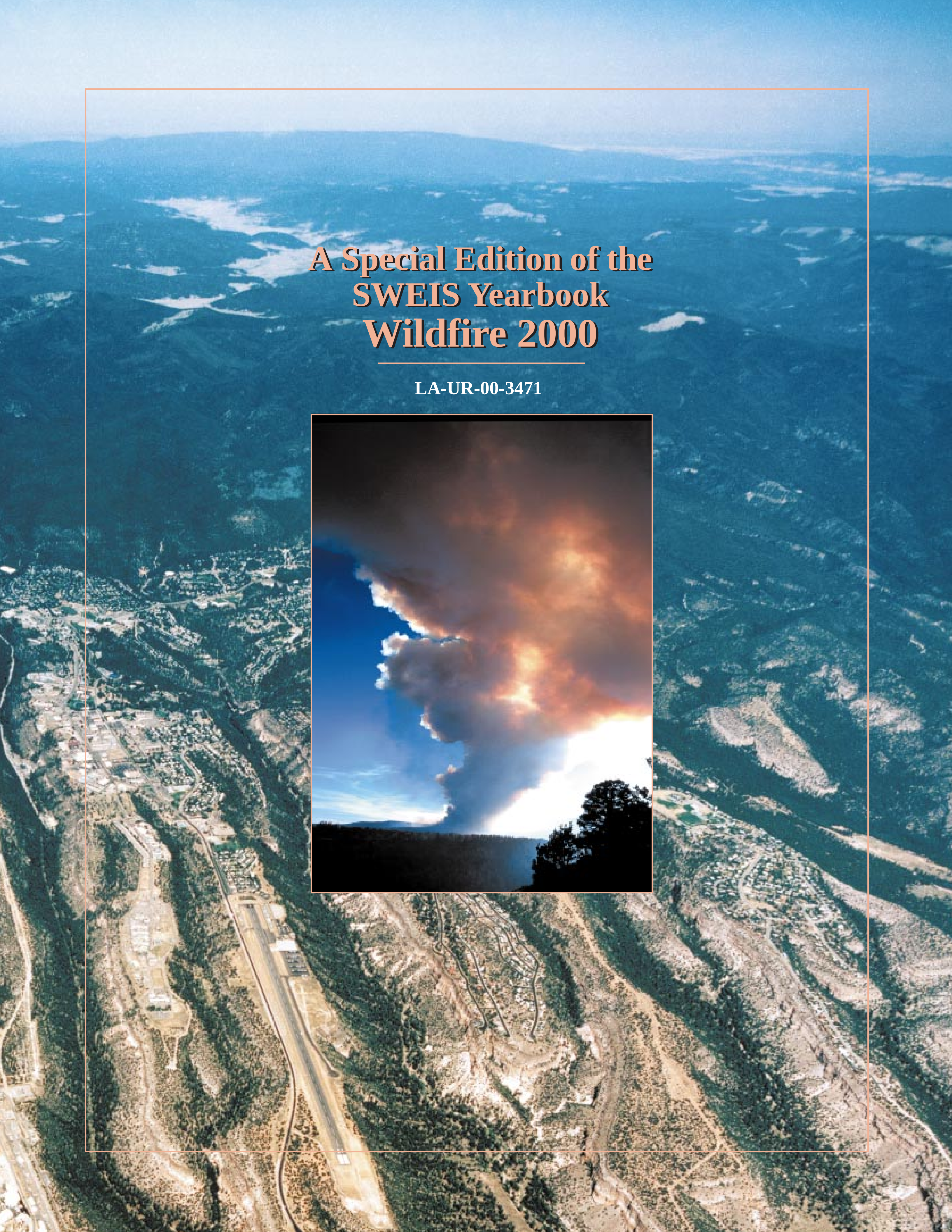

A Special Edition of the SWEIS Yearbook
Wildfire 2000

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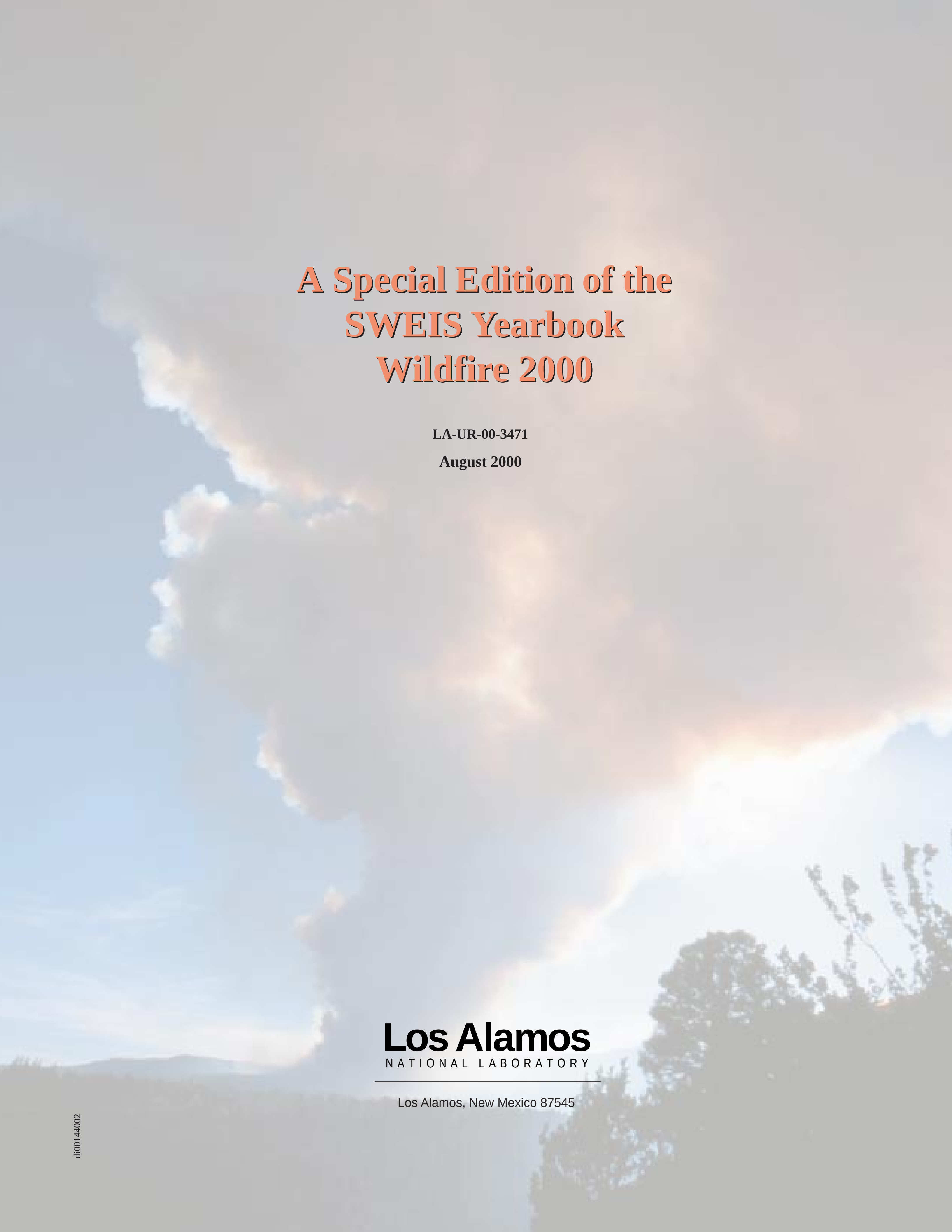

A Special Edition of the SWEIS Yearbook Wildfire 2000

LA-UR-00-3471

August 2000

Los Alamos
NATIONAL LABORATORY

Los Alamos, New Mexico 87545

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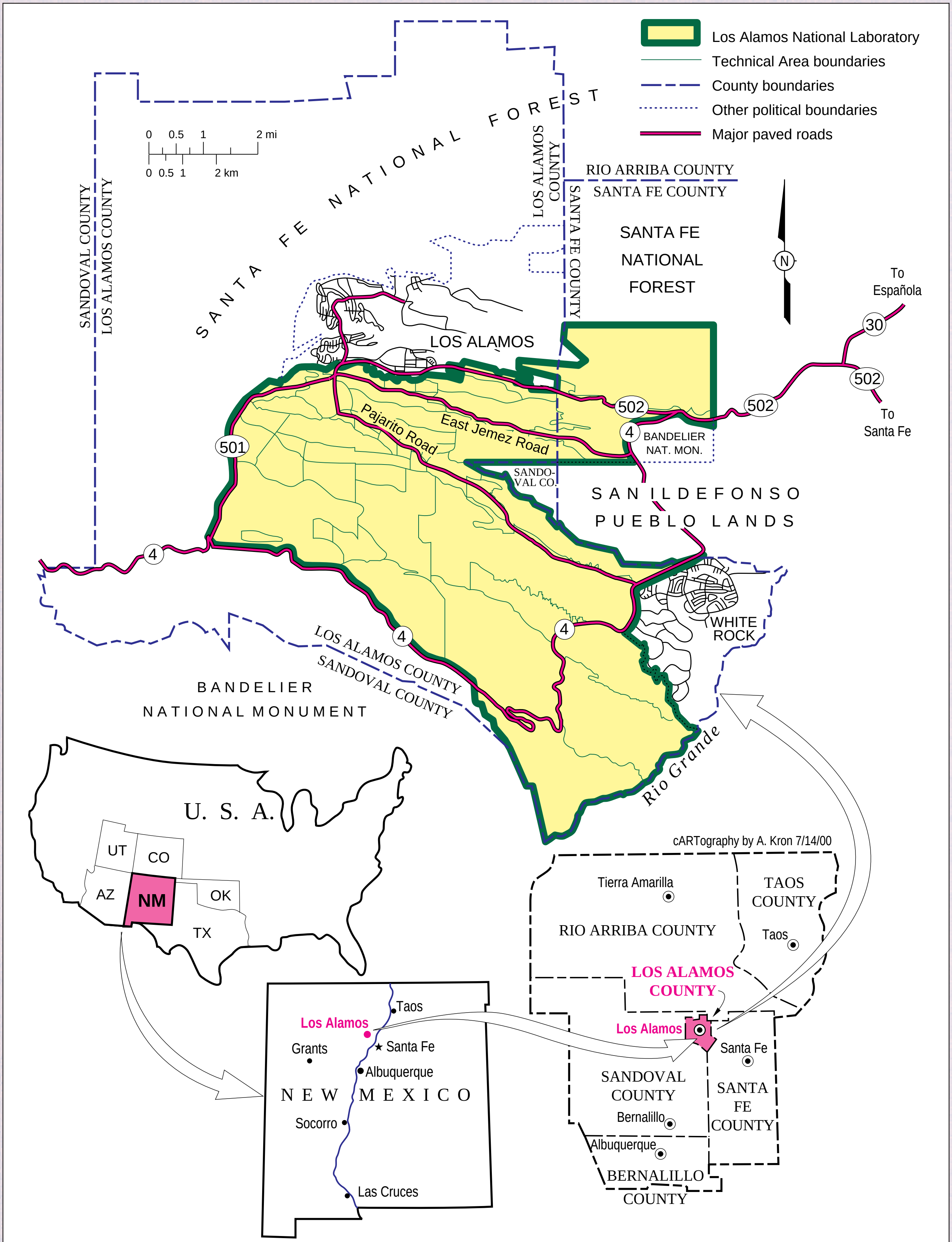


Location of Los Alamos National Laboratory.

A Special Edition of the SWEIS Yearbook

Wildfire 2000

A Comparison of the LANL Site-Wide Environmental Impact Statement Wildfire Accident Analysis with the Cerro Grande Fire

1.0 Introduction

The US Department of Energy (DOE) issued a Site-Wide Environmental Impact Statement (SWEIS) for continued operation of Los Alamos National Laboratory (LANL) (DOE 1999a) and a Record of Decision (ROD) in 1999 identifying how DOE would operate LANL in the future (DOE 1999b).

The SWEIS included analyses of accident scenarios, both facility specific and site-wide. Accident analyses are necessary for making a reasoned choice among alternatives and for appropriate consideration of mitigation measures.

The SWEIS for LANL included a wildfire accident scenario entitled “Site Wildfire Consuming Combustible Structures and Vegetation,” coded as SITE-04. This accident scenario was added to the SWEIS as a result of public comments and concerns expressed by a US Forest Service (USFS) employee assigned to the nearby Santa Fe National Forest. The accident is described in detail in Appendix G of the SWEIS. SITE-04 had the highest return frequency of all accidents analyzed in the SWEIS, with a probability of occurrence of once in ten years.

SITE-04 had two cases: a wildfire without mitigation that resulted in burning seven facilities with hazardous and chemical inventories and a wildfire with mitigation (tree thinning and brush clearing) that resulted in no burning of facilities with inventories. The latter scenario was very closely paralleled by the Cerro Grande fire of May 2000.

The Laboratory publishes an annual SWEIS Yearbook (LANL 1999a), comparing actual LANL operations, effluents, and impacts to those projected in the SWEIS ROD. This Special Yearbook Edition—Wildfire 2000—compares the postulated accident with the Cerro Grande fire. The purpose of this analysis is to do a direct comparison of a ‘real life’ accident to that postulated in the LANL SWEIS as a practical evaluation of the accuracy of the SWEIS analysis. The comparison of the Cerro Grande fire and the SWEIS wildfire scenario will allow DOE to better assess the usefulness and approach of accident analyses.

As time progresses and detailed field surveys are conducted, the data reported here for the Cerro Grande fire will be refined and are expected to change (i.e., acreage burned, damage lists of facilities, maps of the fire, etc.). The information presented here was collected immediately following the fire and represents data available in mid-July 2000.

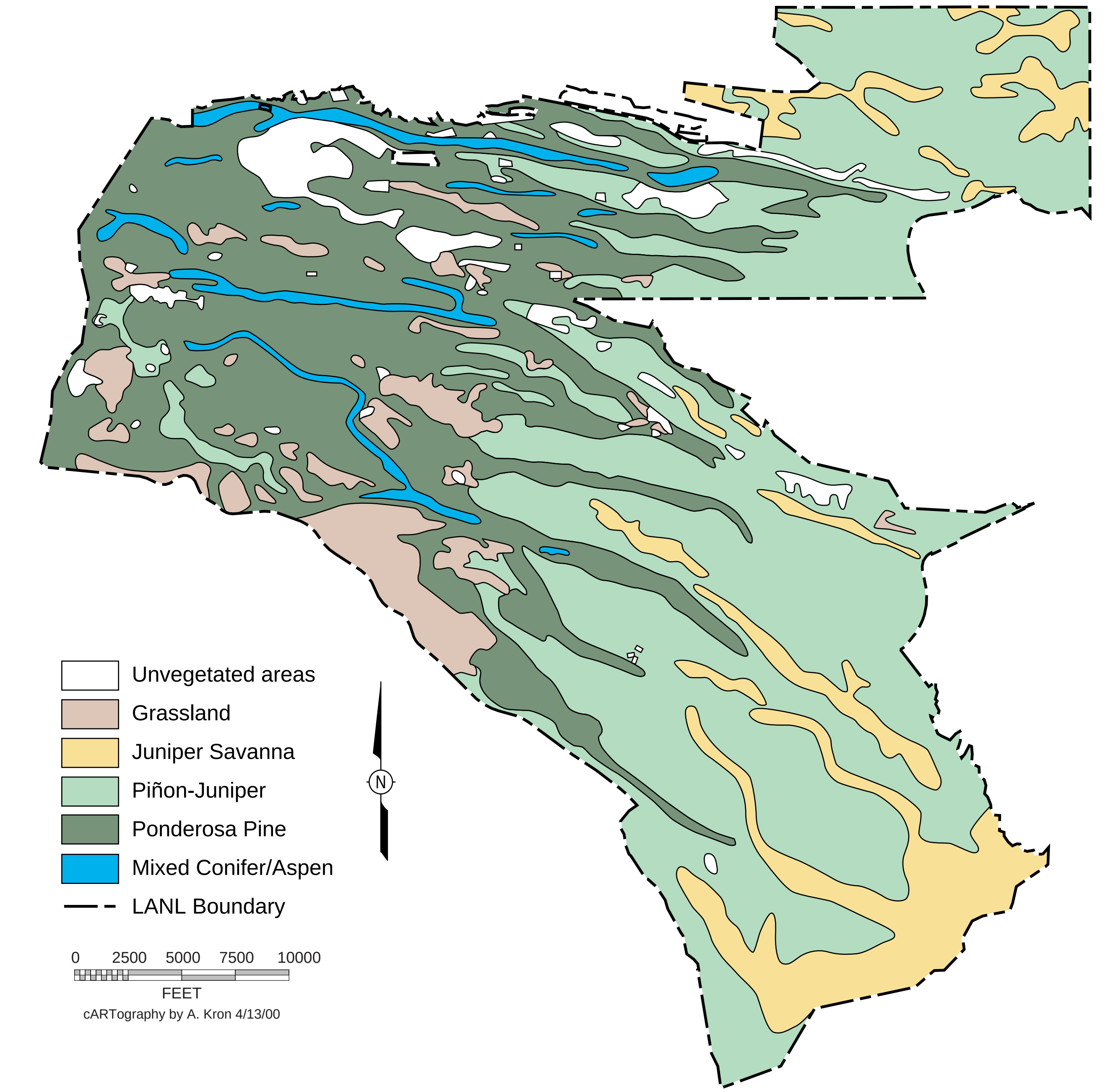
2.0 Background

2.1 Conditions Existing before the Cerro Grande Fire

At LANL, piñon-juniper woodlands grade into ponderosa pine and spruce-fir forests as elevation increases from the Rio Grande into the Jemez Mountains. Land to the west of LANL is covered by spruce-fir and ponderosa pine forests, land to the south is covered by piñon-juniper woodland and ponderosa pine forest, and land to the east is covered by piñon-juniper woodland and juniper savanna.

Before 1890, surface fires in ponderosa pine forests on the Pajarito Plateau were part of the natural environment with a return interval of between 5 and 15 years (Allen 1989). A surface fire spreads across the forest floor, burning grasses and debris, only occasionally igniting individual trees. Surface fires, while hot, generally do not burn deeply into the soil and are more easily suppressed than other more consumptive fires. Frequent surface fires favor a grassy understory (Armstrong 1998) and keep tree density down.

Before 1890, the higher elevation mixed conifer forest areas (i.e., spruce and fir) had a fire



Dominant vegetation types at Los Alamos National Laboratory.

return interval of about 10 years (Allen 1989), while patches of aspen within the mixed conifer forests experienced crown fires at various return frequencies (Armstrong 1998). A crown fire is a catastrophic fire that spreads quickly through the tops of trees in dense forests. Crown fires are very hot, burning deeply into the soil, and are very dangerous and expensive to suppress. Spruce-fir forests probably experienced high-intensity fires at mean intervals of over 150 years (Allen 1989).

Overgrazing practices were common across the Jemez Mountains in the 19th century, such that by 1893 widespread fire occurrence in the area had ceased (Armstrong 1998). The high-frequency, low-intensity surface fires common to the area before 1893 were suppressed as a function of the reduction in continuity and quantity of herbaceous fine fuels (such as grasses and broadleaf plants) (Armstrong 1998). These fires kept tree density down and surface fuel

di000146049

Example of low-intensity wildfire.

di000146014

Example of high-intensity wildfire.

accumulation in check (Armstrong 1998). Clearing by homesteaders around the LANL area further reduced area vegetation. Commercial logging in the Jemez Mountains began in 1897 and continued until 1980. The majority of cutting at and around LANL selectively removed the larger, and incidentally, more fire resistant trees (e.g., fully mature, thick-barked ponderosa pine and Douglas fir) (Armstrong 1998). At the same time, this practice encouraged the establishment of shade-tolerant and fire-intolerant species of trees (such as Englemann spruce) (Armstrong 1998).

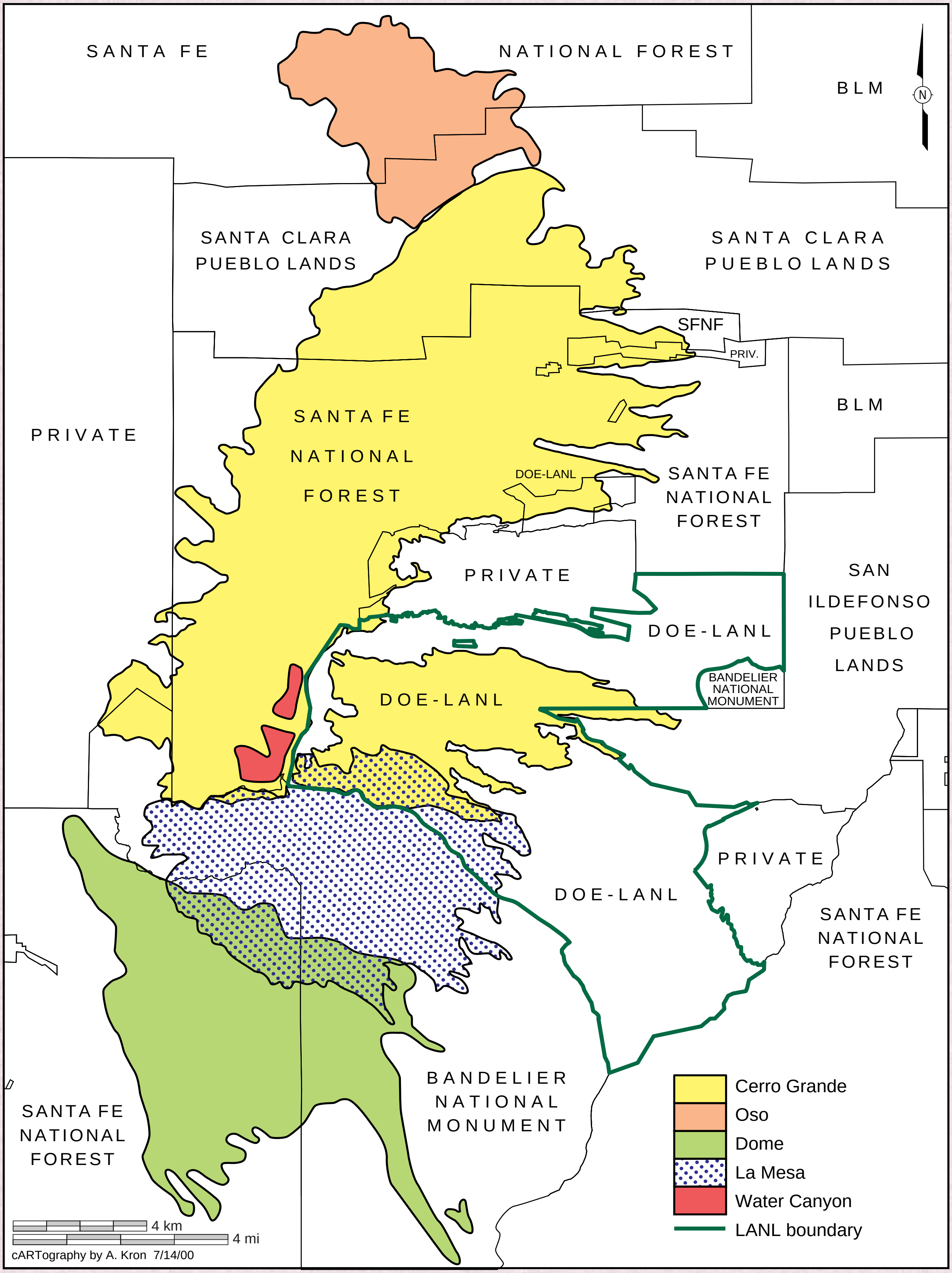
Land management practices employed by various land stewards in the vicinity of LANL during the last half of the 20th century were characterized by severe reductions in cattle grazing and timber cutting and by artificial (institutionalized) fire suppression. The most obvious effects of these practices have been an increase in overall tree stand densities, continuity, and fuel loading with a concomitant decrease in understory cover. The heavily forested areas within and surrounding LANL have become overgrown with dense stands of unhealthy trees having excessive amounts of standing and fallen dead tree material. These areas present an extreme hazard to nearby communities from high-intensity wildfires.

In the last fifty years, this area has seen five major fires—the Water Canyon fire in 1954, the La Mesa fire in 1977, the Dome fire in 1996, the Oso fire in 1998, and the Cerro Grande fire in 2000. In each case, the fire occurred during the late spring, early summer fire season when fire danger was high or extreme. Weather conditions were hot and dry, fuel moisture content was low, and fuel loads were high. These conditions led to development of spectacular crown fires where flames leapt from treetop to treetop and resulted in the death of vegetation from the ground up over large expanses of land.

2.2 Building Vulnerability to Wildfire

The LANL Fire Protection Group prepared a building vulnerability analyses in 1998.

Vulnerability to wildfire is based upon three factors—structure hazard, slope hazard, and fuel hazard. Structure hazard considers the combustibility of the exterior of a structure and is assigned a numerical value between 0 and 3. Slope hazard considers location of the structure relative to hillsides and is assigned a numerical value from 5 to 20. Fuel hazard is itself the product of two components, fuel loading and distance factor. Fuel loading is assigned a value of 0 for short grass and asphalt and is assigned a numerical value for other conditions as described in Aids to Determining Fuel Models for Estimating Fire Behavior (NWCG



Location of five major wildfires in the Los Alamos National Laboratory region.

1982). Distance factor expresses distance of the fuel from the structure and is assigned a value between 0 and 3.

Total structure vulnerability is calculated as vulnerability = (structure hazard) x (slope hazard + fuel hazard). Vulnerabilities are grouped into one of six categories from none to extreme. This approach identifies which structures are more likely to be damaged or destroyed should a wildfire occur. It does not provide the probability that a wildfire will approach a structure nor the probability that any particular structure will burn.

Building vulnerability was then combined with information on chemical and radiological materials inventory to prioritize wildfire fuel reduction activities (e.g., maintenance action of tree thinning within a 100-foot-perimeter area) at certain facilities. Fuel reduction was undertaken at nuclear facilities regardless of vulnerability.

2.3 Mitigation

Since the Dome fire in 1996, many activities were undertaken to reduce threat of wildfire to LANL. The Laboratory expedited its routine maintenance of fire roads and improvements to enhance forest accessibility. A fuel break was created along State Road 501 to create a defensible separation between the Santa Fe National Forest and the Laboratory's western perimeter. A fire cache (e.g., a collection of fire-fighting equipment such as shovels, axes, backpacks, clothing, etc.) and heliport with an emergency water tank were constructed at Technical Area (TA) 49, along LANL's border with Bandelier National Monument.

LANL's goal is to reduce fuel loading from the current 400 to 800 trees per acre to 50 to 150 trees per acre within the Laboratory. The primary focus is on areas with ponderosa pine or spruce-fir forests. These areas represent approximately 10,000 acres of the Laboratory's 27,520 acres. By the time of the Cerro Grande fire, approximately 800 acres had been treated, primarily around buildings, roads, and parking lots, as discussed below.

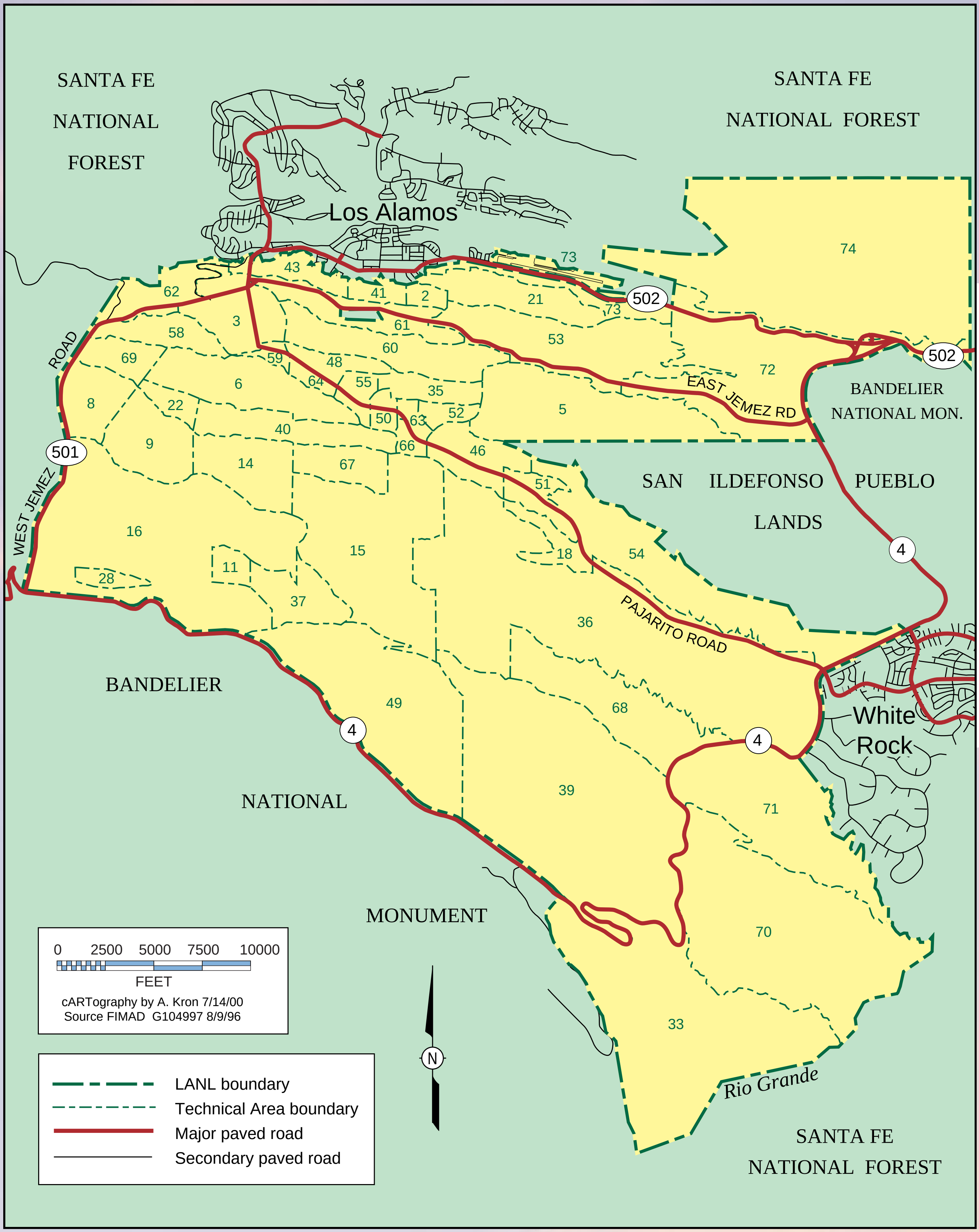
Trees were cut and thinned at specific facilities. The building vulnerability analyses were used to prioritize mitigation. High-priority areas included the high explosive testing and processing areas and nuclear facilities. Tree thinning and brush removal took place at TAs 15, 36, 3, 48, 55 (thinning activities took place outside the security fence), 35, and 59. Landscape maintenance was performed at TA-21 and other locations as deemed appropriate.

Two facilities, the low-level waste disposal site at TA-54 (Area G) and the Weapons Engineering Tritium Facility (WETF), were given special attention since they were the sources of the majority of the projected public dose in the SWEIS wildfire accident scenario. Approximately 30 acres surrounding WETF were thinned from around structures, roads, and parking areas. At TA-54 (Area G), trees were cut on about 10 acres, and wooden pallets on which waste drums were stacked were replaced with aluminum pallets.

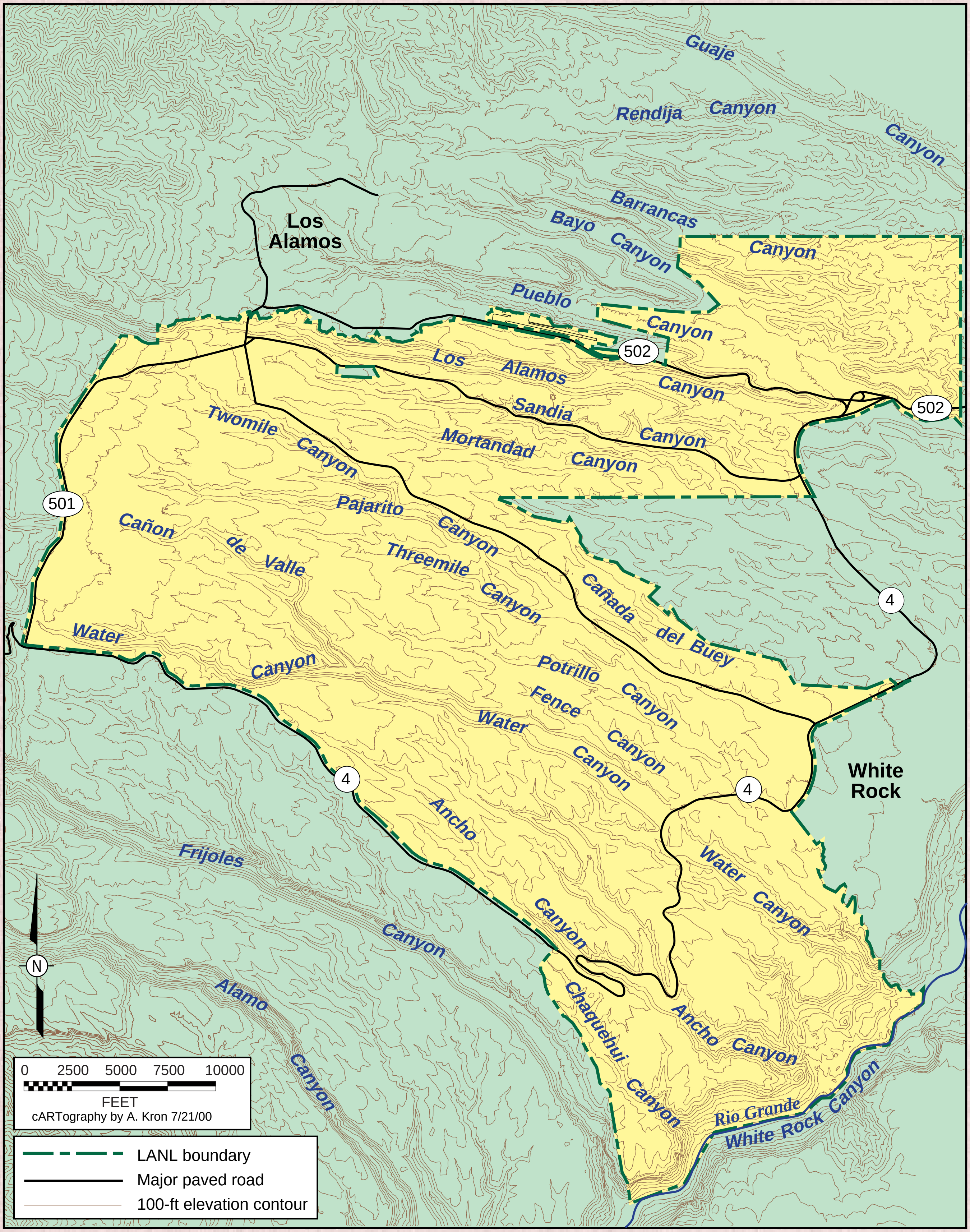
In addition, the regional Interagency Wildfire Management Team (IWMT) was formed in 1996 to provide fire control advice and a forum to exchange expertise and information among land stewards in the East Jemez region. The IWMT has representatives from the Laboratory, DOE, Los Alamos County, the Forest Service, the Park Service, the Pueblo of San Ildefonso, the State of New Mexico, and other interested parties. The IWMT fostered consultations between agencies and developed information for evaluating wildfire problems, proposing optimal mitigation strategies, and undertaking implementation. The IWMT collaborated on the fuel break activities along State Road 501 and the fire cache/heliport development at TA-49.

3.0 Wildfire Progressions

The LANL SWEIS postulated an extensive wildfire initiated to the southwest of LANL, near the border of Bandelier National Monument, with the fire path a function of fuel loading and wind direction. The analysis assumed that about 8000 acres of LANL property would burn. The analysis did not include surrounding USFS land or the



Los Alamos National Laboratory technical areas.



Major canyons crossing Los Alamos National Laboratory.

townsite, since such inclusion would not be appropriate for an analysis of LANL's facilities. The analysis did note that the townsite would be affected.

On May 4, 2000, the National Park Service at Bandelier National Monument set a controlled burn that subsequently became a wildfire. The Cerro Grande fire was the largest in New Mexico State history and burned about 43,000 acres of forest and residential land, including about 7500 acres of the LANL site.

The progression of the postulated wildfire and the actual Cerro Grande fire were very similar. The ignition point was at the same location (near the junction of State Road 4 and State Road 501), both fires followed areas with heavy fuel loads, and wind patterns were typical for late spring, early summer.

3.1 SITE-04 Wildfire Accident

The SWEIS wildfire accident scenario (SITE-04) postulated that a wildfire would begin southwest of LANL near the border of Bandelier National Monument and the Dome Wilderness area. The wildfire would occur sometime between late April and early July at a time of high or extreme fire danger. Winds were assumed to be southwesterly and on the order of 20 mph. Relative humidity was assumed to be low during the daytime and increase in the evenings. Temperatures were expected to be high during the daytime and decrease during the evenings. The fire would ignite at an elevation between 6500 ft to 8200 ft above sea level in an area with heavy ponderosa fuels and limited forest access.

In the accident scenario, local resources would prove insufficient in suppressing the fire due to remoteness of the fire, lack of road access, and fire behavior. The arrival of additional resources would be delayed because of distance, limited roads, and opposing evacuation traffic. The fire could not be suppressed before it enters the Laboratory.

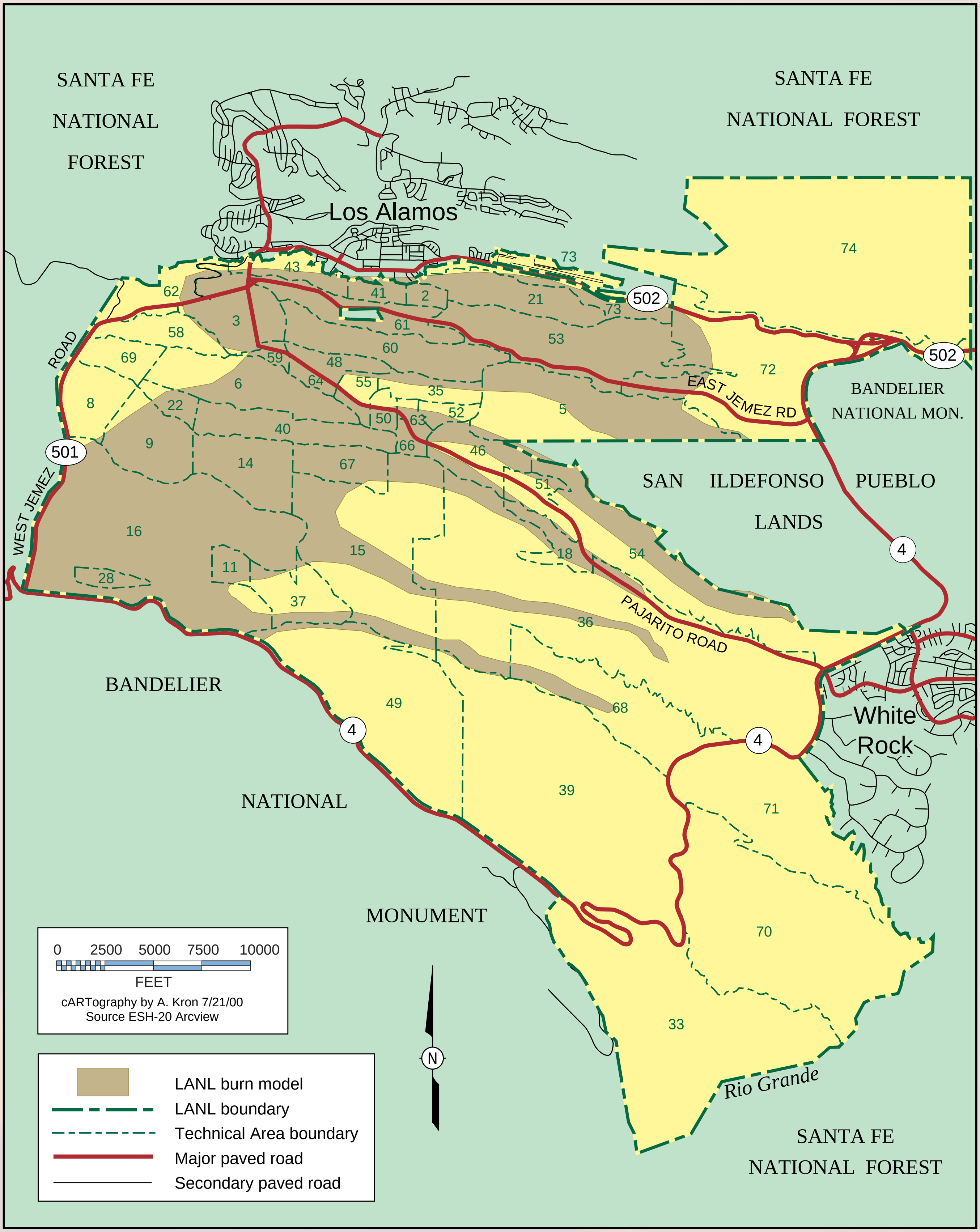
Day One: The fire began at 10:00 a.m. and burned about 1000 acres in the first three hours. As it developed, it became an intense crown fire with a broad front. The daytime convection column rose 20,000 to 25,000 feet. During the night, lower temperatures and higher relative humidity decreased fire activity, and the nighttime plume rise dropped to about 2000 feet.

Day Two: The fire grew to about 6000 acres. Fire intensity was regained by 10:00 a.m. Strong southwest winds (up to 20 mph) and low daytime humidity promoted spot fires 0.5 to 1.25 mile in front of the main fire. The fire easily jumped canyons and fuel breaks. It entered the Laboratory near the junction of State Road 4 and State Road 501 by noon.

In this scenario, a control line was established at Pajarito Road. The fire burned both west of and on Laboratory property, but easterly progress was constrained by breaks in ponderosa fuel continuity and transition into piñon-juniper dominated vegetation. TAs threatened by the fire included the high explosive areas (TAs 37, 15, 16, and 66) and those to the west located along continuous fuel lines and edges of forested canyons.

Day Three: Adverse meteorological conditions (e.g., low humidity and increased winds) allowed the fire to jump the Pajarito Road control line. During the night, the fire burned up to the Pajarito Road control line west of TA-66. By mid-morning increased wind speed and low humidity aided fire intensity and it crossed the Pajarito Road control line between TA-3 and TA-55 by noon, surrounding TA-3 and TA-48. The fire entered Los Alamos Canyon and progressed to TA-2 and TA-41, then climbed the mesa to TA-53 and TA-21. The fire spotted in Mortandad Canyon. The canyon fires burned eastward unabated because of limited access. When there were sufficient trees on the canyon slopes, the fire climbed out of the canyon and ignited combustible fuels and structures on canyon edges.

Day Four: The fire entered the townsite. In lower parts of canyons, the fire came under control with help of weather, human interference, and natural breaks in fuel continuity.



Site-04 wildfire accident area burned on Los Alamos National Laboratory.

The final acreage burned in this scenario was about 27,000 acres. Of that, about 8000 acres were within Laboratory boundaries. By following the canyons, the fire was presumed to burn TA-54, Area G, even though this facility was not directly in the path of the prevailing winds driving the fire.

3.2 Cerro Grande Wildfire

On May 4, 2000, the National Park Service started a prescribed burn on Cerro Grande peak within Bandelier National Monument. The intended burn, a 300-acre meadow at 10,119-ft elevation, was located about 3.5 miles west of the Laboratory boundary in the headwaters of Water Canyon and Cañon de Valle. The prescribed burn was started in the evening and was declared a wildfire by 1:00 p.m. the following day.

Meteorological data, obtained from the LANL Air Quality Group, collected from stations located at TAs 6, 49, and 54, show above average temperatures and low humidity for the first ten days of the fire. Wind speeds ranged from 6 to 17 mph during this ten-day period, and wind gusts ranged from 27 to 54 mph.

The following chronology is a compilation of facts from LANL and Los Alamos County sources (Burick 2000, Tucker 2000).

Day One, Thursday, May 4: A test fire was started near the summit of Cerro Grande peak at 7:20 p.m. and fire behavior was within expected parameters. Ignition of the prescribed burn began at about 8:00 p.m. and continued through the night.

Day Two, Friday, May 5: The prescribed burn was declared a wildfire about 12:55 p.m. when fire on the northeast burn area boundary became difficult to contain with the crew at hand. At 4:30 p.m., a spot fire was detected and contained about 0.25 mile east of the main fire burning in Water Canyon. At 11:55 p.m., the National Weather Service issued a spot weather forecast calling for a fire weather watch on Saturday, May 6. The DOE/LANL Emergency Operations Center (EOC) was activated.

Day Three, Saturday, May 6: Fireline operations, including backfires, were conducted along the east and west sides of the fire down to State Road 4. A spot fire to the east of the main fire area was observed and contained.

Day Four, Sunday, May 7: Several spot fires were observed up to 0.25 mile east of the main fire. Driven by winds over 30 mph, the fire crossed the headlands of Water and Pajarito Canyons and Cañon de Valle above the Laboratory to the west and reached Los Alamos Canyon, adjacent to the townsite. Backfires were set along sections of State Road 501 and Camp May Road to protect the Laboratory. By 12:40 p.m., a decision was made to evacuate portions of USFS land (e.g., Graduation Flats and American Springs). By 1:00 p.m., interagency road closures and evacuation procedures were initiated for portions of the Los Alamos townsite. The Laboratory announced an emergency closure effective Monday.

Day Five, Monday, May 8: The fire burned north and east to the edge of the State Road 501 and Camp May Road fire breaks. Spot fires started on Laboratory lands. Slurry bomber activity increased and bulldozer lines were cut within the Laboratory. The Laboratory suspended all programmatic work. LANL was closed to minimize traffic and facilitate use of public roads by firefighters moving equipment. At 9:00 a.m., officials also ordered the closure of all businesses in the Los Alamos townsite for the same reason. By the end of the day, about 2000 acres had burned, mostly on USFS land.

Day Six, Tuesday, May 9: Spot fires on the Laboratory were still being fought, but no facilities were threatened. There was reduced fire activity due to cooler temperatures associated with a weak weather front. The firebreak at Camp May Road was still holding. The Forest Service mobilized a Type I Incident Command Team at TA-49. The fire grew west and south. At this point, the fire had consumed about 4300 acres, mostly USFS land.

Day Seven, Wednesday, May 10: Fire activity increased early in the morning with the probability of ignition (e.g., the probability that an ember would ignite combustible material) at 100%. Spotting occurred up to 0.75 mile in front of the main fire. Laboratory facilities were directly threatened by a spot fire in Water Canyon, specifically the WETF. The EOC identified Laboratory buildings to be defended at all cost. The Los Alamos Fire Department Structural Protection Team was assigned to LANL.

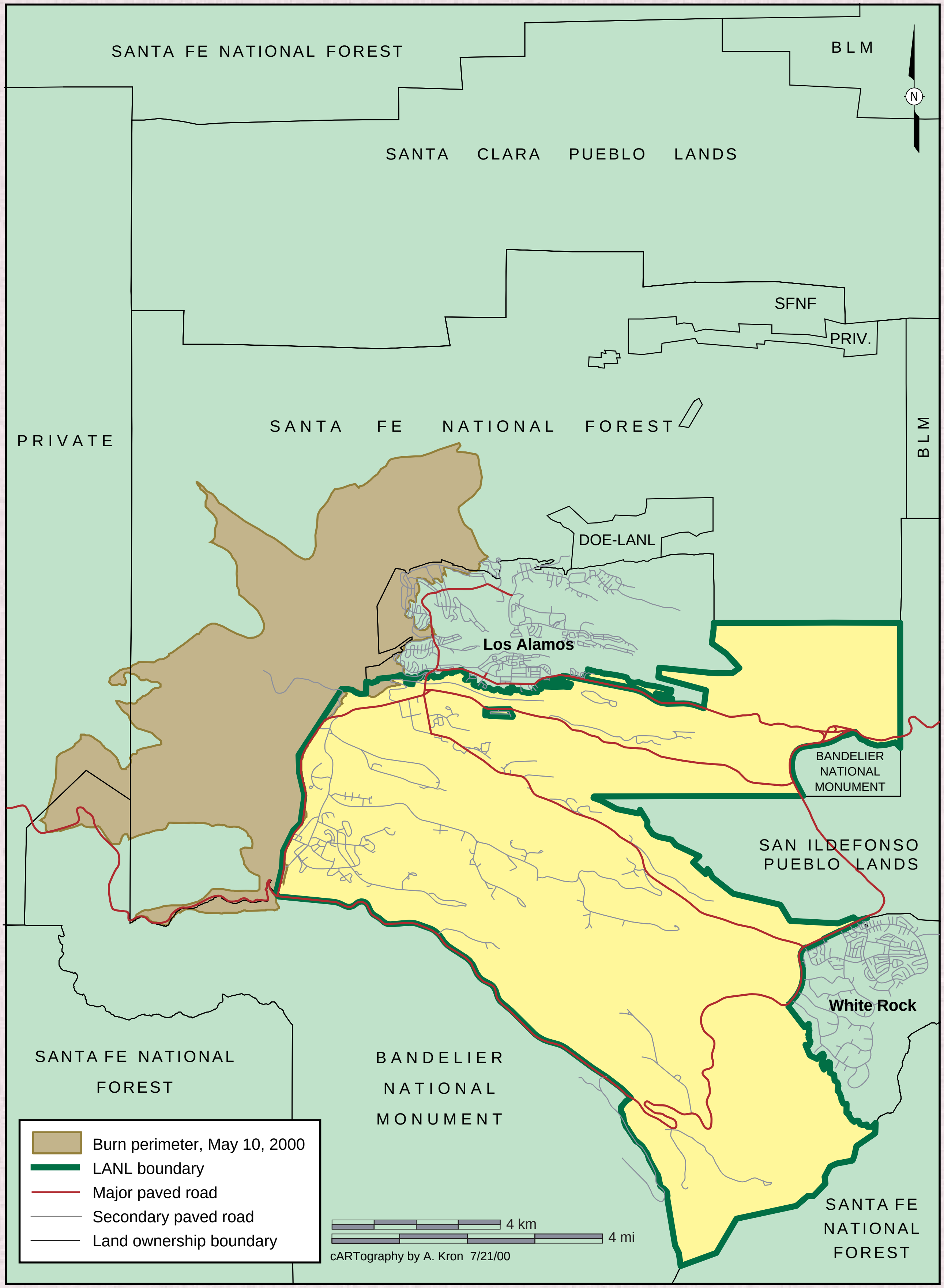
The fire burned on two fronts. By 1:00 p.m., the fire crossed Camp May Road north into the upper watershed of Los Alamos Canyon, directly threatening the townsite. This led to a mandatory evacuation for the remainder of the Los Alamos townsite. At the same time, the fire on Laboratory property in Water Canyon burned uncontrolled despite firefighting efforts as winds sporadically exceeded 50 mph. The fire spread north and east and crossed the mesa top at TA-16. It also went through Cañon de Valle onto Three-Mile Mesa to the edge of Pajarito Canyon. The fire burned actively through the night and consumed nearly 20,000 acres, including many private residences in the Los Alamos townsite. The President designated the fire a disaster, and the Federal Emergency Management Agency was activated. Acreage burned on Laboratory land was an estimated 500 acres.

Day Eight, Thursday, May 11: The townsite of White Rock was evacuated at 1:00 a.m. The fire on Laboratory land progressed east and north over night. It ran eastward down Water Canyon and Cañon de Valle and threatened TA-49. It ran eastward down Pajarito Canyon, Mesita del Buey, and Cañada del Buey threatening structures at TAs 50, 55, 54, and 18. It crossed the Laboratory boundary onto Pueblo of San Ildefonso land. It also progressed north into the headwaters of Mortandad Canyon and Sandia Canyon and directly threatened TA-3, the main administrative area of the Laboratory. The main fire continued north and skirted the major portion of the Los Alamos townsite. It ran east down Rendija and Guaje Canyons and north across the headwaters of these canyons almost to Santa Clara Canyon. Much of the firefight focused on keeping the fire from running down Los Alamos Canyon across Laboratory land. Estimated total acreage burned was about 33,000 acres with about 5000 acres on Laboratory property.

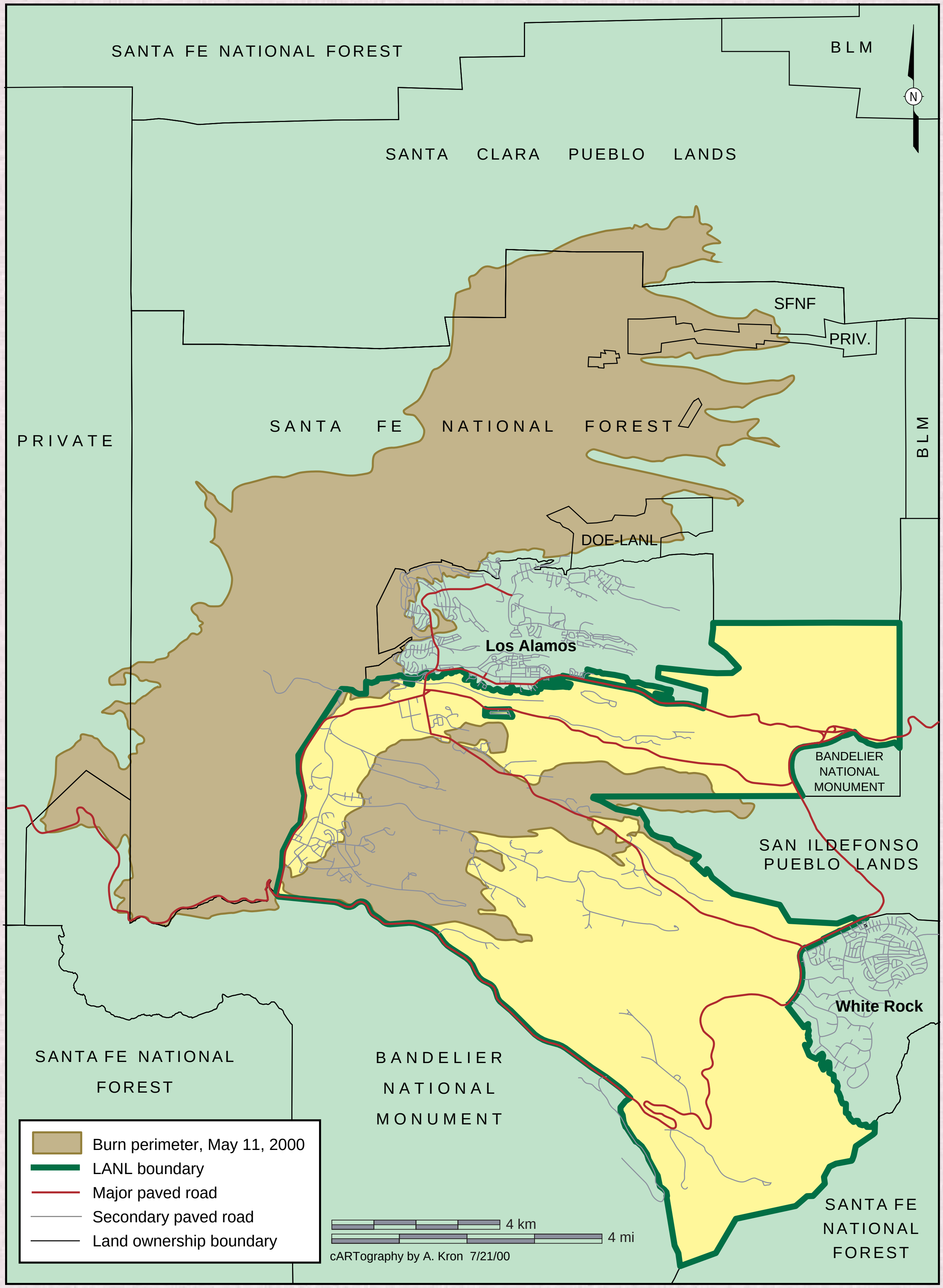
Day Nine, Friday, May 12: The fire on Laboratory land grew east down Potrillo Canyon and northeast into Water Canyon below Cañon de Valle. A spot fire grew south of TA-18 and directly threatened structures at TA-18 and TA-54. The fire also burned west at the high explosive area (TAs 9, 22, 6, and 69) and back toward State Road 501. The main fire continued to burn north and west toward the ridgeline of the mountains. Estimated total acreage was about 34,000 acres with about 7400 acres on Laboratory property.

Day Ten, Saturday, May 13: The fire on Laboratory land advanced north across Mortandad Canyon into Sandia Canyon. The fire line at East Jemez Road held the fire at this point, protecting TA-53. The fire also grew east down Portrillo Canyon and south out of Water Canyon onto the mesa top at TA-49. The main fire continued to climb west toward the ridgeline and north where it crossed into Santa Clara Canyon. Estimated total acreage was about 36,000 acres with about 7500 acres on Laboratory property.

Day Eleven, Sunday, May 14: The fire stopped progressing on Laboratory land. The main fire continued to advance west and north into Santa Clara Canyon and included isolated hot spots all along the perimeter and within the area



Cerro Grande fire, area burned through day seven.



Cerro Grande fire, area burned through day eight.

burned. The evacuation was lifted for White Rock residents on Sunday and for Los Alamos residents on Monday, May 15. The USFS Burned Area Emergency Rehabilitation team arrived, the Laboratory began planning the systematic process to reoccupy the site, and the Laboratory partially reopened on May 22. Wildfire crews continued to work what became over 95 miles of fire lines.

The fire was fully contained by June 6. Total acreage burned was about 43,000 acres with about 7500 acres on Laboratory property. An estimated 37 million trees were lost in the fire. One hundred twelve Laboratory structures and 235 residential structures in the townsite were damaged or destroyed.

4.0 Fire Effects on LANL Buildings

The Cerro Grande fire damaged or destroyed 112 structures (e.g., 67 damaged and 45 destroyed) at LANL. Damaged and destroyed structures consisted largely of office trailers and small storage sheds. No facilities with radioactive or chemical inventories burned.

4.1 SITE-04 SWEIS Wildfire Analysis

The SWEIS accident evaluated LANL facilities for vulnerability to wildfire using LANL's Fire Protection Group's building vulnerability analysis, completed in 1998. This evaluation placed each operating facility into one of six vulnerability categories, from "none" to "extreme." In addition, the SWEIS accident analysis reviewed all nuclear and non-nuclear hazard categorizations of LANL facilities. The list of buildings vulnerable to wildfire and the list of buildings with hazard categories were crosswalked to determine which set of buildings were vulnerable to wildfire and had a hazard categorization. This step ensured that all buildings that had a hazard categorization and rated as moderate or high for wildfire vulnerability were considered in the analysis (LANL 1998).

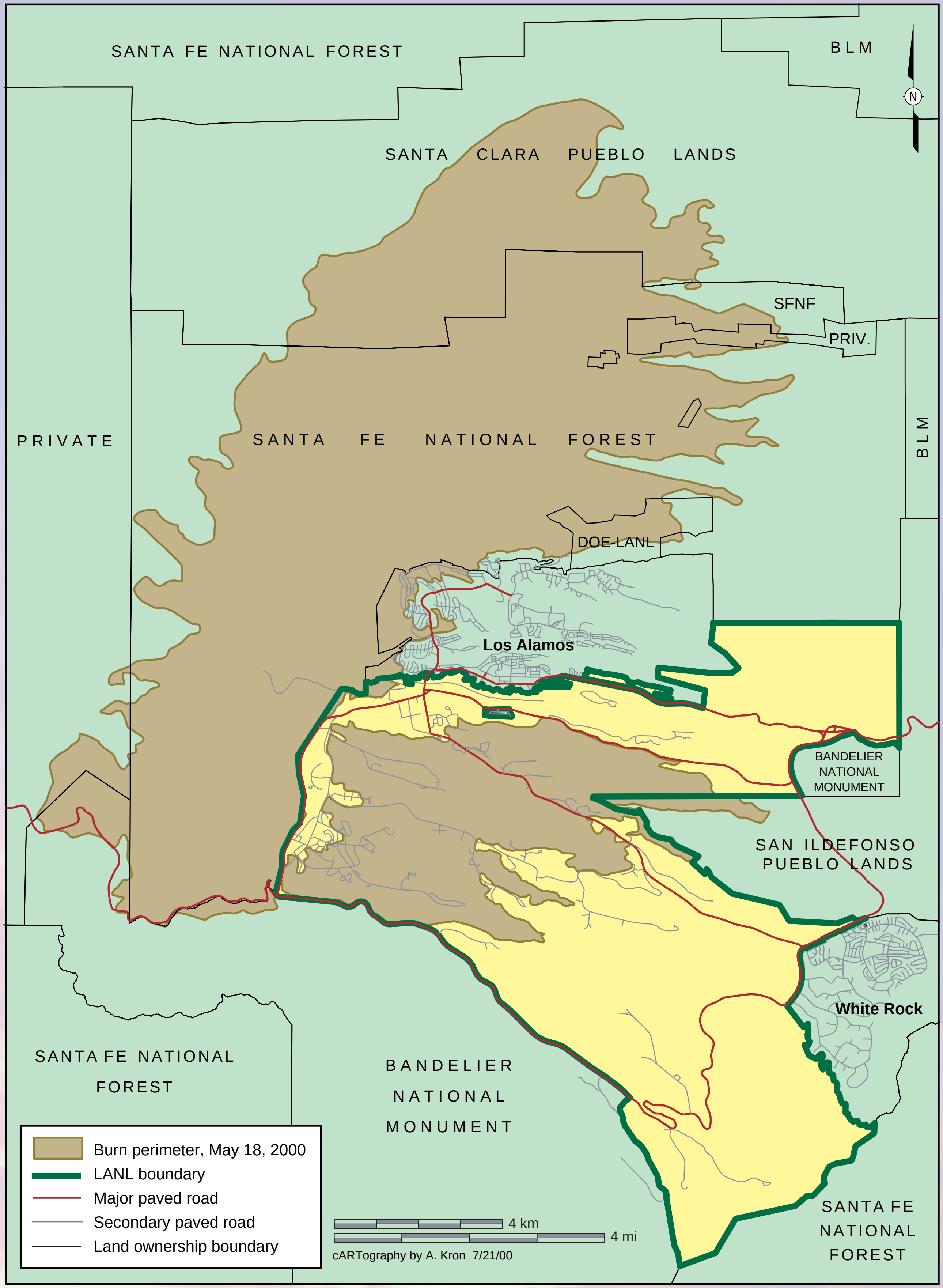
4.1.1 SITE-04 / No Mitigation Actions

Vulnerable buildings without a hazardous facility ranking were not evaluated for potential exposures of the public. The remaining buildings, vulnerable to wildfire and with a chemical or radioactive hazard rating, were assumed destroyed. Seven LANL facilities met this criteria:

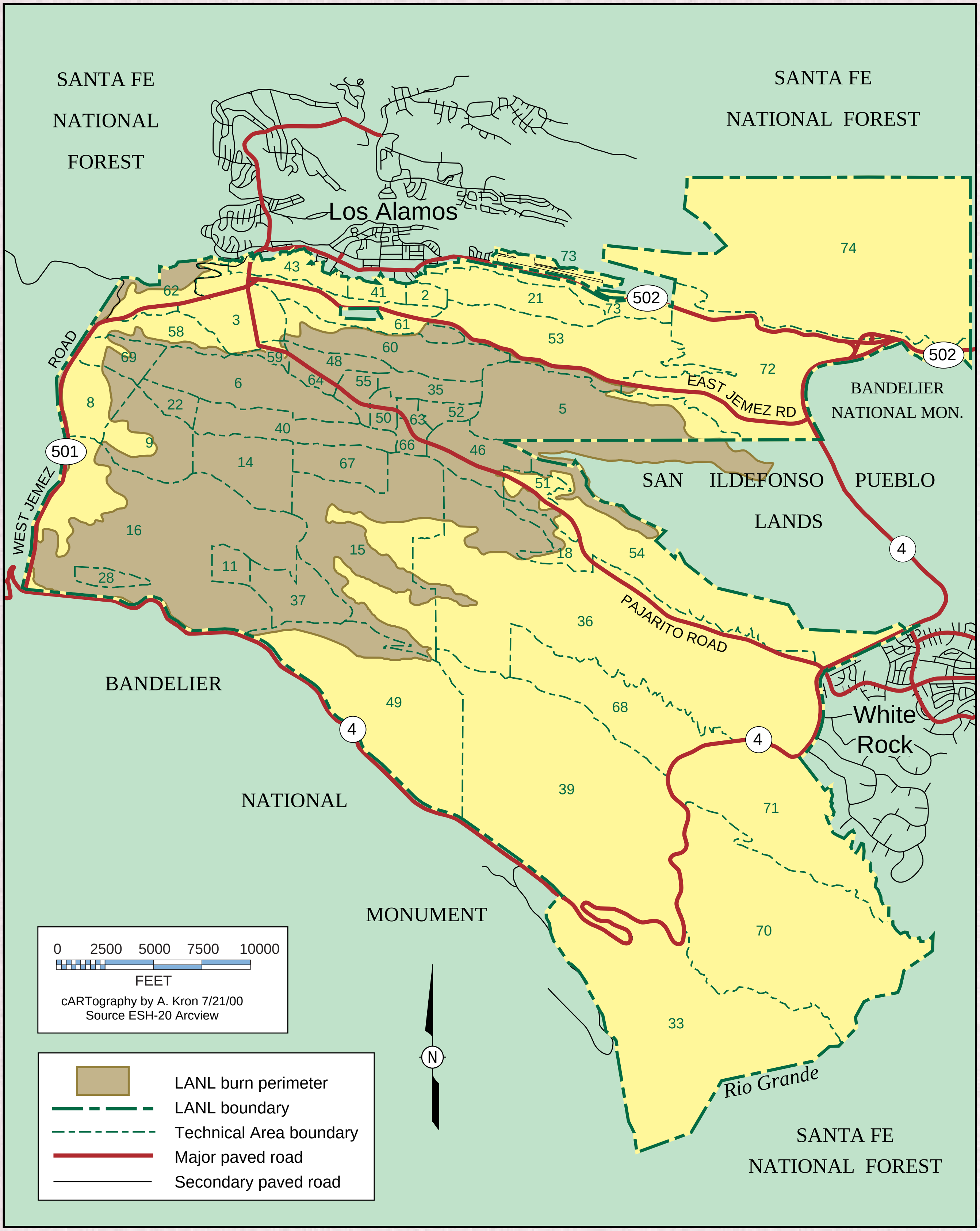
- TA-03-66/451, the Sigma Building
- TA-16-205, the Weapons Engineering Tritium Facility (WETF)
- TA-21-155, the Tritium Science Test Assembly (TSTA)
- TA-21-209, the Tritium Science and Fabrication Facility (TSFF)
- TA-43-01, the Health Research Laboratory (HRL)
- TA-48-01, the Radiochemistry Facility
- TA-54 (Area G) transuranic (TRU) waste storage facilities

After the Cerro Grande fire, destroyed and intact storage sheds, side-by-side.

After the Cerro Grande fire, destroyed and intact office trailers, side-by-side.



Cerro Grande fire, total area burned.



Cerro Grande fire, area burned on Los Alamos National Laboratory.

The inclusion of TA-54 (Area G) in this analysis is based on the assumption that the fire follows the fuel load in canyon bottoms and along north-facing slopes. The fire exits the canyons where fuel loading is high and burns facilities on canyon rims.

4.1.2 SITE-04 / Mitigation Actions

The SWEIS accident analysis also includes a mitigation scenario in which actions such as tree thinning, cutting away of underbrush, landscape maintenance, etc., are taken to reduce wildfire risk. When these mitigation actions are considered, none of the facilities (see Section 4.1.1 above) except those at TA-43 and TA-48 are considered susceptible to fire.

4.2 Cerro Grande Fire

The Cerro Grande fire affected operational readiness of 237 structures at LANL, of which 112 were either damaged or destroyed (LANL 2000). LANL has over 2000 structures, of which about 1800 are actual buildings. The others are items such as meteorological towers, pump houses, water towers, manhole covers, and small storage sheds.

Fire effects affecting operational readiness are categorized as follows:

- Pest control (10 structures): Facility cleanup is required because of entry of field mice, which are carriers of the Hantavirus, during the wildfire.
- Filters / Custodial (99 structures): The fire generated large volumes of smoke and ash, which were pulled into facilities by ventilation equipment. This necessitated the cleanup of equipment, carpets, walls, and ventilation systems; the replacement of heating, ventilation, air conditioning, and swamp cooler filters; the cleaning of air supply ducts; and other general custodial cleanup actions.
- Communications (16 structures): This involved loss of telephone service to a structure.

Fire effects categorized as damaged or destroyed are as follows:

- Damaged (67 structures): This consists of broken windows; exterior paint damage; outside doors burned; PVC skirt melted; water damage; sprinkler damage; roof damage; etc.
- Destroyed (45 structures - but no permanent buildings that were in current use for operations): The structure was either burned to the ground or damaged so heavily that repairs were not feasible.

Areas that suffered most during the fire were TAs 15, 16, 46, and 64, as shown below:

Structures Damaged and Destroyed

Area	Damaged	Destroyed
TA-15	14	12
TA-16	13	7
TA-46	9	8
TA-64	4	14
All other	27	4

TAs 15, 16, and 64 are within ponderosa pine forest, and TA-46 is within piñon-juniper woodland.

Although the Cerro Grande fire burned more than 7500 acres of Laboratory land, and although the burned area contained many of the Laboratory's important facilities, no major buildings were significantly damaged, and no facilities with a nuclear hazard classification (DOE Order 5480.23) were affected. The seven facilities identified in SITE-04 were not burned.

Tree thinning enabled the Los Alamos Fire Department to successfully defend these facilities and prevent fire damage. A good example of this is WETF, a facility containing tritium, which was directly in the path of the Cerro Grande fire and survived intact. Damaged and destroyed structures consisted largely of office trailers, small storage sheds (used to store standard items such as tools and supplies, not used to store chemicals or radioactive materials), or old buildings that were no longer in use.

Forest surrounding WETF before mitigation.

Patrick J. Valerio

Forest surrounding WETF after mitigation.

Patrick J. Valerio

Forest surrounding WETF during the Cerro Grande fire. The mitigation measures kept the fire on the ground, and the tree crowns were not affected.

Patrick J. Valerio

5.0 Emissions - Air

The SWEIS accident scenario only analyzed consequences from fire in the Laboratory. Emissions reported from the Cerro Grande fire represent the entire area burned—forest, Laboratory, and townsite. Data indicate emissions from the Cerro Grande fire were consistent with those emissions expected from natural sources burning vegetation and soils.

5.1 Background on Wildfire Emissions - Air

All wildfires, regardless of location, emit radioactive lead-210, bismuth-210, and polonium-210, which are naturally occurring decay products of radon (Lambert 1991, le Cloarec 1995, Nho 1996, Dibb et al. 1999). Radon is a gas, but these decay products are metals that settle to the ground and on plant surfaces. During a fire, these particles become airborne, measurably increasing in concentration. Other radionuclides also exist naturally (potassium-40, carbon-14, beryllium-7, and uranium) at lower concentrations. In addition, human-made radioisotopes are expected in small quantities from world wide fallout resulting from historical atmospheric testing.

The concentrations of polonium-210 and bismuth-210 summarized in the table below compare emissions from the Cerro Grande fire to a typical wildfire in Africa. Lead-210 emissions are not given because the lead-210 concentration is generally equal to the bismuth-210 concentration. The first three rows show background, which is the amount measured when there is no fire. The backgrounds are similar in the US (NCRP 1987, Report No. 94), Los Alamos (LANL 1999b), and Africa (Lambert 1991, Nho 1996). During the Cerro Grande fire, the increase in concentration was similar to that measured near African fires (Lambert 1991). Directly in the plumes of African fires and four meters above these fires, the concentrations increase even more (Lambert 1991, le Cloarec 1995). In Los Alamos, 48th Street, which was surrounded by fire, may be comparable to these plumes.

5.2 SITE-04 Wildfire Accident

Both cases (pre-mitigation and post-mitigation) of SITE-04 assumed everything directly in the fire path burned. Because soil is entrained into the fire from burning vegetation, concentrations of soil contaminants transported and dispersed downwind from LANL were calculated using the Open Burn/Open Detonation Dispersion model. To be conservative, the total amount of contaminants found in the upper three inches of soils were assumed to be entirely on the surface and exposed to fire.

Because this was a hypothetical accident, doses were calculated using source terms and predictive models. In this case, the MELCOR Accident Consequences Code System was used. Therefore, airborne emissions, typically expressed as picocuries (1.0 E-12 curie) or femtocuries (1.0 E-15 curie) per cubic meter of air, although calculated, were not stated in the SWEIS.

Calculations for Wildfire Emissions

	Polonium-210 (fCi/m^3)	Bismuth-210 (fCi/m^3)
US background	1	11
Los Alamos background	0.9 ± 0.4	12 ± 3
African background	2 ± 1	20 ± 10
Near Cerro Grande fire	20 ± 10	30 ± 10
Near African fires	16 ± 6	43 ± 10
Cerro Grande fire, Los Alamos 48th St	114 ± 18	32 ± 8
In plumes of African fires	238 ± 94	238 ± 83
Four meters above African fires	2000 ± 1000	not measured

(Note: 1 fCi is 1.0 E-15 curie.)

5.3 Cerro Grande Fire

Since the Cerro Grande fire involved the Laboratory, there was considerable interest in radioactive and chemical emissions during the fire. Samples of the smoke plume were analyzed for both chemical and radioactive constituents by several organizations.

5.3.1 Radiological Emissions - Air

Four organizations—LANL, DOE, Environmental Protection Agency (EPA), and New Mexico Environment Department (NMED)—sampled the air for radiological emissions during the fire. Results of the monitoring efforts are discussed below.

AIRNET (LANL): This system, consisting of 50 air monitoring stations at LANL and in surrounding communities and Pueblos, is the primary system used by LANL to identify air quality impacts from ongoing operations. It was used to continuously measure ambient air radioactive isotope concentrations before, during, and after the Cerro Grande fire.

Air filters are typically collected and analyzed from this system every two weeks; however, because of increased particulate matter in the smoke clogging filters, samples were collected more frequently during the fire. All other sampling protocols remained the same. As expected, the AIRNET system detected increased radioactivity in the ambient air due to the Cerro Grande fire. The isotopes responsible for this increase are natural decay products of radon: lead-210, bismuth-210, and polonium-210. Calculated concentrations of isotopes common to Laboratory operations (plutonium, uranium, and americium-241) were generally consistent with historical data. Furthermore, the uranium appears to be from natural sources based on isotopic comparison.

NEWNET (LANL): This is a monitoring network that measures gamma radiation in local areas around the Laboratory and in the communities surrounding the Laboratory. This system did not measure any statistically significant increase in gamma radiation during or after the Cerro Grande fire.

RN97186006

Typical air monitoring station.

RAP (DOE): This system, consisting of seven stations, measures radioactive particulate matter in ambient air. It was deployed during the early days of the fire to provide short-term, rapid analysis of air quality. The system was activated May 11 and measured continuously until May 17. RAP detected increased radioactivity in ambient air consistent with the AIRNET data.

RAD (EPA): This system measures radioactive particulate matter in ambient air and is similar to AIRNET. It was deployed from May 14 through May 17 at 20 locations within LANL and in communities around northern New Mexico. Analyses were performed in EPA's Mobile Environmental Radiation Laboratory that had been dispatched to Española. Gross alpha and beta results were very low, "on the order of samples collected across the United States for other purposes" (EPA 2000a). The only gamma radionuclides identified were naturally occurring elements (EPA 2000b and EPA 2000c).

ERAMS (NMED and EPA): This one sampler situated atop the PERA Building in Santa Fe is part of a nationwide network of EPA air monitoring stations. Sample filters from this station are typically collected once per week, but were collected daily during the fire. Filters were sent to EPA's National Air and Radiation Laboratory for beta and gamma analysis. Beta results ranged from 0.0067 to 0.0337 picocuries per cubic meter, versus typical background levels of about 0.02 picocuries per cubic meter. Only naturally occurring gamma radioisotopes were detected: beryllium-7, potassium-40, thallium-208, lead-212, bismuth-212, and radium-226 (EPA 2000d).

RAD (NMED): The NMED Oversight Bureau operates this system consisting of five air monitoring stations. Filters were collected by Oversight personnel and sent to an independent laboratory for analysis. Samples were collected more frequently than normal during the fire. Data for alpha and beta radiation and for uranium and plutonium isotopic analysis indicate levels of uranium and plutonium emissions were consistent with typical regional background concentrations (NMED 2000a and NMED 2000b).

5.3.2 Chemical Emissions - Air

LANL, NMED, and EPA sampled for non-radiological air emissions during the fire. As expected, all sampling networks showed higher-than-normal air concentrations of particulate matter associated with smoke from the fire. The EPA also detected metals and organic compounds, but at concentrations that did not pose a health risk. These compounds may normally be present in the atmosphere or are expected emissions from fires.

Results of each monitoring effort are discussed below.

PM-10 Monitoring by LANL: A single air sampling station was operated at TA-54 to monitor for emissions of respirable-size (i.e., less than 10 microns) particulate matter (PM-10). The EPA standard for PM-10 is 150 milligrams per cubic meter. During the early days of the fire, air concentrations were only slightly elevated versus typical concentrations. When the fire approached TA-54 on May 12 and 13, however, air concentrations as high as 1000 milligrams per cubic meter resulted because of proximity to the fire and the smoke plume.

EPA: From May 11 through May 15, the EPA placed air monitoring stations within LANL and in surrounding communities. The stations measured for PM-10, organic compounds, pesticides, and metals. Results were released to the public on May 17 (JIC 2000a):

- Samples were analyzed for 21 pesticides. No pesticides were found.
- Samples were analyzed for 23 metals. All samples showed very low concentrations of metals, and quantities measured were well below accepted workplace concentrations. These metals appeared to be attributable to burning vegetation.
- Samples were analyzed for 63 organic compounds. Only 12 organic compounds were detected, and the highest observed organic concentration was less than 10% of the prescribed workplace standard.

NMED: The State of New Mexico operates a network of stations to monitor for PM-10. Measurements indicated higher than normal particulates in the air during the Cerro Grande fire.

NMED: The State of New Mexico also sampled for asbestos. The highest air sample result, 0.013 fibers per cubic centimeter, was above typical background levels (0.0025 fibers per cubic centimeter) for the Los Alamos area, but was only 10% of the Occupational Safety and Health Administration (OSHA) asbestos limit.
In addition, NMED conducted surface swipe samples in 13 different locations. All surface swipe samples were negative for asbestos-containing material (JIC 2000b).

6.0 Exposures

The SWEIS wildfire accident made two sets of exposure projections—those before mitigation and those following mitigation. In the former case, the fire at TA-54 (Area G) dominated exposures. In the second case, where certain buildings were not destroyed, the SWEIS wildfire accident analysis assumed that mitigation measures (e.g., thinning trees and removing fuel sources around specific facilities) were effective, the buildings did not burn, and material was not released. Thus, emissions and exposures were reduced to levels projected by burning only vegetation and soils. This second case resulted in a population dose of 50 person-rem, with an associated 0.025 excess latent cancer fatalities and a maximum exposed individual (MEI) dose projection of less than 1 millirem. One early estimate for the Cerro Grande fire is 0.2 millirem for a maximally exposed person (a firefighter).

6.1 SITE-04 SWEIS Wildfire Analysis

The SWEIS wildfire accident analysis identified source terms, dose to the MEI, and collective dose to the population within a 50-mile radius of LANL.

6.1.1 SITE-04 / No Mitigation Actions

The SWEIS wildfire accident included calculations based on burning specific facilities with significant radiological or chemical inventories when mitigation measures were not taken. These calculations resulted in the following:

- A MEI dose, estimated at 22,000 millirem, received by a person in White Rock resulting from burning a TRU storage dome at TA-54 (Area G).
- An estimated 675 person-rem total population dose, resulting in 0.34 latent cancer fatalities, primarily from burning buildings and their inventory of radioactive materials. Approximately 400 person-rem of this dose results from burning one storage dome at the TA-54 Waste Management Complex. It also includes the 189 person-rem from burning the WETF.
- An estimated 11 members of the public exposed to formaldehyde in excess of ERPG-2 concentrations from burning the HRL adjacent to the Los Alamos Medical Center. ERPG-2 concentrations are the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. In addition, six individuals would be exposed to formaldehyde in excess of ERPG-3 concentrations (life-threatening health effects).

6.1.2 SITE-04 / Mitigation Actions

The SWEIS wildfire accident also included calculations based on burning only vegetation and soils (e.g., a subset of the information presented in Section 6.1.1) since mitigation measures protected structures. These calculations resulted in the following:

- An estimated 50 person-rem population dose resulting in .025 latent cancer fatalities. The SWEIS also concluded that the MEI dose from site-wide vegetation fires would be less than 1 millirem.

In addition to public exposures, the accident evaluated impacts to LANL employees and firefighters.

- The SWEIS accident analysis estimated no impacts to LANL employees, based on the assumption that all threatened workers would be evacuated before the arrival of the fire front.
- The SWEIS estimated that some firefighters and emergency personnel were likely to have significant but transient effects from smoke inhalation, but that there would be no fatalities.

6.2 Cerro Grande Fire

The Cerro Grande fire consumed none of the buildings at LANL having large radiological or chemical inventories. The fire burned across 308 potential release sites (PRSs)*, removing surface cover and requiring implementation of best management practices on 91 of these PRSs to avoid impacts from erosion; however, none of these sites released measurable contaminants into the smoke plume.

The fire also burned across areas with known low levels of surface contamination from open air firing of test devices containing high explosives and various metal components. Again, monitoring data indicate that none of these materials were released in measurable quantities into the smoke plume.

6.2.1 Preliminary Radiological Dose Calculations

Preliminary radiological dose calculations presented were based on air monitoring data available to date that were collected by the LANL AIRNET system during the Cerro Grande fire. Normal analyses include uranium isotopes, plutonium isotopes, americium-241, and tritium. In addition to these normal analyses, some of the samples taken during the fire were analyzed for polonium-210 and lead-210. The analyses for lead and polonium were made because increases in gross alpha and gross beta activity were likely the result of increased atmospheric suspension of these and other radionuclides in the natural radon (radon-222) decay series.

Two doses were calculated: 1) to the hypothetical maximally exposed fireman or volunteer who was working actively in the Los Alamos area throughout the worst of the burn duration and 2) to the maximally exposed member of the public outside Los Alamos (based on air monitoring results). These are discussed below.

Maximally Exposed Person within Los Alamos Area

The calculations considered the dose contributions from naturally occurring radionuclides in the radon decay chain and from potential LANL-derived radionuclides including plutonium, uranium, and americium. Concentrations of radionuclides in the natural radon (radon-222) decay series were approximately 1000 times greater than those of potential LANL origin. Samples of uranium isotopes in areas of public access indicate that only natural uranium was seen in the air and therefore uranium was not included in the dose assessment.

The greatest smoke concentrations and highest concentrations of radon-decay elements occurred in the Western Area of Los Alamos between May 8 and May 11. After that time, concentrations decreased as the fire moved toward the north. Based on discussions with the Los Alamos Fire Department, no individual could have been in that area for more than 60 hours during May 8 through May 13. Assuming that an individual was working in the Western Area for 60 hours, the doses he/she would have received are summarized below.

Calculations for Maximally Exposed Person within Los Alamos Area

LANL-Derived Radionuclides	Dose*(mrem)	Natural Radionuclides	Dose*(mrem)
Americium-241	-0.003 (0.008)	Polonium-210	0.14 (0.02)
Plutonium-238	0.001 (0.003)	Lead-210	0.06 (0.02)
Plutonium-239	0.004 (0.007)	Bismuth-210	0.0008 (0.0002)
	0.002 (0.012)		0.2 (0.03)

** The values in parentheses are the uncertainties, in mrem, of the reported numbers.*

** A PRS is a site where known or suspected contamination may exist because of historical operations that either were or still are under DOE control. Identification and clean up of PRSs are being accomplished by the Environmental Restoration Program at LANL.*

Because of the short sampling times during the fire, the uncertainties associated with the plutonium and americium analyses were very large compared to the calculated concentrations. When the uncertainty of a number is larger than the number itself, the number is not considered to be statistically valid. For the sake of conservatism regarding potential LANL contributions during the fire, concentrations for plutonium-238 and -239 and americium-241 in the Los Alamos area were calculated for the peak of the fire. A dose was calculated based on these concentrations. Concentrations of each radionuclide at all sampling locations within and around the public areas of Los Alamos were averaged. Gross doses for polonium, lead, bismuth, plutonium, and americium are presented; no subtractions for background were done.

These calculated doses from americium and plutonium show the large uncertainty with extremely small numbers and are not statistically significant. The doses from polonium, lead, and bismuth are statistically significant (because the concentration is much larger than its uncertainty) and represent the increase in airborne concentrations of these natural radon products during the fire. Background of normal radon products were not subtracted; therefore, the actual doses caused by the fire were less than those reported above.

To put some perspective on these doses, a person travelling on a jet airliner across the country would receive approximately 1 millirem, and those living in the Los Alamos area receive about 360 millirem from natural sources each year. No health effects are expected from the small increase in natural radioactivity associated with the Cerro Grande fire.

Maximally Exposed Person outside the Los Alamos Area

Outside of Los Alamos, Española had the highest concentrations of gross alpha and gross beta radiation and these occurred between May 8 and May 11. In fact, the local gross alpha concentrations do not appear to have increased above normal levels other than during this period. Concentrations from May 8 to May 11 were used to calculate the dose someone might have received had they been outside throughout that 72-hour period. The results of these dose calculations are summarized below. Background concentrations (what we normally see) were not subtracted from the concentrations to make these calculations.

The doses from lead, polonium, and bismuth are quite small, barely above those that would have been experienced had the Cerro Grande fire never happened, and are due to the slight increases in airborne natural radioactive elements. Because of short sampling times, small quantities of material present, and large uncertainties, the calculated doses from LANL-derived radionuclides were negative. The negative doses are meaningless but are presented to demonstrate that quantities of LANL-derived radionuclides were extremely small in the smoke plume. The conclusion is that the doses are insignificant and that no health effects will occur as a result of radiological doses during the Cerro Grande fire.

Calculations for Maximally Exposed Person Outside the Los Alamos Area

LANL-Derived Radionuclides	Dose*(mrem)	Natural Radionuclides	Dose*(mrem)
Americium-241	-0.004 (0.02)	Polonium-210	0.022 (0.006)
Plutonium-238	-0.004 (0.009)	Lead-210	0.04 (0.01)
Plutonium-239	-0.0004 (0.02)	Bismuth-210	0.0007 (0.0002)
	-0.008 (0.03)		0.07 (0.01)

** The values in parentheses are the uncertainties, in mrem, of the reported numbers.*

6.2.2 Chemical Exposures and Injuries

As shown in Sections 5.2.1 and 5.2.2 above, LANL, NMED, and EPA operated air-sampling stations. All sampling networks showed higher-than-normal air concentrations of particulate matter. This would be expected given the extreme volumes of smoke. The EPA detected metals and organic compounds, but at concentrations that did not pose a health risk. No pesticides were detected in EPA air samplers. The NMED conducted sampling for asbestos, but the highest sample result was only 10% of the OSHA asbestos limit. No measurable releases of chemicals were detected from LANL facilities during the Cerro Grande fire, and therefore, no measurable chemical exposures to members of the public from burning LANL facilities were calculated.

Three of the 1600 firefighters were injured during the fire. One Los Alamos Fire Department firefighter fractured his heel when jumping from a fire truck. Another re-injured his shoulder, but reported to work the following shift. A third suffered a minor injury to his eye when poked by a stick. None of these injuries were permanent.

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Firefighters fighting the Cerro Grande fire.

di000270020

After Cerro Grande fire: mosaic of unburned, moderately burned, and completely burned vegetation above Los Alamos National Laboratory and townsite.

7.0 Environmental Impacts

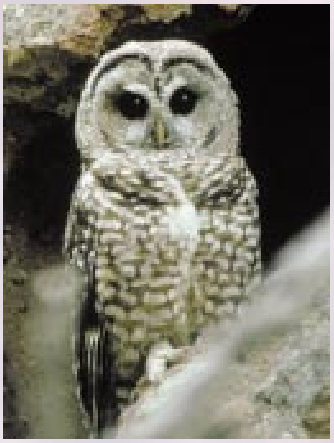
The environmental impacts postulated in the SWEIS accident analysis and actually seen following the Cerro Grande fire mirror those expected from any wildfire as presented in information published in the open literature. Detailed descriptions of wildfire impacts can be found in the “Fire Effects Guide,” published by the National Wildfire Coordinating Group (NWCG 1994).

The Cerro Grande fire has a variety of consequences that will continue through time and space. The most dramatic immediate effect of the wildfire is visual—the forests in and around LANL now have stands of dead trees with black portions in full view. The fire progressed in a series of low-, moderate-, and high-intensity burns that wandered across the landscape and left a mosaic of unburned, moderately burned, and completely burned patches of vegetation.

This pattern of burned vegetation represents changes in habitat, and, for some species, complete loss of critical habitat, which directly affects wildlife populations following the fire. Animal behavior and population dynamics change as it takes time for wildlife to adjust to changes in habitat. As vegetation is re-established, an altered community of animal species will follow, its composition changing with the evolution of the plant communities. Early plant communities of grasses could provide additional forage for the large elk population in and around LANL and could contribute to existing management concerns.

In addition, ground cover removal (e.g., loss of vegetation, surface fuels, and the duff layer) results in magnified runoff, increased soil erosion, sedimentation, increased risk from contaminants, contaminant transport, and exposure of cultural resources previously hidden beneath litter and duff on the forest floor.

Ecological staff at LANL are currently conducting field surveys to determine the impact of the fire on habitat, cultural resources, floodplains, and wetlands. Therefore, it is still too early to assess environmental impacts following the fire; however, preliminary field investigations indicate that the Mexican spotted owl has returned.


NM Dept. of Game & Fish

LANL will be evaluating the effects of the fire and post-fire mitigation measures over the next several years. As information becomes available, it will be addressed in the SWEIS Annual Yearbook.

8.0 Conclusion

The SWEIS wildfire accident analysis proposed two cases. First, it presented a wildfire without mitigation that resulted in burning seven facilities with hazardous chemical and radioactive inventories. This fire resulted in significant doses (see Section 6.1.1). Second, it presented a wildfire where mitigation actions had been taken (e.g., thinning trees and removing brush from around these facilities) that resulted in no burning of facilities with inventories. This resulted in minimal doses that are typical of all wildfires (see Section 6.1.2).

The post-mitigation case became reality.

8.1 Comparison Summary

The following table shows a summary of the Cerro Grande fire and the SWEIS accident analysis. The sizes of the SWEIS accident analysis fire and the Cerro Grande fire on LANL property were consistent—approximately 8000 acres versus 7500 acres, respectively. The SWEIS projected that the fire would start off LANL property and would move to the townsite, projecting the total acreage of the fire to be 27,000 compared to the 43,000 of the Cerro Grande fire.

The SWEIS accident analysis chose a realistic fire path based on fuel loading, but that also involved the maximum number of buildings considered vulnerable to wildfire with significant inventories of chemical and radioactive materials. The SWEIS accident focused on the emissions/doses from the combustion of seven specific facilities.

Limited mitigation measures such as tree thinning, cutting underbrush, etc., were undertaken while the SWEIS was still in preparation. In particular, the areas around six facilities identified in the SWEIS as having significant radiological or chemical inventories were treated. The SWEIS accident analysis acknowledged these actions and projected that these buildings would be defensible and not burn in the event of a wildfire. The SWEIS also analyzed emissions and doses from resuspension of contaminated soil from firing sites and canyons, as well as the potential emissions and doses from combustion of vegetation. These analyses resulted in an estimated MEI dose from burning vegetation and soils on LANL property of less than 1 millirem.

None of the buildings having significant radiological or chemical inventories analyzed in the SWEIS were burned during the Cerro Grande fire. This compares to the post-mitigation scenario presented in the SWEIS. Data collected and dose estimates made during the fire were consistent with SWEIS projections. It should be recognized that LANL's contribution to these data and dose estimates was inseparable from the total emissions from the fire. One early dose estimate is 0.2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After the Cerro Grande fire, the area to the left is still a fire hazard, the area to the right has been mitigated by nature.

Summary Comparison of the Cerro GrandeFire to the SWEIS Accident

	SWEIS, w/o mitigation	SWEIS, w/ mitigation	Cerro Grande Fire
Wildfire scenario	Total burned – 27,000 acres LANL burned – 8000 acres	Total burned – 27,000 acres LANL burned – 8000 acres	Total burned – 43,000 acres LANL burned – 7500 acres
Major Wildfire frequency	One per decade	One per decade	Second major fire to burn LANL property in 57 years
Weather conditions	Preceded by low precipitation; SW winds on the order of 20 mph; Low humidity High temperatures	Preceded by low precipitation; SW winds on the order of 20 mph; Low humidity High temperatures	Preceded by low precipitation; SW winds at 16-17 mph, with gusts exceeding 50 mph Daytime humidity of 2-8% Temperatures, night & day, at 10-20 ºF above normal.
Mitigation actions [a]	None	Actions taken around Sigma Building, Area G, three tritium facilities (WETF, TSTA, TSFF), and Radiochemistry Facility	Actions taken around Sigma, Area G WETF, DARHT, TA-48, TA-55, & TA-59; Fuel break along SR 501
Buildings burned	7 buildings w/ releases: Sigma Building, Radio-chemistry Lab, Area G, HRL, and three tritium facilities (WETF, TSTA, TSFF)	2 buildings with releases: HRL and Radiochemistry Lab.	Totals of 67 buildings damaged and 45 buildings destroyed. No nuclear facilities damaged. No detectable chemical or radioactive releases.
Non-radiological emissions	30 liters of formaldehyde, some sulphuric acid, hydrogen fluoride, and chlorine	30 liters of formaldehyde, some sulphuric acid, hydrogen fluoride, and chlorine	Heavy particulate emissions; Metals (23), organic compounds (12) attributable to burning vegetation and well below allowable workplace concentrations; no pesticides detected; asbestos at 10% of OSHA limit. No formaldehyde, sulphuric acid, hydrogen fluoride, or chlorine – the buildings did not burn.
Radiological emissions	Not stated	Radioactive emissions due to burning of vegetation (natural sources)	Radioactive emissions due to burning of vegetation (natural sources)
Worker effects	Smoke inhalation, no deaths.	Smoke inhalation, no deaths.	3 injuries among 1600 firefighters: fractured heel, shoulder injury, and minor eye injury.
Population exposures chemical	11 persons exposed to ERPG-2 concentrations from formalde-hyde, and 6 persons exposed to ERPG-3 concentrations from formaldehyde.	11 persons exposed to ERPG-2 concentrations from formalde-hyde, and 6 persons exposed to ERPG-3 concentrations from formaldehyde. None from the other chemicals.	None
Individual exposures radiological	From TA-54, Area G, a MEI dose of 22 rem	A MEI dose of less than 1 millirem	A dose of 0.2 millirem for the maximally exposed person (firefighter) in Los Alamos A dose of 0.07 millirem for the maximally exposed person in Espanola.
Population exposures radiological	A population dose of 675 person-rem; 0.34 latent cancer fatality	A population dose of 50 person-rem; 0.025 latent cancer fatality [b]	Not Calculated.

a: Actions that precede the Cerro Grande fire.b: Note typo on page G-123, which reports 0.25 latent cancer fatalities under mitigation scenario.

millirem for the maximally exposed person (a firefighter) during the Cerro Grande fire.

8.2 Ongoing Wildfire Threat

Members of the IWMT have stated that the fire hazard continues to be high to extreme. The mosaic burn pattern of the fire left large blocks of forest with heavy fuel loads. The canyon systems of Los Alamos County and LANL are still heavily forested. Within the 7500 acres of LANL property that were subjected to the Cerro Grande fire, approximately 65% of the forest fuels remain intact. Continued mitigation of these fuels is necessary.

Fuel loading reduction has a goal of treating the approximate 10,000 acres of LANL property that is predominantly ponderosa pine or mixed-conifer (the vegetation most in need of mitigation). The typical current concentration of fuel in many places is 400 to 800 trees per acre. These areas need to be reduced to an average of 50 to 150 trees per acre to reduce the fire hazard and improve the health of the forest. By the time of the Cerro Grande fire, approximately 800 acres, primarily around buildings and roads, had been treated and fuel loading reduced. The Cerro Grande fire itself was estimated to have significantly reduced the fuel loading on an additional 800 acres. Therefore, there are still well over 8000 acres of forest on LANL that need initial treatment.

More importantly, however, fuel load reduction is an ongoing need. Each area that has an initial treatment needs to be revisited and maintained at about 5-year intervals. Fuels around facilities need to be cut back regularly to maintain defensibility in case of a fire. Fire roads and firebreaks need to be maintained. Fire training and equipment need to be maintained. As Dr. Richard Burick, Deputy Director of Operations for LANL, stated in his testimony to Congress on June 7, 2000, “We have learned from the Cerro Grande fire that these measures were effective and should be continued and expanded.”

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Fuel load reduction is an on-going need to prevent forest fires.

8.3 Other Analyses

In the SWEIS ROD, DOE committed to develop by December 1999 a preliminary program plan for comprehensive wildfire mitigation, including construction and maintenance of strategic fire roads and fire breaks, creation of defensible space surrounding key facilities, and active forest management to reduce fuel loadings. The Mitigation Action Plan, October 1999, states that the wildfire hazard at LANL was currently being reduced by thinning trees, maintaining fire roads and fire breaks, and other measures (DOE 2000a).

On July 6, 2000, DOE issued a draft Environmental Assessment (EA) to its stakeholders and the public on the “Wildfire Hazard Reduction and Forest Health Improvement Program at LANL” (DOE 2000b). This EA reviews the history of fire around LANL, including the recent Cerro Grande fire. It examines the potential environmental impacts of a program to reduce forest fuel loads at LANL. The program is intended to provide initial treatment for approximately 10,000 acres (or less, depending on the amount of fuel reduced by the fire), at the rate of 1200 acres a year for a period of 10 years, dependent upon funding. Concurrently with the initial treatment program, maintenance of treated areas will be required every 5 years.

On June 21, 2000, DOE issued a Notice of Emergency Action in which it indicated its intention to prepare a Special Environmental Analysis (SEA). The SEA will review environmental impacts of activities undertaken to suppress the fire at LANL and activities currently being undertaken at LANL to reduce the danger of major flooding. The SEA is currently in development and is expected to contain information on the environmental effects of the fire, insofar as this information is available.

The SWEIS Yearbook is published annually. The Yearbook will summarize the growing body of information on the environmental effects of the Cerro Grande fire as long as that information continues to become available. The goal of the SWEIS summary will be to review the baseline of the affected environment contained in the SWEIS in light of the information on the effects of the fire. It will take a number of years for the full effects of the fire to be ascertained as nature recovers from the fire.

Severely Burned Area, La Mesa Fire.

Taralene Foxx

1978, Standing dead trees one year after the fire.

Taralene Foxx

1985, Typical fall of dead trees over several years following the fire.

Taralene Foxx

1998, Shows savanna-like appearance of healthy forest.

References

Allen 1989: C.D. Allen, "Changes in the Landscape of the Jemez Mountains, New Mexico." Ph.D. Dissertation. Berkeley, CA: University of California at Berkeley, 314 pp (1989).

Armstrong 1998: B. Armstrong, "Analysis of the Risk of Crown Fire Initiation and Spread in the Valle Ecosystem Management Area on the Espanola District of the Santa Fe National Forest, Northern New Mexico." U.S. Forest Service document (1998).

Burick 2000: R. Burick, Deputy Laboratory Director for Operations, "Testimony to the National Parks and Public Lands Subcommittee and the Forest and Forest Health Subcommittee of the Resources Committee, US House of Representative." Los Alamos National Laboratory, June 7, 2000.

Dibb 1999: J. Dibb et al., "Constraints on the Age and Dilution of Pacific Exploratory Mission Tropics Biomass Burning Plumes from the Natural Tracer ^{210}Po." Journal of Geophysical Research, v. 104, No. D13, pp. 16233–16241 (1999).

DOE 1999a: US Department of Energy, "Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory." US Department of Energy, Albuquerque Operations Office, Albuquerque, NM, DOE/EIS-0238 (1999).

DOE 1999b: US Department of Energy, "Record of Decision: SWEIS in the State of New Mexico." 64FR50797, Washington, D.C., September 19, 1999.

DOE 2000a: US Department of Energy, "Los Alamos Site-wide EIS Analyzed Wildfire Impacts, Prompted Mitigation Actions." US Department of Energy, National Environmental Policy Act, Lessons Learned, Issue No. 23, June 1, 2000.

DOE 2000b: US Department of Energy, "Environmental Assessment for the Wildfire Hazard Reduction and Forest Health Improvement Program at Los Alamos National Laboratory, Los Alamos, New Mexico." US Department of Energy, Los Alamos Area Office, Draft Report, DOE-EA-1329 (2000).

EPA 2000a: Environmental Protection Agency, "Cerro Grande Fire Radiological Air Sampling Around Los Alamos National Laboratory, Second Data Set – May 16, 2000." Press release by G.D. Dempsey, Radiological Emergency Response Team Leader (May 17, 2000).

EPA 2000b: Environmental Protection Agency, "Cerro Grande Fire Radiological Air Sampling Around Los Alamos National Laboratory, Third (Final) Data Set – May 16, 2000." Press release by G.D. Dempsey, Radiological Emergency Response Team Leader (May 17, 2000).

EPA 2000c: Environmental Protection Agency, "Low Volume Air Samples Collected on May 15, 2000 (Stations #1–20)." found at http://www.nmenv.state.nm.us/aqb/fires/defalt.htm. (May 15, 2000)

EPA 2000d: Environmental Protection Agency, "Alpha, Beta Counts, Gamma Spec." Results from EPA's Environmental Radiation Air Monitoring System, found at http://www.nmenv.state.nm.us/aqb/fires defalt.htm. (May 26, 2000) Department) FEMA-DR-1329-NM-PR51. (May 19, 2000)

JIC 2000b-9: Joint Information Center, "Los Alamos Asbestos Sampling Complete." Press release by the Joint Information Center (Federal Emergency Management Agency and New Mexico Environment

JIC 2000c-b: Joint Information Center, "Cerro Grande Fire Chemical Contaminant Air Sampling Around Los Alamos National Laboratory, First Data Set." Press release by the Joint Information Center (Federal Emergency Management Agency and New Mexico Environment Department) FEMA-DR-1329-NM-PR54. (May 19, 2000)

Lambert 1991: G. Lambert et al., "Long-lived Radon Daughters Signature of Savanna Fires." In conference proceedings, *Global Biomass Burning*, ed. J.S. Levine, MIT Press pp. 181–184 (1991).

LANL 1999a: Los Alamos National Laboratory, "SWEIS 1998 Yearbook: Comparison of 1998 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory." Los Alamos National Laboratory report LA-UR-99-6391 (1999).

LANL 1999b: Los Alamos National Laboratory, "Environmental Surveillance at Los Alamos during 1998." Los Alamos National Laboratory report LA-13633-ENV (1999).

LANL 2000. Los Alamos National Laboratory, "Fire Damaged Facilities List." Posted at www.lanl.gov/worldview/news/ fire/pdf). (June 5, 2000)

le Cloarec 1995: M.F. le Cloarec et al., "^{210}Po in Savanna Burning Plumes." Journal of Atmospheric Chemistry 22:111–122 (1995).

NCRP 1987: National Council on Radiation Protection, "Exposure of the Population of the United States and Canada from Natural Background Radiation." National Council on Radiation Protection report 94 (1987).

Nho 1996: E.Y. Nho et al., "Origins of ^{210}Po in the Atmosphere at Lamto, Ivory Coast." Atmospheric Environment 30:3705–3714 (1996).

NMED 2000a: New Mexico Environment Department, "NMED Radiation Monitoring Results." Samples collected by the Oversight Bureau found at http://www.nmenv.state.nm.us/aqb/fires/defalt.htm. (May 26, 2000)

NMED 2000b: New Mexico Environment Department, "U and Pu Analyses." Samples collected by the Oversight Bureau found at http://www.nmenv.state.nm.us/aqb/fires/defalt.htm. (June 8, 2000)

NWCG 1982: National Wildfire Coordinating Group, "Aids to Determining Fuel Models for Estimating Fire Behavior." National Wildfire Coordinating Group general technical report INT-122 (1982).

NWCG 1994: National Wildfire Coordinating Group, "Fire Effects Guide." National Wildfire Coordinating Group general technical report PMS 481, NFES 2394 (1994).

Tucker 2000: D. Tucker, "Cerro Grande Fire, May 2000." Los Alamos County Fire Department, Los Alamos, New Mexico. Produced by E.H. Ortiz and M.A. Thompson June 2000.

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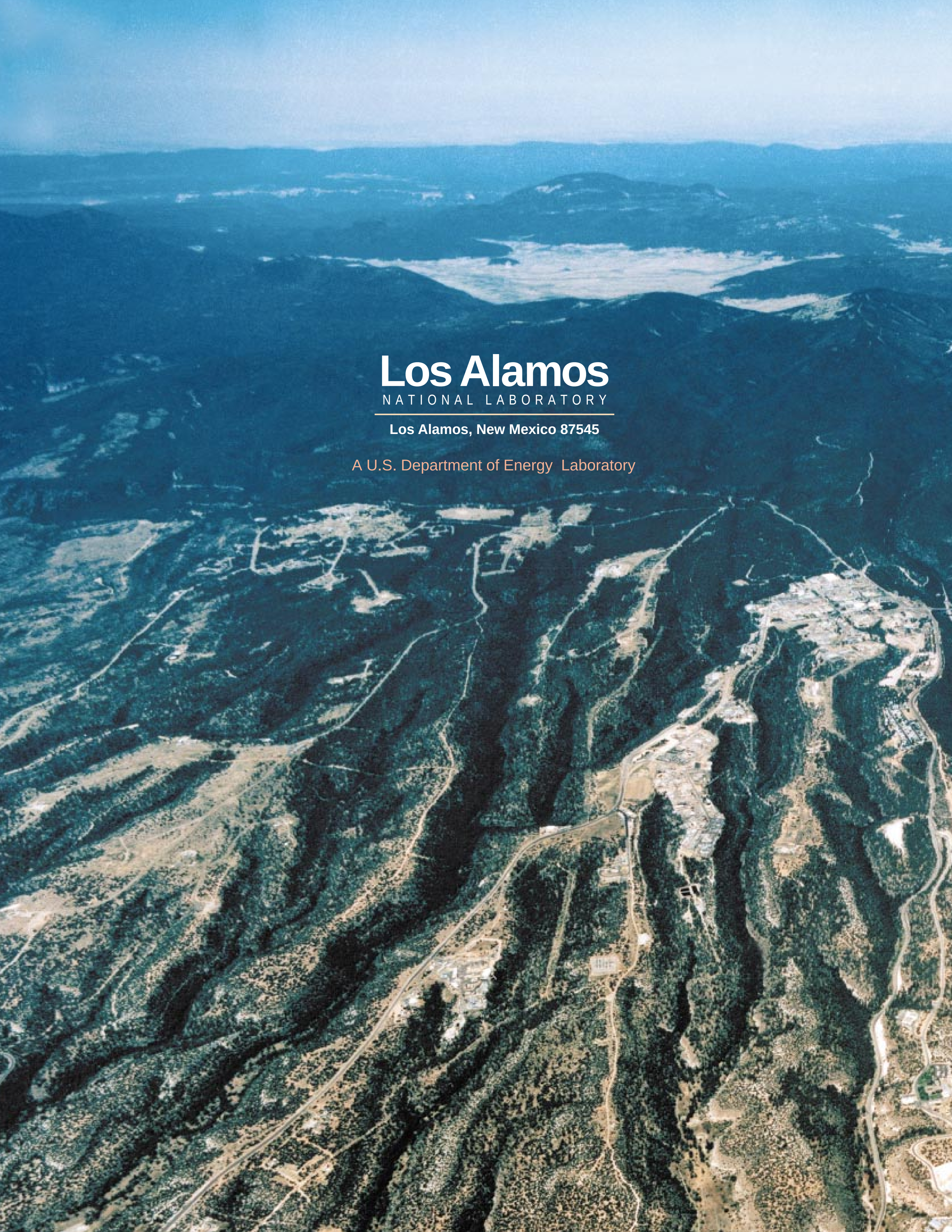

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