Los Alamos National Laboratory

Environmental Report 2010

Los Alamos
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EST. 1943

LA-14445-ENV

Los Alamos National Laboratory Governing Policy for Environment

- We approach our work as responsible stewards of our environment to achieve our mission.
- We prevent pollution by identifying and minimizing environmental risk.
- We set quantifiable objectives, monitor progress and compliance, and minimize consequences to the environment, stemming from our past, present, and future operations.
- We do not compromise the environment for personal, programmatic, or operational reasons.

LA-14445-ENV
Issued September 2011

Los Alamos National Laboratory Environmental Report 2010

Waste and Environmental Services Division
505-667-0808

Environmental Data and Analysis Group
505-665-2917

Environmental Programs Directorate
505-606-2337

Corrective Actions Program
505-665-3388

Engineering & Technology
505-667-3460

TA-21 Closure Project
505-665-4897

Environmental Protection Division
505-667-2211

Environmental Stewardship Group
505-665-8855

Water Quality and RCRA Group
505-665-0666

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Los Alamos National Laboratory Environmental Report 2010 reports are prepared annually by the Los Alamos National Laboratory (the Laboratory) environmental organizations, as required by US Department of Energy Order 450.1, *Environmental Protection Program*, and US Department of Energy Order 231.1A, *Environment, Safety, and Health Reporting*.

These annual reports summarize environmental data that are used to determine compliance with applicable federal, state, and local environmental laws and regulations, executive orders, and departmental policies. Additional data, beyond the minimum required, are also gathered and reported as part of the Laboratory's efforts to ensure public safety and to monitor environmental quality at and near the Laboratory.

Chapter 1 provides an overview of the LANL site and the Laboratory's major environmental programs. Chapter 2 reports the Laboratory's compliance status for 2010. Chapter 3 provides a summary of the maximum radiological dose the public and biota populations could have potentially received from Laboratory operations and discusses chemical exposures. The environmental surveillance and monitoring data are organized by environmental media (air in Chapter 4; water and sediments in Chapters 5 and 6; soils in Chapter 7; foodstuffs and biota in Chapter 8; and subsurface soil vapor in Chapter 10) in a format to meet the needs of a general and scientific audience. Chapter 9 provides a summary of the status of environmental restoration work around LANL. Chapter 11 provides an overview of the performance of the analytical chemistry laboratories that provide sample analyses to the Laboratory. Chapter 12 provides an overview of the health of the Rio Grande, monitoring results from the Valles Caldera and Jemez Mountains, and explains the actions taken to reduce environmental risks at the Laboratory. Appendix A explains the standards for environmental contaminants, Appendix B explains the units of measurements used in this report, Appendix C describes the Laboratory's technical areas and their associated programs, and Appendix D provides web links to more information. Appendix E provides a glossary of terms, Appendix F provides acronyms and abbreviations. Appendix G provides Elemental & Chemical Nomenclature, and Appendix H provides errata for the 2009 report.

In printed copies of this report, we've also enclosed a disk with a copy of the full report in Adobe Acrobat portable document format (PDF) and detailed supplemental tables of data from 2010 in Microsoft Excel format. These files are also available for download from the web.

An on-line web survey for providing comments, suggestions, and other input on the report is available at the web address given below. Inquiries or comments regarding these annual reports may be directed to

US Department of Energy
Office of Environmental Operations
3747 West Jemez Road
Los Alamos, NM 87544
Telephone: 505-667-5491

or

Los Alamos National Laboratory
WES Division
P.O. Box 1663, MS M992
Los Alamos, NM 87545
Telephone: 505-667-0808

To obtain copies of the report, contact

ESR Coordinator
Los Alamos National Laboratory
P.O. Box 1663, MS M992
Los Alamos, NM 87545
Telephone: 505-665-0239
e-mail: ***dewart@lanl.gov***

This report is also available on the World Wide Web at

http://www.lanl.gov/environment/all/esr.shtml

FIGURES

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APPENDICES

LANL ENVIRONMENTAL REPORT 2010

This year's report incorporates some changes to the format and content, including a change in the report name, a change in the report's organization, and a summary of two major 2011 events, the Japanese Fukushima reactor accident and the Las Conchas forest fire.

CHANGE OF REPORT NAME

Starting this year, we have changed the report name to "Los Alamos National Laboratory Environmental Report 2010." The Laboratory has published a summary report of environmental monitoring since 1969. In 1973, the report title became "Environmental Surveillance at Los Alamos during 1973," and the report maintained this title convention through the 2009 report. The term surveillance was used to encompass the full range of environmental sampling and monitoring activities.

The new name more closely aligns the report's name and purpose with the DOE Order 231.1 requirement for an annual site environmental report. The report will continue to encompass the full range of environmental sampling and monitoring activities. In addition, as the Laboratory's environmental restoration program moves into the corrective measures phase, the report will evolve to provide a more integrated look at the long-term monitoring conducted to assure that corrective measures continue to protect the environment.

REPORT ORGANIZATION

Three major changes are implemented in the 2010 report organization:

- Consolidation of DOE Order compliance performance in Chapter 2,
- Presentation of soil gas monitoring information in Chapter 10, and
- Consolidation of analytical chemistry laboratory performance in Chapter 11.

The consolidation of DOE Order compliance performance in Chapter 2 allows the reader to find a comprehensive summary of DOE Order compliance in one location.

Soil gas monitoring has been conducted at Technical Area (TA)-54 and TA-21 for a number of years. Chapter 10 presents this contaminant pathway data, which is also used in developing the Consent Order corrective measures for these TAs.

In previous reports, analytical chemistry laboratory performance information was reported in each media sampling chapter, giving the appearance that LANL has many individual analytical laboratory programs. In fact, the Laboratory has one program for procuring analytical laboratory services, verifying and validating analytical data, and assessing analytical laboratory performance. Bringing each media together into Chapter 11 allows the reader to understand the entire program.

2011 EVENTS SUMMARIZED

The Laboratory performed sampling and monitoring of two significant environmental events during the first half of 2011: Japan's Fukushima reactor accident in March and the Santa Fe National Forest Las Conchas forest fire in June and July. Preliminary environmental monitoring and assessment information from these events are presented in the 2010 report. A more detailed discussion will be presented in the 2011 Environmental Report.

CHAPTER AUTHORS AND CONTRIBUTORS

Abstract/Preface/Executive Summary
Jean Dewart

1.0 Introduction
Jean Dewart
Alison Dorries
Chris EchoHawk
John Isaacson
Scot Johnson
David Rogers
Marjorie Wright

2.0 Compliance Summary
Debra Archuleta
Gian Bacigalupa
Marc Bailey
Bob Beers
Davis Christensen
Michelle Coriz
Albert Dye
Joe English
Greg Erpenbeck
Sean French
David Fuehne
Kari Garcia
Gil Gonzales
Kathleen Gorman-Bates
Mark Haagenstad
Leslie Hansen
John Isaacson
David Keller
Terrill Lemke
Jake Meadows
Geri Martinez
Jennifer Nisengard
Linda Nonno
David Paulson
Dan Pava
Peggy Powers
Sonja Salzman
Steve Story
Leonard Trujillo
Steven Veenis
Luciana Vigil-Holterman
Walter Whetham
Monica Witt
Tim Zimmerly

3.0 Radiological and Non-Radiological Dose Assessment
William Eisele
Michael McNaughton
Jeffrey Whicker

4.0 Air Surveillance
David Fuehne
Andrew Green
Scot Johnson
Michael McNaughton

5.0 Groundwater Monitoring
David Rogers

6.0 Watershed Monitoring
Paul G. Drakos
Armand R. Groffman
Kristen L. Lockhart
Paul Mark
Steven L. Reneau
Randall T. Ryti
Emily S. Schultz-Fellenz
Steven J. Veenis
Amanda B. White

7.0 Soil Monitoring
Philip Fresquez

8.0 Food Stuffs and Biota Monitoring
Philip Fresquez
Chuck Hathcock
Dave Keller

9.0 Environmental Restoration
Richard J. Mirenda

10.0 Subsurface Vapor Monitoring
Kay Birdsell
Daniel Romero

11.0 Analytical Laboratory Quality Assurance
Nita Patel

12.0 Environmental Stewardship
Jean Dewart
Philip Fresquez
Steven Reneau
Ardyth Simmon

Introduction

Los Alamos National Laboratory (LANL or the Laboratory) is located in Los Alamos County in north-central New Mexico (NM), approximately 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe (Figure ES-1). The 36-square-mile Laboratory is situated on the Pajarito Plateau, a series of mesas separated by deep east-to-west-oriented canyons cut by stream channels. Mesa tops range in elevation from approximately 7,800 feet on the flanks of the Jemez Mountains to about 6,200 feet above the Rio Grande at White Rock Canyon. Most Laboratory and Los Alamos County developments are confined to the mesa tops. With the exception of the towns of Los Alamos and White Rock, the surrounding land is largely undeveloped, and large tracts of land north, west, and south of the Laboratory site are held by the Santa Fe National Forest, the US Bureau of Land Management, Bandelier National Monument, the US General Services Administration, and Los Alamos County. In addition, Pueblo de San Ildefonso borders the Laboratory to the east.

The mission of LANL is to develop and apply science and technology to (1) ensure the safety and reliability of the US nuclear deterrent, (2) reduce global threats, and (3) solve other emerging national security challenges. Meeting this diverse mission requires excellence in science and technology to solve multiple national and international challenges. Inseparable from the Laboratory's focus on excellence in science and technology is its commitment to environmental stewardship and full compliance with environmental protection laws. Part of LANL's commitment is to report on its environmental performance, and as such, this report does the following

- Characterizes LANL's environmental management, including effluent releases, environmental monitoring, and estimated radiological doses to the public and the environment,
- Summarizes environmental occurrences and responses,
- Confirms compliance with environmental standards and requirements, and
- Highlights significant programs and efforts.

Environmental Monitoring

The Laboratory monitors emissions, effluents, and environmental media to meet environmental compliance requirements, determine actions to protect the environment, and monitor the long term health of the local environment. We collect data from the surrounding region to establish baseline environmental conditions in areas not influenced by LANL operations. LANL monitoring includes the radiological ambient air sampling network (AIRNET); groundwater, soil, foodstuffs, and biota (plants and animals) sampling as far away as Dixon, NM (40 direct miles away); and sediment monitoring along the Rio Grande as far upriver as Abiquiu Reservoir and downriver as Cochiti Reservoir. We also collect data on site and at the Laboratory perimeter to determine if operations are impacting LANL or neighboring properties (e.g., Pueblo and Los Alamos County lands). Perimeter monitoring also measures the highest potential impact to the public. During 2010, the Laboratory collected environmental samples from more than 4,000 locations and received more than 1.4 million analyses or measurements on these samples.

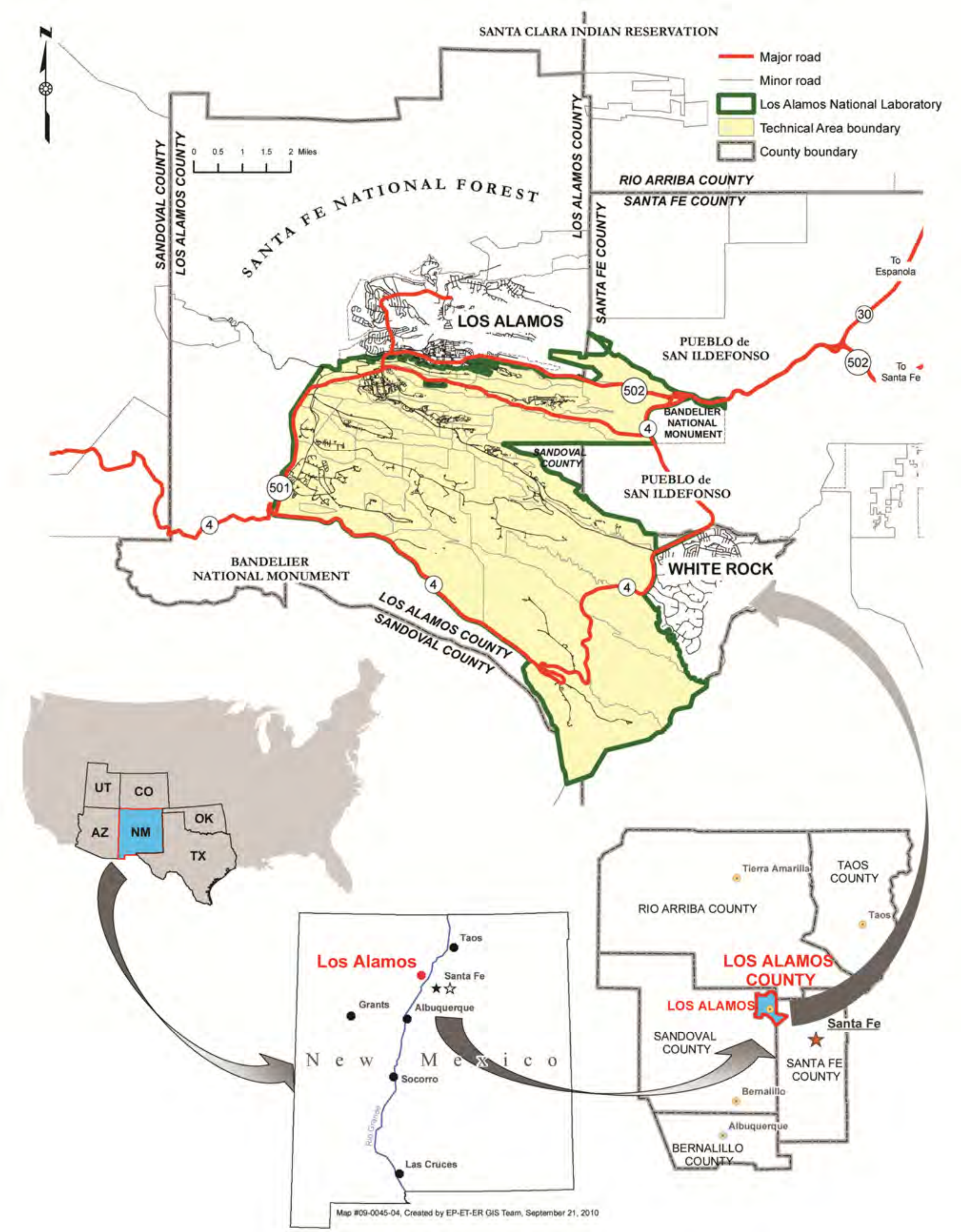

Figure ES-1 Regional location of Los Alamos National Laboratory

Environmental Protection Programs

The Department of Energy (DOE) has established a series of Orders directing each DOE site to implement sound stewardship practices that are protective of natural and cultural resources. These Orders require the implementation of an Environmental Management System (EMS), a Site Sustainability Plan, Radiation Protection of the Public, and Radioactive Waste Management.

As part of its commitment to protect the environment and improve its environmental performance, LANL continued the implementation of its EMS pursuant to DOE Order 450.1A and the international standard ISO14000-2004. The EMS is a continuous cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental missions and goals. Three audits of the LANL EMS occurred in 2010; no significant corrective actions were identified.

- ❖ LANL met six high-level environmental stewardship goals
- ❖ LANL met six of seven waste reduction goals.
- ❖ LANL won six NNSA Pollution Prevention Awards
- ❖ LANL published the first Site Sustainability Plan for energy, water, and transportation

LANL met six high-level environmental stewardship commitments during fiscal year (FY) 10.

- Increase public outreach events for environmental projects
- Maintain 98% and higher successful environmental program self-inspections
- Ensure compliant implementation of waste and air quality permits
- Improve transuranic (TRU) waste shipments to the Waste Isolation Pilot Plant (WIPP)
- Complete funded New Mexico Environment Department's (NMED's) Compliance Order on Consent (Consent Order) deliverables
- Implement a program for assuring that wastes are managed prior to employee departure from LANL and a chemical pharmacy that allows chemical users to purchase the exact amount of chemicals required to reduce chemical waste generation.

LANL FY10 waste generation was reduced over FY09 in all waste categories with the exception of routine hazardous waste.

The Pollution Prevention Program implements waste minimization, pollution prevention, sustainable design, and conservation projects to enhance operational efficiency, reduce life-cycle costs of programs or projects, and reduce risk to the environment. Reducing waste directly contributes to the efficient performance of the Laboratory's national security, energy, and science missions. LANL was awarded six NNSA awards in 2010:

- Video Teleconferencing Cuts Travel Costs and Reduces Greenhouse Gas Emissions
- Sustainable Projects for a Sustainable Future
- Sigma Electroplating Discharge Reduction
- Integration of Site Sustainability Plan Goals and LANL's EMS
- New Plutonium Removal Technique Means Less Waste
- LANL Algal Biofuels Consortium Development Team

LANL published the first Site Sustainability Plan in 2010. This plan sets energy, transportation, and water stewardship goals to assure that LANL can maintain its mission activities in a sustainable manner. During FY10, the Laboratory met milestones for the Sanitary Effluent Reclamation Facility (SERF) expansion, purchased renewable energy credits, reduced fleet petroleum consumption, and installed water and electricity metering at individual buildings.

The Laboratory met all DOE public and biota dose limits, As Low As Reasonably Achievable (ALARA) assessments, and clearance of real and personal property requirements during 2010.

DOE approved Laboratory operations to generate, treat, or dispose of radioactive waste during 2010. LANL generated, processed, and disposed of approximately 25,000 m^3 of low-level waste during 2010; approximately 10% was buried at Technical Area (TA)-54, Area G, and the remaining wastes were shipped off site for disposal. The Laboratory shipped 723 m^3 of TRU waste to WIPP during calendar year 2010 (Figure ES-2). DOE and LANL have set 2015 as the goal to complete the shipment of all stored TRU waste from Los Alamos to WIPP.

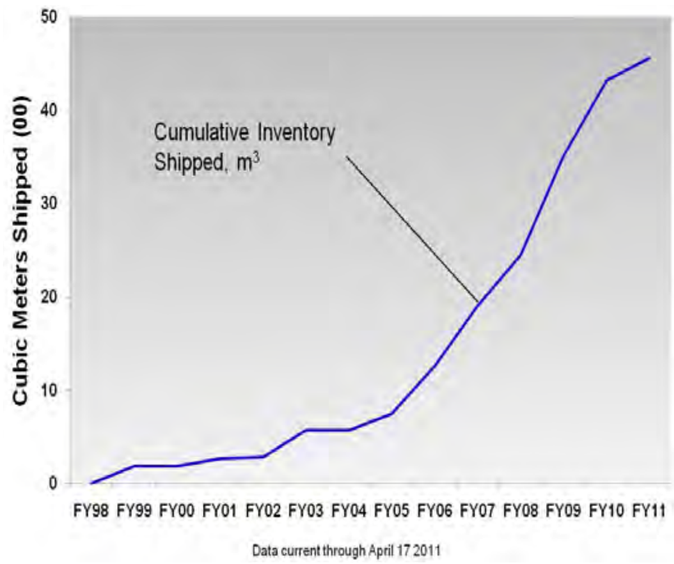

Figure ES-2 TRU waste shipping profile

Compliance with State and Federal Regulations

The Environmental Protection Agency (EPA) and NMED regulate Laboratory operations under various environmental statutes (e.g. Clean Air Act, Clean Water Act, etc.) through operating permits, construction approvals, and the DOE/NMED Consent Order. These permits are designed by the regulatory agencies to allow Laboratory operations to be conducted while assuring that the public, air, land, soils, water, and biota are protected. The Laboratory's compliance performance is an assessment of our protection of the environment. Table ES-1 presents a summary of the Laboratory's status in regard to environmental statutes and regulations for 2010.

- NMED renewed the LANL RCRA Hazardous Waste Facility Permit.
- EPA issued the Individual Permit for storm water discharges from Solid Waste Management Units (SWMUS) and Areas of Concern (AOCs).

NMED renewed the Laboratory's RCRA Hazardous Waste Facility Permit in November 2010 and the EPA issued the Individual Permit for storm water discharges from Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs). The Laboratory submitted Groundwater Discharge Permit applications to NMED for the TA-46 Sanitary Waste Water System and the Domestic Septic Tank/Leachfield Systems in 2010.

Compliance Order on Consent

The March 2005 Consent Order between LANL, DOE, and NMED is the principal regulatory driver for LANL's environmental restoration programs. The Consent Order contains requirements for investigation and cleanup of SWMUs and AOCs at the Laboratory. The major activities conducted by the Laboratory included investigations and cleanup actions. All major deliverables of the Consent Order were met by the Laboratory during 2010. The projects wrote and/or revised 22 work plans and 37 reports and submitted them to NMED. A total of 220 documents or reports were submitted to NMED. LANL installed two groundwater monitoring wells (with three screens) in the perched/intermediate aquifer and 12 groundwater monitoring wells (with 20 screens) in the regional aquifer to support Consent Order characterization and remediation activities.

- The Consent Order governs the Laboratory's environmental restoration. It specifies actions that the Laboratory must complete to characterize and remediate contaminated sites.
- The Laboratory met all 2010 Consent Order deliverables.

Table ES-1
Environmental Permits or Approvals under which the Laboratory Operated during 2010

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
RCRA[a] Permit	Hazardous Waste Facility Permit: Permitted hazardous waste storage units: TAs-3, -50, -54, and -55	November 1989, renewed November 2010	December 2020	NMED[b]
	40 CFR 265 Standards: Interim Status hazardous waste storage and treatment facilities: TAs-14, -16, -36, -39, and -54. Permit applications to be submitted to NMED.	Post-1980 hazardous waste units; Post-1991 mixed waste units	Inclusion in Hazardous Waste Facility Permit or closure	NMED
Consent Order	Legacy and contaminated waste site investigations, corrective actions, and monitoring; revised to establish new notification and reporting requirements for groundwater monitoring data	March 1, 2005; revised June 18, 2008	September 20, 2015	NMED
CWA[d]/NPDES[e]	Outfall permit for the discharge of industrial and sanitary liquid effluents	August 1, 2007	July 31, 2012	EPA[f]
	MSGP[g] for the discharge of storm water from industrial activities	September 29, 2008	September 29, 2013	EPA
	NPDES Individual Permit for storm water discharges from SWMUs and AOCs	November 1, 2010	March 31, 2014	EPA
	Construction General Permits (17) for the discharge of storm water from construction activities	June 30, 2008	July 31, 2011 (proposed extension until January 31, 2012)	EPA
CWA Sections 404/401	COE[h] Nationwide Permits (four)	NA	NA	COE/NMED
Groundwater Discharge Permit , TA-46 SWWS[i] Plant	Discharge to groundwater	July 20, 1992 Renewed January 7, 1998 Renewal application submitted on July 2, 2010	January 7, 2003*	NMED
Groundwater Discharge Plan, TA-50, Radioactive Liquid Waste Treatment Facility	Discharge to groundwater	Submitted August 20, 1996	Approval pending	NMED
Groundwater Discharge Plan, Domestic Septic Tank/Leachfield Systems	Discharge to groundwater	Submitted April 27, 2006 Application resubmitted on June 25, 2010	Approval pending	NMED

Table ES-1 (continued)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
Air Quality Operating Permit (20.2.70 NMAC[j])	LANL air emissions Renewal 1	August 7, 2009	August 7, 2014	NMED
Air Quality Construction Permits (20.2.72 NMAC)	Portable rock crusher	June 16, 1999	None	NMED
	Retired and removed from operating permit	June 15, 2006		
	Permit number will remain active to track exempt sources at LANL			
	TA-3 Power Plant	September 27, 2000	None	NMED
	Permit revision	November 26, 2003		
	Permit modification 1, Revision 1	July 30, 2004		
	Permit modification 1, Revision 2	March 5, 2009		
	1600-kW generator at TA-33	October 10, 2002	None	NMED
	Permit revision	May 28, 2008	None	NMED
	Two 20-kW generators and one 225-kW generator at TA-33	August 8, 2007	None	NMED
	Asphalt Plant at TA-60	October 29, 2002	None	NMED
	Permit revision	September 12, 2006	None	NMED
	Data disintegrator	October 22, 2003	None	NMED
	Chemistry and Metallurgy Research Replacement (CMRR), Radiological Laboratory, Utility, Office Building (RLUOB)	September 16, 2005	None	NMED
Air Quality (NESHAP[k])	Beryllium machining at TA-3-141	October 30, 1998	None	NMED
	Beryllium machining at TA-35-213	December 26, 1985	None	NMED
	Beryllium machining at TA-55-4	February 11, 2000	None	NMED

[a] Resource Conservation and Recovery Act
[b] New Mexico Environment Department
[c] Hazardous and Solid Waste Amendments
[d] Clean Water Act
[e] National Pollutant Discharge Elimination System
[f] Environmental Protection Agency
[g] Multi-Sector General Permit
[h] US Army Corps of Engineers
[i] Sanitary Wastewater Systems Plant
[j] New Mexico Administrative Code
[k] National Emission Standards for Hazardous Air Pollutants

* Permit was administratively continued though 2010

The status of Consent Order investigations and remediations is presented in Figure ES-3. For those aggregate areas presented as complete, all investigation activities have been completed, and no additional field sampling campaigns, investigation reports, or corrective measures activities are anticipated. Aggregate areas listed as in progress include sites or areas where field sampling campaigns or corrective measure activities are currently being conducted, or investigation reports are being prepared or finalized. Aggregate areas listed as pending include sites or areas where work plan preparation and field sampling campaigns have not yet started. As of December 2010, scheduled investigation activities are complete at six aggregate areas, are in progress at 21 aggregate areas, and are pending at two aggregate areas. NMED granted Certificates of Completion for 34 SWMUs and AOCs in 2010.

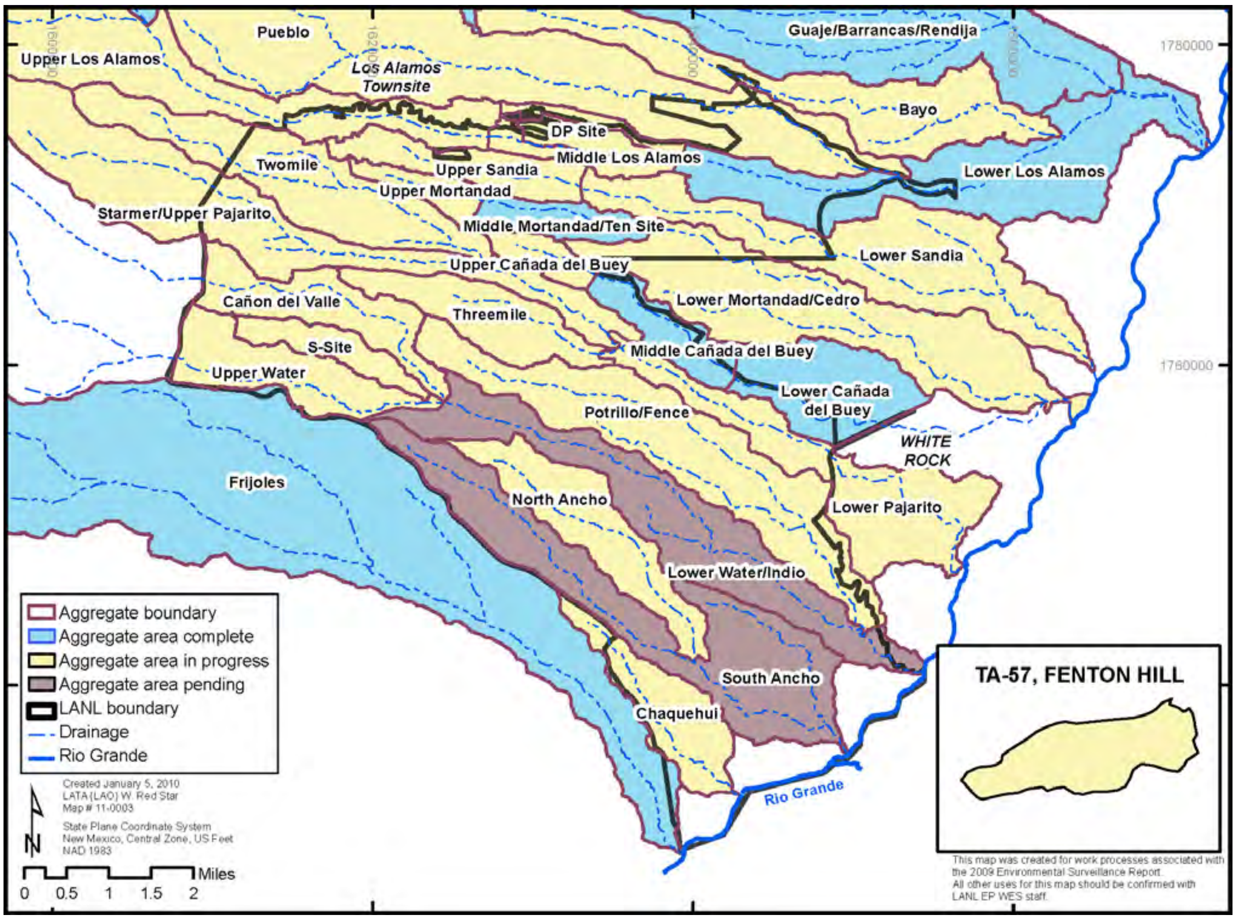

Figure ES-3 **Aggregate areas as defined for the NMED Consent Order and their status. Status is shown as aggregrate area activities complete, activities in progress, or activities pending.**

In November 2010, EPA Region 6 issued an Individual Permit (IP) that authorizes discharges of storm water from certain Potential Release Sites (PRSs), SWMUs, and AOCs at the Laboratory. The sites listed in the IP are associated with historical LANL operations dating back to the Manhattan Project era of the 1940s. The IP lists 405 permitted sites that must be managed to prevent the transport of contaminants off site via storm water runoff.

Site-specific storm water control measures that reflect best industry practice considering their technological availability, economic achievability and practicability are required for each of the 405 permitted sites to minimize or eliminate discharges of pollutants. These controls are referred to as Best Management Practices (BMPs).

The local storm water drainage around sites (called Site Monitoring Areas [SMAs]) has been hydrologically analyzed, and sampling locations have been identified to most effectively sample runoff from sites.

Stormwater is monitored from these SMAs to determine the effectiveness of the controls. When target action levels (TALs) which are based on New Mexico water quality standards, are exceeded, corrective actions are required. In 2010, the Laboratory completed the following tasks:

- Development of a Site Discharge Pollution Prevention Plan (SDPPP) for SWMU/AOCs that describes three main objectives: identification of pollutant sources, description of control measures and monitoring that determines the effectiveness of controls at all regulated SWMU/AOCs
- Fieldwork:
    - ❖ Completed more than 1,000 rain event inspections conducted on all 250 SMAs
    - ❖ Conducted BMP maintenance during inspection at 140 SMAs
    - ❖ Conducted BMP installation at 205 SMAs
    - ❖ Maintained 45 gauge stations for storm event sampling in support of environmental surveillance and Los Alamos/Pueblo canyon monitoring
    - ❖ Decommissioned/removed sampler and equipment at 45 previous Federal Facilities Compliance Agreement (FFCA) locations

Unplanned Releases

There were no unplanned airborne releases and no unplanned releases of radioactive liquids from LANL in 2010. There were 23 spills or releases of non-radioactive liquids, most of which were potable water, hydraulic fluid, or domestic wastewater. Other liquids included re-use water, steam condensate, and sanitary wastewater. LANL reported all liquid releases to NMED; the releases will be administratively closed upon final inspection.

Radiological Dose Assessment

Humans, plants, and animals potentially receive radiation doses from various Laboratory operations (Table ES-2). The DOE dose limits for the public and biota are the mandated criteria that are used to determine whether a measurement represents a potential exposure concern. Figure ES-4 shows doses to the hypothetical maximally exposed individual (MEI) via the air pathway over the last 10 years at an off-site location; this location was at LA Inn South in 2010. The annual dose to the MEI for the airborne pathway was approximately 0.33 mrem, similar to the previous four years, and well under the regulatory limit of 10 mrem (Figure ES-4). During 2010, the population within 80 km of LANL received a collective dose of about 0.22 person-rem, down from 0.57 person-rem in 2009. The doses received in 2010 from LANL operations by an average Los Alamos residence and an average White Rock residence were less than 0.1 mrem at each location. The maximum all-pathways dose, composed almost entirely of direct radiation from waste stored at TA-54, Area G, could result in an exposure of 0.9 mrem per year to a hypothetical individual in the adjacent sacred area of Pueblo de San Ildefonso. Doses were also calculated for members of the public who hike on LANL property or areas previously impacted by LANL effluents: Acid Canyon, Pueblo Canyon, lower Ancho Canyon, and along the Rio Grande. All doses were calculated to be less than 0.1 mrem.

- ❖ Radiation dose in 2010 to the MEI was similar to the very low-level dose calculated in 2009.
- ❖ The location of the hypothetical MEI for airborne radionuclides was determined to be at the LA Inn South in downtown Los Alamos. This location received low levels of radiation from resuspension of contaminated soils in Los Alamos Canyon.

Table ES-2
Sources of Radiological Doses

Source	Recipient	Dose	Location	Trends
Background (includes human-made sources)	Humans	~700 mrem/yr*	Not applicable	Not applicable
Air	Humans	0.33 mrem/yr	LA Inn South in downtown Los Alamos	Similar to very low level in previous four years
Direct radiation	Humans	0.9 mrem/yr	LANL-San Ildefonso boundary	Similar to previous years
Food	Humans	< 0.1 mrem/yr	All sites	Steady
Drinking water	Humans	< 0.1 mrem/yr	All sites	Steady
All	Terrestrial animals	< 0.01 rad/day	All sites	Steady
All	Terrestrial plants	< 0.1 rad/day	All sites	Steady

* Increased from previous years due to new information about average medical doses.

Biota Dose

The DOE biota dose limits are intended to protect populations of plants and animals, especially with respect to preventing the impairment of reproductive capability within the biota population. All radionuclide concentrations in vegetation sampled were far below the plant 0.1 rad/day biota dose screening level (10% of 1 rad/day dose limit), and all radionuclide concentrations in terrestrial animals sampled were far below the terrestrial animal 0.01 rad/day biota dose screening level (10% of 0.1 rad/day dose limit) (Table ES-2).

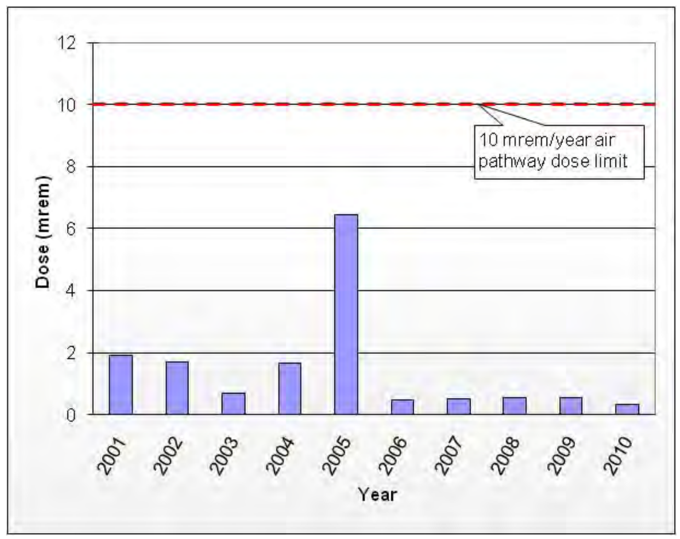

Figure ES-4 Annual airborne pathway dose (mrem) to the off-site MEI over the past 10 years. The 2010 location of the calculated MEI is at the southern edge of the Los Alamos townsite, on the edge of Los Alamos Canyon.

Radiological Air Emissions

The Laboratory measures the emissions of radionuclides at the emission sources (building stacks) and categorizes these radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous activation products, (3) tritium, and (4) gaseous air activation products (radioactive elements created by the Los Alamos Neutron Science Center [LANSCE] particle accelerator beam). In addition, the Laboratory collects air samples at general locations within LANL boundaries, at the LANL perimeter, and regionally to estimate the extent and concentration of radionuclides that may be released from Laboratory operations. These radionuclides include isotopes of plutonium, americium, uranium, and tritium.

LANL monitored 28 stacks for emissions of radioactive material to the ambient air in 2010. Total stack emissions during 2010 were approximately 298 curies (Ci), a decrease from 800 Ci in 2009, Short-lived air activation products from LANSCE stacks and diffuse emissions contributed 211 Ci of the total. Most of the curies from LANSCE are from very short-lived radionuclides that decay significantly before reaching the LANL site boundary. Tritium emissions composed about 87 Ci of the total. Combined airborne emissions of other radionuclides, such as plutonium, uranium, americium, and thorium, were less than 0.000020 Ci and emissions of particulate/vapor activation products were 0.016 Ci.

- As in previous years, there were no detections of radionuclides above background at Pueblo de San Ildefonso and regional locations.
- The largest off-site ambient air measurements of radionuclides occurred adjacent to the environmental restoration work at TA-21, MDA B. These concentrations were less than 9% of the EPA 10-mrem public dose limit.

Radionuclide concentrations in ambient air samples in 2010 were generally comparable with concentrations in prior years. As in past years, the AIRNET system detected slightly elevated radionuclides from known areas of contamination and active environmental remediation sites. At regional locations away from Los Alamos, all air sample measurements were consistent with background levels. Annual mean radionuclide concentrations at all LANL perimeter stations were less than 9% of the EPA dose limit for the public. Measurable amounts of tritium were reported at a number of on-site locations and at perimeter locations. The highest off-site tritium concentration was 0.2% of the EPA public dose limit. The highest on-site tritium measurement (less than 3% of the DOE limit for worker exposure) was made at Area G near disposal shafts containing tritium-contaminated waste. Environmental restoration work at TA-21, material disposal area (MDA) B, produced higher plutonium-239/240 concentrations at perimeter locations and at decontamination and demolition (D&D) locations during 2010 than in previous years. Maximum concentrations were less than 9% of the EPA dose limit for the public. The maximum annual uranium concentrations were from natural uranium at locations with high dust levels from local soil disturbances. There were three detections of enriched uranium (near the environmental restoration work at TA-21, MDA B) and two likely detections of depleted uranium (which has lower radioactivity than natural uranium).

Non-Radiological Air Emissions and Air Quality

LANL demonstrated full compliance with all Clean Air Act monitoring and reporting requirements. Emissions of criteria pollutants (nitrogen oxides, sulfur oxides, carbon monoxide, particulate matter, volatile organic compounds, and hazardous air pollutants) were similar to the previous five years. The TA-3 power plant and boilers located across the Laboratory were the major contributors of nitrogen oxides, carbon monoxide, and particulate matter. Science research and development activities were responsible for most of the volatile organic compound and hazardous air pollutant emissions. In 2010, LANL provided the second greenhouse gas emissions report to NMED, as required by state regulation. The 2009 emissions of carbon dioxide (reported in 2010) were approximately 56,426 metric tons of carbon dioxide equivalents from the combustion of fossil fuels. During 2010, LANL removed more than 5,900 pounds of ozone-depleting refrigerants from the active inventory.

Air monitoring for particles with diameters of 10 micrometers (μm) or less (PM-10) and for particles with diameters of 2.5 μm or less (PM-2.5) continued at one White Rock and one Los Alamos location. The annual averages at both locations for PM-10 was about 13 micrograms (μg)/m^3 and about 6 μg/m^3 for PM-2.5 and were mostly caused by natural dust and wildfire smoke. In addition, the 24-hour maxima for both PM-10 and PM-2.5 at both locations did not exceed 40% and 55% of the respective EPA standards.

The Laboratory analyzed air filter samples from 38 sites for beryllium, aluminum, and calcium. These sites are located near potential beryllium sources at LANL and in nearby communities. All concentrations measured this year were at or below 2% of the National Emission Standards for Hazardous Air Pollutants standard of 10 ng/m^3 and were similar to those of recent years. Past studies closely correlated beryllium concentrations with aluminum concentrations, which indicates that all measurements of beryllium are from naturally occurring beryllium in re-suspended dust. Aluminum and calcium are used to evaluate elevated uranium measurements and no unusual concentrations were measured.

Groundwater Monitoring

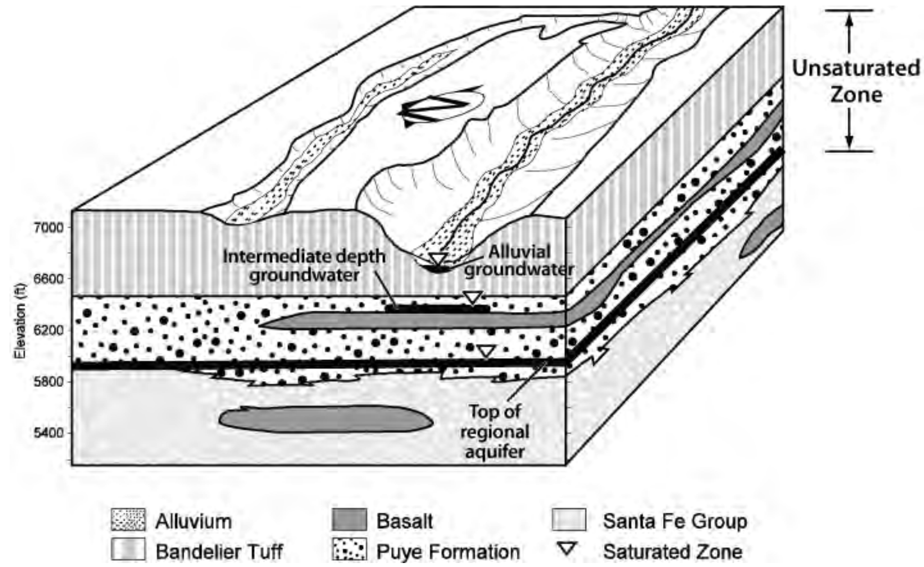

Figure ES-5 Three modes of groundwater occurrence

Groundwater at the Laboratory occurs as a regional aquifer (water-bearing rock capable of yielding significant quantities of water to wells and springs) at depths ranging from 600 to 1,200 feet and as perched groundwater of limited thickness and horizontal extent, either in canyon alluvium or at intermediate depths of a few hundred feet (Figure ES-5). All water produced by the Los Alamos County water supply system comes from the regional aquifer and meets federal and state drinking water standards. No drinking water is supplied from the alluvial and intermediate groundwater.

In 2010, LANL installed two perched intermediate groundwater monitoring wells and 12 regional aquifer monitoring wells. Eight regional wells were installed to monitor for potential contamination from MDAs in TA-54 and to support Corrective Measures Evaluation (CME) reports for MDAs at TA-54. Two regional wells were installed downgradient of TA-49 and MDA-AB. One regional well was installed east of TA-74 to monitor for potential contamination near the municipal production well Otowi 1. One regional well was installed in Mortandad Canyon as part of the ongoing chromium investigation. One intermediate well was installed as a hydrologic test well to support the TA-16 260 Outfall corrective measures implementation.

The Laboratory has changed groundwater quality through liquid effluent disposal, with the greatest impact on alluvial groundwater. Laboratory contaminants have also affected the intermediate perched zones and the regional aquifer. The contaminated alluvial and intermediate perched groundwater bodies are separated from the regional aquifer by hundreds of feet of dry rock, so infiltration from the shallow groundwater occurs slowly. As a result, less contamination reaches the regional aquifer and impacts on the regional aquifer are reduced.

Since the early 1990s, the Laboratory has significantly reduced both the number of industrial outfalls (from 141 to 12 active) and the volume of water released (by 80%). From 1993 to 1997, total estimated average release was 1,300 million (M) gal./yr. Flow decreased to 230 M gal./yr from 1998 to 2005 and was 141 M gal./yr in 2010. Major upgrades to the TA-50 Radioactive Liquid Waste Facility (RLWTF) in 1999 through 2002 brought effluents into compliance with standards for radionuclides and constituents regulated under NPDES and NM groundwater discharge permits. Alluvial groundwater quality in Mortandad Canyon has improved due to these project improvements. The Laboratory uses federal and state drinking water and human health standards as "screening levels" to evaluate concentrations in all groundwater, even though many of these standards only apply to drinking water.

Where Laboratory contaminants are found in deep groundwater, the setting is either a canyon where alluvial groundwater is usually present (because of natural runoff or Laboratory effluents) or a location where large amounts of liquid effluent have been discharged (e.g., Mortandad Canyon and upper Sandia Canyon). During 2010, LANL received and evaluated 153,000 analytical results for groundwater samples from wells and springs. Table ES-3 summarizes contaminants detected in portions of the groundwater system.

Table ES-3
LANL Impacts on Groundwater that Result in
Values Near or Above Regulatory Standards, Screening Levels, or Risk Levels

Chemical	On-Site	Off-Site	Significance	Trends
Chromium	Regional aquifer in Mortandad Canyon, intermediate groundwater in Mortandad and Sandia Canyons	No	Found in regional aquifer above groundwater standards; not affecting drinking water supply wells; source eliminated in 1972.	Increasing in Mortandad intermediate groundwater. Fairly steady over five years at other locations in Mortandad and Sandia canyons' intermediate and regional groundwater
Nitrate	Intermediate groundwater in Pueblo and Mortandad canyons, and regional groundwater in Sandia Canyon and Mortandad Canyon	Pueblo and Los Alamos Canyons	In Pueblo Canyon, may be due to Los Alamos County's Sewage Treatment Plant; otherwise due to past effluent discharges. TA-50 RLWTF effluents have met discharge limits since 2000.	Generally variable in Pueblo, steady in Sandia, decreasing in Mortandad Canyon
Perchlorate	Alluvial, intermediate, and regional groundwater in Mortandad Canyon; intermediate in Los Alamos Canyon; regional aquifer in Pueblo Canyon	Pueblo Canyon	Reflects past outfall discharges that have ceased	Decreasing in Mortandad Canyon alluvial groundwater due to effluent quality improvement; increasing at one location in the regional aquifer in Mortandad Canyon
Dioxane[1,4-]	Intermediate groundwater in Los Alamos, Mortandad, and Pajarito Canyons	No	Not used as drinking water supply; limited in extent	Fairly steady or decreasing concentrations over five years in Los Alamos and Mortandad; seasonal variation in Pajarito
Trichloroethane [1,1,1-]; dichloroethene[1,1-]	Intermediate groundwater near main warehouse	No	Not used as drinking water supply; limited in extent	Seasonally variable, undergoing corrective action
RDX	Alluvial and intermediate groundwater in Cañon de Valle, intermediate groundwater in Pajarito Canyon	No	Not used as drinking water supply; limited in extent	Generally stable, seasonal fluctuations. In the regional aquifer in Pajarito Canyon, values are below standards, but increasing at one location.
Barium	Alluvial groundwater in Cañon de Valle and Pajarito and Mortandad Canyons	No	Not used as drinking water supply; limited in extent	Generally stable in Cañon de Valle, in others likely due to cation-exchange caused by road salt
Boron	Intermediate groundwater in Cañon de Valle	No	Not used as drinking water supply; limited in extent	Generally stable, seasonal fluctuations
Tetrachloroethene, trichloroethene	Alluvial and intermediate groundwater in Cañon de Valle	No	Not used as drinking water supply; limited in extent	Generally stable, seasonal fluctuations
Strontium-90	Alluvial groundwater in Los Alamos and Mortandad canyons	No	Not used as a drinking water supply; has not penetrated to deeper groundwater. TA-50 RLWTF effluent discharges decreased since 2000.	Mainly fixed in location; some decrease due to effluent quality improvement
Fluoride	Alluvial groundwater in Los Alamos and Mortandad canyons. Intermediate groundwater in Pueblo and Los Alamos canyons. Regional aquifer in Pueblo Canyon	Pueblo Canyon	Result of past effluent releases; not affecting drinking water supply wells	In alluvium, slow decrease in concentration due to effluent quality improvement

Table ES-3 (continued)

Chemical	On-Site	Off-Site	Significance	Trends
Chloride, total dissolved solids	Alluvial groundwater in Pueblo, Los Alamos, Sandia, Mortandad, Pajarito canyons, intermediate groundwater near TA-3 main warehouse	Pueblo Canyon	Due to road salt in snowmelt runoff	Values generally highest in winter or spring samples
Fluoride, uranium, nitrate, total dissolved solids	No	Pine Rock Spring, Pueblo de San Ildefonso	Water quality apparently affected by irrigation with sanitary effluent at Overlook Park	Steady over several years

- LANL continues to investigate the hexavalent chromium found at up to 20 times the NM groundwater standard in the regional aquifer under Mortandad Canyon and nearby Sandia Canyon. One new regional well north of the LANL/Pueblo de San Ildefonso boundary measured chromium above the NM groundwater standard.
- One regional well was installed in Mortandad Canyon as part of the ongoing chromium investigation.

The Laboratory has detected hexavalent chromium in several regional aquifer monitoring wells: at up to 20 times above the NM groundwater standard in Mortandad Canyon and at 50% of the standard in nearby Sandia Canyon. Samples from an intermediate well in Sandia Canyon contain chromium at 10 times the standard and support a path for the chromium contamination from beneath Sandia Canyon southward to the regional aquifer below Mortandad Canyon. The Phase II Investigation Report for Sandia Canyon will be submitted to NMED in 2012; Corrective Measures Evaluations will be developed following NMED approval of this report.

Concentrations of chloride above one half of groundwater standards are present in alluvial groundwater in Pueblo, Los Alamos, Sandia, Mortandad, and Pajarito canyons, and in the intermediate groundwater near TA-3 main warehouse. The source is runoff from road salting during the winter months.

Nitrate was up to 60% of the NM groundwater standard in Sandia Canyon and Mortandad Canyon regional aquifer monitoring wells. Intermediate groundwater concentrations of nitrate have decreased below the groundwater standard in Mortandad Canyon. Intermediate groundwater concentrations of nitrate are about 50% of the groundwater standard in Pueblo and Lower Los Alamos canyons.

Perchlorate is detected in most groundwater samples analyzed across northern NM. Naturally occurring perchlorate concentrations range from about 0.1 μg/L to 1.8 μg/L. One unused drinking water well in the Los Alamos area has been impacted by past Laboratory discharges of perchlorate. During 2010, perchlorate concentrations in Well O-1 in Pueblo Canyon dropped to 1.3 μg/L. Perchlorate is above the 4 μg/L Consent Order screening level at a nearby regional aquifer Pueblo Canyon well, but below the EPA interim health advisory of 15 μg/L. Perchlorate concentrations in Mortandad intermediate groundwater wells are above the EPA screening level but have been decreasing over the past five years. Concentrations are also above the Consent Order screening level in the regional aquifer below Mortandad Canyon and have increased over the past four years.

Following well rehabilitation activities in 2008, trichloroethene was detected at 1,147 feet in Pajarito Canyon regional aquifer monitoring well R-20. Trichloroethene detections have continued for five consecutive sample events through the end of 2010. The concentrations have dropped from 60% to less than 20% of the 5 μg/L EPA screening level in 2010. The source has not been determined.

- Beginning in late 2008, trichloroethene was detected in Pajarito Canyon regional aquifer monitoring well R-20 for five consecutive sample events through the end of 2010. The concentrations have decreased from 60% to less than 20% of the 5 µg/L EPA screening level.

The intermediate groundwater in various locations shows localized levels of tritium, organic chemicals (RDX, chlorinated solvents, dioxane[1,4-]), and inorganic chemicals (hexavalent chromium, barium, boron, perchlorate, fluoride, and nitrate) from Laboratory operations. A series of actions began in 2009 to implement corrective measures for high explosives and barium at the 260 Outfall at TA-16, including soil removal and installing a permeable reactive barrier. Monitoring of the effectiveness of corrective measures will be reported in the 2011 environmental report,

The total radionuclide activity from LANL discharges exceeded the dose limit that is applicable to drinking water (4 mrem/yr) only in the alluvial groundwater in portions of Mortandad and DP/Los Alamos canyons. This is mainly due to the presence of strontium-90. Because strontium-90 bonds tightly to sediments, the contamination is not moving downward from the alluvial system. In addition, the TA-50 RLWTF discharges have been less than the 100 mrem/yr DOE public dose limits since the mid 1990s.

The Laboratory monitors springs in White Rock canyon as a principal discharge of regional aquifer groundwater that flows underneath the Laboratory. Naturally occurring levels of uranium, perchlorate, and arsenic are present in some springs. Similar results are found in samples from Pueblo de San Ildefonso wells.

Laboratory surveillance monitoring of the Los Alamos County drinking water system and the Santa Fe Buckman well field demonstrate no impact from LANL contaminants.

Watershed Monitoring

Watersheds that drain LANL property are dry for most of the year. Of the more than 80 miles of watercourse, approximately three miles are naturally perennial and approximately four miles are perennial water created by effluent discharges (most notably in upper Sandia Canyon). Snowmelt runoff originating in the Jemez Mountains can extend across the Laboratory to the Rio Grande. Storm water runoff transporting sediment can leave the Laboratory boundary, but is short-lived. The surface water within the Laboratory is not a source of municipal, industrial, or irrigation water, though wildlife does use the water.

- The overall quality of most surface water within the Los Alamos area is very good.
- Of the more than 100 analytes measured in watersheds across LANL, most are within normal ranges or at concentrations below regulatory standards or risk-based advisory levels.
- Nearly every major watershed, however, shows some effect from Laboratory operations.

None of the streams within the Laboratory boundary average more than one cubic foot per second (cfs) of flow annually. It is unusual for the combined mean daily flow from all LANL canyons to be greater than 10 cfs. The largest flows in 2010 occurred on August 16, with a total estimated mean daily flow of 25 cfs entering the Rio Grande from the Los Alamos Canyon watershed. By comparison, the average daily flow in the Rio Grande at Otowi Bridge on August 16 was 1,060 cfs.

Snowmelt runoff, estimated to be 185 acre-feet (ac-ft), crossed the eastern Laboratory boundary in Los Alamos Canyon continuously in April and May. Total storm water runoff at downstream gages in the canyons leaving the Laboratory is estimated at about 42 ac-ft, approximately 92% of this occurring in Los Alamos and Pueblo Canyons and 7% in Cañada del Buey above White Rock. In addition, approximately 4 acre-feet of effluent released from the Los Alamos County wastewater treatment plant is estimated to have passed the eastern LANL boundary in Pueblo Canyon.

The overall quality of most surface water in the Los Alamos area is good, with low levels of dissolved solutes. Of the more than 100 analytes measured in sediment and surface water within the Laboratory, most are at concentrations far below standards and screening levels. However, nearly every major watershed indicates some effect from Laboratory operations, often for just a few analytes. Table ES-4 lists the locations of Laboratory-impacted surface water. All radionuclide levels are well below applicable guidelines or standards.

Table ES-4
LANL Impacts on Surface Water that Result in Values Near or Above Screening Levels

LANL Impact	On-Site	Off-Site	Significance	Trends
Specific radionuclides (e.g., Pu-239/240, Sr-90, and Cs-137)	No	No	No LANL-derived radionuclides exceeded DOE biota concentration guides or derived concentration guidelines in 2010	Steady
Gross alpha radioactivity	Pueblo, Los Alamos, Sandia, Mortandad, Pajarito, and Water Canyons.	Yes, including canyons not affected by LANL	56% of storm water results from 2010 greater than New Mexico Water Quality Control Commission (NMWQCC) standards. Major source is naturally occurring radioactivity in sediments, except in Mortandad, Pueblo, and Los Alamos Canyons where there are LANL contributions	Steady
Chromium	Mortandad Canyon	No	Single result above standard	Steady
Copper	Mortandad and Sandia Canyons	No	Copper was elevated in 2010 at a few sites that receive runoff from developed areas, including TA-3 and the Los Alamos town site	Steady
Mercury	Los Alamos Canyon	No	Two results above standard	Steady
Zinc	Los Alamos and Sandia Canyons	No	Zinc was above standards at two locations with small drainage areas receiving runoff from paved roads and other developed areas	
Polychlorinated biphenyls (PCBs)	Los Alamos, Mortandad, and Sandia Canyons	Yes, including canyons not affected by LANL	Above standards. PCBs have been released by historic LANL discharges and from runoff from developed areas, including the Los Alamos town site. PCBs are also found in background areas on Santa Fe National Forest land, resulting from regional atmospheric fallout	Steady

Laboratory activities have caused contamination of sediment in several canyons, mainly because of past industrial effluent discharges. These discharges and contaminated sediment also affect the quality of storm water runoff, which carries much of this sediment during short periods of intense flow. In some cases, sediment contamination is present from Laboratory operations conducted more than 50 years ago. However, all measured sediment contaminant levels are below screening levels for recreational uses.

Consistent with previous years, many surface water samples in 2010 had gross alpha radiation greater than the surface water standard of 15 pCi/L for livestock watering. Laboratory impacts are relatively small and the majority of the alpha radiation in surface water on the plateau is due to the decay of naturally occurring isotopes in sediment and soil carried in storm water runoff from uncontaminated areas. This is supported by the generally positive correlation between gross alpha radiation and suspended sediment in non-filtered surface water samples.

Highest concentrations of radionuclides from Laboratory sources were measured in surface water samples from Acid, DP, Los Alamos, and Mortandad canyons downstream from facilities that have released radioactive effluents. Concentrations are highest near historic discharges points and directly above the Los Alamos Canyon weir; concentrations decrease below the Los Alamos Canyon weir. Concentrations were similar to previous years, and no values exceeded the DOE biota concentrations guides.

- The highest concentrations of LANL-derived radionuclides in surface water samples were measured in Acid, DP, Los Alamos, and Mortandad Canyons. All measurements are consistent with previous years and are below screening levels.
- The highest concentrations of radionuclides in sediment were obtained from several locations in Acid, Los Alamos, and Mortandad canyons below present and former outfalls. Results and are consistent with previous years.

Eight radionuclides in sediment were detected above background concentrations in 2010: americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, uranium-234, uranium-235, and uranium-238. The maximum values for seven radionuclides were found in the Mortandad Canyon stream channel or in the Los Alamos Canyon sediment retention basins. The highest plutonium-239/240 result occurred in the Acid Canyon stream channel below historic discharges from TA-1 and TA-45, consistent with previous years.

Seven inorganic chemicals from Laboratory sources, including runoff from developed areas, were detected above NMWQCC standards: arsenic, cadmium, chromium, copper, mercury, selenium, and zinc. The concentrations above standards resulted from 5% or less of the total number samples. Arsenic, cadmium, copper and zinc are only above standards in drainages that receive runoff from developed areas, including TA-3 and the Los Alamos town site.

Metals and other inorganic chemicals are found in sediments at concentrations above typical background levels in 3% to 16% of samples collected during 2010. These constituents partially represent historic discharges from Laboratory outfalls in Los Alamos, Sandia, and Mortandad canyons. Runoff from developed areas at the Laboratory and the Los Alamos town site also contribute to sediment concentrations of cadmium, copper, lead, manganese, selenium, and zinc. Some of the results also represent naturally elevated concentrations.

High explosives were detected in surface water samples from Cañon de Valle, downstream from a high explosive machining facility at TA-16. Concentrations were less than standards. These results are consistent with previous years. Corrective measures were implemented to address this high explosive contamination in 2009 and 2010.

PCBs were detected above the human health and wildlife standards in surface water in Los Alamos, Sandia, Mortandad, and Pajarito canyons. These results are consistent with previous years. PCBs were also measured above the screening level in runoff from developed areas, including the Los Alamos town site, and in background areas, such as Cañada de los Latas north of Los Alamos. The PCBs in background areas are derived from regional atmospheric fallout. In 2010, LANL constructed two grade control structures in DP and Pueblo Canyons to stabilize sediments in place and reduce the transport of PCBs in storm water in Los Alamos and Pueblo Canyons. Monitoring results show no measurable levels of PCBs from LANL in the Rio Grande.

- PCBs are measured in storm water in Los Alamos, Sandia, Mortandad, and Pajarito canyons above standards. PCBs are also detected above standards in runoff from the Los Alamos town site and in background areas, the latter derived from regional atmospheric fallout.
- LANL completed sediment control projects in Pueblo and DP canyons in 2010 to reduce the transport of contaminated sediments.
- The flux of LANL-contaminated sediments into the Rio Grande is small.

We obtained PCB congener data from sediment samples in Laboratory canyons and along the Rio Grande during 2010. Consistent with data from 2009, the mixtures of PCB congeners upriver and downriver from LANL sources are essentially identical, but different than the PCB signature in LANL canyons. These congener data, therefore, show no measureable evidence of LANL contributions to PCBs along the Rio Grande. The PCB data from the Rio Grande were also combined with data on suspended sediment flux to estimate PCB flux in the river above LANL drainages. A preliminary estimate of PCB flux from Los Alamos Canyon is about 0.003 to 0.005 kg/yr, or 1% to 3% of the flux in the Rio Grande.

Soil Monitoring

LANL conducts large-scale soil sampling within and around the perimeter of LANL every three years. The most recent comprehensive soil survey was conducted in 2009. In general, results confirmed the results from previous sampling events and show on-site and perimeter areas contained radionuclides at very low (activity) concentrations, and most were either not detected or below regional statistical reference levels (RSRLs) (equal to the average plus three standard deviations). The few samples with radionuclide concentrations above the RSRLs were collected near known or expected areas of contamination. These samples are below industrial screening levels and thus do not pose a potential unacceptable dose to the public.

We also annually collect soil samples from two locations on the Pueblo de San Ildefonso land downwind of TA-54, Area G. Radionuclides and metals in the 2010 soil samples were below background or near background and were consistent with levels measured in previous years.

- Concentrations of radionuclides in soil samples from TA-54, Area G, are above background and less than industrial screening levels.
- Uranium concentrations in soils at DARHT have decreased since the Laboratory began conducting high explosives test shots in containment vessels in 2007.

The annual samples from around the perimeter of Area G contained above-background concentrations of tritium, americium-241, plutonium-238, and plutonium-239/240 at levels similar to those found in previous years. The highest levels of tritium around Area G were detected at the southern end, and the highest levels of the americium and plutonium were detected around the northern, northeastern, and eastern sections. Although americium-241, plutonium-238, and plutonium-239/240 in soil along the northern, northeastern, and eastern sections of Area G are slightly elevated, all levels are well below residential screening levels used to trigger investigations and decrease rapidly with distance from Area G.

The Laboratory began using containment vessels for high explosives testing in 2007 at the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility. Soil concentrations of uranium-238 near the firing point showed significantly lower levels than measured prior to 2009, and the concentrations are well below industrial screening levels. High explosives were not detected in any samples around DARHT.

In 2008, the NMED collected five soil samples from high-elevation areas (11,099 to 12,476 ft) in New Mexico and Colorado and provided them to LANL to determin the origin of the detected concentrations of cesium and plutonium activity. In the four samples from New Mexico, approximately 75% of the radionuclides were from global fallout from large thermonuclear atmospheric tests conducted by the United States and the former Soviet Union, and 25% of the radionuclides were from regional fallout from much smaller atmospheric nuclear tests conducted at the Nevada Test Site (NTS). No measurable contribution to the plutonium concentration from LANL operations could be detected.

Foodstuffs Monitoring

In 2010, we collected 107 fruit and vegetable samples from on-site, perimeter (including crops irrigated with Rio Grande waters), and regional background locations. In general, all radionuclides in all produce samples were very low and primarily not detected or below the RSRLs. The highest tritium concentrations were found in fruit samples from on-site locations near tritium processing and waste operations at TA-21 and TA-54, Area G. Results were similar in past years.

Goat milk from perimeter and regional locations was sampled and analyzed. No radionuclides that we analyzed for were detected, similar to previous years.

Chicken eggs from perimeter and regional locations were sampled and analyzed. No radionuclides that we analyzed for were detected or similar to RSRLs.

Honey from bee hives located at on-site, perimeter, and regional locations were sampled and analyzed. Radionuclides, with the exception of tritium at TA-54, were either not detected or similar to RSRLs. Tritium in honey from TA-54 is from Area G operations and is not sold or consumed by the public; it is solely maintained as an experimental hive and shows that honey bees can be used as effective environmental monitors.

Crayfish were collected from the Rio Grande in one reach above LANL and in another reach downstream of the confluence of Los Alamos Canyon and the Rio Grande; the goal was to increase the number of samples and analyses available for evaluation. All concentrations of inorganic and metal constituents in the edible portions of the crayfish in the downstream reach were similar to the crayfish sampled in the reach above LANL.

Two elk were killed in vehicle accidents on Laboratory property in 2010; one within TA-36 and another within TA-54. Muscle and bone tissues from the animals were collected for analysis. Uranium concentrations were above RSRLs, but far below screening levels. Other radionuclides, inorganic constituents, and PCBs were either not detected or below RSRLs, in agreement with previous years' results. Two road-kill deer were analyzed: one from TA-46 and one from State Road 4 on Pueblo de San Ildefonso property. All radionuclide concentrations in muscle and bone were similar to those collected from regional background locations.

Biota Monitoring

No wide-scale monitoring of biota was conducted in 2010. Sampling in 2009 and in previous years shows that, in general, all concentrations of radionuclides and inorganic constituents in vegetation are very low and indistinguishable from regional background levels.

At TA-54, Area G, all radionuclides, with the exception of tritium, in native overstory vegetation (branches and needles) were either not detected or below the RSRLs. Tritium is detected above RSRLs in vegetation collected on the south side of TA-54, Area G, near tritium waste disposal shafts. Results are well below screening levels and similar to previous years.

- ❖ Vegetation at Area G contained elevated levels of radionuclides near known sources but far below screening levels.
- ❖ Biota samples at DARHT contained depleted uranium, but the levels were lower than previous years because of new contained testing measures.
- ❖ Biota samples collected above the Los Alamos Canyon Weir contained slightly elevated levels of some radionuclides and PCBs, but the concentrations were far below screening levels.

In vegetation around the DARHT facility, concentrations of radionuclides and metals were either not detected or below RSRLS. Uranium concentrations are lower than in previous years because high explosives testing is now conducted in metal vessels instead of in the open. Concentrations of radionuclides in mice at DARHT were not elevated with the exception of uranium. Uranium concentrations were slightly above baseline levels. The isotopic distribution of uranium isotopes indicates that the type of uranium is depleted uranium, released in historic open-air high explosives tests. Bees contained slightly higher levels of aluminum, copper, vanadium, and lead than RSRLs, but the concentrations were far below ecological screening levels.

Populations, composition, and the diversity of birds collected just west of the DARHT facility in 2010 were compared with samples collected in 1999 (preoperational phase). The purpose of the bird monitoring project is to determine the general ecological stress levels around the vicinity of DARHT that may be associated with facility operations (e.g., noise, disturbance, traffic, etc.). The number of birds, number of bird species, diversity, and evenness (distribution) collected in 2010 are similar to those collected before the start-up of operations at DARHT in 1999. In general, there are a large number of birds and types of birds located in the vicinity of the DARHT complex (see Figure ES-6).

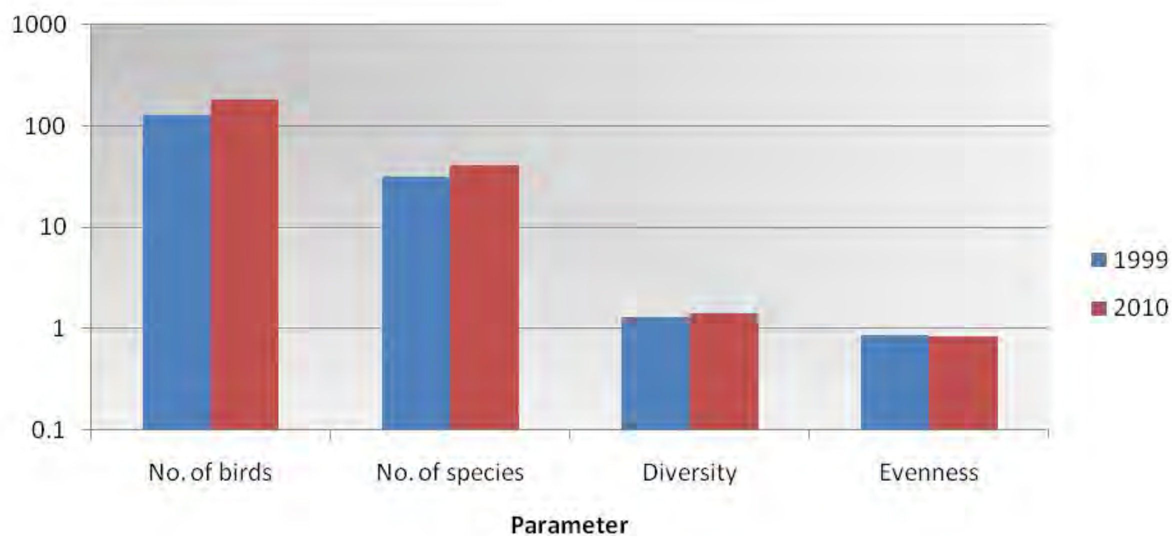

Figure ES-6 Populations, number of species, diversity, and evenness of birds occurring before (1999) and during (2010) operations at DARHT. Note the logarithmic scale on the vertical axis.

Special studies were conducted in 2010 to follow up on two Laboratory projects constructed following the 2000 Cerro Grande fire: Los Alamos Canyon weir and Pajarito Canyon Flood Control Retention Structure (FCRS). The weir was constructed to reduce the transport of contaminated sediments off site and the FCRS was constructed to protect Laboratory facilities downstream from post-fire flash flooding. Native vegetation and field mice were monitored for radionuclides, PCBs, organics, and inorganics. With a few exceptions, all contaminant concentrations in vegetation and field mice were not detected or below RSRLs. For the few contaminants above RSRLs, values were far below screening levels.

Environmental Restoration Program

Corrective actions proposed and/or conducted at LANL in 2010 follow the requirements of the Consent Order. The goal of the investigation efforts is to ensure that waste and contaminants from past operations do not threaten human or environmental health and safety. The investigation activities are designed to characterize solid waste management units (SWMUs), areas of concern (AOCs), consolidated units, aggregate areas, canyons, and watersheds. The characterization activities conducted include surface and subsurface sampling, drilling boreholes, geophysical studies, and installation of monitoring wells. Corrective action activities performed included the removal of structures (e.g., buildings, septic systems, sumps, and drain lines), excavation of contaminated media, and confirmatory sampling. These activities define the nature and extent of contamination and determine the potential risks and doses to human health and the environment.

Accomplishments in 2010 include the submission to NMED of initial or revised CME reports for TA-54, MDAs G, H, and L, completion of the D&D of buildings at TA-21, commencement of the TA-21, MDA B, excavation project, the completion of the remediation and investigations required by the TA-16 260 Outfall Corrective Measures Implementation (CMI) plan, and the completion or continued investigation of TA-50, MDA C, TA-49, three canyons, and eight aggregate areas. The CMEs recommend the removal of buildings from the TA-54 MDAs, construction of an evapotranspiration cover over disposal pits and shafts, and the operation of a soil vapor extraction (SVE) system at MDAs L and G. In conjunction with the CME reports, an SVE pilot test was conducted at MDA G demonstrating that this technology is effective

- Characterization and cleanup of sites contaminated or potentially contaminated by past LANL activities follow the Consent Order.
- The Laboratory submitted 59 new or revised investigation work plans and reports.
- The Laboratory submitted initial or revised Corrective Measures Evaluations for TA-54, MDAs G, H, and L.
- The D&D of buildings at TA-21 was completed. The excavation of TA-21, MDA B was initiated.
- Investigations were completed or continued at TA-50, MDA C, TA-49, three canyons, and eight aggregate areas

in removing volatile organic compound (VOC) vapors from the soil beneath the MDAs. Groundwater monitoring conducted to support the MDA G CME demonstrates no compelling evidence for the presence of contamination in the regional aquifer downgradient of MDA G.

The final buildings of the Laboratory's TA-21 plutonium processing facility were decontaminated and demolished during 2010. Excavation of MDA B began in June 2010. The asphalt cover on the site was removed and 7,265 yd^3 of waste materials were excavated. The active area of excavation was covered with a metal building with active air filtration to minimize the emission of contaminated soils during excavation operations.

The TA-16, 260 Outfall, CMI plan remediation and investigation activities were completed in 2010. Removal actions and final confirmation sampling were conducted in the lower drainage channel. Toxicity testing demonstrated no reductions in chironomids. A summary report on these activities was submitted to NMED. No potential unacceptable risks remain for industrial, construction worker, or residential scenarios. A CMI monitoring plan was submitted to NMED. Data generated from the monitoring activities will assist in determining if high explosives and barium contamination has been effectively remediated.

During 2010, environmental restoration activities collected samples at more than 1,600 locations and requested 850,000 analyses or measurements on these samples.

In 2010, LANL submitted 22 new or revised investigation work plans and 37 new or revised investigation reports to NMED. In 2010, NMED approved a total of 11 plans and 14 reports, most with modifications or directions. In addition, LANL submitted 35 periodic monitoring reports on periodic sampling activities, 53 plans and reports on groundwater monitoring well activities, and 24 miscellaneous reports or plans. NMED approved 34 SWMUs or AOCs as complete, requiring no further remedial actions.

Subsurface Vapor Monitoring

The Laboratory is conducting periodic monitoring of subsurface vapor at TA-54, MDAs G, H, and L, and at TA-21, MDAs T and V, for VOCs and tritium. The monitoring is conducted to determine if there is a threat to the groundwater from VOCs and tritium vapors originating from the waste buried at these MDAs. The Laboratory monitors subsurface vapors at 56 monitoring wells at a total of 196 ports. The ports are located from a few feet below the ground surface to as great as 700 feet below the ground surface. The approximate depth to the regional aquifer at TA-54 is between 930 and 1,300 feet. The Laboratory has also done some investigation sampling at TA-50 MDA C.

The primary VOCs of concern at MDA G and L are trichloroethane-1,1,1 (TCA) and trichloroethene (TCE) . We estimate that the mass of TCA and TCE at MDA G to be 210 kg and 79 kg, respectively. At MDA L, we estimate the mass of TCA and TCE to be 428 kg and 245 kg, respectively. The total amount of VOCs is much smaller at MDA H: we estimate the total mass of all VOCs to be less than 2 kg. Most of the mass of the VOC vapors below each of the TA-54 MDAs is contained within 200 feet of the surface, within the Bandelier tuff (Figure ES-7).

Subsurface tritium vapors at TA-54 are found primarily at MDA G which has active tritium waste disposal activities. The highest concentrations are located near tritium disposal shafts in the south-central portion of MDA G.

Methylene chloride, perchloroethylene (PCE), and TCA are the primary VOCs of concern at TA-21 MDA T; tritium is also monitored. VOCs and tritium consistently peak at a single depth below the surface over time. Further analyses are being conducted to support the Corrective Measures Evaluation (CME) report.

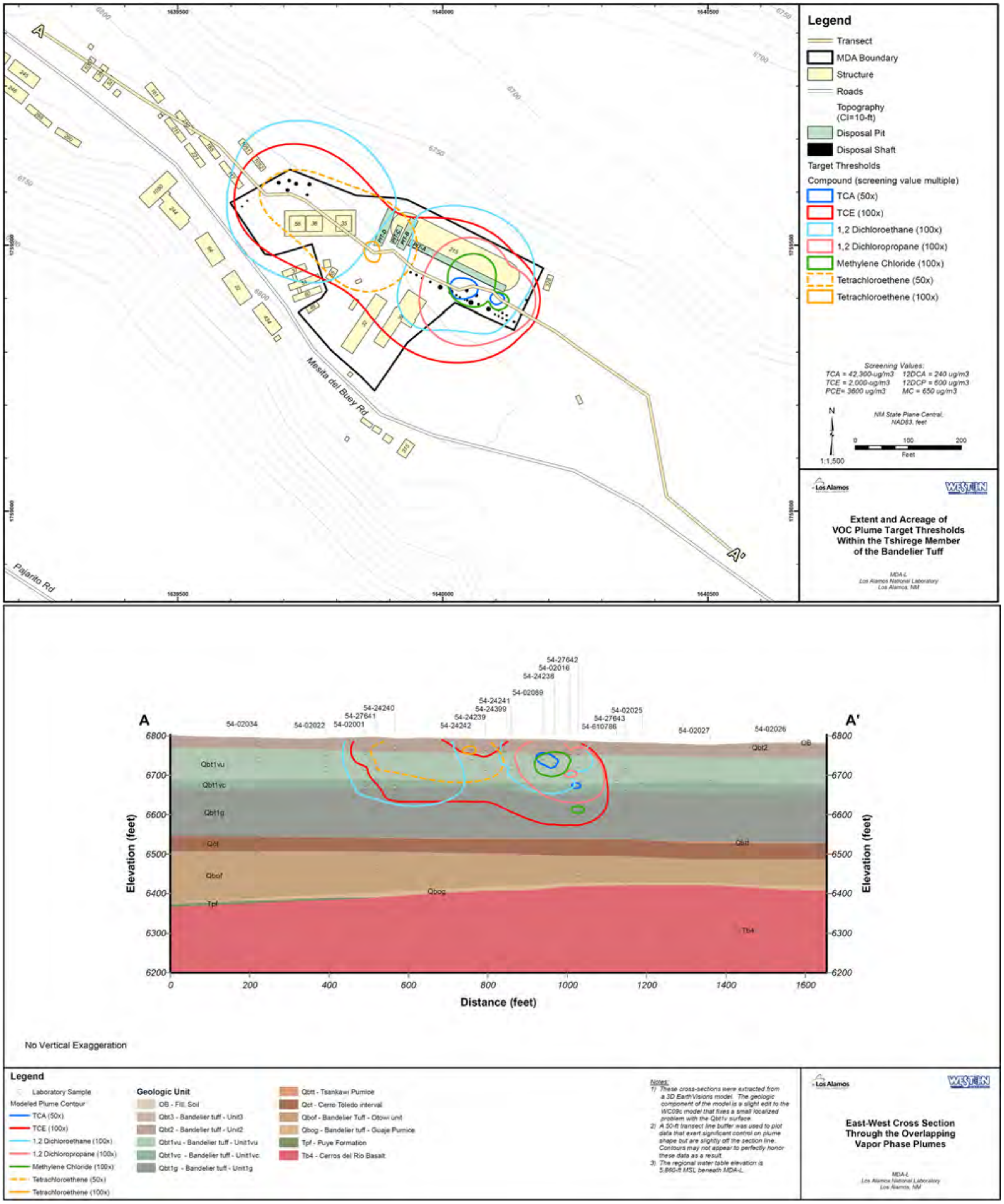

Figure ES-7 East-west horizontal and vertical cross-section of MDA L VOC plume thresholds, including 1,2-dichloroethane; 1,2-dichloropropane; methylene chloride; tetrachloroethene; TCA; and TCE

Remediation activities at TA-21, MDA V, were completed in 2005; however, the extent of tritium in subsurface vapors was not determined and so periodic monitoring has been conducted. A consistent prominent peak of tritium activity is found near 300 feet below ground surface. This may be produced by a subsurface geologic feature known as the Tsankawi pumice bed. Vapor monitoring will continue until remediation activities are completed at nearby MDA B.

Analytical Laboratory Quality Assurance

Environmental samples collected by the Laboratory are processed and analyzed by commercial independent analytical chemistry laboratories to determine contaminant concentrations in the samples. Each analytical laboratory must follow EPA-approved analysis methods to determine contaminant concentrations and implement a stringent quality assurance/quality control program to assure the accuracy of the results. All analytical laboratory results undergo validation by a LANL subcontractor. If data validation identifies analytical results that do not meet EPA or LANL requirements, then LANL will perform a follow-up assessment with the analytical laboratory to identify issues and corrective actions. Finally, LANL requires each analytical laboratory to participate in third-party independent review and certification programs as a further quality assurance requirement.

- Independent commercial chemistry laboratories analyze LANL environmental samples.
- The quality assurance performance of these laboratories is best-in-class.

For 2010, approximately 98% of all analytical chemistry results were of good quality and usable for environmental compliance and assessment. Approximately 16% of the accepted results were qualified due to some portion of the analysis not meeting requirements; however, the concentration results were still acceptable for use.

Data validation efforts identified three individual analytical laboratory data quality issues in 2010. Organic contaminants were introduced into several groundwater samples by the analytical laboratory or from sample bottles. Chromium concentrations in several groundwater samples that were near detection limits were incorrectly identified as detections due to analytical laboratory software issues. Selenium concentrations in soil were incorrectly identified as detections due to instrumentation errors. Each of these issues has been corrected and procedures implemented to prevent recurrence.

A new analytical laboratory for low-level tritium analyses was used by LANL during 2010; due to minor differences in analytical methods at the two laboratories, the more recent data are not directly comparable to earlier values.

LANL performed a review of some previous groundwater sampling results for plutonium-238 in the Buckman Well field. In 2006, one plutonium-238 detection was identified for a sample from Buckman Well #1. Upon additional review, this analysis was found to be incorrect; plutonium-238 was not detected in this 2006 sample. This information has been updated in the RACER database.

An analytical result data package assessment was conducted at one analytical laboratory during 2010, when validation identified more systematic issues at the analytical laboratory. A total of 109 individual issues and “time-savings” opportunities were identified. The analytical laboratory developed a comprehensive corrective action plan and each issue was resolved.

Each analytical laboratory participated in third party reviews; samples of known concentration are sent to the analytical laboratory and the laboratory must demonstrate that they can produce similar results. Each analytical laboratory that LANL uses met all independent testing and certification requirements during 2010.

Overall, the performance of LANL’s analytical laboratories is excellent.

Monitoring of the Rio Grande

> ❖ LANL impacts on the Rio Grande are small.

Water quality, sediments, and biota/foodstuffs have been monitored for many years in and along the Rio Grande to assess LANL impacts. Radionuclides found in surface water samples are naturally occurring. In 2010, LANL sampled fruits and vegetables irrigated with Rio Grande water upstream and downstream of LANL. In general, contaminants in all produce samples were very low (pCi range) and most were either not detected or detected below the RSRLs.

Natural stream flow and sediment loading in the Rio Grande are quite large compared with Los Alamos area streams. A preliminary estimate of PCB flux in lower Los Alamos Canyon into the Rio Grande is 1% to 3% of the total estimated long-term flux in the Rio Grande. LANL installed grade control structures to stabilize sediments and contaminants in place to reduce the sediment from LANL property reaching the Rio Grande. Automated storm flow monitoring stations have been installed to notify BDD Project personnel of major flow events reaching the Rio Grande. Two storm water flows entered the Rio Grande from Los Alamos and Pueblo Canyons during 2010; notifications were made to BDD Project in both cases.

Past risk assessments of the potential risk to the public from chemicals and radioactive materials released from the Cerro Grande fire found minimal exposure risks. The Buckman Direct Diversion (BDD) Project Independent Peer Review found that no risk to BDD Project drinking water from LANL-derived radioactive or chemical contaminants.

In summary, any LANL contributions to the Rio Grande are masked and overwhelmed by contaminants from upriver sources. With the exception of mercury and PCBs in fish, derived from non-LANL sources, the levels of contaminants in the Rio Grande are below all levels of concern.

Monitoring In the Jemez Mountains and Valles Caldera

We performed a review of Laboratory environmental monitoring studies performed in the Jemez Mountains and the Valles Caldera to the west and southwest of the Laboratory. Elevated concentrations of trace elements occurred in vegetation when receiving episodic discharges from the Fenton Hill hot dry rock site. When the discharges ended, these elevated concentrations were no longer measured. A very few sporadic detections of radionuclides and chemicals have been measured in air, surface water, sediment, soil, and biota and foodstuffs over the period of record. The detections appear to be isolated instances and show no spatial or temporal trends. The detections cannot be attributed to Laboratory operations or influences.

Risk Reduction

> ❖ The Laboratory reduced environmental risks during 2010 though reduction in TRU waste inventories, D&D of plutonium processing buildings at TA-21, installation of sediment control structures, and ongoing wildland fire tree thinning.

The Laboratory is committed to reducing environmental hazards and the associated risk to people and the environment. Over the years, the Laboratory has decreased its release of materials into the environment and has reduced the amount of legacy contamination. These efforts have significantly reduced or eliminated potential exposure and risk to workers, the public, and the environment.

Examples of ongoing risk reduction activities include the transport of stored legacy transuranic waste from TA-54, Area G, to WIPP in Carlsbad, NM, the D&D and cleanup of the former plutonium processing facility at TA-21, and ongoing studies of groundwater contamination to evaluate future hazards and risks, and numerous investigations and corrective actions at potentially contaminated sites.

During 2010, the Laboratory continued design work on evaporation tanks to allow elimination of the TA-50 RLWTF outfall. The Laboratory also eliminated three cooling tower outfalls. LANL completed construction of grade control structures in Pueblo and DP Canyons to reduce the transport of contaminated sediments off LANL property. The Laboratory signed an MOU for five years of monitoring to support the BDD Project.

As part of the Laboratory's Wildland Fire Management Plan, the Laboratory performed tree thinning operations on 380 acres of LANL property. These mitigation actions were extremely important in minimizing the amount of LANL lands burned by wildfire during the 2011 Las Conchas fire.