APPENDIX A

FACILITY DESCRIPTION

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LIST OF ABBREVIATIONS/ACRONYMS

20.4.1 NMAC	New Mexico Administrative Code, Title 20, Chapter 4, Part 1
AASHTO	American Association of State Highway and Transportation Officials
amsl	above mean sea level
D&D	decommissioning and demolition
DOE	U.S. Department of Energy
ft	feet/foot
HE	high explosives
in.	inch(es)
LANL	Los Alamos National Laboratory
NNSA	National Nuclear Safety Administration
POV	privately-owned vehicles
R&D	Research and Development
sf	square feet
TA	technical area
TRUPACT	transuranic waste package transporter
TRUWF	Transuranic Waste Facility

APPENDIX A
FACILITY DESCRIPTION

The information provided in this appendix is submitted in accordance with the applicable requirements of the New Mexico Administrative Code, Title 20, Chapter 4, Part 1 (20.4.1 NMAC), revised October 1, 2003 [10-01-03]. The following subject areas are addressed in this appendix or are referenced to permit renewal documentation for Los Alamos National Laboratory (LANL):

- A general description of the LANL facility and a general description of Technical Area (TA) 52 [20.4.1 NMAC § 270.14(b)(1)];
- Site-specific traffic patterns, volume, and control [20.4.1 NMAC § 270.14(b)(10)];
- Site-specific facility location information for compliance with the seismic standard and floodplain requirements [20.4.1 NMAC §§ 270.14(b)(11) and 270.14(b)(19)(ii), and 20.4.1 NMAC § 264.18(a) and (b)];
- Site-specific topographic map requirements [20.4.1 NMAC § 270.14(b)(19)];
- Site-specific groundwater monitoring and protection information [20.4.1 NMAC § 270.14(c) and 20.4.1 NMAC § 264.90(a)].

A.1 GENERAL DESCRIPTION [20.4.1 NMAC § 270.14(b)(1)]

LANL is located in Los Alamos County, an incorporated county, in north-central New Mexico, approximately 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe. The regional location of LANL is shown on Figure A-1. LANL is divided into TAs, as shown on Figure A-2. LANL, which occupies an area of approximately 40 square miles, and the associated residential and commercial areas of Los Alamos County, which occupy an area of approximately 109 square miles, are situated on the Pajarito Plateau. The plateau consists of a series of finger-like mesas separated by deep east-west trending canyons. Ephemeral, interrupted, or intermittent streams lie at the bottoms of all the canyons. The mesa tops range in elevation from approximately 7,800 feet (ft) above mean sea level (amsl) at the flank of the Jemez Mountains, located to the west of Los Alamos, to about 6,200 ft amsl at their eastern extent, where they terminate above the Rio Grande.

LANL's central mission is the reduction of global nuclear danger supported by research that also contributes to conventional defense, civilian, and industrial needs. This includes programs in nuclear, medium energy, and space physics; hydrodynamics; conventional explosives; chemistry; metallurgy; radiochemistry; space nuclear systems; controlled thermonuclear fusion; laser research; environmental technology; geothermal, solar, and fossil energy research; nuclear safeguards; biomedicine; health and biotechnology; and industrial partnerships. LANL is owned by the U.S.

Department of Energy (DOE) and is operated jointly by the DOE National Nuclear Security Administration and the Los Alamos National Security, LLC. The facility mailing address is P.O. Box 1663, Los Alamos, New Mexico, 87545.

LANL is an existing treatment and storage facility. This permit modification request is submitted for the addition of the Transuranic Waste Facility (TRUWF) that will be located at TA-52 to the LANL Hazardous Waste Facility Permit. Permit renewal documentation has previously been submitted for treatment and storage units that are current or proposed "active" operating units.

Hazardous waste is generated at LANL primarily from research and development (R&D) activities, general facility operations, corrective action activities, and decontamination and decommissioning (D&D) projects. Mixed low-level waste is generated mainly from R&D activities, processing and recovery operations, general facility operations, D&D projects, and corrective action activities. Mixed transuranic waste is generated primarily from R&D activities, processing and recovery operations, and D&D projects. High explosives (HE) contaminated waste is generated mainly from R&D activities, corrective action activities, wastewater treatment processes, and building maintenance and modification activities. Brief descriptions of specific hazardous and mixed waste management units at LANL are presented in this permit modification package and in permit renewal documents, as appropriate. Waste generated from R&D activities, processing and recovery operations, and corrective action activities may be received from off-site facilities, as described in the most recent version of the LANL General Part B Permit Renewal Application (LANL, 2003).

A.1.1 Transuranic Waste Facility General Description [20.4.1 NMAC §270.14(b)(1)]

The TRUWF (Building 190) will be located at TA-52 on a mesa between a branch of Mortandad Canyon on the north and Pajarito Canyon on the south in the north central portion of LANL. The TRUWF is currently scheduled for beginning construction of the requested permitted building in 2010 and for completion in 2012. This hazardous waste management unit will be located on approximately 7 acres. The TRUWF will be approximately 28,100-sf (square feet). The layout of the facility is depicted in Figure A-3 with the location of areas where storage will occur highlighted.

A.2 TRAFFIC PATTERNS [20.4.1 NMAC §270.14(b)(10)]

General traffic pattern information, traffic volumes, and traffic control signals for the LANL-wide facility are provided in the most recent version of the LANL General Part B Permit Renewal

Application (LANL, 2003). Roadways will be provided for truck and trailer storage, spare Transuranic Waste Package Transporter (TRUPACT) II storage, and access for staff and traffic to onsite roads.

A.2.1 Routes of Travel

Hazardous and/or mixed waste is occasionally transported to and from TA-52 to other areas at LANL (e.g., TA-54). The primary traffic routes that will be used to transport hazardous and mixed waste to and from TA-52 include Diamond Drive, Pajarito Road, and Puye Drive as shown on Figures A-4 and A-5.

A.2.2 Traffic Volumes

The buildings at TA-52 are located northwest of the intersection of Pajarito Road and Pecos Drive, as shown on Figure A-5. According to a traffic study conducted by Johnson Controls World Services, Inc. (JCI) (JCI, 1999), Pajarito Road has an average daily traffic volume of 12,000 vehicles. This includes vehicles traveling both northwest and southeast. Pecos Drive has an average daily traffic volume of 5,000 vehicles per day. This includes vehicles traveling both north and south. These values are based on a 24-hour period. Vehicle types include cars, light- and medium-duty trucks, and vans.

A.2.3 Traffic Control Signals

Roadway access is required for privately-owned vehicles (POV), site vehicles, TRUPACT II tractors/semi-trailers, other waste trucks, delivery vehicles, and characterization trailers. The TRUWF will be located north of Puye Road at TA-52, which is connected approximately 1500 ft west of the facility to Pajarito Road, a major east-west route at LANL. The locations of proposed traffic control signals at the TRUWF are shown on Figure A-5. Other traffic control signals on Puye Road include stop signs, posted speed limits, a traffic light, and other traffic and pedestrian control signs.

A.2.4 Road Load-Bearing Capacity

Roads within TA-52 are generally two lane roads with asphaltic-concrete surfaces. Load-bearing capacity for these roads is 32,000 pounds per axle. These roads are typically constructed with a 6-inch (in.) thick base with a 3-in. thick asphaltic-concrete surface. These roads were designed and constructed to meet the American Association of State Highway and Transportation Officials (AASHTO) specification HS-20 (AASHTO, 1996).

A.3 LOCATION INFORMATION [20.4.1 NMAC §270.14(b)(11)]

A.3.1 Seismic Standard [20.4.1 NMAC §270.14(b)(11)(i - ii) and 20.4.1 NMAC §264.18(a)]

TA-52 is in compliance with the seismic standards of 20.4.1 NMAC §270.14(b)(11) and 20.4.1 NMAC §264.18(a) [10-01-03]. Based on information contained in Supplement A.1 of this permit modification submittal, there has been no evidence observed of Holocene faulting within 3,000 ft of the proposed facility.

A.3.2 Floodplain Standard [20.4.1 NMAC §270.14(b)(11)(iii - v) and 270.14(b)(19)(ii); 20.4.1 NMAC §264.18(b)]

The hazardous and mixed waste management units at TA-52 are located on a mesa top. In accordance with 20.4.1 NMAC §270.14(b)(11)(iii) [10-01-03], the hazardous and mixed waste management units addressed in this permit application are not located within the 100-year floodplain boundary. Additional floodplain information is provided in the most recent version of the LANL General Part B Permit Renewal Application (LANL, 2003).

A.4 TOPOGRAPHIC MAPS [20.4.1 NMAC §270.14(b)(19)]

Topographic maps and figures are provided herein or referenced to meet the requirements of 20.4.1 NMAC §270.14(b)(19) [10-01-03]. All maps clearly show the map scale, the date of preparation, and a north arrow. The maps and figures used to fulfill these regulatory requirements include the following:

- LANL-wide 100-year floodplain maps are provided as Appendix C of the “Response to Request for Supplemental Information: Technical Adequacy Review, RCRA Permit Application; General Part A,” April 1998, Revision 0.0; and “Los Alamos National Laboratory General Part B,” October 1998, Revision 1.0; Los Alamos National Laboratory, EPA ID No. NM 0890010515” (LANL, 2001).
- A map showing surface waters, including intermittent streams, near TA-52 is included as Figure A-6.
- Surrounding land uses are shown on Figure A-1.
- Wind roses for TA-6, the TA directly west-northwest of TA-52, are shown on Figures A-7 and A-8.
- A map showing the boundaries of LANL (including TA-52) is provided as Figure A-2.
- Access control features at TA-52 (e.g., fences, gates) are included on Figure A-5.

- A map showing supply wells, monitoring wells, test wells, springs, and surface-water sampling stations near TA-52 is included as Figure A-6 of this permit modification request and on Map 3 of the most recent version of the "Los Alamos National Laboratory General Part A Permit Application," hereinafter referred to as the LANL General Part A (LANL, 2006).

- The locations of proposed buildings, hazardous waste management unit, and loading and unloading areas at the TRUWF are shown on Figure A-3.

- A map showing National Pollutant Discharge Elimination System point source discharge locations is included in the most recent version of the LANL General Part A (LANL, 2006).

- Storm, sanitary, and process sewer systems at LANL are shown the most recent version of the LANL General Part B Permit Renewal Application (LANL, 2003). The TRUWF will be connected to the LANL sanitary system and storm water pollution prevention and drainage systems will be installed.

- Drainage control features (e.g., run-on/runoff) are shown on Figure A-9.

- Fire stations serving LANL and the County of Los Alamos are shown the most recent version of the LANL General Part B Permit Renewal Application (LANL, 2003).

- The equipment cleanup area for LANL is located at TA-50-1. The location of TA-50-1 is shown the most recent version of the LANL General Part A Permit Application (LANL, 2006).

Contour lines on the topographic map (Figure A-6) are in intervals sufficient to detail natural drainage at LANL and in the vicinity of the waste management unit proposed for TA-52. As provided in 20.4.1 NMAC §270.14(b)(19) [10-01-03], LANL has submitted the maps to the New Mexico Environment Department at these scales and contour intervals due to the size of the waste management units, the extent of the LANL facility, and the topographic relief in the area.

A.5 GROUNDWATER MONITORING [20.4.1 NMAC, Subpart IX, 270.14(c) and 20.4.1 NMAC, Subpart V, 264.90(a)]

Groundwater monitoring information is provided in the most recent version of the LANL General Part B Permit Renewal Application (LANL, 2003).

A.6 OTHER PERMIT ACTIVITIES

Other types of Resource Conservation and Recovery Act permits include, but are not limited to, the following:

- Permits by Rule
- Emergency Permits

- Hazardous Waste Incinerator Permits
- Permits for Land Treatment Demonstrations Using Field Test or Laboratory Analyses
- Interim Permits for Underground Injection Control Program Wells
- Research, Development, and Demonstration Permits
- Permits for Boilers and Industrial Furnaces Burning Hazardous Waste

Currently, none of these permit types are in effect for operations at TA-52.

A.7 REFERENCES

AASHTO, 1996 and all approved updates, "Standard Specifications for Highway Bridges," 16th Edition, American Association of State Highway and Transportation Officials.

JCI, 1999, Telecon from John Bradley, Johnson Controls World Services, Inc. to Jessica Moseley, IT Corporation, on February 10, 1999, Los Alamos, New Mexico.

LANL, 2006 and all recent revisions, "Los Alamos National Laboratory General Part A Permit Application, Revision 5.0, April 2006," LA-UR-06-2553, Los Alamos National Laboratory, Los Alamos, New Mexico.

LANL, 2003 and all recent revisions, "Los Alamos National Laboratory General Part B Permit Application, Revision 2.0, August 2003," LA-UR-03-5923, Los Alamos National Laboratory, Los Alamos, New Mexico.

LANL, 2001, "Response to Request for Supplemental Information: Technical Adequacy Review, RCRA Permit Application; General Part A," April 1998, Revision 0.0; "Los Alamos National Laboratory General Part B," October 1998, Revision 1.0, Los Alamos National Laboratory, EPA ID No. NM0890010515," Los Alamos National Laboratory, Los Alamos, New Mexico.

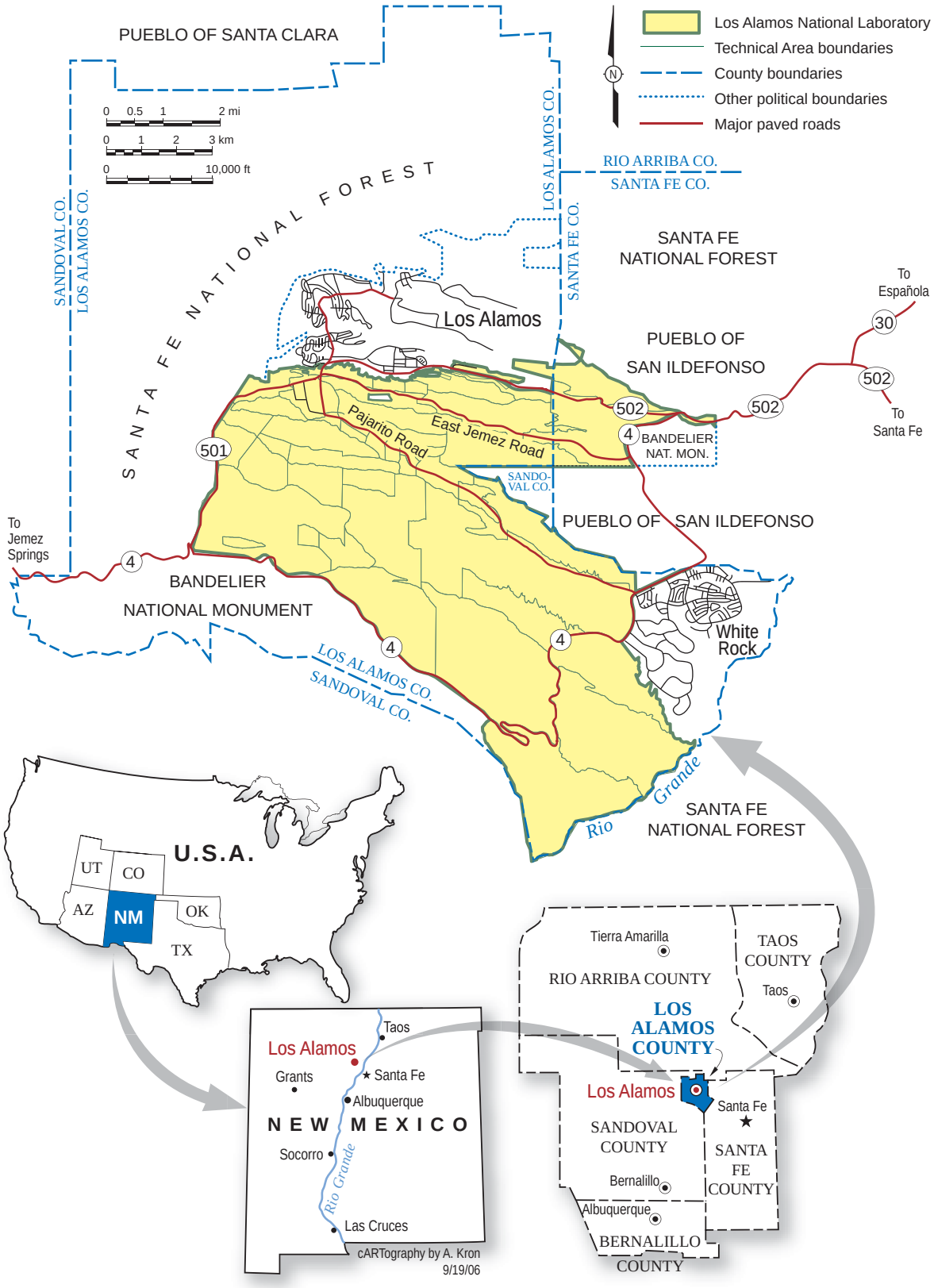


Figure A-1

Regional Location Map of Los Alamos National Laboratory and Surrounding Land Use

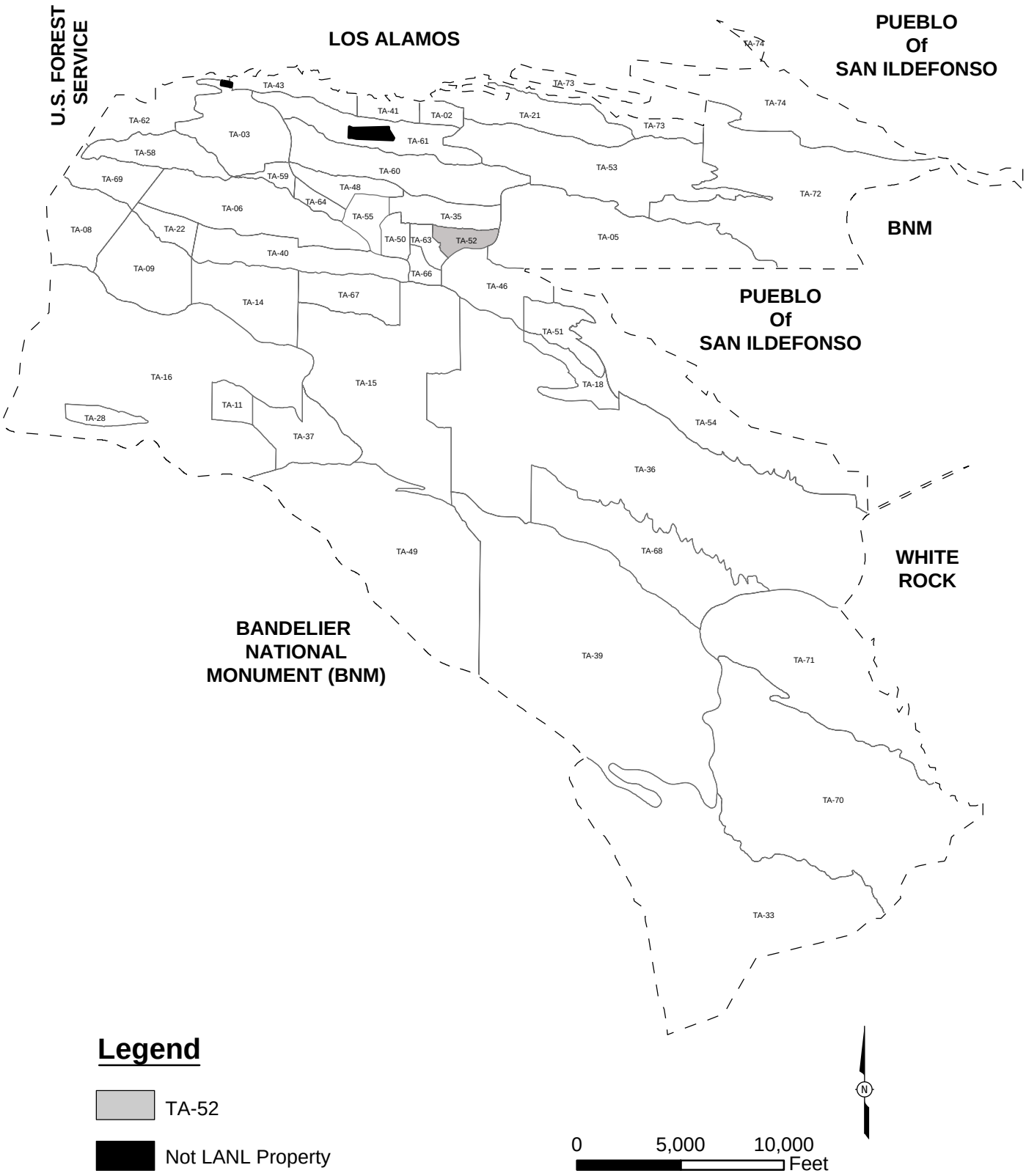


Figure A-2

Location of Technical Area (TA) 52 at Los Alamos National Laboratory (LANL)

Created by ERSS GIS TEAM. Map Number 06-0108 September12, 2005
State Plane Coordinate System New Mexico Central Zone North American Datum 1983 (ft)
This map was created for work processes associated with the Environmental &Remediation Support Services. All other uses for this map should be confirmed with LANL EP-ERSS staff.
Boundary of Department of Energy Property I Around the Los Alamos National Laboratory; Los Alamos National Laboratory, SSMO Site Planning & Project Initiation; infrastructure Planning Office. 10 February 2006
Boundary of Department of Energy Property In and Around the Los Alamos National Laboratory; Los Alamos National Laboratory, SSMO Site Planning & Project Initiation; 01 February 2003 as captured 07 September 2004.

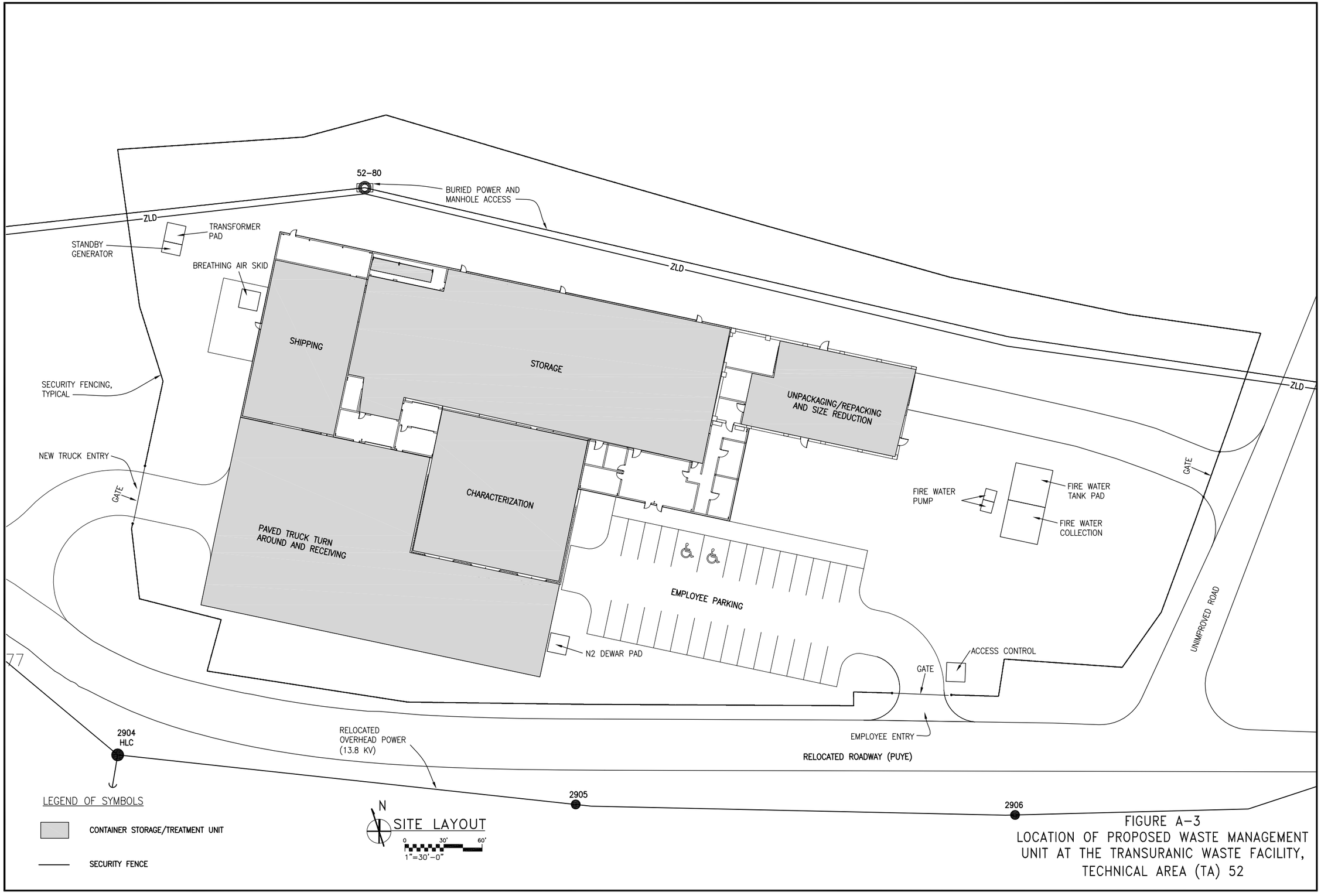


FIGURE A–3
LOCATION OF PROPOSED WASTE MANAGEMENT UNIT AT THE TRANSURANIC WASTE FACILITY, TECHNICAL AREA (TA) 52

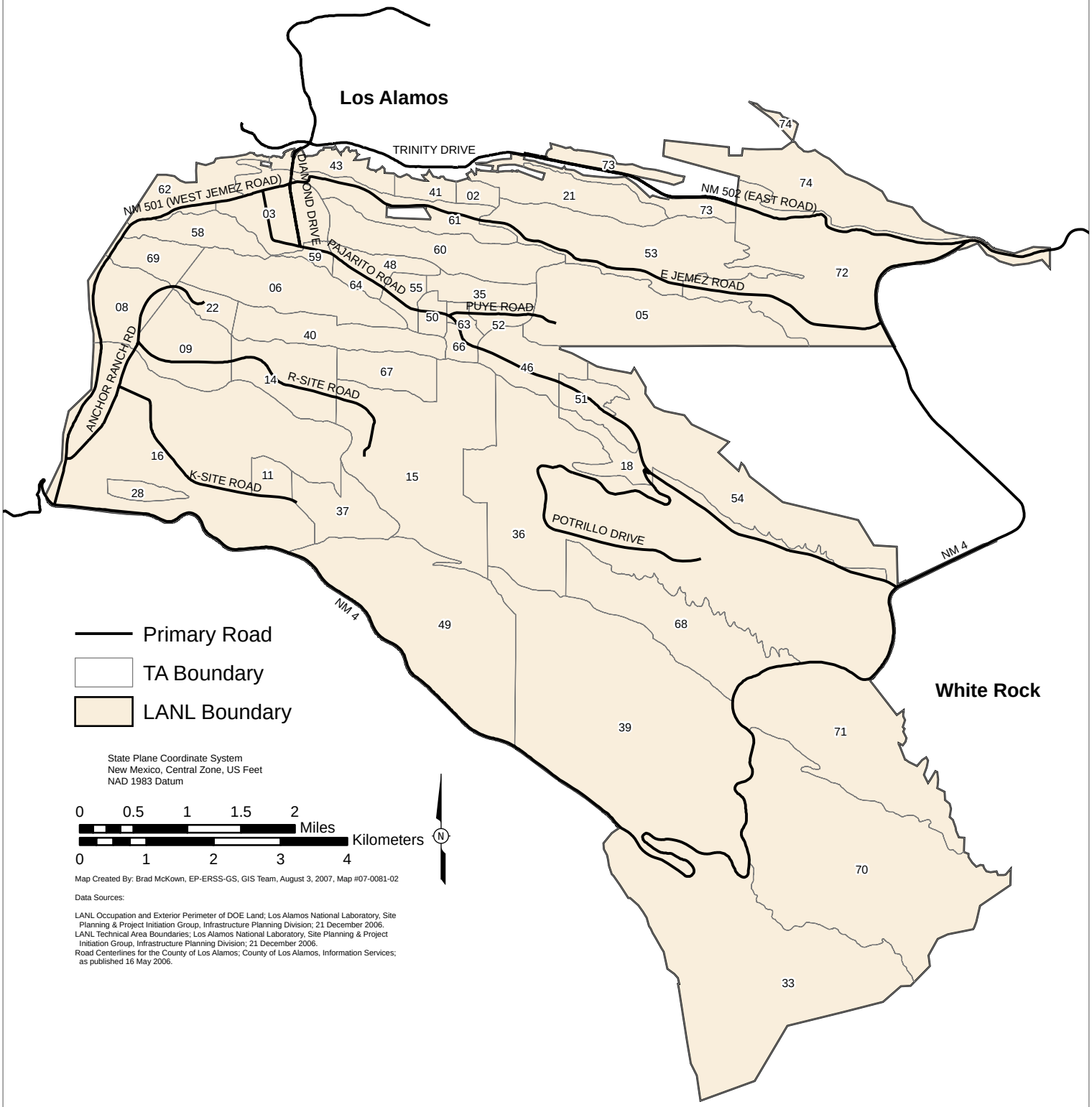


Figure A-4

Major Roads and Primary Traffic Routes at Los Alamos National Laboratory (LANL)

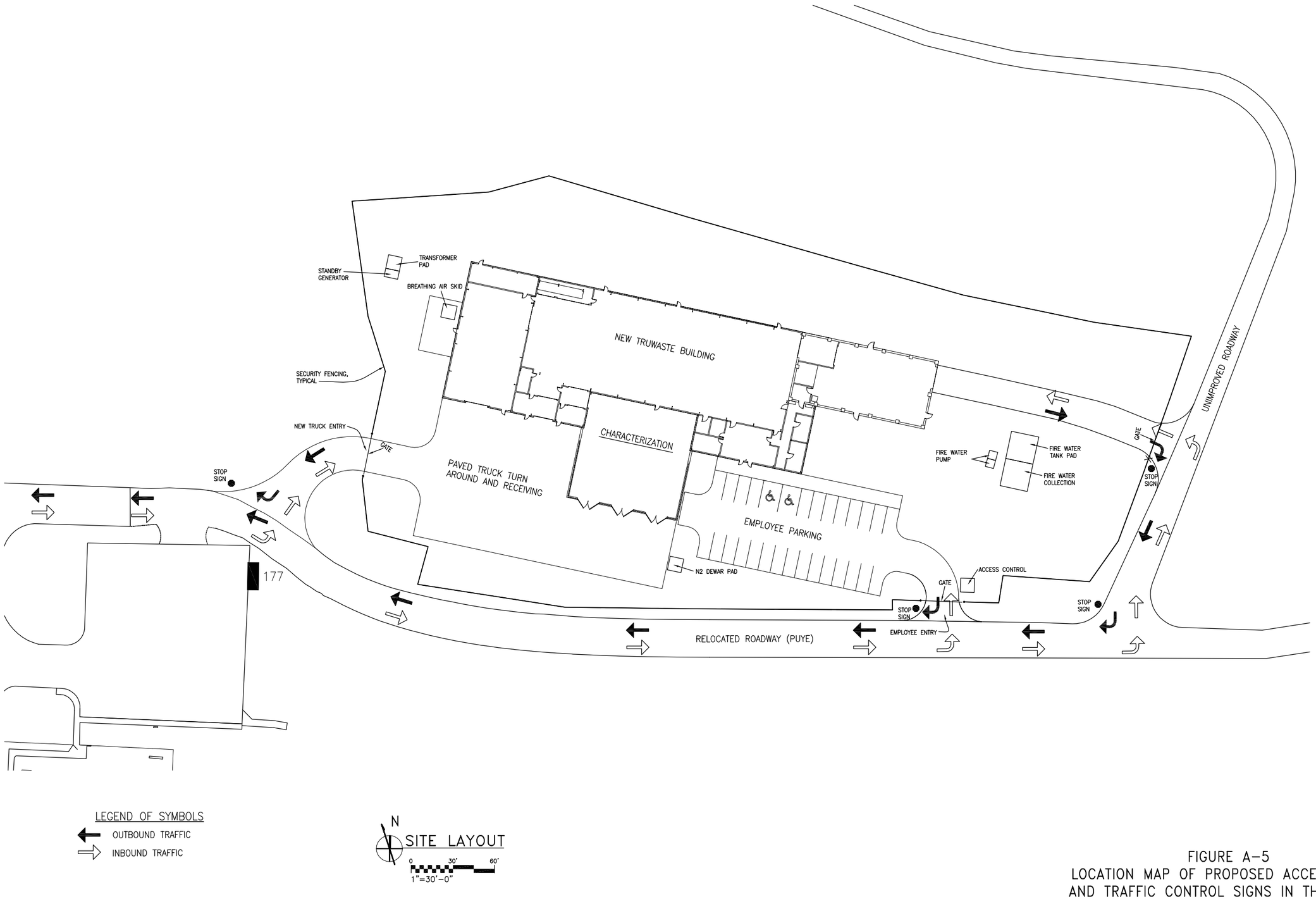
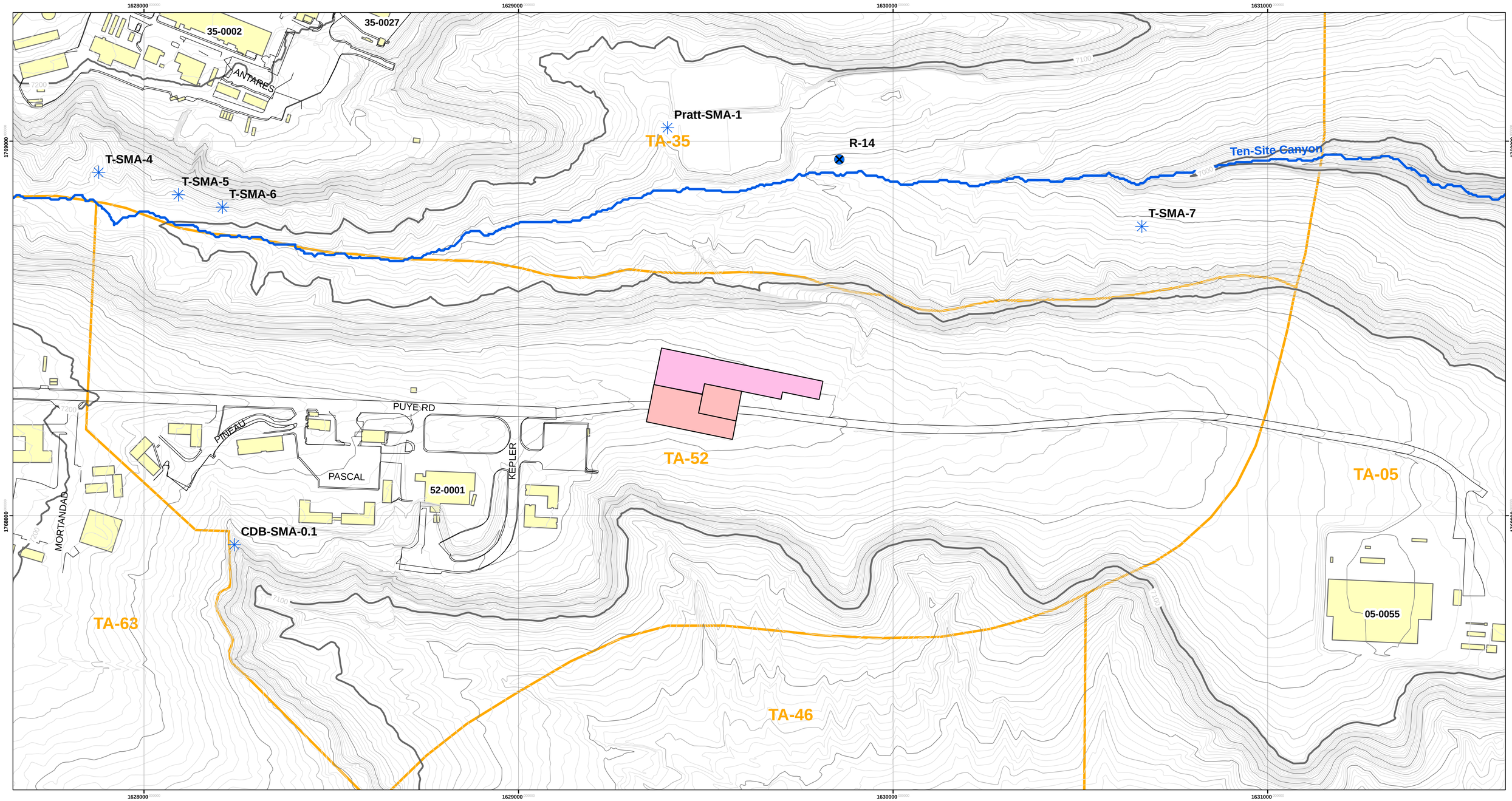


FIGURE A-5
LOCATION MAP OF PROPOSED ACCESS ROADS AND TRAFFIC CONTROL SIGNS IN THE VICINITY OF THE TECHNICAL AREA (TA) 52



1:1,476

State Plane Coordinate System
New Mexico, Central Zone, US Feet
NAD 1983 Datum

Grid Interval 1000 Feet, Contour Interval 2 Feet

N

Feet 0 190 380 570 760

Meters 0 75 150 225 300

Data Sources:

Hypsography, 100, 20, and 10 Foot Contour Intervals; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.
WQH Drainage_arc; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; 1:24,000 Scale Data; 03 June 2003.
Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 27 April 2007.
Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 10 July 2007.
Penetrations; Los Alamos National Laboratory, Environment and Remediation Support Services, EP2007-0442; 1:2,500 Scale Data; 16 July 2007.

Map Created By: Brad McKown
EP-ERSS, GIS Team
August 2, 2007
Map #07-0081-01

Figure A.6
Contour Map Showing the Location of the Proposed Hazardous Waste Management Unit at Technical Area (TA) 52

SMA Sampler Location	Storage Building
Well	Outdoor Storage
Drainage	TA Boundary
Paved Road	Structure

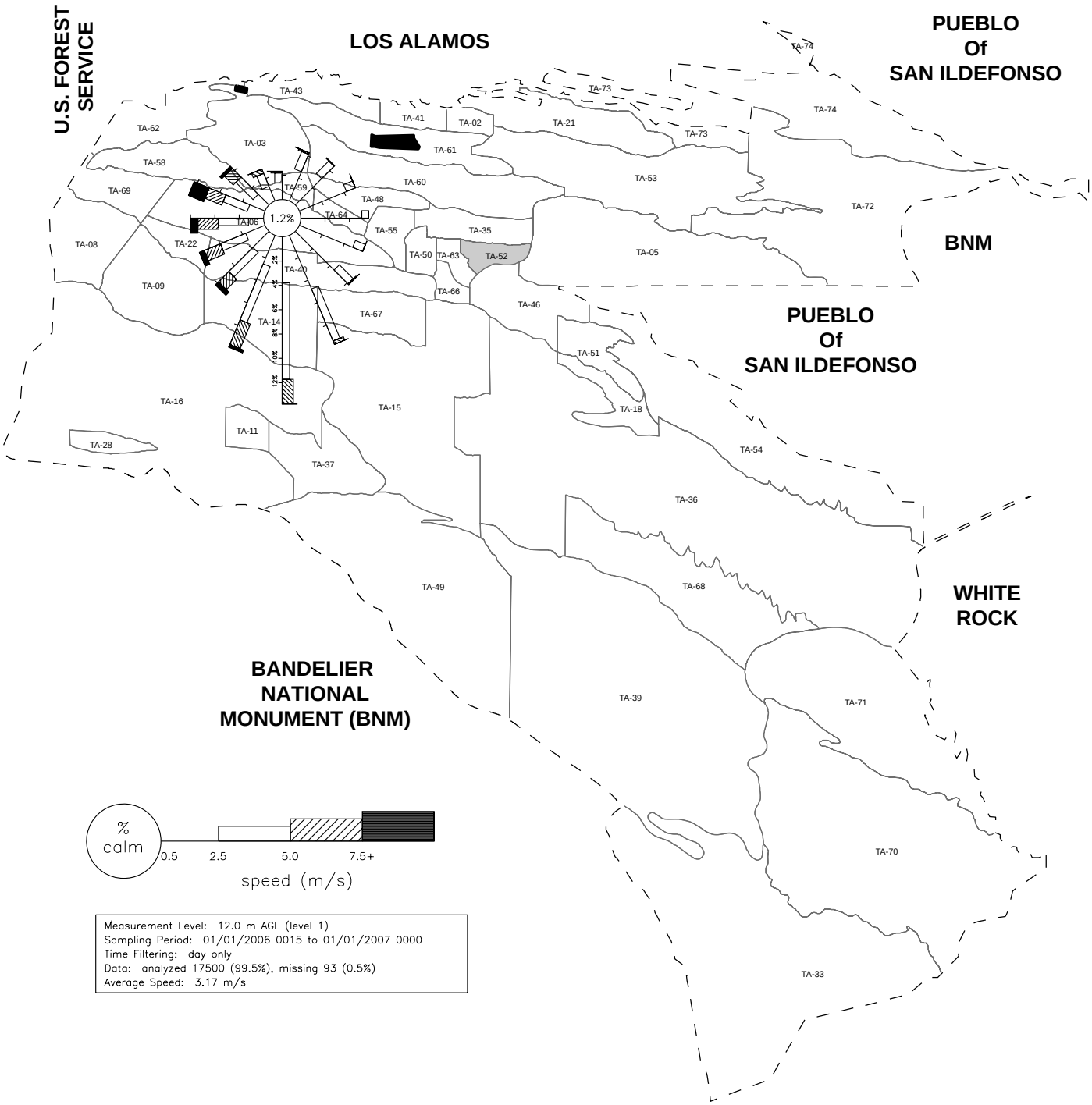


Figure A-7

Annual Wind Rose for Technical Area (TA) 6 at Los Alamos National Laboratory (LANL) -- Day

Created by ERSS GIS TEAM. Map Number 06-0108 September12, 2005
State Plane Coordinate System New Mexico Central Zone North American Datum 1983 (ft)
This map was created for work processes associated with the Environmental &Remediation Support Services. All other uses for this map should be confirmed with LANL EP-ERSS staff.
Boundary of Department of Energy Property I Around the Los Alamos National Laboratory; Los Alamos National Laboratory, SSMO Site Planning & Project Initiation; infrastructure Planning Office. 10 February 2006
Boundary of Department of Energy Property In and Around the Los Alamos National Laboratory; Los Alamos National Laboratory, SSMO Site Planning & Project Initiation; 01 February 2003 as captured 07 September 2004.

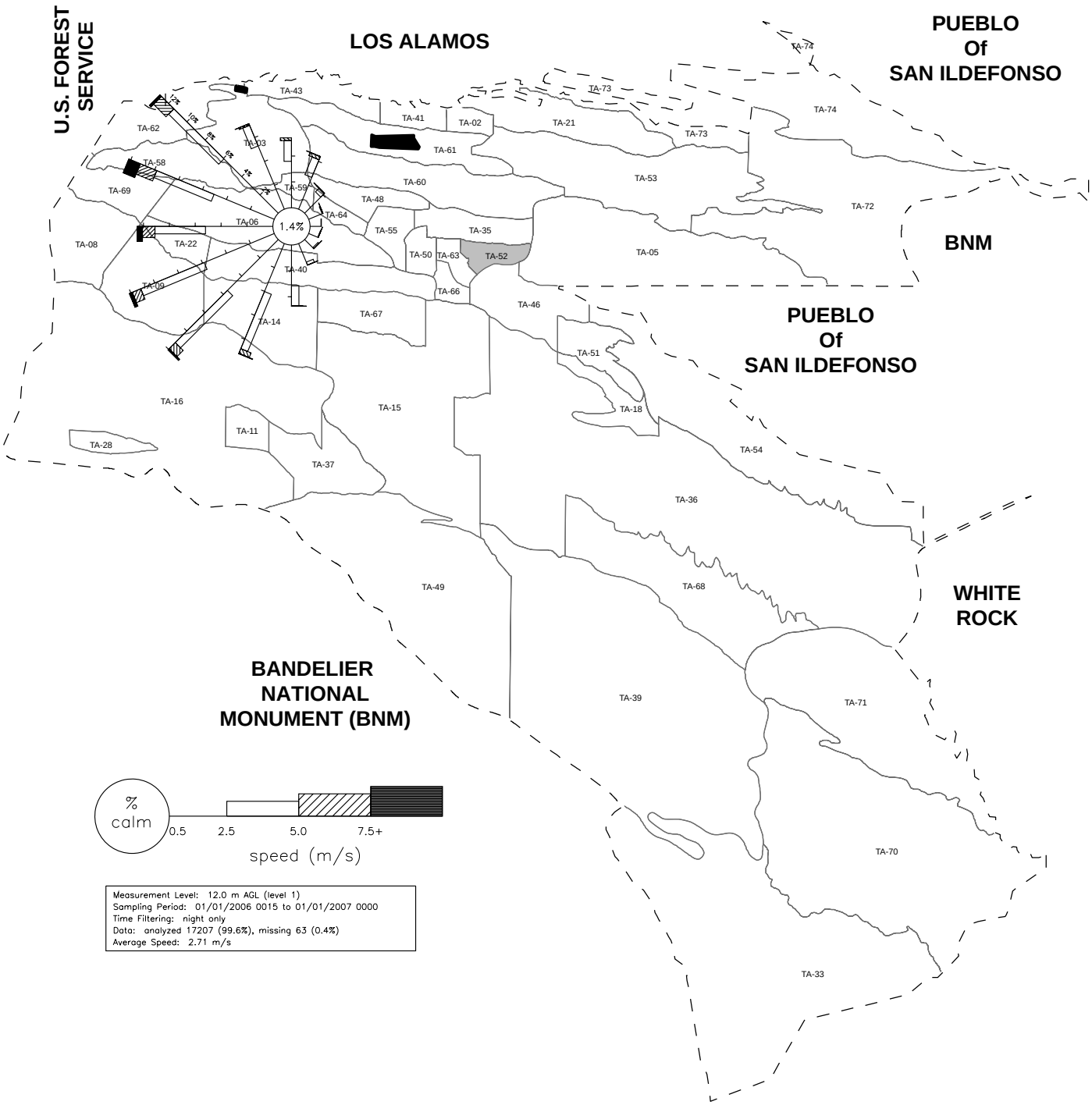
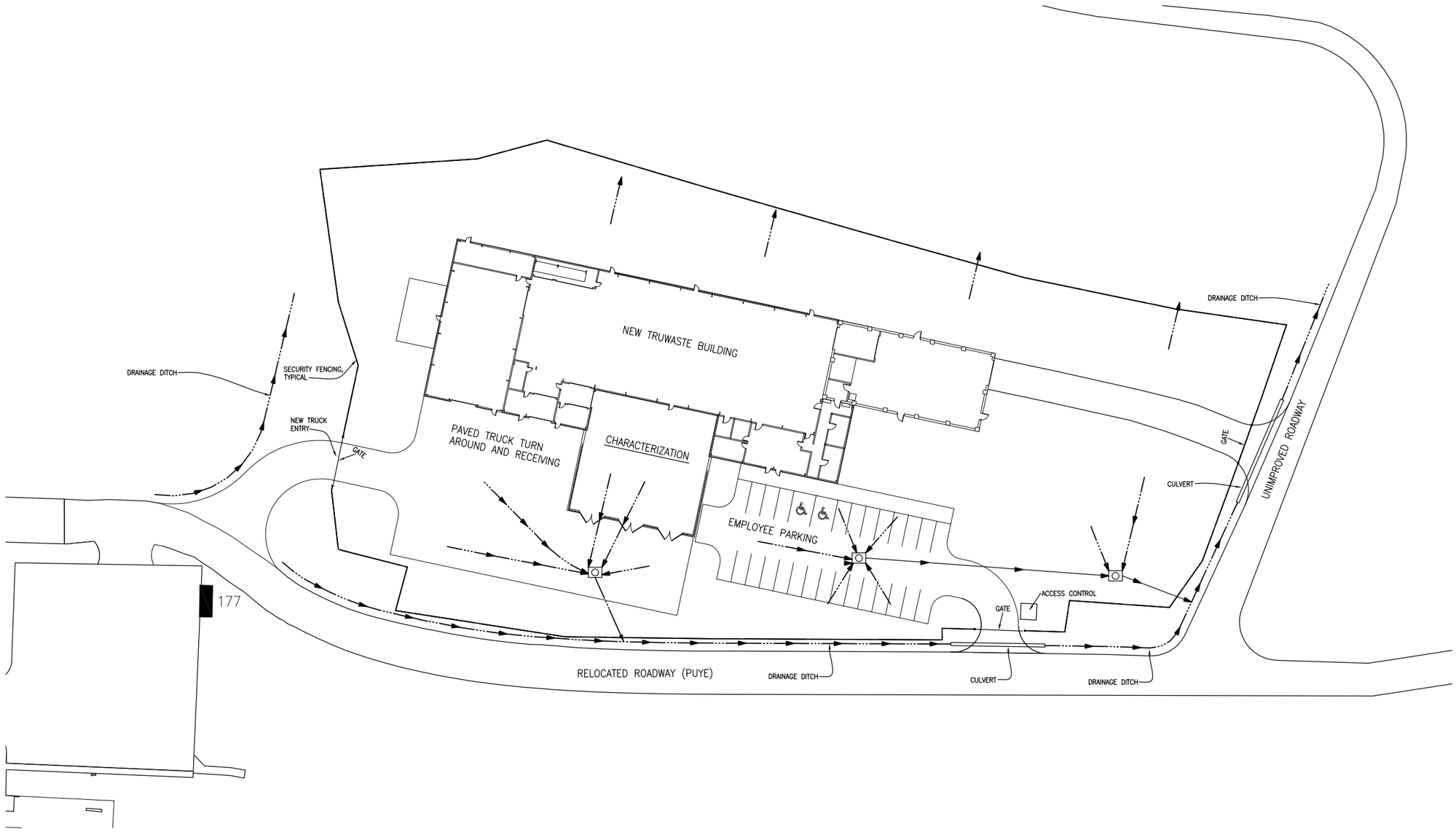


Figure A-8

Annual Wind Rose for Technical Area (TA) 6 at Los Alamos National Laboratory (LANL) -- Night

Created by ERSS GIS TEAM. Map Number 06-0108 September12, 2005
State Plane Coordinate System New Mexico Central Zone North American Datum 1983 (ft)
This map was created for work processes associated with the Environmental &Remediation Support Services. All other uses for this map should be confirmed with LANL EP-ERSS staff.
Boundary of Department of Energy Property I Around the Los Alamos National Laboratory; Los Alamos National Laboratory, SSMO Site Planning & Project Initiation; infrastructure Planning Office. 10 February 2006
Boundary of Department of Energy Property In and Around the Los Alamos National Laboratory; Los Alamos National Laboratory, SSMO Site Planning & Project Initiation; 01 February 2003 as captured 07 September 2004.



LEGEND OF SYMBOLS

DRAINAGE ROUTE

STORM DRAIN

N

SITE LAYOUT

0 30' 60'

1"=30'-0"

FIGURE A-9
PROPOSED DRAINAGE CONTROL FEATURES AT
THE TRANSURANIC WASTE FACILITY,
TECHNICAL AREA (TA) 52

Supplement A.1

Review of the Geologic And Structural Setting Near the Site of the Proposed Transuranic Waste Facility (TRUWF), Technical Area 52 (TA-52), Los Alamos National Laboratory
LA-UR-07-5191

REVIEW OF THE GEOLOGIC AND STRUCTURAL SETTING NEAR THE SITE OF THE PROPOSED TRANSURANIC WASTE FACILITY (TRUWF), TECHNICAL AREA 52 (TA-52), LOS ALAMOS NATIONAL LABORATORY

Emily S. Schultz-Fellenz and Jamie N. Gardner

LA-UR-07-5191

ABSTRACT

Because of Los Alamos National Laboratory's proximal location to active geologic structures, assessment of seismic hazards, including the potential for seismic surface rupture, must occur prior to construction of any facilities housing nuclear or other hazardous materials. A transuranic waste facility (TRUWF) planned for construction at Technical Area 52 (TA-52) provides the impetus for this report. While no single seismic hazards field investigation has focused specifically on TA-52, numerous studies at technical areas surrounding TA-52 have shown no significant, laterally continuous faults exhibiting activity in the last 10 ka within 3000 ft of the proposed facility. A site-specific field study at the footprint of the proposed TRUWF would not yield further high-precision data on possible Holocene faulting at the site, since post-Bandelier Tuff sediments are lacking and the shallowest subunit contacts of the Bandelier Tuff are gradational. Given the distal location of the proposed TRUWF to any mapped structures with demonstrable Holocene displacement, surface rupture potential appears minimal at TA-52.

I. INTRODUCTION AND RATIONALE

This document evaluates existing literature documenting previous analyses of stratigraphy, structural geology, and/or seismic hazard in the vicinity of the proposed TRUWF at TA-52 of Los Alamos National Laboratory (LANL). Through this, we provide information on the presence or absence of active faults at the proposed facility site and in surrounding technical areas, as well as an assessment of the potential for seismic surface rupture near the footprint of the proposed facility at TA-52.

Siting, design, and construction of waste facilities at Department of Energy (DOE) sites require compliance with Environmental Protection Agency (EPA) regulations for seismic hazards. Standards and compliance for the proposed TRUWF fall within the auspices of the Resource Conservation and Recovery Act (RCRA) of 1976. Seismic considerations for RCRA location standards are presented in the Code of Federal Regulations, Title 40 (40 CFR) Part 264, Subpart B, "General Facility Standards". Regarding the siting of hazardous waste facilities, 40 CFR 264 states that portions of new facilities where treatment, storage, or disposal of hazardous waste will be conducted must not be located within 200 ft (61 m) of a fault that has had displacement in Holocene time (within the last 10,000 years). If Holocene faults are present within 3000 ft (914 m) of a proposed facility, a comprehensive geologic analysis of the site is required.

LANL lies within the Española Basin of the Rio Grande rift (Figure 1), a tectonically active zone of east-west crustal extension along a north-south trending series of asymmetrical

basins (e.g. Kelley, 1979; Sanford et al., 1991; Baldridge et al., 1995; Kelson and Olig, 1995). The Rio Grande rift is a major tectonic feature of the North American continent, has been active for at least 30 million years, and continues to be tectonically and magmatically active (e.g. Riecker, 1979; Baldridge et al., 1984; Wolff and Gardner, 1995). In the area of LANL, the Pajarito fault system is the active western margin of the Rio Grande rift. The Pajarito fault system includes the potentially seismogenic Pajarito, Rendija Canyon, and Guaje Mountain faults (Figure 2).

Because of LANL's location relative to active geologic features, seismic hazards, including the potential for seismic surface rupture, must be assessed before construction of any facilities housing nuclear or other hazardous materials. Paleoseismic investigations indicate that there have been three Holocene seismic events of magnitude ~6-7 on the Pajarito fault system (Gardner et al., 1990; Wong et al., 1995; Kelson et al., 1996; McCalpin, 1998, 1999; Reneau et al., 2002; Gardner et al., 2003; LANL Seismic Hazards Geology Team, in prep.). The fault system in the western and northern parts of LANL and west of LANL has been mapped in detail to better understand the kinematics of the fault system and to assess the potential for seismic surface rupture at specific Laboratory sites (e.g. Gardner et al., 1998, 1999, 2001; Lewis et al., 2002; Lavine et al., 2003; Schultz et al., 2003, Lewis et al., in review).

II. GENERALIZED GEOLOGIC SETTING

The proposed site of the TRUWF at TA-52 (Figure 2) sits atop a sequence of Quaternary-aged rhyolitic ash-flow tuffs collectively called the Tshirege Member of the Bandelier Tuff, east of the principal faults of the Pajarito fault system (Gardner et al., 1999). The Tshirege Member (Qbt) of the Bandelier Tuff is a 1.22 million-year-old complex series of ash-flow tuffs erupted from the Valles Caldera, the eastern rim of which is approximately 10 miles (~16 km) west of the TA-52 site (age from Izett and Obradovich, 1994; Figure 1). The suite of eruptive subunits that comprise the Tshirege Member includes pyroclastic surge deposits, which in some locations mark contacts between Tshirege Member subunits. In the vicinity of the proposed TRUWF at TA-52, Qbt is generally subdivided into three principal subunits, or cooling units (from top to bottom: Qbt3, Qbt2, and Qbt1; Figure 3), whose contacts are identified by welding characteristics as well as pumice, phenocryst, and lithic characteristics (Broxton and Reneau, 1995; e.g. Gardner et al., 1999; Lewis et al., 2002; Lavine et al., 2003). Physical characteristics of the tuff (including degree of welding, thickness of cooling units, and post-depositional mineralization) vary with distance from the caldera source. Contacts between the subunits of the Tshirege Member serve as useful markers for determining the presence or absence of faulting (e.g. Gardner et al., 1998, 1999, 2001; Lewis et al., 2002; Lavine et al., 2003; Schultz et al., 2003).

III. PREVIOUS WORK

In 1985, J. Gardner (unpublished data) developed a Los Alamos area fault model projecting the southern termini of the Rendija Canyon and Guaje Mountain faults into LANL technical areas, including the TA-55 area (Plutonium Facility). At the time of development of this early model of the Pajarito fault system, no detailed data existed to define the southward

projections of these faults with any certainty. An iteration of this unpublished fault model was obtained in 2002 by the LANL Solid Waste Regulatory Compliance Group and included as Figure A-5 within the LANL TA-50 Part B Renewal Application (LA-UR-02-4739). Since this early fault model was generated, and even prior to publication of the 2002 TA-50 report, a great deal of high-precision geologic mapping has been completed on the southern extent of the Rendija Canyon and Guaje Mountain faults. Studies by Gardner et al. (1999, 2001), Lewis et al. (2002), Lavine et al. (2003), and Lewis et al. (in review) provide detailed geologic data, particularly with respect to structure, which supersedes that presented in Figure A-5 of the TA-50 Part B Renewal Application of 2002 (Figure 2).

Gardner et al. (1999) showed that the geometry of the surface expression of the Rendija Canyon fault, moving along-strike from north to south, begins to bend southwest at Pueblo Canyon, runs beneath the Los Alamos townsite, and continues beneath LANL's main technical area (TA-3) where a series of southwest-trending, small *en-echelon* faults connect the Rendija Canyon fault with the master Pajarito fault. Along-strike from north to south, the last definite surficial expression of the Guaje Mountain fault is at Bayo Canyon in the northern part of the Los Alamos townsite (Gardner et al., 2003). The high-precision surveys and geologic mapping of Gardner et al. (1998, 1999) have shown no vestige of the Rendija Canyon or Guaje Mountain faults in the TA-55, TA-50, or TA-52 areas.

The proposed TA-52 TRUWF is situated approximately 4 miles (6.4 km) east of the Pajarito fault, which is the master structure in the Los Alamos area (Figure 2). The antithetic Rendija Canyon fault is located 1.5 miles (2.5 km) west of TA-52, and the southernmost-mapped expression of the Guaje Mountain fault is 2.5 miles (4 km) north of TA-52 (Figure 4). A southward projection of the Guaje Mountain fault would skirt the eastern boundary of TA-48, approximately 1 mile (1.6 km) west of TA-52.

IV. SITE-SPECIFIC GEOLOGIC STUDIES AT LANL

The site of the proposed TRUWF lies near the margins of detailed geologic mapping studies completed by the LANL Seismic Hazards Geology Team (e.g. Gardner et al., 1999, 2001; Lewis et al., 2002; Lavine et al., 2003; Lewis et al, in review). Figure 4 shows the location of the proposed facility at TA-52 with respect to previous studies and geologic structures. Figure 5 shows the footprint of the proposed facility at TA-52 with respect to mapped geologic contacts and structures within both a 200-ft and a 3000-ft radius of the site, per the requirements of 40 CFR 264. Additional site-specific detailed geologic studies, including trenching, mapping, fracture analyses, and borehole studies, have been completed at technical areas near the proposed facility, and are addressed below in order of increasing distance from the site (after Lewis and Gardner, 2006).

IV.A. Evaluation of the potential for surface faulting at TA-63

Geologic investigations at TA-63 (Figure 4) for a proposed radioactive liquid waste treatment facility (RLWTF) included mapping, trenching, and fracture analysis (Kolbe et al., 1995). Five trenches with a total length of 2250 ft (685 m) were excavated across the full extent

(west to east) of TA-63 and southern parts of TA-52. Trenches were oriented perpendicular to the north-south strike of the Guaje Mountain fault, which was thought to pass within the 3000 ft (914 m) envelope surrounding the proposed site. Although ubiquitous north- to north-northeast-striking subvertical fractures in the Bandelier Tuff were observed throughout the trenches, no significant increase in fracture density was noted toward or within the southward projection of the Guaje Mountain fault and no evidence of Holocene faulting was observed. The observed fractures were documented as small tensile openings, and likely do not behave as faults. Kolbe et al. (1995) identified slickensides in a few fractures in unit Qbt3 but concluded they were a result of gravitational slip toward drainages bounding the eastern edge of the site. Additionally, the motion appeared to be quite small (on the order of a few tens of millimeters between blocks). Nevertheless, the probability of Holocene movement on fractures could not be fully discounted due to the lack of continuous late Quaternary deposits across the area of investigation. Kolbe et al. (1995) also indicated that if deformation was distributed over a wide zone, small offsets (sub-centimeter) could easily be unrecognizable in the Bandelier Tuff or post-Bandelier deposits.

IV.B. Conceptual design report for the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) upgrade project

Kleinfelder, Inc. performed exploratory drilling of eight borings to depths of 23-26.5 ft (7.0-8.1 m) was using a hollow-stem auger (DMJM H&N, 2005). One boring was extended to a depth of 90 ft (27.4 m) for environmental purposes only. Logs indicate the presence of Bandelier Tuff at depths of 2-9 ft (0.6-2.7 m) beneath fill. Subunits of Bandelier Tuff were not distinguished in their report and contacts between said subunits were not noted, but all tuff in the borings appears to be poorly welded, purple to brown in color, and slightly to extensively fractured. Based on rock outcrop in the area, as well as observations from the boring logs, the tuff present in the borings is likely to be Qbt3. Unit Qbt4 is not present in outcrop at TA-50, but could be present in localized areas in the subsurface where post-Bandelier Tuff deposits have been preserved (see Kolbe et al., 1995).

IV.C. Seismic Hazards investigations at and near TA-55

Geologic studies performed in the TA-55 area include geologic mapping and trenching (Dames and Moore, 1972; Purtymun et al., 1995; Gardner et al., 1998, 1999). As part of a geologic study of TA-55, Vaniman and Wohletz (1990) demonstrated high fracture density and large fracture apertures in Bandelier Tuff where East Jemez Road crosses the southward projection of the Guaje Mountain fault (near the intersection of East Jemez Road and La Mesita Road, the entrance to TA-53). Detailed geologic mapping of Gardner et al. (1998, 1999) included total station surveying of the Qbt3-Qbt4 contact along Pajarito Road, and the Qbt2-Qbt3 contact in Mortandad Canyon to the north and Twomile Canyon to the south. The most useful marker horizon for identifying small-displacement faults [<1 ft (0.3 m) vertical displacement] in this area is the Qbt3-Qbt4 contact, which is generally quite sharp and commonly marked by a pyroclastic surge deposit. The Qbt2-Qbt3 contact is gradational over approximately 3 ft (1 m), and is not as useful for locating small faults. The presence of both contacts enhances determination of the absence or presence of faulting.

Gardner et al. (1999) identified no mappable faults within the Bandelier Tuff at TA-55. The study identified a single-point location of 2 ft (0.61 m) down-to-the-north displacement on the Qbt2-Qbt3 contact, and that feature is situated near the 3000-ft envelope and at the edge of detailed geologic mapping performed by Seismic Hazards Geology Team personnel, seen on Figure 4 of this document. Identification of small displacement on a known gradational contact, its lack of lateral continuity, and no evidence of Holocene movement support the inconsequential nature of this single-point location in an assessment of surface rupture hazard. Post-Bandelier Tuff deposits are nearly absent at TA-55, having been in large part stripped away by modern building activities and replaced with fill. Olig et al. (1996) calculated a probabilistic displacement hazard for a principal trace of the Rendija Canyon fault near its southern end as 0.67 inches (1.7 cm) in 10,000 years. Gardner et al. (1999) therefore determined that the potential for seismic surface rupture at TA-55 has to be extremely low because virtually no deformation in the last 1.22 million years can be documented there.

Lavine et al. (2005) examined borehole logs and cores from geotechnical drilling studies performed at the site of the proposed Chemistry and Metallurgy Research Facility Replacement (CMRR) building at TA-55 to determine whether Tshirege Member contact elevations reveal any faulting at the site. The study resulted in three-dimensional models of a surface defined by the Qbt3-Qbt4 contact and identified no significant [e.g. expressing several feet (>1 m) of vertical displacement] faulting.

Investigations by the EES-9 Seismic Hazards Geology Team at the site of the CMRR excavation are currently underway. These investigations include detailed examinations of the Qbt3-Qbt4 contact, the undulating pyroclastic surge deposit separating the Tshirege Member subunits, and any fracturing or structures which might be present, as well as a high-precision total station survey of identified geologic features. The pyroclastic surge exhibits radical thickness changes over short distances. Units Qbt3 and Qbt4 are intensely fractured in places, with the fractures exhibiting variable amounts of vertical continuity and displacement across the pyroclastic surge in particular. The fractures are often curvilinear and frequently terminate at the contact with the pyroclastic surge. Minor faults with less than 2 ft (0.61 m) of vertical displacement across the pyroclastic surge are present, which may represent initial cooling and compaction of the tuff shortly after emplacement 1.22 million years ago. Field investigations and detailed analysis of the geologic features at the CMRR excavation, including interpretation of their relationship (if any) to the Rendija Canyon and Guaje Mountain faults, are slated for completion in February 2008.

IV.D. Surficial materials and structure at Pajarito Mesa, TA-67

Exploratory trenching and surficial geologic mapping were conducted along Pajarito Mesa (Figure 4) to evaluate the potential for surface faulting at a proposed Mixed Waste Disposal Facility (Kolbe et al., 1994; Reneau et al., 1995). Trenches totaling 4400 linear feet (1340 m) were excavated. These trenches exposed deposits of Bandelier Tuff and a robust post-Bandelier Tuff stratigraphy. These studies concluded that active faulting on that portion of Pajarito Mesa had been absent for at least the last 50-60 kyr. Other studies focusing on fractures along the south edge of Pajarito Mesa (Vaniman and Chipera, 1995) showed no zones of high or

increasing fracture density, nor any zones of wide fracture opening, in the locations where the Rendija Canyon or Guaje Mountain faults were believed to cross the mesa.

IV.E. Fracture characteristics in a disposal pit on Mesita del Buey, TA-54

Reneau and Vaniman (1998) performed detailed total station surveys of Tshirege Member contacts on Mesita del Buey, approximately 1.1 miles (1.7 km) southeast of the proposed TRUWF (Figure 4), to assess the presence or absence of structure in support of contaminant transport studies. Their investigations found 37 faults with 0.1-2.1 ft (5-65 cm) of vertical displacement on surge deposits at the Qbt1v-Qbt2 contact (Figure 3) on the north wall of Pajarito Canyon. Faults in the western end of the surveyed area form two small grabens and exhibit the greatest amount of vertical displacement [3.2-6.5 ft (1-2 m) per fault on the surge between Qbt1v-Qbt2]. Faults mapped in this area have a wide range of orientations and sense of offset, and form numerous horst-and-graben structures. Reneau and Vaniman (1998) inferred that faults at TA-54 were associated with deformation during paleoseismic events on the Pajarito fault or even on more regional structures, and that the small faults at TA-54 likely do not represent a major, independent fault zone.

IV.F. Geology of the north-central to northeastern portion of LANL, TA-53

Geologic mapping and related field investigations, with the purpose of assessing seismic hazards in the north-central to northeastern portion of LANL including and surrounding TA-53, revealed only small faults that have little potential for seismic surface rupture (Lavine et al., 2003). These small faults lie east of the Pajarito fault system, show no clear connectivity to the Sawyer Canyon fault or other mapped or inferred structures, and likely represent subsidiary distributed faulting associated with earthquakes occurring on the Pajarito fault system.

V. EFFICACY OF FUTURE PALEOSEISMIC STUDIES AT SITE OF THE PROPOSED TA-52 TRUWF

The area of detailed geologic mapping by Lavine et al. (2003) and by the Seismic Hazards Geology Team (unpublished mapping) includes the footprint of the proposed TRUWF. The studies identified no laterally continuous geologic structures in the area. Geologic units exposed on the surface at the mesa top are primarily Qbt3, covered in some areas with thin colluvium (Figure 5). Qbt3 is at least 40 ft (~12 m) thick in this location. No post-Bandelier Tuff deposits were identified and recent field reconnaissance confirms the lack of significant post-Bandelier Tuff deposits in the area. Such deposits were never deposited, have been stripped by geomorphic processes over time, or have been removed by anthropogenic activities at the TA-52 site.

The absence of a robust sequence of post-Bandelier Tuff stratigraphy overlying Qbt3 in this location creates significant difficulty in embarking on future paleoseismic studies near the TRUWF footprint at TA-52. Without such units, the ability to identify paleoseismic events that postdate the deposition of the tuff (i.e. Holocene events) and to establish ages for identifiable paleoevents is essentially eliminated. Investigating the Qbt3-Qbt2 contact is not feasible as a

trenching study. An alternative to shallow trenching would be to excavate or drill to the Qbt3-Qbt2 contact, which is at least 40 ft (~12 m) below the ground surface at the proposed TRUWF. A further complication to assessment of faulting using the Qbt3-Qbt2 contact, as opposed to using other Tshirege Member subunit contacts, is that the Qbt3-Qbt2 contact is marked by a gradational increase in welding downsection [over 1.5-3ft (0.5-1 m)] from nonwelded unit Qbt3 to moderately- to partially-welded unit Qbt2. The gradational nature of the Qbt3-Qbt2 contact limits its usefulness in identifying small-offset faults and establishes only an approximate offset on larger structures. Given this geologic dataset, identification of the presence of Holocene faults in the TA-52 area through trenching or drilling could not be definitively ascertained.

VI. CONCLUSIONS

Detailed geologic studies done at technical areas near TA-52 identified no evidence for significant, laterally continuous Holocene faulting near the proposed facility site. Trenches at TA-67 identified no active faults younger than 50-60 kyr. Fault studies at TA-53 showed subsidiary structures with very small offsets and small potential for surface rupture. Geologic investigations at TA-55 have thus far shown no evidence for Holocene faults; detailed fracture and fault analyses are currently ongoing in support of the CMRR facility with results forthcoming. A detailed total station survey at TA-54 recognized numerous small-offset faults that represent distributed hangingwall deformation from events on the principal Pajarito fault, but did not show independent Holocene movement. However, at TA-55 and TA-63, the post-Bandelier Tuff stratigraphy was thin to absent and therefore the presence of Holocene faults could not be absolutely confirmed or discounted. Generally, surface rupture potential is highest in close proximity to the major structures in the Pajarito fault system, those being the Pajarito, Rendija Canyon, and Guaje Mountain faults. Given the distal location of the proposed TRUWF to any mapped structures with demonstrable Holocene displacement, surface rupture potential appears quite low at TA-52. Additionally, two small-displacement [2 ft (0.61 m)] features were identified on the Qbt2-Qbt3 contact within the 3000-ft envelope surrounding the TA-52 facility (see Figure 5). The features were identified on a known gradational contact of two Bandelier Tuff subunits, meaning that uncertainty on any identified offsets is high. Additionally, the features lack lateral continuity, and no evidence was found demonstrating that offset on the features were generated as a result of a Holocene seismic event. This reaffirms the low potential for surface rupture at TA-52.

While the Pajarito and Rendija Canyon faults have been mapped in detail for their full along-strike distance in the vicinity of LANL, the southern end of the Guaje Mountain fault has not been mapped in detail. Although its defined surface expression ends at Bayo Canyon, displacements of Bandelier Tuff subunit contacts ~10 ft (~ 3 m) down-to-the-west were identified on the north side of Pueblo Canyon, approximately 1.75 miles (~2.8 km) north of the TA-52 site (Lavine and Schultz-Fellenz, unpublished mapping). The absolute location of the Guaje Mountain fault near the proposed TA-52 TRUWF, and its southernmost termination, are not known; however, detailed geologic studies in technical areas surrounding TA-52 (including TA-55, TA-63, TA-53, and TA-54) found no clear evidence of the Guaje Mountain fault in those areas. Geologic investigations near the TA-52 TRUWF site suggest that the potential for seismic surface rupture is likely to be extremely minimal.

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FIGURE CAPTIONS

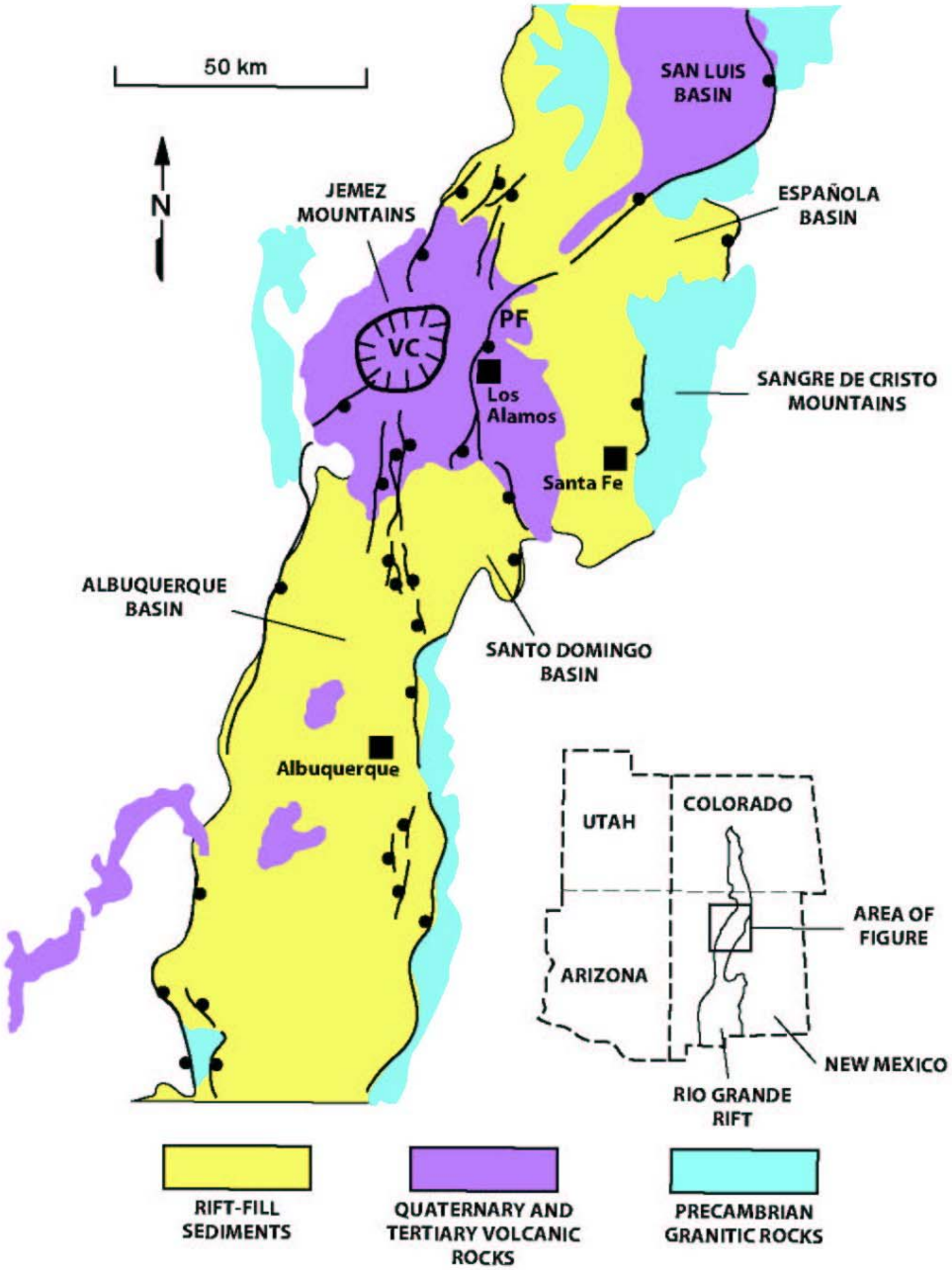
Figure 1. Map of the Rio Grande rift system in northern New Mexico. Major fault systems are shown schematically, with ball on downthrown block. PF = Pajarito fault. VC = Valles-Toledo caldera complex, source of the Quaternary-aged Bandelier Tuff. Modified from Gardner and Goff (1984).

Figure 2. Map of the Pajarito fault system in the vicinity of Los Alamos National Laboratory. Gray shaded area shows the area that has been mapped in detail to assess potential for faulting at LANL. Dark gray outline shows the extent of LANL. A red star indicates the site of the proposed TRUWF at TA-52. Faults and related folds shown in black are from Gardner and House (1987), Reneau et al. (1995), Gardner et al. (1999, 2001), Lewis et al. (2002), Lavine et al. (2003), Lewis et al. (in review) and Gardner and Reneau (unpublished mapping). Abbreviations: PF = Pajarito fault; RCF = Rendija Canyon fault; GMF = Guaje Mountain fault; SCF = Sawyer Canyon fault.

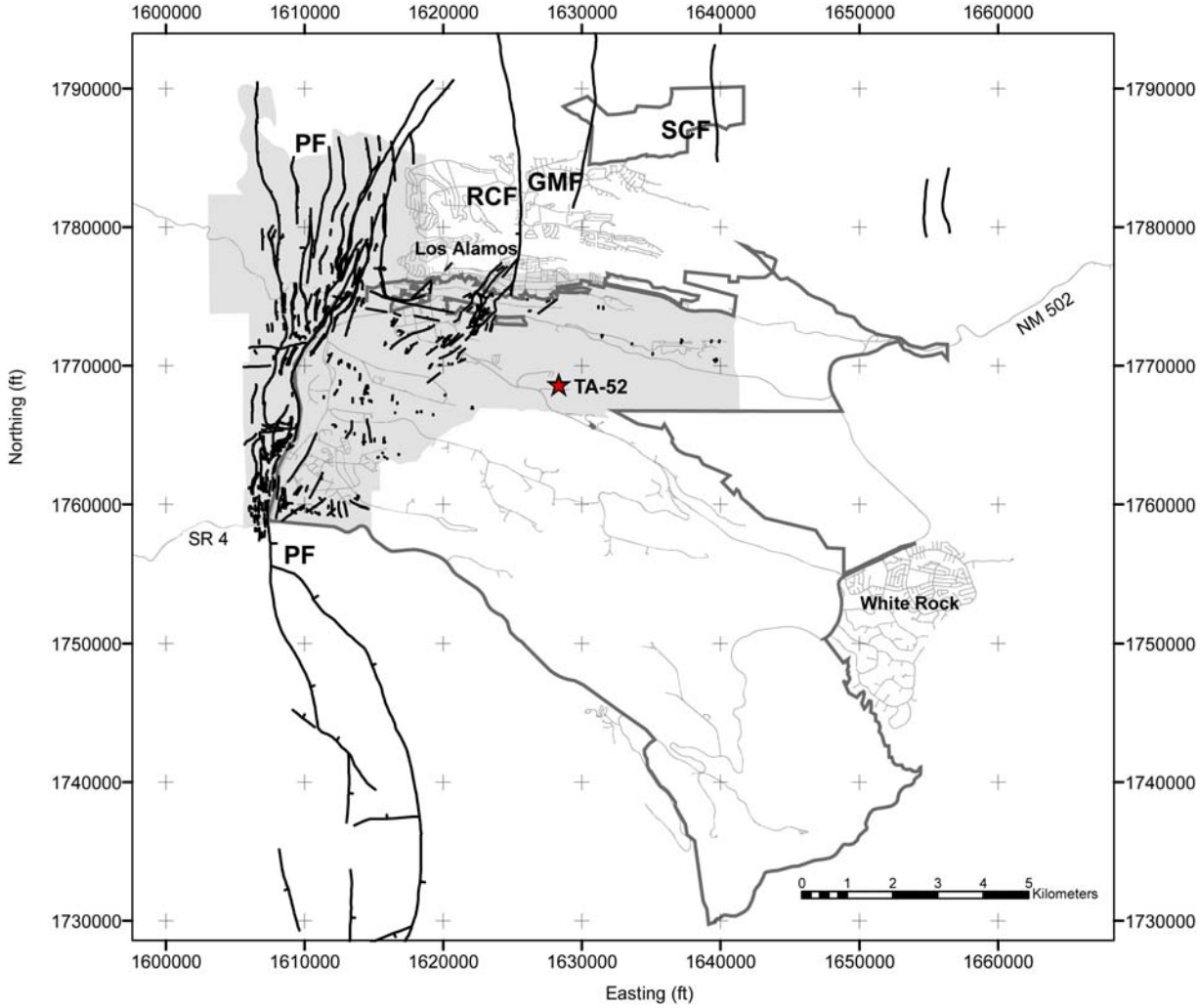
Figure 3. Generalized stratigraphy of the lower units of the Bandelier Tuff and Cerro Toledo interval exposed in the study area (from Lavine et al., 2003). Thickness of units is shown schematically and varies over the Pajarito Plateau. Unit Qbt2(+1vw) in the study area is equivalent to Qbt2 to the west (e.g., Gardner et al., 1999) and to unit Qbt2 and the upper part of Qbt1v-u to the east of the study area.

Figure 4. Pajarito fault system structural map, with emphasis on subsidiary structures associated with the system. The Pajarito fault system includes the down-to-the-west Rendija Canyon (RCF), Guaje Mountain (GMF), and Sawyer Canyon (SCF) faults, as well as the master down-to-the-east Pajarito fault (PF). Faults and related folds shown in black. TA-52 labeled in red. Other site-specific geologic studies conducted at LANL and discussed in Section 4 are labeled in green by technical area. Modified from Gardner et al. (2003).

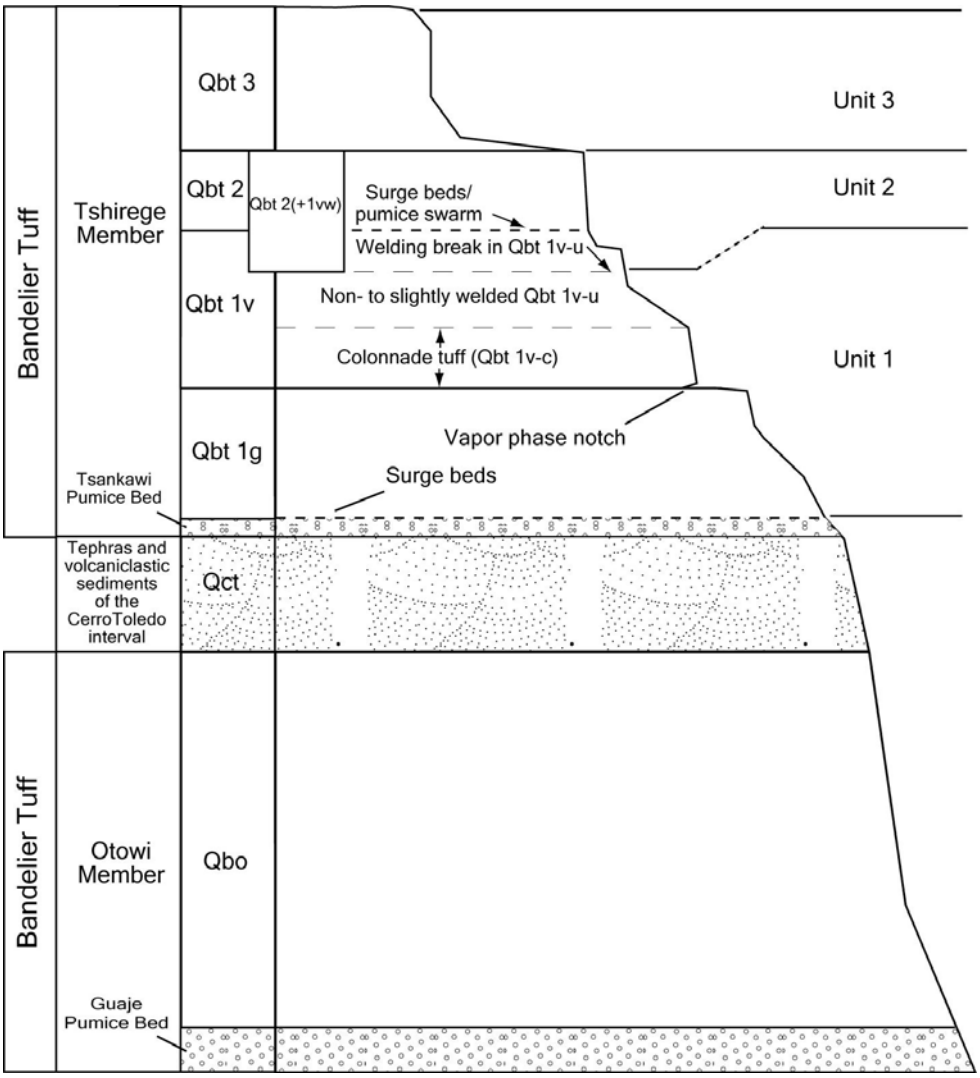
Figure 5. Localized geologic map of the TA-52 area, including 200-ft and 3000-ft standoffs per 40 CFR 264. Colored polygons represent different mapped geologic units (refer to Figure 3 for Bandelier Tuff stratigraphic nomenclature). Red lines represent faults; red dots represent identified displacements on Bandelier Tuff subunit contacts with no observed continuity. Numbers and letters associated with red dots and lines indicate amount and sense of observed displacement (e.g. 2 DTN = 2 ft down-to-the-north). Geologic and structural mapping from Gardner et al. (1999), Lavine et al. (2003), and Seismic Hazards Geology Team (unpublished mapping).



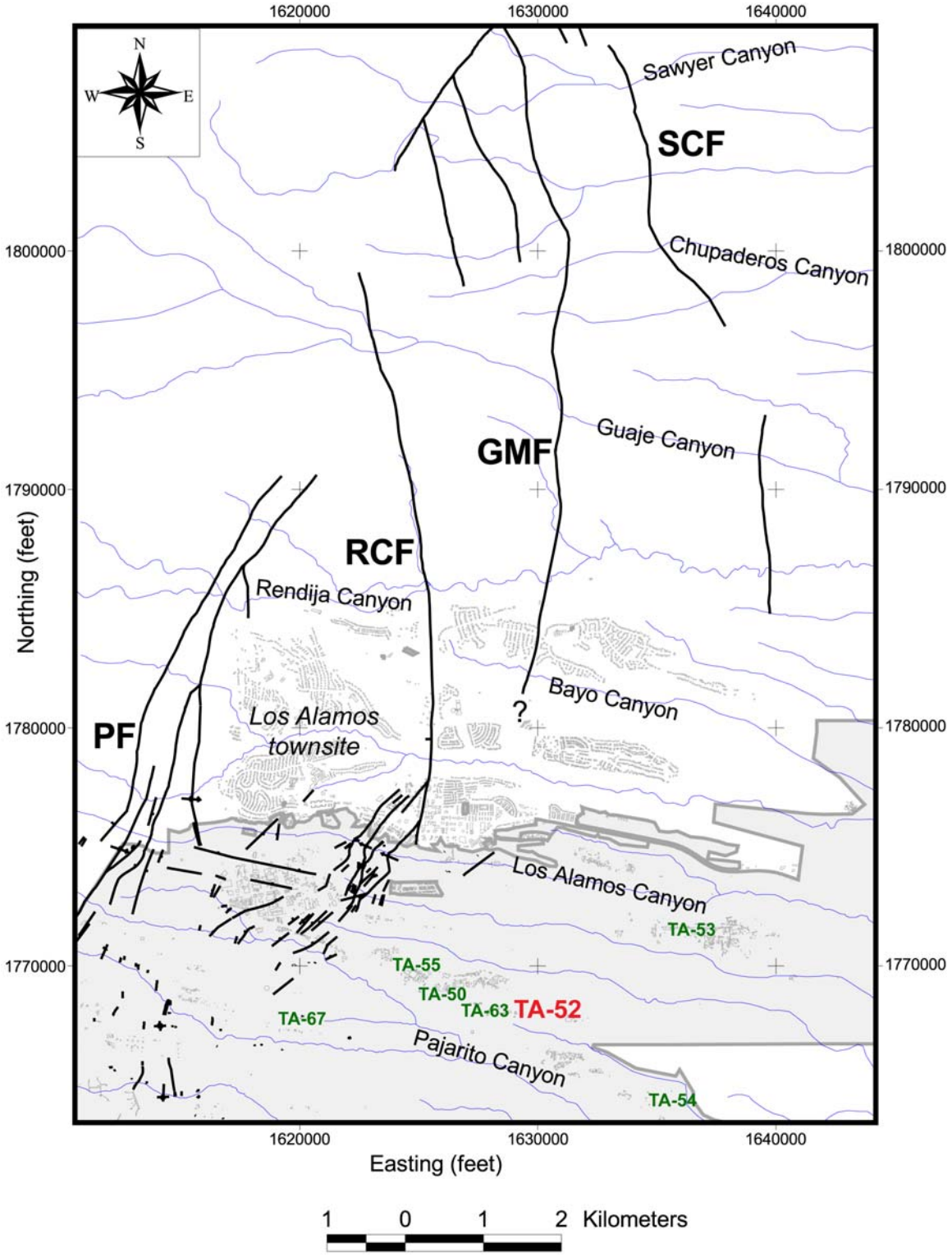
Schultz-Fellenz and Gardner, Figure 1.



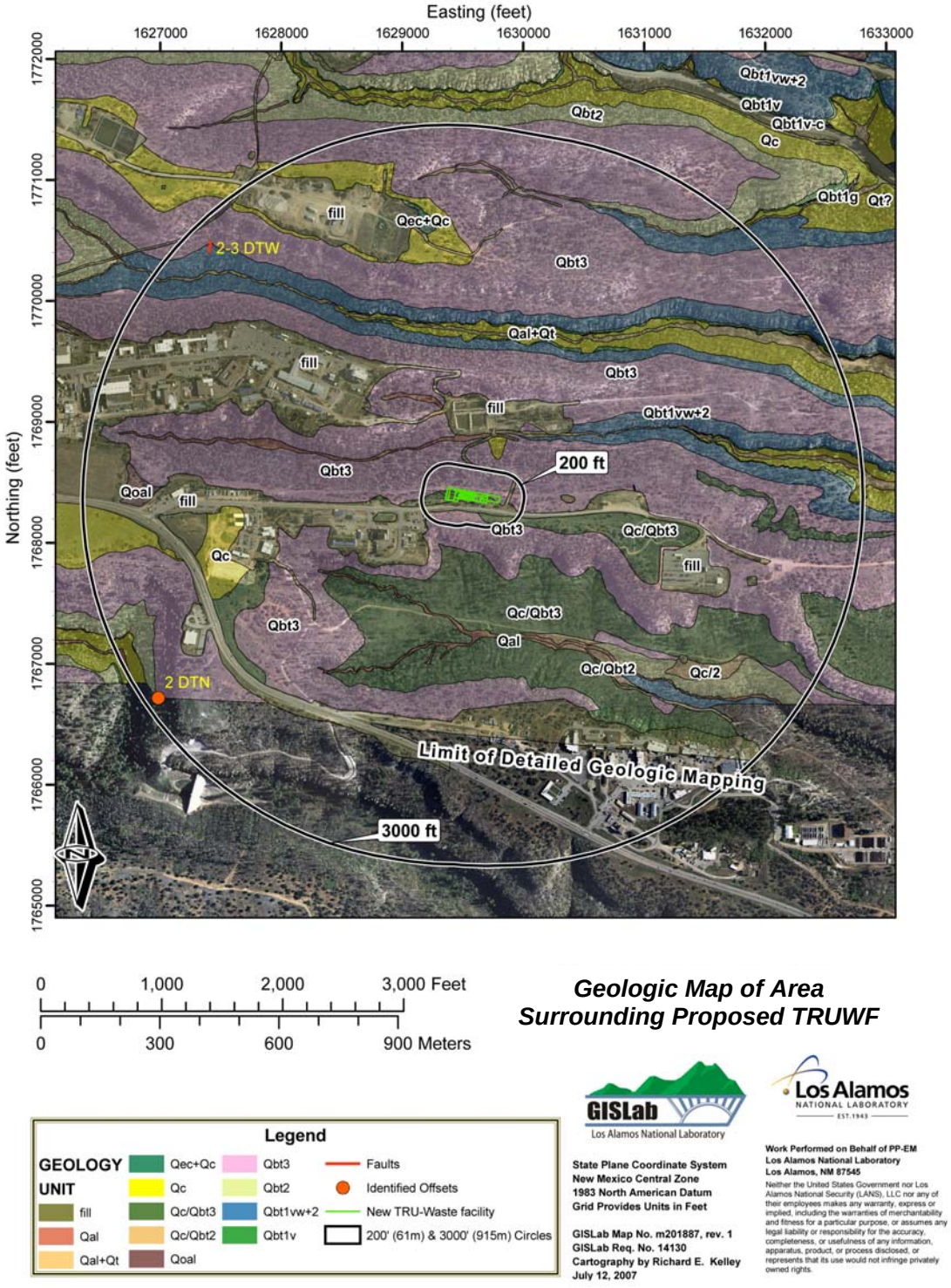
Schultz-Fellenz and Gardner, Figure 2.



Schultz-Fellenz and Gardner, Figure 3.



Schultz-Fellenz and Gardner, Figure 4.



Schultz-Fellenz and Gardner, Figure 5.