Environment, Safety and Health Division

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Remarks: ☐ Urgent ☐ For you review ☐ Reply ASAP ☐ Please Comment

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No. of Pages (includes cover): 29

Attached is an excerpt from the Accident Analysis Appendix of the Los Alamos site-wide EIS that deals with the wildfire scenario. It contains alot of useful information about vulnerability of buildings and the consequences of radioactive and hazardous chemical releases in the event of fire.

Pat Hammack / Pages G-113 + G-114 contains the list of buildings with significant chemical inventories at risk.

Pages G-115, 116, + 117 show that, except for HRL, no chemicals presented significant hazards.

Please show Pat these pages. They can be a basis to ask questions about how the materials are secured. We will try to find out what we can, but will have to work through the Los EOC people for further information.

Pages G-10 + 11 have the definitions for ERPG levels.

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G.2.2 Human Health Effects of Exposure to Hazardous Chemicals

Human health effects resulting from exposure to hazardous chemicals vary according to the specific chemical of interest and the exposure route and concentration. The most immediate risks to human health from exposure to chemicals in the environment arise from airborne releases of toxic gases, and it is this route of exposure upon which the accident analysis for the SWEIS is focused. (The effects of toxic chemicals are discussed in section D.1 of appendix D, Human Health.) In this analysis, exposures to toxic chemicals are compared to Emergency Response Planning Guidelines (ERPGs). ERPGs are community exposure guidelines derived by groups of experts in industrial hygiene, toxicology, and medicine. ERPGs are then published by the American Industrial Hygiene Association (AIHA) after review and approval by their ERPG Committee. ERPGs are defined as follows (AIHA 1991):

- ERPG–1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or perceiving a clearly defined objectionable odor.
- ERPG–2 is 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.
- ERPG–3 is 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 life-threatening health effects.

Human responses to chemical exposure do not occur at precise exposure levels, but rather, extend over a wide range of concentrations. The values derived for ERPGs do not protect everyone, but are applicable to most individuals in the general population. Furthermore, the ERPG values are planning guidelines, not exposure guidelines. They do not contain the safety factors normally associated with exposure guidelines (AIHA 1991).

In developing an ERPG, emphasis is given to the use of acute or short-term exposure data. Human experience data are emphasized; but usually only animal exposure data are available. When it is believed that adverse reproductive, developmental, or carcinogenic effects might be caused by a single acute exposure, the data are considered in the ERPG derivation.

Unless one is provided information to the contrary by toxicologists, it is necessary to regard ERPGs as ceiling concentrations (i.e., the highest concentration acceptable for the time period). As such, the ERPG would be treated as an exposure that should not be exceeded within 1 hour. Any extrapolation from the ERPG is not to be made without significant considerations; specifically, to make such an adjustment, the ERPG documentation for each chemical must be reviewed fully by toxicologists. The effects of exposure times longer than 1 hour may not be limited to those associated with the ERPG.

In addition to ERPGs, this analysis incorporated the temporary emergency exposure limits (TEELs) developed by the DOE Emergency Management Advisory Committee, Subcommittee of Consequence Analysis and Protective Actions (SCAPA). Published ERPG values were available for only 69 chemicals. TEEL values are interim, temporary, or ERPG-equivalent exposure limits provided for an additional 297 chemicals. In the absence of ERPG or TEEL values, the hierarchy developed by SCAPA and published in the AIHA Journal was utilized (Craig et al. 1995).

ERPG–1 defines a level that does not pose a health risk to the community but that may be noticeable due to slight odor or mild irritation. Above ERPG–2, for some members of the community there may be significant adverse health effects or symptoms that could impair an individual's ability to take protective actions. These symptoms might include severe eye or respiratory irritation or muscular weakness. Above ERPG–3 there may be life-threatening effects and, at sufficiently high concentrations and exposure times that vary with the chemical, there could be death. The length of an individual's exposure to high concentrations will depend upon that individual's situation and response (that is, by his/her recognition of the threat and its location, attaining shelter, and escaping). Later in this analysis, consequences are presented as the number of people exposed to concentration greater than the ERPG–2 and ERPG–3 guidelines; but there are too many uncertainties to speculate as to the specific effects that would occur to those people.

G.2.3 Chemical Accidents—ALOHA™ Code

The Areal Locations of Hazardous Atmospheres (ALOHA™) code developed by EPA, the National Oceanographic and Atmospheric Administration (NOAA), and the National Safety Council (NSC), was used for the analysis of chemical releases. It is listed by DOE (DOE 1994c) and EPA (EPA 1996) as an acceptable code for air dispersion modeling.

The ALOHA™ code is designed to be used for emergency responders in the case of chemical accidents. The code predicts the rate at which chemical vapors may escape to the atmosphere from broken gas pipes, leaking tanks, and evaporating puddles and predicts how the resulting hazardous gas cloud disperses horizontally and vertically into the atmosphere following release (NSC 1995).

Especially near the source of a release, short-term gas concentrations depart markedly from average values in response to random turbulent eddies and are unpredictable. As the cloud moves downwind, concentrations within the cloud become more similar to ALOHA™ calculations. ALOHA™ shows concentrations that represent averages for time periods of several minutes and predicts that average concentrations will be highest near the release point and along the center line of the release cloud (this is typical Gaussian plume modeling). The concentration is modeled as dropping off smoothly and gradually in the downwind and crosswind directions.

ALOHA™ models neutrally buoyant gases with a Gaussian plume model. Airborne particulates are assumed to be passive; that is, they behave as nonbuoyant gases. Heavy gases are modeled using a variation of the DEGADIS heavy gas model. Some simplifications were implemented into ALOHA-DEGADIS to speed computational procedures and reduce the requirement for input data that would be difficult to obtain during an accidental release. These simplifications include the assumptions that: (1) all heavy gas releases originate close to ground level; (2) mathematical approximations are faster but less accurate than those in DEGADIS; and (3) modeling sources for which the release rate changes over time as a series of short, steady releases rather than a number of individual point source puffs. The authors worked closely to ensure a faithful representation of DEGADIS model dynamics, and the resulting ALOHA-DEGADIS model was checked to ensure that only minor differences existed in results.

Although ALOHA™ models the dispersion of heavy gases, the model assumes that the terrain is flat. Thus, if canyons are located between the release point and a potential receptor, ALOHA™ models the scenario as though the canyon were not present. This is a conservative

LCFs. Projected doses and associated health effects primarily result from the postulated releases associated with TA–55–4 (accounting for almost 82 percent of the total) and TA–3–29 (accounting for an additional 14 percent of the total). No fatalities from acute radiation exposure are predicted to result from the earthquake event. The bounding dose at the MEI location in the Royal Crest Trailer Park is approximately 247 rem. The LANL seismic event exposures are almost exclusively from inhalation of plutonium, for which the exposures are more protracted and the acute effects are correspondingly reduced or absent.

The chemical release consequences for SITE–03 are the same as those for SITE–02 (section G.5.4.2).

The MAR (dominant contributors), earthquake frequencies, and accident conditions are the same for all four SWEIS alternatives; consequently, accident consequences across the alternatives are also projected to be comparable.

Recent and ongoing seismic studies have identified the potential for ground faulting at the CMR Building (TA–3–29). The assessment of ground faulting impacts on facility damage is difficult to quantify. For the CMR Building, the facility structure is assumed to collapse as part of the SITE–01 earthquake, with the CMR basement vault being intact until an earthquake magnitude comparable to a HCLPF of 0.34 *g* (frequency of 7.1×10^{-5} per year). The annual frequency associated with significant (greater than 50 centimeters) fault displacement is estimated to be 1 to 3×10^{-5} per year. Should fault displacement at the CMR Building occur in addition to other SITE–03 impacts, additional releases from the CMR Building could result. A conservative sensitivity assessment of this impact was completed. It should be reiterated that a detailed understanding of the additional damage and associated releases at the CMR Building has not been completed. The conservative sensitivity assessment results in an additional 133,823 person-rem collective population dose, resulting in about 99 additional excess LCFs. The MEI doses would increase by 133.9 rem at the Los Alamos townsite and 99.3 rem at the Royal Crest Trailer Park.

G.5.4.4 *SITE–04, Site-Wide Wildfire Consuming Combustible Structures and Vegetation*

General Scenario Description

The LANL site and surrounding vicinity are generally forested areas with high fuel loading. Wildfires are frequent occurrences on nearby U.S. Forest Service land, with obvious potential for encroaching on the LANL site, as demonstrated by recent events. For this site-wide accident, it is postulated that a wildfire is initiated to the southwest of LANL near the border of the Bandelier National Monument and the Dome Wilderness Area. While there is a potential for initiation of a wildfire at many locations within and near the LANL site, this location was considered as resulting in the most widespread impact to the site and surrounding area.

The fire begins mid day in the late April through June time frame, at a time of high or extreme fire danger, and is not extinguished in the first hour. The initial location is in an area populated with heavy ponderosa pine fuels that are found between roughly 6,500 and 8,200 feet (1,980 and 2,500 meters) elevation. As the fire grows, local jurisdictions respond to the fire, but are not effective due to remoteness, travel time, lack of road access, fire behavior, etc. Resources from more distant jurisdictions are alerted, but cannot arrive in a short time because of distance, limited roads, and opposing evacuation traffic. It proves impossible to put out the fire with the available resources and existing forest access before it enters the laboratory. Unlike the Water Canyon fire (greater than 3,000 acres [1,200 hectares] in June 1954), La Mesa fire (15,270 acres [6,180 hectares] in June 1977), Dome fire (16,500 acres [6,680 hectares]

April 25 to May 5, 1996), and Oso fire (greater than 5,000 acres [2,000 hectares] in June 1998), the weather does not change in time to prevent the fire from sweeping across the western part of LANL and into the townsite.

This specific analysis assumes a common meteorological situation that favors the fire. In this scenario, the fire begins about 10:00 a.m., reaches a size of 1,000 acres (400 hectares) in 3 hours, and becomes a well developed crown fire on a broad fire front containing 6,000 acres (2,400 hectares) in the second day. Like the La Mesa fire (Foxx 1981), at times it advances at a rate of 38 chains[1] per hour (0.44 miles [0.7 kilometers]). It starts spot fires 0.5 to 1.25 miles (0.8 to 0.2 kilometers) in advance, aided by prevailing southwest winds of 20 miles per hour and low daytime humidity. It easily jumps canyons and existing fuel break lines around LANL and the townsite.

The daytime convection column reaches to 20 or 25,000 feet (6 to 7,600 meters). In the Oso fire, the fire burned as actively at night as in the day, with flame heights on the order of 100 feet (30 meters). In this scenario, in order to have a conservative (low height) plume rise, at night the temperature drops and the relative humidity increases. The nighttime plume rise is then about 2,000 feet (600 meters). The fire regains its intensity at 10:00 a.m. each day. Following fire passage, the smoldering remains of vegetation and structures emit smoke and contaminants at the surface level.

The fire reaches State Road 4 and State Road 501, the southwest edge of LANL, at noon on the second day (see Figure G.5.4.4–1). Protective actions are already underway by LANL, such as relocating some radionuclides and barricading some windows, and releasing nonessential personnel following existing emergency plans. (Note that for this analysis, credit is given only for those protective measures that can be easily undertaken, such as ceasing operations or simple material transfers, are given credit.) The fuel break along these roads proves inadequate. At this point, the fire has progressed in areas where access is limited, hampering fire suppression activities due to concern for the safety of the firefighters. A control line is established at Pajarito Road and resources are concentrated there. Consequently, Pajarito Road is closed and not available for public evacuation. The fire burns forest to the west of and within LANL, but its eastern extent within LANL is constrained by pinyon-juniper woodlands and defined by fuel continuity and density.

From aerial photographs, it is estimated that these continuous fuel lines threaten TA–37, TA–15, TA–16, and TA–66, and those TAs to their west, as well as areas in and on the edge of the forested canyons. Following the continuous fuel lines and steered somewhat by southwesterly winds, the fire enters and crosses Pajarito Canyon and Two Mile Canyon, and by 1:00 a.m. of the third day burns up to the Pajarito Road control line just west of TA–66.

Although it would be expected that the control line will contain most fires, in this conservative accident scenario an adverse meteorological situation exists. At noon on the third day, aided by a modest daytime wind speed pickup and low relative humidity, the fire crosses the Pajarito Road control line between TA–3 and TA–55. It surrounds TA–3 and TA–48, and enters Los Alamos Canyon either directly or by spotting. The fire continues down Los Alamos Canyon on both sides of Omega Road where TA–41 and TA–2 are located. Because Omega Road continues down Los Alamos Canyon as a dirt road below the Omega site, it is unsafe for firefighters to enter Los Alamos Canyon, and the fire progresses essentially unabated.

From Los Alamos Canyon, the fire climbs onto the mesas where TA–53 and TA–21 are located. The fire also spots into Mortandad Canyon. The canyon fires are necessarily allowed to burn eastward, due to their inaccessibility, until they

1. 80 chains = 1 mile (1.6 kilometers).

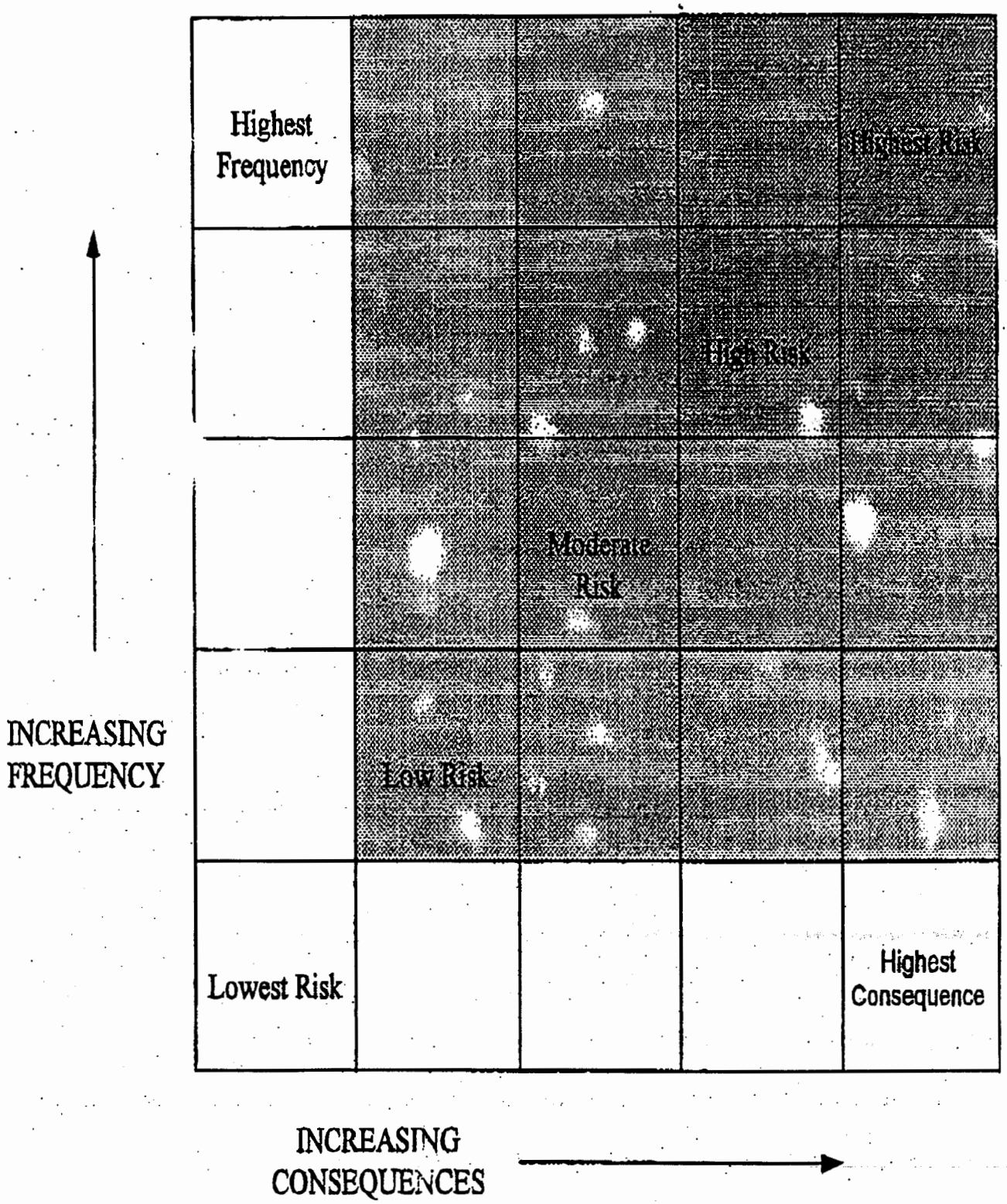

FIGURE G.5.4.4–1—*Location of the Los Alamos National Laboratory.*

reach the thinner stands of pinyon-juniper common to the lower parts of the canyons. There they come under control, by wind and weather changes, lack of fuel continuity, by human interference, or some combination of these. When there are sufficient trees on the canyon walls, fire climbs the walls and then ignites combustible structures and fuel at the canyon edges. It enters the townsite early on the fourth day after initiation.

An alternative fire scenario could have the fire initiate to the west of LANL and townsite in the Santa Fe National Forest of mixed conifer and ponderosa pine. This crown fire, similar to the Oso fire of 1998, travels downslope somewhat more slowly on a broad front. This fire spots only 1/4-mile or more in advance. The present, relatively narrow fuel break around the town and laboratory along State Road 501 would be overreached. This fire also would consume the ponderosa pine and combustible structures in continuous fuel areas over the same western part of LANL and townsite, and the fire would spread down the lengths of canyons until it encountered thin pinyon-juniper stands. It also could not be fought successfully because there is no access to the National Forest west and north of LANL and townsite, and because there is no north-south fuel break comparable to Pajarito Road where a control line can be established and defended. This alternative is not analyzed because the selected scenario is believed to maximize the exposure to the Los Alamos townsite from laboratory releases. The final acreage burned in both scenarios is on the order of 27,000 acres (10,900 hectares) of which about 8,000 acres (3,200 hectares) are within LANL boundaries.

On the LANL site, the fire is assumed to consume all combustible structures in its path that are evaluated as having moderate or higher risk from wildfire under the LANL Building Appraisal Program. The fire also exposes the surface of contaminated earth previously protected by vegetation in the firing sites and canyons. This text separately discusses the exposures from fire burning the soil cover and suspending the underlying soil, and the exposures from burning structures. Exposures from canyon fires are calculated individually, thus enabling the assessment of fires of lesser extent than the site-wide fire.

This accident analysis does not consider off-site damage directly caused by the flames and smoke from LANL fires, and does not address the direct effects of the fire on the townsite. It is recognized that there is continuous fuel joining the National Forest and the residential areas, and that fires in the canyons at LANL also could propagate into the townsite.

Wildfire Frequency

Conditions that Favor Wildfire. These scenarios are quite credible, in view of the present density and structure of fuel surrounding and within LANL and townsite, as well as the occurrence of three major fires in the past 21 years. Some protection is afforded LANL by the fire scars of the previous Dome and La Mesa fires, but there is ample fuel continuity remaining to bring an off-site wildfire to the southwest and western boundary of LANL.

The probability of high to extreme fire danger is determined by the frequency of meteorological conditions of low precipitation for 2 to 3 weeks preceding; low relative humidity for 3 consecutive days; and high temperatures. When the high to extreme fire danger exists in New Mexico in May through July, there are certain to be multiple ignition sources (from lightning, carelessness, and human causes). There is a high frequency of lightning and lightning-caused fires in the Jemez Mountains (Armstrong 1998). From 1975 to 1996, there were 372 fire starts (17.7 per year) in the 40,000 acres (16,000 hectares) of Santa Fe National Forest and Bandelier National Monument adjacent to LANL. Using as input the frequency of different sized fires, the PROBACRE model yielded a 30 percent probability of exceeding

5,000 acres (2,000 hectares) in a 5 year period (Armstrong 1998). Armstrong's calculation was made prior to the 1998 Oso fire, whose inclusion would increase the probability.

The frequency of a large fire encroaching on LANL is estimated as the joint probability of ignition in the adjacent forests, high to extreme fire danger, failure to promptly extinguish the fire, and a 3-day spell of southwesterly to westerly wind over 11 miles per hour (5 meters per second), low humidity, and no precipitation.

Determining the Joint Probability of Occurrence of Weather and Fire Danger Conditions. The probability of occurrence of the weather and fire conditions needed for this scenario were determined using wind data and fire danger data for April through June of 1980 through 1998. These months were chosen on the general knowledge that fire risk and frequency is greater in those months. Note that site-wide fires also are possible, but less probable, in other months besides April through June; thus, the annual frequency of fire-favorable weather is somewhat greater than quantified for April through June.

The fire danger was determined using Energy Release Component (ERC) data obtained from Bandelier National Monument (PC 1998b). The ERC is a component of the National Fire Danger Rating System, and the adjective ratings, such as "moderate" or "extreme," are determined from categories of the ERC, with higher values of the ERC representing conditions of higher fire danger. Above a threshold value of the ERC, the fire danger is "very high" and "extreme," and this threshold value was used to determine days of very high and extreme fire danger. Interpolation was performed to estimate for days when ERC data was missing.

In general, wind direction at any location varies and does not persist in a single direction for a few days. LANL is no exception. At LANL, persistent daytime winds are interrupted for a few hours when nighttime drainage winds occur. However, granting short interludes of drainage flow, there are many instances in which a dominant direction, such as southwesterly, westerly, northerly, etc., can exist for 3 days without precipitation.

For determining fire-favorable weather frequency, 15-minute average wind data from the 11.5-meter level of the TA–59 and TA–6 meteorological towers were used. For each day in April through June of 1980 through 1998, an average afternoon wind was calculated from the 15-minute data in order to eliminate local diurnal changes in wind speed and direction that are common to the area. Average afternoon wind speeds of greater than 10 miles (16 kilometers) per hour were chosen to represent strong winds. While this threshold may seem low for a strong wind, wind gusts of over 30 miles (48 kilometers) per hour and sometimes over 40 miles (64 kilometers) per hour were seen on most days when the afternoon average wind was above 10 miles (16 kilometers) per hour. The wind direction thresholds were set at 180° (southerly, meaning from the south) through 292.5° (west-northwesterly). Three-day periods from the same data set were then examined to determine if the ERC, wind speed, and wind direction fell above (or within) set thresholds. All 3-day periods falling within the set limits were then extracted.

The results show that it is not uncommon to see a 3-day period exhibiting the selected characteristics in a given year, and that when such a 3-day period appears, it is likely that more than one such period will occur within that year. Specifically, the resulting statistics show that of the 19 years examined, 5 of them displayed at least one 3-day period within the limits, or 1 every 4 years. Of these 5 years, 4 of them had an average of 3.6, 3-day periods. (An instance of 5 days in a row is counted as 3, 3-day periods.) This comes to 15.4 instances in 19 springs.

In summary, fire-favorable weather conditions occur on the order of once per year; the ignition sources are prevalent; and fire fighting is hampered by limited accessibility. Therefore, this analysis concludes that a major fire moving up to the edge of LANL is not only credible but likely, probably on the order of 0.1 per year. This frequency is the same for all alternatives.

Dispersion Meteorology

As noted, only certain meteorological conditions are compatible with such a fire. The meteorology of June 7 to 10, 1998, was selected for modeling the accident sequence because these dates were recognized as a recent time of serious fire danger to LANL. These conditions are regarded as conservative, in that in this period the wind is generally from LANL toward the nearby Los Alamos townsite and would result in higher total population doses. Santa Fe is much more distant, and concentrations would therefore be lower. Under northwesterly winds, exposures in Santa Fe (had the alternate scenario been used) would surely be less than exposures to the Los Alamos townsite from the southwesterly winds in this scenario.

Exposures at 100 meters distance from burning exposed soils are calculated using C stability and 6.6 feet (2 meters) per second wind speed. These exposures can be regarded as MEI exposures, although it is unlikely that anyone other than firefighters will be present at that distance. Exposures at 3,300 feet (1,000 meters) are also reported. In canyons, where elongated area sources exist, the calculation provides integrated exposure at 330 and 3,300 feet (100 and 1,000 meters) downwind of the long axis of the area, thus maximizing the exposure. This situation could occur with winds turning to follow the canyon profile, such as under drainage wind conditions. Thus, the calculation applies to plumes that are destined for any receptor within and beyond the contaminated sections of the canyons.

Soil Resuspension Following the Fire

Suspension by the wind of a fraction of the surface soil can occur following denuding of the vegetation. This has the potential of exposing workers returning to the area, as well as the transient public, until the situation has stabilized and vegetation has begun to recover. As proven by the continuing existence of soil and ash following a fire, the suspension of fire residue and of burned soil is very small compared to the bulk quantity that continues to remain. Only the loose material would be suspended, and, if the material is not mechanically disturbed, the rate of suspension would taper off. Even if precipitation halting the suspension did not occur, the wind direction would change many times so that the resuspended material would not be transported as effectively as that from the shorter term, initial release. Consequently, resuspension doses are only calculated for an individual standing directly on the contaminated area.

Large, brief suspensions for unweathered materials occur under mechanical disturbance, such as the passage of vehicles. This is highly dependent upon vehicle speed and wind speed (Figure 4-23, DOE 1994d). The highest, bounding resuspension rate is 1×10^{-2} per passage for a car driven directly through powder tracer material on an asphalt road (DOE 1994d). However, there are no asphalt roads and no fast vehicle traffic on the firing ranges, and most of the contamination is not near roads. Hence, suspension by vehicles will not be of this magnitude and is not included in this analysis. Rather, the direct suspension by the wind is analyzed.

A rate of resuspension is often expressed as the ratio of the airborne concentration and the areal surface contamination, usually with the units of $meters^{-1}$. This ratio is called the resuspension factor. Its magnitude depends upon the wind speed, particle size, and nature of the cover. The

resuspension factor decreases with time due to weathering and downward migration of a portion of the contamination. Although most material remains in the surface soil, it becomes unavailable to the wind. Sehmel (1984) provides a substantive discussion of resuspension factors, their use, and limitations. Note, this concept strictly applies to the resuspension of material deposited from the atmosphere and applied to the soil as tracers in experiments and may not apply to material otherwise incorporated in the soil matrix. Most resuspension factors range from 10^{-5} to 10^{-11} per meter.

Note that the resuspension factor is not the fraction of the material that becomes airborne, and therefore cannot be treated as an airborne release fraction (ARF) or source term for dispersion models. Because of the way the resuspension factor is defined and measured, the concentrations apply only in the immediate vicinity (i.e., above) the contaminated soil. Concentrations beyond the area will be much lower, due to variations in the wind direction and atmospheric diffusion.

Although resuspension factors are highly irregular and poorly defined (Sehmel 1984), they were applied to evaluate residual concerns with reoccupying burned out contamination areas. A conservative resuspension factor of 1×10^{-5} meters^{-1} (sandy soil with charred debris) is selected for use in this analysis (from Section 4.4, Table 4-16, page 4-91, DOE 1994d). The fraction of the suspended contaminant that is respirable (less than 10 micrometers equivalent aerodynamic diameter) at the soil surface following the fire passage, is unknown. The particle size is likely to be large, as the contaminants will be attached to soil particles; but, because it is unknown, an RF of 1.0 is assumed. The appropriate time period for application of this conservative value is probably only a few days long, depending upon precipitation, because resuspension factors decrease by several orders of magnitude with time.

The resuspension factor of 1×10^{-5} meters^{-1} was applied to the mean areal soil concentration in the top layer of the contaminated sites, with the resultant radiological exposures shown in Table G.5.4.4.–1. These are the estimated exposures that could occur if all the contamination in the top soil layer were right at the surface, if there were no precipitation or soil cover, if there were wind, and if the receptor were standing above a spot that represented the average soil contamination for the contaminated portion of the site or canyon. These estimates are limited by the theoretical and experimental problems with resuspension factors.

In practice, before these known contamination areas would be reoccupied following a fire, the potential for exposure would be assessed and protective actions taken as appropriate to minimize exposure to the personnel.

Exposures from Burning Vegetation and Suspended Soil

Open Burn/Open Detonation Dispersion Model. During the burning of a vegetative cover, some fraction of the soil is entrained into the fire and transported and dispersed downwind. Such downwind concentrations of soil contaminants suspended by fire were calculated using the Open Burn/Open Detonation Dispersion (OBODM) model. The Open Burn/Open Detonation Dispersion Model (OBODM) is intended for use in evaluating the potential air quality impacts of the open-air burning and detonation of obsolete munitions and solid propellants at U.S. Department of Defense and DOE installations (DPG 1997). It can be used to calculate peak concentration, time-mean concentration, time-integrated concentration, and particulate deposition from multiple sources. It can consider instantaneous or quasi-continuous releases from point, volume, and/or line sources.

The model predicts buoyant rise of the plume from the burn and uses default mixing depths generally representative of noncoastal regions

TABLE G.5.4.4–1.—*Estimated Inhalation Doses from Resuspension Following Wildfire*

SITE	AREA (m^2)	TOTAL SOIL CONTAMINATION	MEAN SOIL SURFACE CONCENTRATION	AIR CONCENTRATION	INTAKE PER DAY[a]	EFFECTIVE DCF[b] (mrem/µCi)	RECEPTOR DOSE (mrem/day)
EF Site	11,690	675 kg DU	0.058 kg/m^2	5.8×10^{-7} kg/m^3	17.5 mg[c] 5.8×10^{-3} µCi	1.18×10^5	690
Phermex Site	11,690	568 kg DU	0.049 kg/m^2	4.9×10^{-7} kg/m^3	14.7 mg[c] 4.9×10^{-3} µCi	1.18×10^5	579
Potrillo Canyon	1,200	58 kg DU	0.048 kg/m^2	4.8×10^{-7} kg/m^3	14.6 mg[c] 4.9×10^{-3} µCi	1.18×10^5	575
Mortandad Canyon	13,600	4.7×10^9 pCi mixed	3.4×10^5 pCi/m^2	3.44 pCi/m^3	1.0×10^{-4} µCi	1.58×10^5	16.4
DP Canyon	3,600	1.6×10^7 pCi TRU	4,480 pCi/m^2	0.044 pCi/m^3	1.4×10^{-6} µCi	4.34×10^5	0.58
Los Alamos Canyon	18,900	1.2×10^8 pCi TRU	6,560 pCi/m^2	0.066 pCi/m^3	2.0×10^{-6} µCi	4.33×10^5	0.86
Acid Canyon	100	1.6×10^7 pCi TRU	1.6×10^5 pCi/m^2	1.64 pCi/m^3	5.0×10^{-5} µCi	4.35×10^5	21.6
Pueblo Canyon	28,500	2.5×10^8 pCi TRU	8,912 pCi/m^2	0.089 pCi/m^3	2.7×10^{-6} µCi	4.3×10^5	1.2

Notes:
[a] The breathing rate used is 30.24 m^3/day.
[b] The effective dose conversion factors are for the mixture of nuclides at each firing site and canyon.
[c] These intakes of uranium would exceed the OSHA PEL of 0.25 mg per 8 hours.

in the western United States. The minimum meteorological input consists of wind speed and direction at 10 miles elevation, air temperature, and the Pasquill stability category or the Net Radiation Index. For OBODM wildfire calculations, a conservative stability and wind speed (category C and 2 meters per second at 10 miles height) were selected to maximize the downwind exposures. A stable atmosphere would not represent the mixing conditions in the daytime meteorological situations favorable to a wildfire, and could not exist in the presence of the wildfire.

Vegetation Fire Plume Rise. The OBODM model calculates the plume rise given a fuel loading, rate of burn, and heat content of the fuel. It calculates the resulting concentration distribution at specified receptor points. The fuel model classes and associated rates of burn (defined pursuant to Anderson 1982) were determined by field survey (PC 1998c) and are given in Table G.5.4.4–2.

Caloric values of various terrestrial food plants and seeds are 4.5 to 5.2 cal/gm (Odum 1971). The heat content of dead cellulosic materials does not vary greatly (Simard et al. 1989). For this analysis, the heat content of both grass and of wood were assumed to be 4.95 cal/gm (20.7 J/gm) (Wilgen et al. 1990). The fuel models contain the sum the dead and live vegetation in various conditions of dryness and have an associated rate of fire spread. The range of uncertainty in the fuel load is large enough that the uncertainty in the moisture content, heat content, and rate of burn is not material. The total heat produced is used only to calculate the plume rise, which has only a modest effect on concentrations at moderate to large distances from the source.

Areas of Contaminated Soil Analyzed. The areas of contaminated soil were identified as PHERMEX Firing Site and EF Firing Site in TA–15, Potrillo Canyon (from runoff at the EF Firing Site), DP Canyon and Los Alamos Canyon below TA–21, and Mortandad Canyon below and east of TA–35. The radioactive waste lagoon at the end of TA–35 has cattails in it, but contains water. Acid Canyon received untreated waste water until 1953, then treated waste water until 1963. It has been cleaned up, but residual contamination still shows up in the Acid Weir sediment trap. The area of contamination in Acid Canyon is estimated as 3.3 feet wide by 330 feet long (1 meter wide by 100 meters long) (PC 1998d). Acid Canyon empties into Pueblo Canyon, which also is of low concentrations. Other, numerous contaminated areas that have been covered with clean soil are not at risk of suspension during and following wildfire and therefore were not evaluated. Ten Site Canyon below the Radioactive Liquid Waste Treatment Facility in TA–50 was not evaluated, as its contamination is primarily strontium-90, which has a lower dose conversion factor than plutonium and because it has such low concentrations that it is no longer sampled (PC 1998e).

The contamination levels were obtained from several publications, as identified at various places in this text and in the summary Table G.5.4.4–2. To be conservative, the total amount in the upper tier of sampled soil, usually 0 to 1 or 0 to 3 inches (2.5 or 7.6 centimeters) depth, were assumed to be entirely on the surface and exposed to the fire.

Airborne Release Fractions During Vegetation Fires. The model OBODM requires as input the fraction of contamination present in the fuels being burned. For these calculations, the ratio of this suspended contamination to the mass of fuel burned over the same area was presented to the model. To get this ratio, the mass of contamination suspended during the fire passage is the product of the contamination in the top layer of surface soil and the release fraction. For this assessment, all the contamination in the top layer of soil is assumed to be released with the release and respirable fraction (ARF x RF) appropriate to uranium metal under thermal stress.

For contamination in the soil, duff and litter, the burning temperature is going to be low and the burning time short, with the fire front progressing at 0.2 to 0.44 meter per second in timber and grass, respectively. The possibility of shrapnel in trees is recognized. However, there are few trees around the firing sites, and the release fraction from burning DU is small. Uranium is not capable of continued burning after the fire has departed, and so the burning release time would be short. The ARF x RF for uranium metal under thermal stress is taken from DOE 1994d, Section 4.2.1.2.1, page 4-42. The observed geometric mean ARF x RF is 1×10^{-4}, with a 95 percent confidence level ARF x RF of 4×10^{-4}. In this analysis, the value 4×10^{-4} also is used for beryllium and its compounds in the absence of experimental data dealing directly with beryllium. There are no release fractions available for radionuclides other than plutonium and uranium in the DOE-HDBK-3010-94 (DOE 1994d) or in the Nuclear Fuel Cycle Facility Accident Analysis Handbook NUREG/CR-6410 (NRC 1998). The bounding ARF x RF for powders subjected to thermal stress are 6×10^{-5} for nonreactive compounds and 1×10^{-5} for reactive compounds (DOE 1994d, Section 4.4.1, page 4-61). For consistency, the conservative ARF x RF of 4×10^{-4} also was used for other nuclides in contaminated soils.

Contamination in Plants and Animals. Small mammals have tissue/soil uranium ratios of 10^{-3} and 10^{-4} (Miera et al. 1980), and tissue/soil cesium and strontium ratios on the order of 1.0 (Whicker and Schultz 1982, Table 17). (It is unclear whether these ratios are wet or dry weights in the animals, plants, and soils.) For the reasons of their low concentration ratios, their escape ability, and their very small total mass compared to that of the vegetation, animals are ignored as a source of airborne nuclides in this analysis.

The NRC has published a list of plant/soil concentration ratios (NRC 1977). The ratios for stable strontium and cesium are 0.017 and 0.01, respectively, although there will be cases where observed values differ substantially (Whicker and Schultz 1982). Whicker and Schultz stated that the ratios for uranium range from 10^{-4} to over 10^{-1}, that ratios for plutonium are particularly dependent on chemical form, and that ratios for americium are perhaps 100-fold higher than plutonium. Plants growing where uranium concentrations in surface soils were 20 times to 3,500 times background, have exhibited uranium concentration factors of 0.05 (spring) to 0.08 (fall). Late fall standing dead vegetation at the EF site averaged 320 micrograms uranium per gram of dry vegetation (Miera et al. 1980). Applying this observation, the 1,987 kilograms of vegetation at the EF site would contain 0.64 kilogram of depleted uranium, all of which would presumably become airborne in the fire. Application of the ARF of 4×10^{-4} to the EF site soil would produce 0.27 kilogram of airborne depleted uranium. Thus, the dose from burning vegetation could contribute 2.37 times the dose from the suspended soil, and the doses could be 3.37 times the value given for soil alone in the final column of Table G.5.4.4–2.

Wenzel et al. (1987) studied radionuclide concentrations in soil, litter, and vegetation growing in a TRU waste area, and concluded that a higher resolution sampling is needed for cesium-137 and plutonium-239/plutonium-240 to interpret surveillance results and produce reliable risk assessments. Their observations, suggest that the concentrations of these nuclides, and of depleted uranium, in vegetation is always less than the concentrations in the top 0.8 inch (2 centimeters) of soil, and generally an order of magnitude less.

Thus, it is concluded that the doses in the final column of Table G.5.4.4–2 could be increased by a factor of three or four to account for the contamination in the vegetation above ground that becomes airborne.

Beryllium Exposures. The 8-hour time weighted average for worker exposure to

TABLE G.5.4.4–2.—*Summary Table for Contaminated Soil Areas*

SITE	PHYSICAL DIMENSIONS	SOIL CONTAMINATION	FUEL TYPE FUEL MODEL	BURN RATE	FUEL LOADING	RECEPTOR DOSE AT 100 m AND 1,000 m
EF Site[a]	200 ft/61 m radius 11,690 m^2	542 ppm area-weighted uranium[b]; 675 kg total	Grass Fuel Model 1	78 chain/hr (0.44 m/s)	1,987 kg; 0.74 ton/acre (0.17 kg/m^2)	0.21 mrem (0.01 mrem)
PHERMEX Site[a]	200 ft/61 m radius 11,690 m^2	456 ppm area-weighted[b]; 568 kg total	Grass Fuel Model 1	78 chain/hr (0.44 m/s)	1,987 kg; 0.74 ton/acre (0.17 kg/m^2)	0.18 mrem (0.008 mrem)
PHERMEX Site[c]	200 ft/61 m radius 11,690 m^2	Simple average 31.7 ppm Beryllium in [illegible] inch soil depth[d]	Grass Fuel Model 1	78 chain/hr (0.44 m/s)	1,987 kg; 0.74 ton/acre (0.17 kg/m^2)	0.8 $\mu g/m^3$ (0.0005 $\mu g/m^3$)[i]
Potrillo Canyon[e]	4 m x 300 m 1200 m^2	58 kg uranium 0 to 15 cm depth	PIPO-Canyon Fuel Model 2	35 chain/hr (0.20 m/s)	566 kg; 2.1 ton/acre (0.47 kg/m^2)	0.0016 mrem (3.5×10^{-4} mrem)
Mortandad Canyon[g]	4 m x 3,400 m 13,600 m^2	Surface inventory of 4.7×10^9 pCi of mixed nuclides	PIPO-Canyon Fuel Model 2	35 chain/hr (0.20 m/s)	6,415 kg; 2.1 ton/acre 0.47 kg/m^2	4.7×10^{-4} mrem (3.6×10^{-5} mrem)
DP Canyon[f,g]	3 m x 1,200 m 3,600 m^2	1.0×10^7 pCi TRU surface inventory	PIPO-Canyon Fuel Model 2	35 chain/hr (0.20 m/s)	1,700 kg; 2.1 ton/acre (0.47 kg/m^2)	2.8×10^{-4} mrem (1.6×10^{-4} mrem)
Los Alamos Canyon[g]	3 m x 6.3 km 18,900 m^2	1.2×10^7 pCi of TRU surface inventory	PIPO-Canyon Fuel Model 2	35 chain/hr (0.20 m/s)	8,920 kg; 2.1 ton/acre (0.47 kg/m^2)	1.5×10^{-7} mrem (1.4×10^{-7} mrem)
Acid Canyon[g,h]	1 m x 100 m 100 m^2	16.4×10^6 pCi of TRU surface inventory	PIPO-Canyon Fuel Model 2	35 chain/hr (0.20 m/s)	47.2 kg; 2.1 ton/acre (0.47 kg/m^2)	4.1×10^{-5} mrem (3.0×10^{-6} mrem)
Pueblo Canyon[g]	3 m x 9.5 km 28,500 m^2	2.5×10^8 pCi of TRU surface inventory	PIPO-Canyon Fuel Model 2	35 chain/hr (0.20 m/s)	13,450 kg; 2.1 ton/acre (0.47 kg/m^2)	2.2×10^{-8} mrem (2.0×10^{-8} mrem)

[a] Data from DOE 1995a Appendix D.
[b] 456 ppm and 542 ppm area-weighted average depleted uranium in 0 to 3 inch depth of surface soil of density 1.4 g/cm^3 yield 568 kg and 675 kg depleted uranium.
[c] Data from Fresquez 1994, results of the soil sampling survey conducted over active RCRA firing site TA–15–184 (PHERMEX).
[d] Simple average concentration in surface soil of density 1.4 g/cm^3.
[e] Data from Miera et al. 1980.
[f] Width and length from PC [illegible].
[g] Data from Environmental Surveillance Reports (ESR) for 1992 (LANL 1994e), 1995 (LANL 1996f), and 1996 (LANL 1997c).
[h] Data from Acid Weir site, Table 5-14 of ESR 1996.
[i] For beryllium, rather than the TEDE or integrated concentration, the peak concentration is provided for comparison to standards. The acceptable maximum peak for a maximum of 30 minutes is 25 $\mu g/m^3$ (NIOSH 1997).
[j] Due to the very long line source oriented down the canyon and the wind blowing down the canyon, dose does not change much with distance down the canyon. In fact, at 10,000 m in Los Alamos Canyon, the dose is effectively the same as at 1,000 m.

beryllium and its compounds is 0.002 milligram per cubic meter. The acceptable maximum peak for a maximum duration of 30 minutes is 0.025 milligram per cubic meter (NIOSH 1997). These are not thresholds that will protect all people but are useful for comparison to the concentrations from burning over the PHERMEX site. The beryllium concentrations calculated by OBODM (Table G.5.4.4–2) were 0.0008 milligram per cubic meter, much less than these thresholds.

Conclusions as to Doses Downwind from Firing Sites and Canyon Fires. The doses at 330 feet and 3,300 feet (100 meters and 1,000 meters) downwind from fires over individual firing sites and canyons are provided in Table G.5.4.4–2. The doses assume that the receptor remains at those locations for the full time of the plume passage. This can be a long time, as the fire front advances at about 0.7 foot per second (0.2 meter per second) in the canyon timber. At this speed, the fire takes 13.5 hours to burn the contaminated area of Pueblo Canyon, 8.9 hours for Los Alamos Canyon, 4.8 hours for Mortandad Canyon, and 1.7 hours for DP Canyon, but only 0.42 hours for Potrillo Canyon and 20 minutes for the EF site.

The largest doses from the vegetation fires are at 330 feet (100 meters) downwind of the firing sites, EF (0.21 millirem), and PHERMEX (0.18 millirem). The 5×10^{-7} LCF per millirem risk factor can be applied to the doses in Table G.5.4.4–2, to receive assurance that there are no effects expected from the radiological exposures from burning vegetation and ground cover over soils. If the total area of contamination is small, such as for the firing sites and Acid Canyon, then the same values would apply for any wind direction. For the other canyons, however, the exposure is integrated for the entire length of the canyon fire, and so the exposure to the side of the canyon would be less than given in Table G.5.4.4–2.

Because the canyons are parallel, a receptor cannot be directly downwind from more than one canyon, and hence, the exposures from multiple canyons should not be added to obtain a new MEI dose. In order for a receptor to receive exposure from multiple canyons, the wind would have to be transverse to them, as it would be in this site-wide fire with the southwesterly winds. However, if the wind were transverse to multiple canyon fires, the orientation of the canyons would assure that the dose from each would be much less than those shown at 100 meters distance in Table G.5.4.4–2. One must conclude that, no matter the orientation of the wind, sources, and receptors, the MEI dose from site-wide vegetation fires must be less than 1 millirem.

Delayed Emissions Following Building Fire

The smoke or emissions from building remains following the fire passage were not modeled. The entrainment of surrounding air by strong fires will capture much of the delayed emissions that occur soon after passage of the fire front, converting them into an elevated release as part of the main fire. However, in the LANL landscape there may not be an intense, continuous fire front; hence, some of the contaminants in the surface emissions may travel and disperse at low elevations. The relative amount of the contaminant that is and is not entrained into the main fire plume cannot be evaluated.

Evaluation of Building Fires

This section analyzes potential individual and population radiological and chemical exposures from buildings burning as a result of wildfire initiation. Each building was first screened for its vulnerability to wildfire. Those that were evaluated as vulnerable were then screened for chemical and radiological inventories. For those with significant inventories, the doses from the fires were then obtained from previous fire analyses (such as in SARs or this SWEIS) or newly calculated using the MACCS code.

Criteria and Process for Determining Building Vulnerability to Wildfire. The evaluation of vulnerability to wildfire is on the basis of building construction, materials and exposure, slope, and the quantity and structure of external fuel as described below. The total wildland fire vulnerability was calculated for this SWEIS by the LANL Fire Protection Group. The vulnerability is the product of the structure hazard times the sum of the fuel hazard and slope hazard, as defined below.

The Structure Hazard Rating considers the combustibility of the exterior structure:

- Underground—0
- Noncombustible exterior (windowless)—1
- Noncombustible (window exposures)—2
- Combustible exterior—3

Fuel Hazard. This is the product of two components, fuel loading and distance factor. The fuel loading is taken as zero for short grass and asphalt, and for other conditions is determined by the fuel model type, as described in *Aids to Determining Fuel Models For Estimating Fire Behavior* (NWCGP 1982).

The distance factor, DF, expresses the distance of the fuel from the structure.

- DF—0, distance is greater than 4 times the height of the fuel.
- DF—1, distance is greater than 2 times the height of the fuel.
- DF—2, distance is the height of the fuel.
- DF—3, distance is less than 1/2 the height of the fuel.

Slope Hazard. Exposing slopes are rated as follows:

Slope Hazard	Slope
5	Mild (0 to 5%)
10	Moderate (6 to 20%)
15	Steep (21 to 40%)
20	Extreme (41% and greater)

The total vulnerability is then calculated as the product of the structure hazard times the sum of the fuel hazard and slope hazard. This number is converted to a word description as follows:

Numerical rating	Vulnerability
0 to 5	None
6 to 49	Very Low
50 to 79	Low
80 to 149	Moderate
150 to 259	High
260 and above	Extreme

Note that this LANL system does not provide a probability that a wildfire will approach the building, or that any particular building will burn in a fire. Rather, it sorts which buildings are more likely to be damaged or destroyed should a wildfire approach. Table G.5.4.4–3 lists the buildings that have a moderate or higher risk, have also been assigned a hazard category in the publication LANL 1998a, and were subsequently evaluated for public exposure from wildfire. Other buildings have no significant amounts of MAR and were not evaluated for this accident analysis.

For each building that has a moderate or higher vulnerability and appears in LANL 1998a, a determination was next made as to whether further analysis of public exposure was needed. Table G.5.4.4–4 provides the results. Some buildings were eliminated based on updated inventories, as having no significant inventories, or an inventory that was present only for brief periods. These determinations appear in the columns headed "Comments and EIS Assessment." The comments column

TABLE G.5.4.4-3—*Evaluation of Vulnerability of LANL Buildings to Wildfire*

TECHNICAL AREA	BUILDING	WILDLAND RISK	NUCLEAR FACILITY	HAZARDS	CONST. TYPE	COMMENTS, AND TENTATIVE INVENTORY PENDING VERIFICATION
TA–02	44	Moderate	No	Rad	1	
TA–02	49	Extreme	No	Rad	3	Cooling Tower
TA–03	130	Moderate	Yes	Rad	2	
TA–03	16/208	High	No	Rad	2	
TA–03	494	Moderate	No	Rad	2	
TA–03	66/451	High	Yes	Rad, Chem	2	Nitric acid, fuming (6,484 lbs.), hydrochloric acid (3,130 lbs.), hydrofluoric acid 48 to 51% (490 lbs.)
TA–08	65	Moderate	No	Rad	1	
TA–08	70	Moderate	Yes		2	
TA–15	183	Moderate	No	Rad	2	
TA–16	205	Moderate	Yes	Rad	2	
TA–16	248	Moderate	No		2	
TA–16	255	High	No		3	Exposes 16 to 205
TA–16	414	Moderate	No	Rad	2	
TA–16	459	High	No		3	Exposes 16 to 205
TA–18	32	Moderate	Yes	Rad	2	
TA–21	155	Moderate	Yes	Rad	2	
TA–21	209	Extreme	Yes	Rad, Chem	2	
TA–21	61	Moderate	No		2	
TA–35	110	High	No	Rad	3	
TA–35	213	High	No	Rad, Chem	2	Nitric acid (406 lbs.)
TA–41	2	Moderate	No		2	
TA–41	30	Moderate	No		2	Outside rad storage
TA–41	4	Moderate	No		2	
TA–43	1	Extreme	No	Rad, Chem	2	Hydrochloric acid (483 lbs.)
TA–46	208	Moderate	No	Rad	3	
TA–46	217/218	Moderate	No		3	Exposes 46 to 75
TA–48	1	Moderate	No	Rad, Chem	2	Sulfuric acid 14% (2,400 lbs.), hydrogen fluoride solution (663 lbs.), chlorine (223 lbs.)

TABLE G.5.4.4-3—*Evaluation of Vulnerability of LANL Buildings to Wildfire*-Continued

TECHNICAL AREA	BUILDING	WILDLAND RISK	NUCLEAR FACILITY	HAZARDS	CONST. TYPE	COMMENTS, AND TENTATIVE INVENTORY PENDING VERIFICATION
TA-48	45	Moderate	No	Rad, Chem	2	Nitric acid (1,812 lbs.), hydrochloric acid (545 lbs.), hydrofluoric acid (23 lbs.). Bldg. not in LANL 1998a
TA-51	11	Moderate	No	Rad	2	
TA-51	12	Moderate	No	Rad	2	
TA-53	1	Moderate	No	Rad	2	
TA-53	3	Moderate	No	Rad, Chem	2	
TA-53	Rad Waste Lagoon	Moderate	No	Rad	2	
TA-54	153	Moderate	No	Rad	3	
TA-54	215	Moderate	No	Rad	3	
TA-54	224	Moderate	No	Rad	3	
TA-54	226	Moderate	No	Rad	3	
TA-54	229	High	No	Rad	3	
TA-54	230	High	No	Rad	3	
TA-54	231	Moderate	No	Rad	3	
TA-54	232	Moderate	No	Rad	3	
TA-54	283	Moderate	No	Rad	3	
TA-54	33	High	No	Rad	3	
TA-54	48	Moderate	No	Rad	3	
TA-54	49	Moderate	No	Rad	3	
TA-54	Area G, Pad 2	Moderate	No	Rad	3	
TA-55	107	Moderate	No		3	
TA-59	118	High	No		3	
TA-59	119	High	No		3	
TA-59	32/33/34	Moderate	No		3	
TA-59	35/36/37	Moderate	No		3	

Notes: For construction type, 0 = Underground, 1 = Noncombustible/Windowless, 2 = Noncombustible, 3 = Combustible.

TABLE G.5.4.4–4—*Final Vulnerability and Consequence Assessment of Building Wildfires*

TECHNICAL AREA	BLDG. NO.	FACILITY NAME	COMMENTS	SWEIS ASSESSMENT
TA–02	4	Laboratory Storage Building, OWR	Former Facility Manager stated that no residual contamination exists in this building, and it would not add contaminants to the plume during a wildfire.	Eliminated based on no residual contamination or inventories.
TA–02	44	Laboratory Storage Building OWR	Former Facility Manager stated that two resin exchange columns exist in this building, and samples could be collected and analyzed to determine the amount of contamination that currently remains in the ion exchange columns. He indicated that the remaining contamination would be very small and may contain cobalt-60.	No data available and therefore could not be analyzed. Public exposures from the small inventory would be bounded by other building fires. Facility is scheduled for disposal.
TA–02	1	Omega West Reactor (OWR)	Former Facility Manager stated that reactor systems were flushed and analyzed as part of the decontamination and decommissioning process, the cooling systems are dry, the reactor vessel or housing is still radioactive, but is encased in a stainless steel vessel that should not burn.	Fuel has been removed; Reactor is in the process of completing any decontamination and decommissioning activities; eliminated based on no wildfire risk to inventory
TA–03	66/451	Sigma Building	130 kg of fines in oil, plus 100 electrodes each 1/4 inch thick by 8 inch by 4 ft. long. Remainder of 65,000 kg of DU is in fixed storage cabinets of 1/2 hour fire resistance. All material is in the basement. Information from facility walkdown conducted by GRAM, Inc. (Garvey 1998) nitric acid, fuming (6,484 lbs.), hydrochloric acid (3,130 lbs.), hydrofluoric acid 48 to 51% (490 lbs.).	The maximum dose from the inventory of 65,000 kg calculated for this scenario was 3.0×10^{-5} rem 50 yr. committed effective dose equivalent (EDE) at approximately 10 km from the release point (Young 1998). Chemicals below grade level and not likely to be affected by fire.
TA–08	24	Isotope Building	The facility is used only intermittently for storage of radioactive material; operations, in the event of a wildfire, would not be conducted or would be terminated and material would not be stored in this facility.	Eliminated based on the intermittent use of the facilities
TA–08	70	Nondestructive Test		Eliminated based on the intermittent use of the facilities

TABLE G.5.4.4-4—*Final Vulnerability and Consequence Assessment of Building Wildfires*-Continued

TECHNICAL AREA	BLDG. NO.	FACILITY NAME	COMMENTS	SWEIS ASSESSMENT
TA–15	203/213	PHERMEX Cavity Shelter	There is no known residual contamination or inventory of radioactive material in this building.	Eliminated based on no residual contamination or inventories
TA–15	313	Radiographic Support	Radiation is only present when machine is operating. Concrete blocks surround equipment; therefore, the equipment would not be at risk in a wildfire.	Eliminated based on no residual contamination or inventories of radioactive material
TA–16	205	Weapons Engineering Tritium Facility (WETF)	100 g, tritium in process; vault storage: 60 g in tubs, 1,200 g in Lp-50 Containers. Information from facility walkdown conducted by GRAM Inc. (Garvey 1998) March 2, 1998 FSAR available, No SER.	The maximum dose (MEI) was calculated as 0.25 rem at 4.85-km distance. Doses are less at shorter distances due to the plume rise. The population dose is 189 person-rem within the 80.5-kilometer (50-mile) radius. (Young 1998)
TA–18	32	Critical Assembly Building	All three kivas are concrete construction, and materials are contained in a concrete vault within the kivas.	Eliminated based on no wildfire risk to the inventories
TA–21	155	Tritium Science Test Assembly (TSTA)	200 g tritium. Information from facility walkdown conducted by GRAM Inc. (Garvey 1998).	The RAD–05 aircraft crash and fire accident consequences from a 200 g release of tritium oxide were 24 person-rem population exposure and mean MEI dose of 0.012 rem at State Road 5 (360 m). These consequences are 25% less under the Reduced Operations Alternative.
TA–21	209	Tritium Science and Fabrication Facility	100 g tritium Information from facility walkdown conducted by GRAM Inc. (Garvey 1998).	Scaling of the RAD–05 aircraft crash and fire accident consequences to a 100 g release of tritium in oxide form results in 12 person-rem population exposure and mean MEI dose of 0.006 rem at Route 502 (360 m).
TA–35	213	Target Fabrication	1 kg beryllium, 10 lbs. boron trichloride, 5 lbs. (solid), 8 kg (solutions) cyanide, 3 lbs. diborane, 3 l. formaldehyde, 4 lbs. metal carbonyls, 171 l nitric acid, 1 lb. phosphene, 20 Ci tritium, 10 kg U-235 Information from facility walkdown conducted by GRAM Inc. (Garvey 1998).	There would be only a very small dose, as 20 Ci is a 1/10 the inventory of the RAD–05 accident, and the TA–35 source is further from the townsite than is the TA–21 source. The chemical inventories are small and therefore not modeled.

TABLE G.5.4.4–4—*Final Vulnerability and Consequence Assessment of Building Wildfires*-Continued

TECHNICAL AREA	BLDG. NO.	FACILITY NAME	COMMENTS	SWEIS ASSESSMENT
TA–41	4	Experimental Science Laboratory Building	Approximately 0.02 g tritium (about 200 Ci) as residual contamination.	The RAD–05 aircraft crash and fire accident consequences from a 200 g release of tritium in oxide form at TA–21 were 24 person-rem population exposure and mean MEI dose of 0.012 rem at Route 502 (360 m).
TA–43	1	Health Research Laboratory	30 liters formaldehyde Information from facility walkdown conducted by GRAM, Inc. (Garvey 1998).	Evaluated in the SWEIS earthquakes. The ERPG–2 and ERPG–3 distances were 0.17 and 0.1 miles (0.27 and 0.16 km), respectively, under conservative daytime dispersion conditions. The number of people exposed to greater than ERPG–2 and ERPG–3 were 11 and 6, respectively.
TA–48	1	Radiochemistry Laboratory	See BIO for TA–48, approved 3/31/97.	Dissolving wing fire (Scenario 2) 0.3 mrem at 720 m, Alpha wing fire is 5.4 mrem at 720 m or at the Royal Crest Trailer Park. The whole facility fire is postulated to be 50 mrem. Chemical exposures at this location are less than ERPG-2.
TA–53	1	Laboratory Accelerator Building		Eliminated based on unavailability of the small inventory to wildfire, per walkdown provided by Chris Del Signore
TA–53	3	Linear Accelerator Building		Eliminated based on unavailability of the small inventory to wildfire, per walkdown provided by Chris Del Signore
TA–54	153, 224, 226, 229, 230, 231, 232, 283, 33, 48, 49, and Pad 2	Waste drum preparation, and domes	Evaluated in RAD–08.	The consequences of the aircraft-initiated fire in RAD–08 were 400 person-rem population exposure, and a mean MEI dose of 22 rem at both White Rock and Pajarito Road.

contains suspected inventories, pending verification.

Public Exposures from Burning Buildings. Those building fires with integrated population and MEI inhalation exposure from burning buildings are also presented in summary Table G.5.4.4–5. Analyses already existed for some buildings in SARs and elsewhere in this SWEIS, such as the case for the aircraft crashes and fires in TA–21 and TA–54, identified as RAD–05 and RAD–08. The exposures assume no sheltering inside buildings or vehicles and that no protective actions are taken by the individual at those locations. Although Area G is not in the direct path of the fire, it borders a canyon and could be victim to a canyon fire even in the absence of a site-wide fire. Therefore, it also has been included in the wildfire analysis. The reader may evaluate the consequences of a partial site-wide wildfire and/or canyon fires by selecting individual canyons from summary Table G.5.4.4–2 and individual facilities from Table G.5.4.4–4 for summation.

Vulnerable buildings and the outdoors in the fire path were screened for their chemical inventories. No new inventories were found that were not available for the analysis of the site-wide earthquake (sections G.5.4.1 and G.5.4.2). For fire-vulnerable facilities, the earthquake chemical results were accepted for the site-wide fire, and entered into Table G.5.4.4–4. Note that, whereas the chemical releases in the earthquake were at ground level, the chemicals in the plume from the fire would be at higher elevations, and the concentrations at ground level would be much less.

Note that the meteorology used for dispersion in the different SARs and for the radiological accidents RAD–05 and RAD–08 in this SWEIS are not the same as that posed for this wildfire. The SARs use more conservative dispersion with low wind speed and stable conditions and will have a higher dose than if they had used wildfire meteorology. The wildfire has significantly stronger wind and a neutral or unstable atmosphere, strongly affected by the fire itself. The SWEIS uses representative meteorology for an entire year and presents a mean MEI (section G.2.4). The representative meteorology includes winds blowing away from any receptor, and the full range of stabilities, weighted by frequency of occurrence. The wildfire meteorology would possibly result in the same dose to the MEI and population as does the mean meteorology because it may be close to the annually typical stability and wind speed. It was concluded that, due to the magnitude of the doses and the conservative assumptions in the wildfire scenario, and the uncertainty of the population distribution during the fire, new calculations were not warranted for RAD–05 and RAD–08.

There are no differences in wildfire frequency among the alternatives. The consequences do not vary with alternatives, except that the inventory and consequences are reduced by 25 percent in RAD–05 under the Reduced Operations Alternative.

Population Exposures

The following information on the exposed population is based upon the Los Alamos County Emergency Plan and the LANL Closure Plan (PC 1998f). In the event of a wildfire approaching from the south, LANL would begin evacuation of the southern area of LANL as soon as it was determined that the fire posed a threat, and proceed north with the evacuation. Personnel deemed essential to shutdown operations would remain until such actions were completed. Some emergency response personnel and security personnel would remain at all times in some areas. There are 10,200 LANL employees (including contractors), of which approximately 4,000 live outside of Los Alamos County and 6,200 within Los Alamos County. The main hill Road 502 will evacuate 800 cars per hour, and the combinati of the

TABLE G.5.4.4-5—*Consequence Summary for Building Fires*

TECHNICAL AREA	BUILDING NUMBER	FACILITY NAME	SWEIS ASSESSMENT
TA–03	66/451	Sigma Building	The maximum dose calculated for this scenario was 3×10^{-5} rem 50 yr. committed effective dose equivalent (EDE) at approximately 10 km from the release point.
TA–16	205	Weapons Engineering Tritium Facility	The maximum dose (MEI) was calculated as 0.25 rem at 4.85-km distance. Doses are less at shorter distances due to the plume rise. The population dose is 189 person-rem within the 80.5-km (50-mile) radius.
TA–21	155	Tritium Science Test Assembly (TSTA)	Release of 200 grams of tritium oxide, resulting in population dose of 24 person-rem, and a mean MEI dose of 0.012 rem at State Road 502 (360 meters). These consequences are 25% less under the Reduced Operations Alternative.
TA–21	209	Tritium Science and Fabrication Facility	MEI dose of 0.006 rem at State Road 502 (360 meters) and 12 person-rem population dose.
TA–43	1	Health Research Laboratory	ERPG–2 and ERPG–3 distances are 0.17 and 0.1 miles (0.27 and 0.16 km) respectively. The number of people exposed to formaldehyde at greater than ERPG–2 and ERPG–3 are 11 and 6, respectively.
TA–48	1	Radiochemistry Laboratory	MEI dose from the entire building fire is 50 mrem at the Royal Crest Trailer Park. Chemical exposures at this location are less than ERPG–2.
TA–54	153, 224, 226, 229, 230, 231, 232, 283, 33, 48, 49, Pad 2	Waste Drum Preparation, and domes	Total population exposure 400 person-rem, and mean MEI of 22 rem at both White Rock and Pajarito Road.

East Jemez and Pajarito roads will evacuate another 800 cars per hour.

In a realistic scenario, evacuation of the town begins when the fire is well into the LANL site, but is impeded because of panic, accidents, and the very limited road system, including the closure of Pajarito Road. Some fraction of the population refuses to leave, and a significant number are relocated to the eastern edge of the town where there is less fuel load. Los Alamos has 11,500 residents, and White Rock has 8,000 residents. Los Alamos County estimates there are 2.4 people per family, and that 25 percent of the families will take two vehicles instead of one. It is accepted that the 6,200 LANL employees will all go home before evacuating the mesas. The 4,000 people living off the hill will take 1.25 hours to evacuate at two people per car in the absence of accidents. If all the employees go home first, the people living off of the hill may have cleared before the townsite begins. There would be 6,832 cars to leave the hill, which would take 4.3 hours. This is based on 2.4 people and the 25 percent extra vehicles. It should also be noted that up to 10 percent of the people might refuse to evacuate.

Because the differing population density as a function of time cannot be predicted, the results of the MACCS calculations must be presented as exposures to the same populations and receptors as used in the other accident analyses. Under the conservative assumptions applied in this analysis, the collective population dose from the wildfire consuming buildings is estimated to be about 625 person-rem. To this there may be added another 50 person-rem to capture the minor exposures from burning vegetation and from unidentified residual contamination in other buildings and vegetation. Most of this dose, about 75 percent, would come from the TA-54 Waste Management Complex. A population exposure of 675 person-rem would be expected to result in 0.34 excess LCFs.

Effects on Workers

All threatened workers would be evacuated prior to arrival of the fire front. Aircraft crashes with fatalities have occurred while dropping slurry on wildfires. Firefighters on the ground are at risk if they enter an area without an alternate escape route, and there have been historical fatalities from such events. However, because life safety is given first priority over protection of property at LANL, it is not likely that there will be worker fatalities. Some firefighters and other emergency personnel are likely to have significant but transient effects from smoke inhalation.

Ancillary Environmental Effects

Firewater. Firewater (water used in fighting building fires) at nonnuclear facilities is captured by outdoor containment and temporary dikes erected for fire fighting. Firewater at nuclear facilities is captured by the drain system and is sent to TA-50 for processing. Conceivably, some radioactively contaminated water could reach the outdoor environment, but would be of such small volume that it would not leave the building environs. Resultant contaminated soil would be eroded, pending the return of vegetative cover. As with other contaminated soils, the environmental and human health threat from the new contamination would be assessed and mitigated.

Loss of Protective Cover. The charred plant remains following a severe wildfire are the only immediate visual consequences. The consequences of a wildfire are diverse, continuing through time and space, and frequently having significant changes in geomorphology and biological communities and processes. LANL is perhaps unique in potential consequences, because in addition to a rich presence of biological communities and cultural remains and resources, there exists soil bearing legacy contaminants from historical operations.

Trees, grass and herbaceous cover, and forest litter are important features in stabilizing soils by: (1) reducing the velocity and impact of falling raindrops; (2) reducing the velocity of runoff, thereby encouraging infiltration and discouraging its transport by water and wind; and (3) reducing runoff quantities. Loss of vegetative cover will create a setting that can have pronounced effects on flow dynamics, soil erosion, and sediment deposition. These changes also can have significant ramifications for plant and animal communities and cultural resources.

Runoff, Soil Erosion, and Sedimentation. Without a protective ground cover, runoff quantities and velocities will be magnified, and soil erosion by water and wind will begin immediately. Contributing to this condition will be the likely formation of an ash layer that will inhibit the infiltration of runoff. Decreased infiltration will increase the quantity and velocity of surface runoff, promoting higher channel volumes and watershed discharges. These higher runoff quantities will be discharged into the Rio Grande where they will contribute to the overall floodwater storage of Cochiti Lake. Modified hydrologic conditions likely will cause some watercourses that have only rarely had sufficient flows to reach the Rio Grande to increase their frequency of discharge.

Commensurate with higher runoff quantities and velocities will be an increase in soil erosion. Sheetflow will begin transporting soil suspended by rainfall droplet impact. Both rill and gullying will begin on sloping ground surfaces with the first significant rainfall event. Higher channel volumes and velocities will promote both downward and lateral scouring of channels in the steeper portions of the watershed and sediment deposition in the lower portions. (These conditions depend on quantity of runoff discharges and resulting changes in channel hydraulics.) Headcutting will increase throughout the channel system. Delta formation will increase at the confluence of watercourses tributary to the Rio Grande, and added sediment will contribute to the depletion of the sediment reserve of Cochiti Lake.

The gradual establishment of ground cover will correspondingly retard soil erosion and a more stabilized hydrologic regime will return.

Effects on Legacy Contaminants. Active erosion processes have moved some contaminants bound to sediment from the watershed into the Rio Grande, mainly as suspended sediment and bedload sediment. Conversely, many of the remaining legacy contaminants at LANL are present in situ or have not been transported far from their origin or remain on site. Water transport is a major mechanism for the transport of contaminants both in the dissolved and suspended sediment phases. Because vegetation acts to hold soil and reduce erosion, its loss (however short term) may significantly increase the potential for erosion and the transportation of contaminants. Some water courses have only rarely had sufficient flow to reach the Rio Grande, and because of this they have become "discharge sinks" for some contaminants. Increases in runoff amounts and frequency will increase the potential to remove and transport contaminants from the ground surface and subsurface and stream channels on LANL into the Rio Grande and downstream to Cochiti Lake.

Effects on Biological Systems. Although fire is a natural part of biological systems, anthropogenic influences such as grazing, logging, and fire suppression have produced conditions that have pronounced adverse effects on forest ecosystems. Natural high-frequency, low intensity fire regimes have been replaced with low-frequency, high-intensity fires that consume a higher percentage of vegetation. As reflected in other nearby areas that have experienced severe wildfires in the past (e.g., Water Canyon, La Mesa, Dome, and Oso Complex fires), a wildfire at LANL will result in a period of disequilibrium with a reversion to early seral development and a corresponding change in animal use (Allen 1996). Fire debris,

fallen trees, and needle cast will gradually begin to check erosion and develop soil conditions that will promote the establishment of grasses and herbaceous vegetation that will in turn further reduce erosion. This gradual re-establishment of ground cover will begin the dynamic process of seral progression toward a wooded or forested plant community.

A loss of forest or woodland habitat will result in a temporary loss of habitat for a broad spectrum of animals. As vegetation is re-established an altered community of animal species will follow, its composition changing with the evolution of the plant community. The pattern of burned vegetation will play a significant role in renewed wildlife use. Early plant communities of grasses and herbaceous growth can have a high biomass and species diversity as exhibited by nearby areas affected by recent wildfires. This expansion of grass and herbaceous growth could provide additional forage for the large elk population in and around LANL and contribute to existing management concerns.

Impacts on threatened and endangered species (e.g., the Mexican spotted owl) will depend on several factors such as the burn pattern, the time of day that the burn occurs, the type of fire, topography, and if nesting is occurring. Threatened and endangered species have remained or returned to nearby areas that have experienced recent burns. Some species, such as the peregrine falcon, could benefit through improved foraging habitat. Individual response to fire also will vary. Perhaps the most significant impact to threatened and endangered species precipitated by a wildfire could be the general disturbance caused by the fire fighting effort itself (e.g., fire fighting crews, aircraft, and vehicular traffic).

As discussed previously, increased runoff discharges will result in a commensurate increase in channel scouring, enlargement, and headcutting. This process and any accompanying sedimentation will have the potential to degrade or remove the limited riparian vegetation on LANL. Wetlands associated with water courses also would be affected, and perhaps several would be removed for a period of time because of changes in channel morphology. With the degradation of riparian vegetation and wetlands would be an associated reduction or loss of habitat for a variety of invertebrates, small and large mammals, amphibians, reptiles, and a diversity of birds.

Any impacts of contaminants transported to downstream riverine and lacustrine ecosystems is unknown, but there could potentially be an increase in ecological risk.

Effects on Cultural Resources. LANL is located in a region of abundant and culturally significant prehistoric and historic resources, including traditional cultural properties. As stated, fire is a normal feature of the landscape and has played and continues to play a natural role in the culture of regional communities. Because of anthropogenic influences, the character of recent fires will be different from historic fires and will affect resources differently. Also, the need to protect property and life from wildfire will necessitate measures that can affect cultural resources.

As discussed, high intensity fires can burn an appreciable amount of ground cover and accelerate erosion. Surface erosion can physically disturb surface features and confuse and distort the contextual integrity of the site. More pronounced erosion in the form of gully formation and lateral bank cutting can permanently remove site features. Also, a high intensity fire can scorch organic remains located near the ground surface, decreasing their interpretive value. Historical structures can suffer through direct incineration. Damage to these resources also can occur as a consequence of vehicular traffic and mechanical disturbance (e.g., bulldozers and fire trucks) and other soil disturbing activities connected with the firefighting effort.

Traditional cultural properties present on and adjacent to LANL include ceremonial and archaeological sites, natural features, ethnobotanical sites, artisan material sites, and subsistence features. These resources are an integral part of the landscape and almost certainly are and have been affected by natural fires. Because of the altered character of fires, these resources may be affected to a greater extent. Depending on the characteristics of these properties, they could either be permanently or temporarily affected by a wildfire and its subsequent ancillary effects (e.g., erosion).

Mitigation

The next fire season begins in April 1999. As a result of the process of this accident analysis, actions were initiated to reduce the wildfire risk to major facilities with significant radiological inventories. Specifically, considerations were given to reducing the risk to low or very low for the following facilities:

- TA–3 Building 66/451, Sigma
- TA–54 (Area G) Pads
- TA–21 Building 209, Tritium Science and Fabrication Facility (TSFF)
- TA–21 Building 155, Tritium Storage and Test Assembly (TSTA)
- TA–16 Building 205/205A, Weapons Engineering Tritium Facility (WETF).

Nevertheless, the public exposure from these specific facilities has been included in this wildfire analysis. With the completion of these actions, the population dose from site-wide wildfire would be reduced from an estimated 675 person-rem to 50 person-rem, with associated 0.25 excess LCF. In addition, although no credit is taken for it in this analysis, the long-term environmental restoration of contaminated sites will reduce airborne nuclides suspended by vegetation fires over those sites.

There also is an ongoing, interagency, collaborative program to reduce the threat of catastrophic wildfire from occurring at LANL and the townsite by thinning and removing vegetation at the perimeter and in the surrounding Santa Fe National Forest and Bandelier National Monument. This will reduce the frequency and intensity of wildfires that could impinge on LANL.

Uncertainties

The frequency of wildfire impinging on LANL was estimated as 0.1 per year under the current fuel conditions in the surrounding forest and perimeter. This frequency includes wildfires approaching from the north through west and south. When fire enters LANL or originates from within LANL, there are numerous credible scenarios, most of which consume less of the LANL area than is covered in this analysis. Specifically, this analysis presumes that the fire jumps the Pajarito Road or any other established control line, spots or otherwise burns into all contaminated canyons, and successfully climbs canyon walls to ignite combustible buildings with moderate and higher wildfire vulnerability. The frequency of such a site-wide fire is surely less than 0.1 per year. The consequences of a complete burning of the western portion of LANL are presented in accord with the conservative nature of this SWEIS as a whole.

The plume rise calculated by OBODM in the canyon fires is likely to be much less than that which would actually occur resulting in lower doses at a distance of 330 and 3,300 feet (100 and 1,000 meters). This analysis used only the heat content of the fuel over the contaminated area; whereas, there is much fuel to the sides of the fire, and the combined heat would loft the plume thousands of feet. The observed convection columns in the past major forest fires would carry most contaminants far above the breathing zone of downwind individuals.

The wind speed used for dispersion of airborne material from the contaminated site fires was only 2 meters per second, which is probably less than would occur during a wildfire. The doses

are inversely proportional to the wind speed, such that if the observed wind were 6 meters per second, the dose would be 1/3 that calculated.

The fraction of the suspended contaminant that is respirable (less than 10 micrometers equivalent aerodynamic diameter) is unknown. According to Section D.5 of the DARHT EIS, the uranium in the soil is not all respirable. The particle size of the airborne soil contamination is likely to be large because the contaminants will be attached to soil particles preceeding the fire and to soil and smoke particles in the plume. Because the airborne contaminant particle size is unknown, an RF of 1.0 is assumed. This is very conservative.

The White Rock and Santa Fe population is included in the MACCS calculations. The additional MACCS calculations for WETF and Sigma made for this wildfire analysis used the winds observed June 7 to 10, 1998, which are toward the Los Alamos townsite; whereas, the previous calculations for the other facilities used representative annual meteorology from 1995 (as described in section G.2.4). Because population is not evenly distributed about these sources, there would be a difference in the integrated population dose (i.e., in the person-rem) depending upon the meteorology used. Because the source inventories at the buildings vulnerable to wildfire do not vary significantly among alternatives, this does not affect the decision. (The inventory at TSTA is reduced by 25 percent under the Reduced Operations Alternative.)

The model calculations for dispersion of the plumes, for canyon sources several and more kilometers long, are most uncertain. The source was input as a volume having the dimensions of the width and length of the contaminated area, oriented along the axis of the wind direction. Differences in concentrations downwind are noted if the source is entered as a volume source versus a line source. The model also objects to a burning time longer than 60 minutes, and was manipulated into accepting these extensively long volumes and longer burn times. The 60-minute limitation in the model is likely intended to prevent the user from exceeding the bounds of experimental data, most of which is for 10 to 30 minute releases. There are no field experiment data to which the canyon results can be compared. However uncertain, the radiological exposures predicted for the canyon fires are orders of magnitude less than the 100 mrem annual limit for public exposure from routine releases.

It has been estimated that there would be 50 person-rem from burning of buildings with residual contamination and from identified and unidentified contaminated soil/vegetation areas. This is a number not supported or disputed by hard data, and is believed to be very conservative.

There are no release fractions available for radionuclides other than plutonium and uranium. For consistency only, the ARF x RF of 4×10^{-4} for uranium was also used for plutonium, americium, and cesium in contaminated soils, which is conservative for plutonium by a factor of 7, and therefore, overestimates the bounding doses for mixed nuclides and TRU in Table G.5.4.4–2 by this factor.

There is no ready evidence that burning of the vegetation over the firing sites would produce detectable airborne DU. The U.S. Army tested DU projectiles at the Jefferson Proving Ground, releasing 50 metric tonnes of uranium in a 4 year period, of which 45.5 metric tonnes were not recovered from the area. Special samples showed that most of the DU was on or near the surface. The vegetative undergrowth was regularly controlled through burning, at which time high volume particulate air samples were collected. Analyses of the air samples did not detect any DU (Abbott 1988). For DU munitions in an intense wood-fuel oil fire burning for 2 hours, no airborne DU was collected in the air samplers at various distances out to 328 yards (100 meters), and 0.01 of

residual oxides was in the respirable size range (DOE 1994d).

The MEI and population doses do not take credit for sheltering in vehicles or buildings, which will easily reduce doses to 1/2 to 1/20 of that outdoors (Engelmann 1990, Engelmann et al. 1991). It should be noted that airborne contamination will be in the smoke, which people are inclined to avoid.

About 400 person-rem, or 75 percent of the total population exposure of 675 person-rem, results from a wildfire at TA-54. The results from RAD-08, an aircraft crash-initiated fire at TA-54, were used for the wildfire. The two fires would be quire different, one entailing aircraft fuel that will challenge waste containers. At present, the combustible loading within the dome structures is small, so that RAD-08 results very conservatively bound the consequences of a wildfire at TA-54.

Another 189 person-rem results from total release of the tritium inventory at WETF, including 1,260 grams in storage, which is assumed to bound an increased administrative limit that may be established. The storage containers are resistant to fire, but have been assumed to release their entire content in tritiated water form, in accord with the highly conservative nature of this analysis.

G.5.5 Chemical Accidents

G.5.5.1 *CHEM-01, Single Cylinder Release of Chlorine from Potable Water Chlorinator*

General Scenario Description

Accident scenario CHEM-01 postulates a chlorine gas leak from a single cylinder at a potable water chlorination station. The accident is initiated by equipment failure or human error during chlorine cylinder replacement or maintenance activities at the chlorinator station. Two, 150-pound chlorine cylinders are connected to the injector system, which adds a small amount of chlorine to the potable water system for purification purposes.

The scenario is modeled as occurring at TA-00-1109, which is a site in the town of Los Alamos north of the high school. This location is one of nine chlorinator sites located around LANL and the town; the other locations are TA-00-1110, TA-00-1113, TA-00-1114, TA-16-560, TA-33-200, TA-54-1008, TA-72-3, and TA-73-9. TA-00-1109 was selected as the modeling location based on its proximity to residential housing and special populations, and provides an upper bound estimate of the potential impacts to the public. (It should be noted that a study is being conducted by LANL to evaluate the conversion of the chlorinator systems from a gaseous chlorine system to a less hazardous MIOX system that hydrolyzes brine to produce chlorine on site. In addition, negotiations are in progress that could lead to the chlorinator system being turned over to Los Alamos County.)

CHEM-01 Release Mechanisms

Chlorine usage has been estimated for the four SWEIS alternatives, with an average of seven to nine cylinders used per year at each of the potable water chlorinator stations. The chlorinator system at TA-00-1109 is a sweetener station that actually uses only two to three cylinders per year Hence, it is conservative to model the station use rate at seven to nine cylinders per year, depending on the alternative.

Three leakage rates were defined for this event. The smallest leak is essentially a pin-hole leak that would result from random equipment failures or human errors. The next leak considered as a valve failure, which would open a 0.25-inch (0.64-centimeter) diameter hole in the cylinder pressure boundary. Finally, a