cost of this alternative would likely increase considerably.

5.3 Reevaluation of Excavation

In the 15-year period between the first two MWL excavation feasibility evaluations (2003 and 2018) there were significant changes that had major impacts on the 2018 reevaluation. These changes are detailed in Sections 5.2 and 5.5 of the first Five-Year Report (SNL/NM January 2019) and are summarized in Section 5.1 of this Report. In the five years since completion of the 2018 reevaluation, there have not been significant changes. Therefore, this 2023 reevaluation is simplified and presents the minor changes from the 2018 reevaluation.

The overall health and safety risk to site workers in this 2023 reevaluation remains high due to the nature of the waste, the complexity and duration of the work, and the risk of physical injury and death associated with remediation and transportation hazards. The overall 2018 excavation and streamlined waste management technical approach is not substantially changed. Therefore, the construction risk (associated with support facility construction, excavation, and waste management activities) and transportation risk (associated with offsite waste disposal and excavation backfill material from offsite locations) remain the same and are summarized below from the 2018 reevaluation (SNL/NM January 2019).

- Construction injuries = 9.0 and fatalities = 0.03
- Transportation injuries = 13.4 and fatalities = 0.16

Internal exposure to airborne radioactive particulates via the inhalation and/or ingestion pathway will always be a significant concern for site workers given the volume of radioactive debris and the unavoidable generation of airborne dust during remediation activities with current excavation and waste management technologies.

Table 5-1 lists the overall duration of the six phases of work. Table 5-2 lists the estimated costs from the 2018 reevaluation. Both tables were originally presented in the first Five-Year Report (SNL/NM January 2019); Table 5-2 has been modified to include an estimated 2023 adjusted net present value cost. These tables summarize the key 2018 reevaluation schedule assumptions and estimated costs for the six work phases that remain valid and applicable to this 2023 reevaluation. Detailed supporting information was included in Appendices D-3 and D-4 of the first Five-Year Report (SNL/NM January 2019).

Table 5-1
Estimated Durations Based on Activity – Offsite Disposal Alternative[a]

Activity	Estimated Duration (work days)	Estimated Duration (calendar years)	Sequential Duration (calendar years)
Planning & Permitting	1,309	5	5
Support Facility Construction	694	2.7	2.7
Excavation & Waste Management	1,768	6.8	6.8
Closure	482	1.8	1.8
Closure Reporting – TSCA & RCRA	1,203[b]	4.6[b]	1.6
Long-Term Monitoring & Maintenance	7,827[b]	30[b]	26.6
		Total Duration	**44.5**

Notes:
[a]Activities and durations taken from the Offsite Disposal Alternative Schedule in Figure 5-3 of the first Five-Year Report (SNL/NM January 2019).
[b]Duration from schedule and includes overlap with previous phase(s).
RCRA = Resource Conservation and Recovery Act.
TSCA = Toxic Substances Control Act.

Table 5-2
Estimated Costs for Excavation – Offsite Disposal Alternative

Project Phase	Cost[a]
Planning & Permitting	$ 8,946,486
Support Facility Construction	$ 57,375,540
Excavation & Waste Management	$ 192,720,257
Closure	$ 27,334,356
Closure Reporting – TSCA & RCRA	$ 2,156,097
Long-Term Monitoring & Maintenance	$ 6,251,000
Indirect/Markup	$ 232,663,073
2018 Net Present Value Cost - 2018	$ 527,446,809
2023 Adjusted Net Present Value Cost[b]	$606,563,830

Notes:
[a]Costs taken directly from RACER® reports presented in the first Five-Year Report (SNL/NM January 2019); Net Present Value Cost is affected by rounding within RACER®.
[b]An escalation factor of 15% was used to adjust the 2018 costs for 2023 to account for inflation and general cost increases for material, equipment, and labor since the 2018 reevaluation.
RACER® = Remedial Action Cost Engineering and Requirements.
RCRA = Resource Conservation and Recovery Act.
TSCA = Toxic Substances Control Act.

Technical implementation challenges remain considerable given the nature of Unclassified and Classified Area waste, security requirements and protocols associated with classified waste, and the size and scope of support facilities required. These factors result in a long-duration project schedule (Table 5-1) and high cost of implementation for the *Complete Excavation with Offsite Disposal* remedial alternative (Table 5-2). To account for inflation and cost increases for material, equipment, and personnel, a 15% increase from the 2018 reevaluation cost was assumed. While this increase likely underestimates the actual cost increase, it is consistent with project cost increases over the last five years. In general, cost is not a driving factor if excavation were determined to be a necessary corrective action for the protection of human health and the environment.

5.4 Summary and Conclusions

The 2023 reevaluation of the *Complete Excavation with Offsite Disposal* remedial alternative was conducted in accordance with the May 2005 Final Order (NMED May 2005) and LTMMP (SNL/NM March 2012) requirements. The comprehensive 2018 reevaluation presented extensive updates to the 2003 evaluation, including excavation and waste management technologies and approaches, waste disposal pathways, site worker risk, and cost. The changes identified in the 2023 reevaluation are minor and do not impact the technical approach or high level of risk to site workers and the public related to construction, remediation (i.e., excavation and waste management), and waste transportation activities. Waste disposal pathways identified in the 2018 reevaluation are still available; this was and remains a significant change from the 2003 evaluation as previously discussed. The most significant change with the 2023 reevaluation is related to costs for material, equipment, and labor, all of which have increased since the 2018 reevaluation.

The 2018 reevaluation remains relevant and applicable to this 2023 reevaluation. The overall health and safety risk to site workers is high due to the nature of the waste, the complexity and duration of the work, and the risk of physical injury and death associated with construction, remediation, and transportation hazards. Internal exposure to airborne radioactive particulates via the inhalation and/or ingestion pathway will always be a significant concern for site workers given the volume of radioactive debris and the unavoidable generation of airborne dust during remediation activities. MWL support facility construction, excavation, and waste management activities inherently involve significant risk to site workers. In addition, risk to site workers (i.e., truck drivers) and the public related to transportation of waste to offsite disposal facilities is also a primary concern.

Technical implementation challenges continue to be considerable given the nature of Unclassified and Classified Area waste, security requirements and protocols associated with classified waste, and the size and scope of support facilities required. These factors, plus the more recent higher rates of inflation and generally higher costs for materials, equipment, and labor result in a high cost of implementation for the *Complete Excavation with Offsite Disposal* remedial alternative.

There is no short-term risk reduction or current driver for further consideration of the excavation remedial alternative, with either offsite or onsite disposal, as current conditions are protective of human health and the environment. Based upon 14 years of experience with the ET Cover in place (2009 through 2022), the last nine years with the LTMMP fully implemented (2014 through 2022), the ET Cover with controls remedy is performing as designed as confirmed by ongoing multi-media monitoring, inspection, maintenance, and repair results. No trigger levels have been exceeded and land-use restrictions are being maintained. Long-term risk is mitigated by ongoing MWL multi-media monitoring and the Trigger Evaluation Process, detailed in Chapter 3 and Section 5.1 of the LTMMP (SNL/NM March 2012), respectively. The multi-media monitoring program focuses on the most mobile contaminants and the most likely exposure pathways. The Trigger Evaluation Process requires timely follow-up action if conditions change in a way that could adversely impact the protection of human health and the environment. Future conditions are expected to be protective without additional corrective action (i.e., implementing additional remedial alternatives), but will be verified through ongoing monitoring, inspection, and maintenance activities required by the Permit and documented in Annual LTMM Reports.

The first two MWL Five-Year Reports have fulfilled the NMED requirement to reevaluate the feasibility of the *Complete Excavation with Offsite Disposal* remedial alternative. Both reevaluations concluded that this alternative could be implemented, if necessary, for the protection of human health and the environment. However, considering all available information, the ET Cover with controls continues to be the preferred remedy because it protects human health and the environment without increasing risk to site workers and the public. The contingency procedures presented in Chapter 7 of the LTMMP (SNL/NM March 2012) address the highest potential failure scenarios and possible corrective actions that would be implemented in accordance with the Trigger Evaluation Process. As detailed in Table 7-1 of the LTMMP, complete excavation is not an anticipated corrective action that would be required for any of the possible failure scenarios. *Complete Excavation with Offsite Disposal* is a remedial alternative that would more likely be driven by a future land use change (i.e., the release of Kirtland Air Force Base and DOE-owned land from federal control for private and/or public development).

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6.0 FINAL SUMMARY AND CONCLUSIONS

Five-year reports are required by the May 2005 Final Order (NMED May 2005) that selected the remedy for SWMU 76, the MWL. This is the second Five-Year Report for the MWL, and the evaluation period for this Report is January 2018 through December 2022. The primary purpose of the five-year report is to evaluate the effectiveness of the selected remedy, the ET Cover with controls, through a review of monitoring, inspection, and maintenance results collected over the evaluation period. The measure of effectiveness is the protection of human health and the environment. This Report also reevaluates the likelihood of contaminants reaching groundwater and the reevaluation of the feasibility of the *Complete Excavation with Offsite Disposal* remedial alternative.

Requirements for the five-year report are specified in the May 2005 Final Order on remedy selection and Section 4.8.2 of the LTMMP (SNL/NM March 2012). The NMED approval letter for the first Five-Year Report (Catechis July 2021) includes two additional requirements specific to this Report (Section 1.4 of this Report).

The monitoring, inspection, and maintenance results presented in Chapter 2 of this Report provide the empirical data necessary to establish current site conditions and evaluate the effectiveness of the ET Cover and remedy controls. Based upon nine years of monitoring, inspection, and maintenance under the LTMMP, MWL site conditions have improved and continue to be protective of human health and the environment. The ET Cover and remedy controls are in good condition and are performing as designed. Multi-media monitoring results are consistent with historical data and no trigger levels were exceeded. There are no indications of changing conditions that would increase the risk to site workers, the public, or indicate an increase in the likelihood of contaminants reaching groundwater.

Inspections of the ET Cover System and controls performed during the 2018 through 2022 evaluation period confirmed the ET Cover, storm-water diversion swale, perimeter security fence and signage, survey monuments, and all monitoring networks and sampling equipment are in good condition and performing as designed. Inspections also confirm land-use restrictions are being maintained. Routine maintenance has been performed and documented in accordance with LTMMP requirements and, together with best-practice maintenance, has improved site conditions. Inspections also confirm land-use restrictions are being maintained.

The ET Cover native vegetation has matured to a level that is similar to the surrounding vegetation in Technical Area-III and is serving its design functions of surface stabilization and minimizing percolation and infiltration of surface water into the disposal area through the process of transpiration. Best-practice weed control activities conducted during this evaluation period helped the native vegetation by minimizing weed growth on the ET Cover, thereby minimizing competition with invasive annual weeds for limited moisture and nutrients. Best-practice site erosion controls and surface-water drainage improvements completed during the first five-year evaluation period continue to be inspected and maintained and are performing as designed. Overall, ET Cover and site maintenance and repairs have decreased over time as a result of successful revegetation efforts, routine and best-practice maintenance, and best-practice site improvements.

Results of additional evaluation and monitoring performed to address the two new NMED requirements specific to this Report (Catechis July 2021) confirm the Regional Aquifer beneath the MWL has not been impacted and the MWL will not limit the development of land surrounding Kirtland Air Force Base, including Mesa del Sol and the Pueblo of Isleta. Of the 13 new compounds that were evaluated, five are already included as part of the multi-media monitoring program. For the other eight compounds there are no anticipated impacts based upon groundwater monitoring results, historical investigation data, and/or process knowledge. No changes to LTMMP monitoring parameters and/or frequencies are necessary for the protection of human health and the environment based upon the information presented in this Report.

A review of LTMMP monitoring trigger levels that are based upon published regulatory standards or risk-based screening levels, and defined in Section 5.2 of the LTMMP, was also performed. Current trigger levels were approved by the NMED in 2014 (Blaine January 2014) and continue to be protective of human health and the environment. More recent changes to the regulatory standards and risk-based screening levels since 2014 are documented in this Report and will be addressed in a future Permit modification request in accordance with Section 5.2 of the LTMMP.

Fate and transport modeling updates were not required based upon a comparison of the 2018 through 2022 monitoring results to the 2005 model (SNL/NM November 2005, Ho et al. November 2005 and January 2007) and the 2018 updated PCE soil-vapor transport model presented in the first Five-Year Report (SNL/NM January 2019). All monitoring results reflect conditions that are consistent with those previously modeled and that are protective of human health and the environment. The PCE soil-vapor concentrations for the 2018 through 2022 evaluation period were generally similar to or lower than concentrations for the 2014 through 2017 evaluation period, which is consistent with the 2018 updated model predictions. VOC soil-vapor results since monitoring began under the LTMMP in 2014 indicate there are no new sources contributing to the MWL VOC soil-vapor plume and the plume is not a threat to groundwater.

The 2023 reevaluation of the *Complete Excavation with Offsite Disposal* remedial alternative presented in this Report updates the comprehensive 2018 reevaluation presented in the first Five-Year Report (SNL/NM January 2019). The 2023 changes to the 2018 reevaluation are minor; the excavation and waste management technical approach, waste disposal pathways, and risk to site workers and the public have not changed. The most significant change is the estimated cost of $606,563,830, which is higher than the 2018 cost estimate due to inflation and generally higher costs for labor, equipment, and materials.

Complete Excavation with Offsite Disposal is a remedial alternative that could be implemented, if necessary, for the protection of human health and the environment. Considering all available information, the ET Cover with controls remedy continues to be the preferred alternative because it protects human health and the environment without increasing risk to site workers and the public. The overall health and safety risk to site workers for the excavation alternative is high due to the nature of the waste, the complexity and duration of the work, and the risk of physical injury and death associated with construction, remediation, and transportation hazards. Internal exposure to airborne radioactive particulates via the inhalation and/or ingestion pathway will always be a significant concern for site workers given the volume of radioactive debris and the unavoidable generation of airborne dust during remediation activities. In addition, risk to the public related to transportation of waste to offsite disposal facilities remains a primary concern.

The ET Cover with controls remedy is effective and performing as designed as confirmed by ongoing multi-media monitoring, inspection, maintenance, and repair results. The multi-media monitoring program is defined in Chapter 3 of the LTMMP (SNL/NM March 2012) and is focused on the most mobile contaminants and exposure pathways. Consistent with the LTMMP and the May 2005 Final Order requirements, the associated Trigger Evaluation Process, defined in Sections 5.1 and 5.2 of the LTMMP, ensures any future releases or movement of contaminants are detected and addressed in a timely manner. The contingency procedures presented in Chapter 7 of the LTMMP address the highest potential failure scenarios and possible corrective actions that would be implemented in accordance with the Trigger Evaluation Process. Complete excavation is not an anticipated corrective action that would be required for any of the evaluated failure scenarios.

The regulatory requirements associated with this Report (Section 1.4 and Appendix B) have been met. No changes are needed for the protection of human health and the environment. Best-practice measures, follow-up field investigations, and evaluation of new and emerging contaminants are part of the protective approach for the MWL that is established in the Permit through the incorporation of the LTMMP in Attachment M. Annual LTMM and five-year reporting requirements will continue and ensure all MWL monitoring, inspection, maintenance, and repair information is provided to the NMED and made available to the public in a timely manner.

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APPENDIX A
Summary of the Mixed Waste Landfill Regulatory History

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Regulatory History
Solid Waste Management Unit 76, Mixed Waste Landfill

The following summary of the Mixed Waste Landfill (MWL) history is provided in support of Chapter 1, Sections 1.2 and 1.3, which include information on the corrective action process and the two Class 3 Permit Modifications approved by the New Mexico Environment Department (NMED). The NMED May 2005 Final Order on remedy selection (NMED May 2005) determined the MWL final remedy and conditions for completing the corrective action process. The NMED February 2016 Final Order (NMED February 2016) granted the October 2014 Class 3 Permit Modification to reflect that the MWL is Corrective Action Complete with Controls. The February Final Order took effect on March 13, 2016. All controls required for the MWL are defined in the MWL Long-Term Monitoring and Maintenance Plan (LTMMP), approved by the NMED on January 8, 2014 (Blaine January 2014). The LTMMP is incorporated through reference in Attachment M of the SNL/NM RCRA Facility Operating Permit (Permit) (Kieling February 2016; NMED January 2015, with all approved modifications). As determined by the NMED (Kieling October 2011), the first five-year evaluation period began on January 8, 2014, when NMED approved the LTMMP (Blaine January 2014) and the first Five-Year Report was submitted in January 2019. In accordance with the two Final Orders and the LTMMP, the first Five-Year Report analyzed the effectiveness of the selected remedy based on monitoring, inspection, and maintenance results for the first four calendar years under the LTMMP (2014 through 2017) and reevaluated the feasibility of MWL excavation with both offsite and onsite disposal alternatives. The NMED approved the first Five-Year Report without comments in July 2021 (Catechis July 2021).

Background and Operational History

The MWL is a 2.6-acre solid waste management unit (SWMU) at Sandia National Laboratories/New Mexico (SNL/NM) that is owned by the U.S. Department of Energy/National Nuclear Security Agency (DOE/NNSA). The MWL was used as a disposal area for low-level radioactive waste, hazardous waste, and mixed waste generated at SNL/NM research facilities and off-site locations from March 1959 to December 1988. The MWL was comprehensively investigated and continues to undergo rigorous long-term monitoring and maintenance controls.

Waste was disposed at the MWL in a 0.6-acre Classified Area, with cylindrical pits 3 to 10 feet in diameter and 15 to 25 feet deep, and in a 2-acre Unclassified Area with parallel trenches approximately 15 to 25 feet wide, 150 to 180 feet long, and 15 to 20 feet deep. A detailed MWL waste inventory summary, by pit and trench, was compiled and presented in MWL documents summarized in Section 1.0 of this report.

Regulatory Status and Corrective Action History

The MWL was designated as a SWMU by the U.S. Environmental Protection Agency and is subject to corrective action under Title 40 of the Code of Federal Regulations (CFR) Part 264 Section 101 (40 CFR §264.101). Completion of the corrective action process at the MWL is documented in the administrative record and briefly summarized below.

The MWL has been extensively studied since 1989 and groundwater monitoring has been conducted since 1990. The Phase 1 and 2 RFIs were completed from 1989 to 1995. Limited releases of contaminants, primarily tritium and volatile organic compounds (VOCs) in soil vapor,

were identified and characterized. As documented in the Phase 2 RFI Report and confirmed by additional investigation (SNL/NM August 2008), 25 years of groundwater monitoring, and nine years of monitoring under the LTMMP, MWL site conditions continue to be protective of human health and the environment.

After a four-day public hearing in December 2004, the NMED Secretary signed the Final Order in May 2005 selecting the remedy of an engineered vegetative soil cover with a biointrusion barrier (i.e., evapotranspirative [ET] cover) combined with long-term monitoring and maintenance. In rendering this decision, the NMED Secretary determined the MWL inventory was reasonably complete and accurate; and the MWL did not contain high-level radioactive waste. The May 2005 Final Order was challenged by Citizen Action New Mexico (CANM) in the New Mexico Court of Appeals. In December 2007 the Court of Appeals affirmed the May 2005 Final Order; in February 2008 the New Mexico Supreme Court denied further review.

The May 2005 Final Order included specific conditions for completing the corrective action process at the MWL (conditions are underlined). These conditions were completed as summarized below.

- Corrective Measures Implementation (CMI) Plan was approved by NMED in December 2008. The construction plan with specifications for the ET Cover was included along with the fate & transport modeling report that evaluated contaminant transport and proposed long-term monitoring triggers for continued protection of human health and the environment. Concurrently, an additional field investigation of tritium, radon, VOCs in soil vapor, and methane was completed that confirmed Phase 2 RFI results.

- Corrective Measures Implementation involved construction of the ET Cover, which was completed from May through September 2009 and documented in the CMI Report. The CMI Report was approved by NMED in October 2011.

- Long-Term Monitoring and Maintenance Plan (LTMMP) was submitted within 180 days of CMI Report approval, and was approved by the NMED in January 2014. The LTMMP established the physical and institutional controls implemented together with the ET Cover to ensure the long-term protection of human health and the environment. Safeguards and controls include inspection, maintenance, and multi-media monitoring with trigger levels that require additional action if exceeded (air, soil, soil vapor, soil moisture, groundwater, and biota); results are reported annually to NMED. Installation of three multi-sampling port soil-vapor monitoring wells required under the LTMMP was completed in September 2014.

Corrective Action Complete with Controls Determination

After completing all conditions of the May 2005 Final Order, DOE/NNSA and SNL/NM personnel submitted a request to NMED for a Class 3 Permit Modification for Corrective Action Complete with Controls status for the MWL in October 2014. The associated regulatory process included two public comment periods and a public meeting held by DOE/NNSA and SNL/NM personnel in November 2014. In response to requests from CANM and others, NMED held a four-day public hearing in July 2015.

The NMED Secretary concluded in the February 2016 Final Order that all MWL corrective action had been completed and conditions at the MWL were protective of human health and the environment. The February 2016 Final Order and NMED approval of Corrective Action Complete with Controls status for the MWL became effective in March 2016. In May 2016 DOE/NNSA and SNL/NM personnel confirmed the prior release of all historical records (as of May 2002) that delineate the contents of the MWL.

Long-Term Monitoring and Stewardship

The MWL LTMMP was fully implemented upon NMED approval and includes a comprehensive set of safeguards and controls to ensure ET Cover performance and the protection of human health and the environment. The multi-media monitoring program and trigger level process provide an early warning system for changing conditions and require timely follow-up if a trigger level is exceeded. Annual Long-Term Monitoring and Maintenance (LTMM) Reports are submitted to NMED by June 30th of each year that document all monitoring, inspection, and maintenance/repair activities for the previous reporting year. The LTMMP and Annual LTMM Reports are available for public access as explained in Section 1.6 of this report.

As determined by the NMED (Kieling October 2011), the first five-year evaluation period began on January 8, 2014, when NMED approved the LTMMP (Blaine January 2014) and the first Five-Year Report was submitted in January 2019. This is the second MWL Five-Year Report.

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APPENDIX B
Requirements Source Documents and Requirements Verification Matrix for the Mixed Waste Landfill Second Five-Year Report

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Final Order, on Request for a Class 3 Permit Modification for Corrective Measures for the Mixed Waste Landfill, Sandia National Laboratories
No. HWB-SNL-04-11(M)

May 26, 2005

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5. Sandia shall prepare a report every 5 years, re-evaluating the feasibility of excavation and analyzing the continued effectiveness of the selected remedy. The report shall include a review of the documents, monitoring reports and any other pertinent data, and anything additional required by NMED. In each 5-year report, Sandia shall update the fate and transport model for the site with current data, and re-evaluate any likelihood of contaminants reaching groundwater. Additionally, the report shall detail all efforts to ensure any future releases or movement of contaminants are detected and addressed well before any effect on groundwater or increased risk to public health or the environment. Sandia shall make the report and supporting information readily available to the public, before it is approved by NMED. NMED shall provide a process whereby members of the public may comment on the report and its conclusions, and shall respond to those comments in its final approval of the report.

6. The Hearing Officer is granted until April 20, 2005 to submit her Report and Proposed Findings of Fact, Conclusions of Law and Proposed Order.

RON CURRY
Secretary, Environment Department

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Long-Term Monitoring and Maintenance Plan
for the Mixed Waste Landfill, Sandia National Laboratories

Environmental Restoration Operations
Sandia National Laboratories

March 2012

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- 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

DOE/Sandia 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. DOE/Sandia 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 Operations Center will provide coordination, resources, and appropriate emergency equipment on an as-needed basis.

Final Order, on Proposal to Grant Corrective Action Complete with Controls Status
for the Mixed Waste Landfill, Sandia National Laboratories
No. HWB-SNL-15-18(P)

February 12, 2016

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privilege log describing the nature of the document (letter, memo, e-mail, etc.), the identity of the person who created the record (to the extent this information is available), the date the record was created (to the extent this information is available), the legal justification for withholding the record and the identities of all of the people involved in making the determination that the record should be withheld. If Applicants determine that all historical records describing the material placed in the MWL were already disclosed, then Applicants shall affirmatively state this in writing and include the dates the records were disclosed and the identity of the person or entity who received the records. Prior disclosure of any records required to be disclosed under this Order shall not relieve the Applicants from providing the privilege log described above.

CONCLUSION

Having considered the administrative record in its entirety, including the Hearing Officer's Report and the post-report submittals; and being otherwise fully advised regarding this matter;

THE SECRETARY HEREBY ADOPTS THE HEARING OFFICER'S REPORT WITH THE FOLLOWING MODIFICATIONS:

1) The Hearing Officer's Report shall be modified to incorporate the minor modifications specified in Part A (above); and,
2) The 2005 Final Order shall be modified as follows:
    a. The Feasibility Report due in 2019 shall evaluate the following two remedies; (1) excavation, removal and appropriate disposal of all of the waste in the MWL; and (2) construction and installation of a modern landfill, which shall at a minimum include a RCRA Subtitle C liner system, an ET cover with biointrusion barrier, and appropriate post-closure monitoring and controls.

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Approval - Mixed Waste Landfill Five-Year Report, January 2019

Sandia National Laboratories
No. HWB-SNL-19-001

July 9, 2021

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TRANSMITTAL VIA ELECTRONIC EMAIL AND CERTIFIED MAIL - RETURN RECEIPT REQUESTED

July 9, 2021

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RE: APPROVAL

MIXED WASTE LANDFILL FIVE-YEAR REPORT, JANUARY 2019
SANDIA NATIONAL LABORATORIES
EPA ID# NM5890110518
HWB-SNL-19-001

Dear Messrs. Harrell and Shoemaker:

The New Mexico Environment Department (NMED) has received the *Mixed Waste Landfill Five-Year Report, January 2019* (Report), with cover letter dated December 14, 2018, submitted by the U.S. Department of Energy on behalf of itself and National Technology & Engineering Solutions of Sandia, LLC (collectively, the Permittees) and received on January 4, 2019.

The May 2005 Final Order established the requirement for the Permittees to submit a five-year report to NMED assessing the remedy performance for the Mixed Waste Landfill (MWL). The May 2005 Final Order also established the requirement that NMED provide a process whereby members of the public may comment on the MWL Five-Year Report and its conclusions and to respond to those comments in its final approval of the MWL Five-Year Report.

On January 8, 2014, NMED approved the MWL Long-Term Monitoring and Maintenance Plan (LTMMP), which started the first five-year evaluation period. NMED received the MWL Five-Year Report on January 4, 2019. On May 24, 2019, NMED issued a public notice announcing a 60-day comment period, which concluded on July 23, 2019. NMED received over 400 comments on the Report. As specified by the May 2005 Final Order, NMED has responded in writing to the comments received. The Response to Comments document is enclosed with this letter and may also be viewed on NMED's webpage at https://www.env.nm.gov/hazardous-waste/snl-mwl-2/.

NMED reviewed the MWL Five-Year Report, relevant environmental data and the public comments received. Additionally, NMED has reviewed and taken into consideration annual monitoring reports submitted for 2019 and 2020. Our review of these annual monitoring reports indicates that no

significant sampling data changes were observed or have been reported since the end of the Five-Year Review reporting period in 2018.

Based on the information provided, NMED determined that the selected remedy is functioning as intended and that there is no threat to human health or the environment. With authority delegated to me from the Cabinet Secretary, I am notifying the Permittees that NMED approves the January 2019 Five-Year Report.

The Permittees must continue monitoring the MWL in accordance with the LTMMP, which provides essential data for oversight of the selected remedy. Going forward, there are two important factors that the U.S. Department of Energy and Sandia National Laboratories must take into consideration in relation to ongoing monitoring and future review of the selected remedy and alternatives. The first is continuing advances in science and associated regulatory changes regarding emerging contaminants of concern to human health and the environment, such as PFAS, that were not available when NMED approved the LTMMP in 2014 and amended the permit in 2016. The second is the continued residential and commercial growth within the Mesa Del Sol area and its ever-encroaching proximity to the MWL, which is an ongoing factor in the risk analysis associated with comparing the alternatives to the selected remedy. Therefore, pursuant to Paragraph 5 of the 2005 Final Order, which requires SNL's five-year feasibility review to include "anything additional required by NMED," NMED requires SNL's next Five-Year Report, due to NMED no later than January 8, 2024, to evaluate:

1. Groundwater quality for all toxic pollutants added to the Ground Water and Surface Water Protection regulations at 20.6.2 NMAC, since January 8, 2014 (see enclosure); and
2. Current and future planned land use activities in previously undeveloped areas around Kirtland Air Force Base, including Mesa Del Sol.

As NMED reviews additional information about the performance of the existing remedy, including any credible evidence obtained by NMED from the Permittees, NMED's own sampling or that of other parties regarding emerging contaminants and the potential human health exposure risks, we will continue to scrutinize the appropriateness of the existing remedy as compared to the alternatives. In addition, NMED will determine whether regulatory changes related to contaminants of emerging concern and conditions at the MWL warrant modification of the approved LTTMP.

If you have any questions regarding this letter, please contact me at (505) 469-6521.

Sincerely,

Christopher S. Catechis
Acting Director, Resource Protection Division

Enclosures:
- Response to Comments on the Five-Year Report
- NMED Groundwater Standards – 2018 Revisions

Cc: R. Maestas, NMED HWB; ricardo.maestas@state.nm.us
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File: SNL 2021 and Reading

New Mexico Environment Department
Ground Water Quality Bureau
20.6.2.3103 STANDARDS FOR GROUND WATER

Revised groundwater standards adopted by the New Mexico Water Quality Control Commission became effective on December 21, 2018. Some standards were changed, and new standards were adopted for additional contaminants. Designations for each contaminant now include the Chemical Abstracts Service (CAS) number for clearer identification. The following table summarizes the additions and changes to the numeric standards in Section 20.6.2.3103 NMAC. **Bold type** highlights the standards that have changed and identifies the contaminants that are new to the numeric standards (previous standard listed as "none"). The second table lists contaminants that were added to the "toxic pollutants" identified in Subsection T of 20.6.2.7 NMAC. For full details, please refer to the Ground and Surface Water Protection Regulations, 20.6.2 NMAC.

Contaminant (Abbreviation) (CAS Number)	Previous Standard	Current Standard
Numerical Standards (mg/l unless otherwise noted)		
Antimony (Sb) (CAS 7440-36-0)	**None**	**0.006**
Arsenic (As) (CAS 7440-38-2)	**0.1***	**0.01***
Barium (Ba) (CAS 7440-39-3)	**1.0**	**2.0**
Beryllium (Be) (CAS 7440-41-7)	**None**	**0.004**
Cadmium (Cd) (CAS 7440-43-9)	**0.01***	**0.005***
Chromium (Cr) (CAS 7440-47-3)	0.05	0.05
Cyanide (CN) (CAS 57-12-5)	0.2	0.2
Fluoride (F) (CAS 16984-48-8)	1.6	1.6
Lead (Pb) (CAS 7439-92-1)	**0.05***	**0.015***
Total Mercury (Hg) (CAS 7439-97-6)	0.002	0.002
Nitrate (NO_3 as N) (CAS 14797-55-8)	10.0	10.0
Nitrite (NO_2 as N) (CAS 10102-44-0)	**None**	**1.0**
Selenium (Se) (CAS 7782-49-2)	0.05	0.05
Silver (Ag) (CAS 7440-224)	0.05	0.05
Thallium (Tl) (CAS 7440-28-0)	**None**	**0.002**
Uranium (U) (CAS 7440-61-1)	0.03	0.03
Radioactivity: Combined Radium-226 (CAS 13982-63-3) and Radium-228 (CAS 15262-20-1)	**30 pCi/l***	**5 pCi/l***
Benzene (CAS 71-43-2)	**0.01***	**0.005***
Polychlorinated biphenyls (PCB's) (CAS 1336-36-3)	**0.001***	**0.0005***
Toluene (CAS 108-88-3)	**0.75**	**1.0**
Carbon Tetrachloride (CAS 56-23-5)	**0.01***	**0.005***
1,2-dichloroethane (EDC) (CAS 107-06-2)	**0.01***	**0.005***
1,1-dichloroethylene (1,1-DCE) (CAS 75-35-4)	**0.005**	**0.007**
tetrachloroethylene (PCE) (CAS 127-18-4)	**0.02***	**0.005***
trichloroethylene (TCE) (CAS 79-01-6)	**0.1***	**0.005***
ethylbenzene (CAS 100-41-4)	**0.75***	**0.7***
total xylenes (CAS 1330-20-7)	0.62	0.62
methylene chloride (CAS 75-09-2)	**0.1***	**0.005***
chloroform (CAS 67-66-3)	0.1	0.1
1,1-dichloroethane (CAS 75-34-3)	0.025	0.025
ethylene dibromide (EDB) (CAS 106-93-4)	**0.0001***	**0.00005***
1,1,1-trichloroethane (CAS 71-55-6)	**0.06**	**0.2**
1,1,2-trichloroethane (CAS 79-00-5)	**0.01***	**0.005***
1,1,2,2-tetrachloroethane (CAS 79-34-5)	0.01	0.01
vinyl chloride (CAS 75-01-4)	**0.001**	**0.002**

PAHs: total naphthalene (CAS 91-20-3) plus monomethylnaphthalenes	0.03	0.03
benzo-a-pyrene (CAS 50-32-8)	**0.0007***	**0.0002***
cis-1,2-dichloroethene (CAS 156-59-2)	**None**	**0.07**
trans-1,2-dichloroethene (CAS 156-60-5)	**None**	**0.1**
1,2-dichloropropane (PDC) (CAS 78-87-5)	**None**	**0.005**
styrene (CAS 100-42-5)	**None**	**0.1**
1,2-dichlorobenzene (CAS 95-50-1)	**None**	**0.6**
1,4-dichlorobenzene (CAS 106-46-7)	**None**	**0.075**
1,2,4-trichlorobenzene (CAS 120-82-1)	**None**	**0.07**
pentachlorophenol (CAS 87-86-5)	**None**	**0.001**
atrazine (CAS 1912-24-9)	**None**	**0.003**
Other Standards for Domestic Water Supply		
Chloride (Cl) (CAS 16887-00-6)	250	250
Copper (Cu) (CAS 7440-50-80	1.0	1.0
Iron (Fe) (CAS 7439-89-6)	1.0	1.0
Manganese (Mn) (CAS 7439-96-5)	0.2	0.2
Phenols	0.005	0.005
Sulfate (SO_4) (CAS 14808-79-8)	600	600
Total Dissolved Solids (TDS) TDS	1000	1000
Zinc (Zn) (CAS 7440-66-6)	10	10
pH	6-9	6-9
Methyl tertiary-butyl ether (MTBE) (CAS 1634-04-4)	**None**	**0.1**
Standards for Irrigation Use		
Aluminum (Al) (CAS 7429-90-5)	5.0	5.0
Boron (B) (CAS 7440-42-8)	0.75	0.75
Cobalt (Co) (CAS 7440-48-4)	0.05	0.05
Molybdenum (Mo) (CAS 7439-98-7)	1.0	1.0
Nickel (Ni) (CAS 7440-02-0)	0.2	0.2

*For purposes of application of the amended numeric standards for arsenic, cadmium, lead, combined radium-226 & radium-228; benzene, PCBs, carbon tetrachloride, EDC, PCE, TCE, ethylbenzene, methylene chloride, EDB, 1,1,2-trichloroethane and benzo-a-pyrene, to past and current water discharges (as of July 1, 2017), the new standards will not become effective until July 1, 2020.

The following table lists contaminants that were added to the "toxic pollutants" identified in Subsection T of 20.6.2.7 NMAC. Narrative standards apply to the full list of toxic pollutants, as described in Subsection A of 20.6.2.3103 NMAC.

Toxic Pollutants Added as of December 21, 2018	
styrene (ethenylbenzene)	1,4-dioxane (1,4-D)
1,2-dichlorobenzene (ortho-dichlorobenzene)	sulfolane (thiolane 1,1-dioxide)
1,4-dichlorobenzene (para-dichlorobenzene)	perfluorohexane sulfonic acid (PFHxS)
1,2,4-trichlorobenzene	perfluorooctane sulfonate (PFOS)
pentachlorophenol (PCP)	perfluorooctanoic acid (PFOA)
1,2-dichloropropane (propylene dichloride, PDC)	atrazine
	prometon

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Table B-1
Mixed Waste Landfill Second Five-Year Report Requirements Verification Matrix

Req#	Within Document	Requirement	Evidence
Final Order — New Mexico Environment Department (NMED) May 2005			
1	Section 5	Sandia shall prepare a report every 5 years, re-evaluating the feasibility of excavation and analyzing the continued effectiveness of the selected remedy.	Chapters 1-7 Appendices A and B
2	Section 5	The report shall include a review of the documents, monitoring reports and any other pertinent data, and anything additional required by NMED.	Chapter 2
3	Section 5	In each 5-year report, Sandia shall update the fate and transport model for the site with current data, and re-evaluate any likelihood of contaminants reaching groundwater.	Chapter 3
4	Section 5	Additionally, the report shall detail all efforts to ensure any future releases or movement of contaminants are detected and addressed well before any effect on groundwater or increased risk to public health or the environment.	Chapter 4
5	Section 5	Sandia shall make the report and supporting information readily available to the public, before it is approved by NMED.	Chapter 1 Sections 1.5 and 1.6
6	Section 5	NMED shall provide a process whereby members of the public may comment on the report and its conclusions, and shall respond to those comments in its final approval of the report.	Chapter 1 Section 1.5
Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill (LTMMP) — March 2012			
7	4.8.2 Paragraph 1, Sentence 1	Department of Energy (DOE)/Sandia will also submit to NMED a report every five years reevaluating the feasibility of excavation and analyzing the continued effectiveness of the selected remedy.	Chapters 1-7 Appendices A and B
8	4.8.2 Paragraph 1, Sentence 2	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.	Chapter 2
9	4.8.2 Paragraph 1, Sentence 3 Bullet 1	The main scope of the Five-Year Reevaluation Report as defined in the Final Order (NMED May 2005) is summarized as follows: -- Reevaluate the feasibility of excavating the Mixed Waste Landfill (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.	Chapter 5

Table B-1 (Continued)
Mixed Waste Landfill Second Five-Year Report Requirements Verification Matrix

Req#	Within Document	Requirement	Evidence
Long-Term Monitoring and Maintenance Plan for the Mixed Waste Landfill (LTMMP) — March 2012 (Continued)			
10	4.8.2 Paragraph 1, Bullet 2, Sentence 1	-- Analyze the continued effectiveness of the evapotranspirative (ET) Cover and the likelihood of contaminants reaching groundwater using current monitoring results and any other pertinent data.	Chapters 3 and 4
11	4.8.2 Paragraph 1, Bullet 3, Sentence 1	-- Update, if necessary, the fate and transport model for the MWL with current data.	Chapter 3
12	4.8.2 Paragraph 1, Bullet 3, Sentence 2	Current monitoring results will be compared to the modeling performed in 2005.	Not Applicable to the 2024 Report
13	4.8.2 Paragraph 1, Bullet 3, Sentences 3&4	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.	Chapter 3 Section 3.2
14	4.8.2 Paragraph 1, Bullet 4, Sentence 1	-- 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.	Chapters 2, 3, and 4
15	4.8.2 Paragraph 2, Sentence 1	The first five-year reevaluation period will begin upon NMED approval of this MWL LTMMP (Kieling October 2011).	Chapter 1 Sections 1.1 and 1.4
16	4.8.2 Paragraph 2, Sentence 2	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.	Chapter 1 Sections 1.1 and 1.4
17	4.8.2 Paragraph 2, Sentence 2	The first Five-Year Reevaluation Report will include monitoring results for the first four years under the LTMMP.	Not Applicable to the 2024 Report
18	4.8.2 Paragraph 2, Sentence 3	Subsequent Five-Year Reevaluation Reports will cover a full five-year monitoring period.	Chapter 1 Section 1.4
19	4.8.2 Paragraph 2, Sentence 4	DOE/Sandia will make the report available to the public in accordance with the requirements in the Final Order (NMED May 2005).	Chapter 1 Sections 1.5 and 1.6

Table B-1 (Concluded)
Mixed Waste Landfill Second Five-Year Report Requirements Verification Matrix

Req#	Within Document	Requirement	Evidence
Final Order — February 2016			
20	CONCLUSION, 2)	The 2005 Final Order shall be modified as follows: The Feasibility Report due in 2019 shall evaluate the following two remedies;	Not Applicable to the 2024 Report
21	CONCLUSION, 2) a. (1)	excavation, removal and appropriate disposal of all the waste in the MWL;	Not Applicable to the 2024 Report
22	CONCLUSION, 2) a. (2)	construction and installation of a modern landfill, which shall at a minimum include a Resource Conservation and Recovery Act Subtitle C liner system, and ET cover with biointrusion barrier, and appropriate post-closure monitoring and controls.	Not Applicable to the 2024 Report
NMED Approval of January 2019 MWL Five-Year Report			
23	Approval Letter Page 2, Paragraph 2, Listed Item #1	Sandia National Laboratories (SNL's) next Five-Year Report shall evaluate the groundwater quality for all toxic pollutants added to the Ground Water and Surface Water Protection regulations at 20.6.2 New Mexico Administrative Code, since January 2014.	Section 2.4.3
24	Approval Letter Page 2, Paragraph 2, Listed Item #2	SNL's next Five-Year Report shall evaluate current and future planned land use activities in previously undeveloped areas around Kirtland Air Force Base, including Mesa del Sol.	Section 4.5

Notes: See Chapter 7 for references