CHAPTER 5.0
ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential direct, indirect and cumulative environmental impacts, or changes, resulting from each of the reasonable alternatives for continuing the operation of LANL: the No Action Alternative, the Expanded Operations Alternative (DOE's Preferred Alternative, with the exception that pit manufacturing would not be implemented at a 50 pits per year level, single shifts, but only at a level of 20 pits per year in the near term), the Reduced Operations Alternative, and the Greener Alternative. Environmental impacts are described and discussed across the various aspects of the affected environment or resource areas that are likely to change at a site-wide level.[1] Aspects of the environment that are not expected to change as a result of implementing any of the four alternatives analyzed are not discussed in detail.

The Region of Influence (ROI) varies across the resources as well as across the alternatives. Chapter 4, Affected Environment, describes the current environment in and around LANL for each of the resource areas (e.g., Land Resources, Air Quality, and Water Quality). The information presented in chapter 4 is the foundation for understanding and evaluating the environmental impacts associated with the four alternatives.

Chapter 5 includes six major sections. Section 5.1 presents the methodologies used for the impact analysis for each resource area. Sections 5.2, 5.3, 5.4, and 5.5 present the impacts associated with the No Action, Expanded Operations, Reduced Operations, and Greener Alternatives, respectively. Section 5.6 presents unavoidable adverse impacts, the relationship of short-term uses and long-term productivity of resources, the irreversible or irretrievable commitment of resources, and the cumulative impacts associated with the continued operation of LANL. Each section except 5.6 is formatted to follow the presentation of the affected environment or resource areas discussed in chapter 4 (e.g., section 5.2.1 presents the impacts of the No Action Alternative to Land Resources). The most detailed discussion is presented in section 5.2, and the impacts associated with each of the other alternatives are usually compared to the impacts of the No Action Alternative (in section 5.2) to minimize repetition. A discussion of bounding potential credible accidents for the four alternatives is presented near the end of each of these sections (i.e., sections 5.2.11, 5.3.11, 5.4.11, and 5.5.11). The discussions in this SWEIS, including discussions in this chapter, are augmented by a classified supplement to the SWEIS. This supplement contains certain classified information and data related to the activities at LANL that, though important to support understanding of certain details underlying the SWEIS and its analyses, must be protected in

1. The scope of the SWEIS was developed prior to issuance of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (SSM PEIS, DOE 1996d) Record of Decision (ROD). Thus, the Expanded Operations Alternative was originally defined to include the high explosives component production and the secondary assembly production mission elements, as discussed in chapter 1. Accordingly, the environmental consequences of the Expanded Operations Alternative (described in section 5.3) include the impacts associated with these mission elements. However, because these activities do not contribute substantially to air quality, water resource, land resource, socioeconomic, or other impacts projected regarding LANL operations, the environmental consequences of the Expanded Operations Alternative with or without these mission elements are substantially the same. Therefore, DOE determined that it was not cost effective to restructure and reanalyze the Expanded Operations Alternative. To the extent that this affects the impact analyses, the environmental consequences of the Expanded Operations Alternative can be expected to be somewhat less than identified in section 5.3.

accordance with the *Atomic Energy Act of 1954* (42 United States Code [U.S.C.] §2011). This information includes details associated with some operations, experiments, processes, or source terms. DOE presents as much information as possible in this unclassified document. Furthermore, the environmental impacts are fully contained in the results presented to the public in this unclassified document.

The major contributors to environmental impacts of operating LANL are wastewater discharges and radioactive air emissions.

- Historic discharges to Mortandad Canyon from the Radioactive Liquid Waste Treatment Facility (RLWTF) have resulted in above background residual radionuclide (americium, plutonium, strontium-90, and cesium-137) concentrations in alluvial groundwater and sediments.
- Plutonium deposits have been detected along the Rio Grande between Otowi and Cochiti Lake.
- The principal contributors to radioactive air emissions have been and continue to be the Los Alamos Neutron Science Center (LANSCE) and high explosives testing activities.

In addition, trace amounts of tritium have been detected in some samples from the main aquifer. (Isolated results have indicated the presence of other radionuclides. However, results have not been duplicated in previous or subsequent samples, making these results suspect.)

The analysis in the SWEIS indicates that there are very few differences in the site-wide environmental impacts among the alternatives analyzed. The major discriminators among alternatives are: collective worker risk due to radiation exposure, socioeconomic effects due to LANL employment changes, and electrical power demand. A summary of impacts is provided in section 3.6 in chapter 3. Tables 3.6.2–1 and 3.6.2–2 provide a direct comparison of expected consequences for each environmental factor across alternatives.

5.1 IMPACT ANALYSIS METHODOLOGIES

5.1.1 Land Resources Methodology

5.1.1.1 *Land Use*

The methodology used for assessing land use impacts is comparative in nature. The operations, facility construction and modification activities, and their predicted effects are compared against existing land use categories for the areas that could be influenced by such actions. In addition, the amounts of land disturbed or taken for construction are also identified. (This information is then used in the analysis of ecological and cultural resource impacts.)

5.1.1.2 *Visual Resources*

Visual impacts to the LANL viewshed depend on physical changes through development at the site, the ability for LANL structures to be seen by viewers because of changes in land cover, and the visibility of the area related to air or light pollution. Thus, this qualitative analysis addresses construction that may change the visibility of LANL structures or obscure views of the landscape, changes in land cover that may make LANL structures more or less visible, and changes in air or light pollution that could change visibility in the area.

5.1.1.3 *Noise*

Noise (unpleasant sounds), air blasts, and ground vibrations may be perceived both within and outside the LANL site boundaries due to the combined effect of the existing traffic, LANL high explosives research, and construction activities. The noise heard by people located outside the site boundaries may be very episodic (such as explosives testing) or may be long term in duration (such as traffic noise). This analysis examines projected activities with a focus on changes from existing noise conditions in the area, as well as the potential for noise impacts to workers and the public. Because noise and vibration impacts to cultural resources are addressed in the cultural resources impact analyses, such impacts are not discussed under land resources impacts.

5.1.2 Geology and Soils Methodology

The methodology used to assess potential impacts to geology and soils across the four alternatives was a two-step process. First, past LANL activities were evaluated to see how they had impacted the geology and soils in the Los Alamos area. The information from this study on the existing environment is presented in chapter 4 (section 4.2). Information from section 4.2 was then used as a basis for assessment of potential impacts that may result from implementing the four alternatives. The impact analysis focuses on any changes that have the potential for causing seismic events, slope instability, soils erosion, and changes to mineral resources. For example, observation and studies of the LANL site in the past have shown where slope stability problems are most likely to occur and under what circumstances. This type of information was then used to evaluate proposed activities to see if those same indicators leading to soil erosion were present in a new action or in a potential change to an existing activity. This manner of analysis is commensurate with the significance of the potential impact in this resource area.

Impacts to geology and soils are primarily associated with effects generated by proposed construction activities. However, for this SWEIS the majority of construction activities are within existing facilities. Where construction activities would occur outside of existing facilities (as in the expansion of Area G), they are explicitly addressed.

The effects on soil contamination from contaminants released to the atmosphere, either directly in gaseous effluents (e.g., air stack emissions) or indirectly from resuspension of on-site contamination (e.g., fugitive dust) were evaluated. As discussed in section 5.2.2, the information provided from the geology and soils sections directly relates to the analysis of several other sections within the SWEIS (such as cultural resources, human health, accidents, and ecological resources). For example, geologic hazards that are important components of accident scenarios are discussed in the accident sections, and the potential for human health and environmental impacts associated with soil contamination are discussed in the ecological and human health sections.

5.1.3 Water Resources Methodology

The primary differences in terms of water resources across the four alternatives are: (1) the change in flow from the permitted National Pollutant Discharge Elimination System (NPDES) outfalls and (2) the influences of water use to main aquifer.

The methodology used for assessing surface and groundwater impacts for the four alternatives was to first obtain index data on the NPDES outfalls (flow rates and analyte concentrations) and compare this information with projected NPDES flow rates and analyte concentrations for each of the alternatives. The majority of the changes, especially increases to NPDES flows for the alternatives, are contributed by the key facilities. Therefore, although index NPDES flows are discussed for the non-key facilities, flow projections for non-key facilities are assumed to be constant across the alternatives. If projections of NPDES outfall flows within each watershed vary within 5 percent of the index and historical NPDES outfall concentrations do not often exceed regulatory limits, effects are considered negligible. If projected NPDES outfall flow variations are greater than 5 percent of the index or historical NPDES outfall concentrations often exceed regulatory limits, consequences are evaluated qualitatively. This qualitative analysis includes evaluating the types of contamination that could originate from these outfalls and the potential for contamination in surface water, groundwater, and sediments to be transported off site. A qualitative analysis was done instead of a quantitative analysis because: (1) detailed information (i.e., distribution coefficient of radionuclides for soil, sediment, and alluvium; remaining sorption capacity of soil, sediment, and alluvium below outfall; vadose zone transport characteristics; moisture content; alluvial groundwater body lateral and vertical extent; alluvial groundwater flow rates alluvial recharge and discharge areas; recharge and discharge rates; stormwater and snowmelt runoff flow rates diluting the effluent; schedule of discharges relative to runoff event; and many others) is not available and (2) a reasonable qualitative assessment can be made. For stormwater runoff, the impact analysis focuses on changes across the alternatives that may have the potential for causing off-site migration of contaminants, such as new construction activities.

The water resources analysis was used as source information in several other sections within the SWEIS, such as ecological resources (i.e., potential effects of reduced flows to wetlands) and the human health and human and ecological risk (i.e., consumption of contaminated water and sediments).

The U.S. Geological Survey (USGS) MODFLOW model for north-central New Mexico (Frenzel 1995) was used to predict water level changes at the top of the main aquifer for the four alternatives. The model includes DOE supply wells, wells for the City of Santa Fe public water supply system, discharges from the Santa Fe sewage treatment plant, and 200 private and industrial wells in Santa Fe County. Water use projections for the purposes of modeling drawdown of the main aquifer and

annual variations in LANL use were projected based on the alternative descriptions (particularly, the timing of construction projects and changes in operations). Projections for Los Alamos County and the National Park Service (NPS) were made also.

The Fenton Hill site (Technical Area [TA]–57), which was the location of LANL's Hot Dry Rock Geothermal Project and is still used for astrophysics research and experiments, is about 20 miles (32 kilometers) west of Los Alamos. The Hot Dry Rock Geothermal Project has been decommissioned and no further clean-up actions are anticipated. The NPDES permit was discontinued as of December 29, 1997, and during the time of operation there were no NPDES permit violations at the Fenton Hill site. For these reasons, there should be no impact to water resources from this facility, and this site is not discussed further in the SWEIS water resources impact analyses.

5.1.4 Air Quality Methodology

Radiological and nonradiological air pollutants are modeled differently, each with models most suitable for the purpose. Meteorological data sets also varied as was judged most appropriate given limitations on data, comparability of measurement points, and conventions typical for regulatory analyses. Details on these points are described below and in appendix B.

5.1.4.1 *Nonradiological Air Quality*

LANL has the potential to emit hundreds of air pollutants into the atmosphere from its laboratory operations (air toxic emissions) and fossil fuel-burning units (criteria pollutant emissions). An air quality assessment was conducted to estimate the potential impacts of the releases of these pollutants under each of the four alternatives identified for the SWEIS. Background information, including the methodology used for these analyses, is provided in this section.

In accordance with Title V of the *Clean Air Act*, as amended (42 U.S.C. §7401) and New Mexico Administrative Code (NMAC) 20 NMAC 2.70, the University of California (UC) submitted a *Clean Air Act* Operating Permit application to the New Mexico Environment Department (NMED) in December 1995 (20 NMAC 2.70, Operating Permit Application for LANL, LA-UR 95-4192).

In the operating permit application, LANL has voluntarily applied for plant-wide applicability limits (PALs) for nitrogen oxides (NOx), carbon monoxide, particulate matter (PM), sulfur dioxide, volatile organic compounds (VOCs), and hazardous air pollutants (HAPs) (as defined in *Clean Air Act Amendments of 1990* at Section 112[b]), while demonstrating compliance with the applicable standards. LANL has voluntarily proposed permit terms for relevant emission units in order to demonstrate the enforceability of the PALs. The purpose of setting a PAL is to keep emissions below levels that trigger more stringent regulatory requirements and to define LANL's potential to emit. These PALs are intended to demonstrate "minor" source status with respect to HAPs and the Prevention of Significant Deterioration (PSD) Program. The amount of HAPs modeled in the screening process for the impact analysis occurs at a level below the proposed voluntary permit limits.

Criteria Pollutants

Criteria pollutants released into the atmosphere from LANL operations are emitted primarily from combustion facilities such as boilers, emergency generators, and motor vehicles. The analysis of these pollutants was conducted for emissions estimated under actual peak and annual average operating conditions of each major combustion unit. With the existing emission data and stack parameter information (i.e., heights, diameters, flow rates) for the criteria pollutants known, these emissions were modeled using the EPA Industrial Source Complex Short Term (ISCST3) model and meteorological data collected at TA–6.

Short-term and long-term concentrations of these pollutants were estimated at the sensitive receptors and the results were compared with applicable air quality standards. Both time frames were analyzed to address the potential short-term (acute) and long-term (chronic) impacts of these pollutants at locations where the public could have both short-term and long-term exposure to emissions from LANL facilities.

Because the emissions rates for the Expanded Operations Alternative are the greatest of the emission rates across the alternatives, the initial analysis of potential impacts due to criteria pollutants was based on these "bounding" emissions. Ambient air quality standards are established at levels that ensure an ample margin of safety, based on health risk assessments. Therefore, in cases where results of the Expanded Operations Alternative analysis of criteria pollutants demonstrate that the highest estimated concentration of a pollutant are well below the appropriate ambient air quality standards, no further analysis was performed. In cases where this alternative threatens such exceedances, more detailed analysis for each alternative was performed.

No quantitative analysis of vehicle emissions was performed as part of this analysis. Although the operational alternatives may have different effects on the travel patterns in the study area as a result of changes in the number of LANL employees who would commute to Los Alamos, the future population of Los Alamos County is not expected to change substantially under any of the alternatives. Therefore, changes in regional emissions under any of the future alternatives are not expected to be more than a few (less than 5) percent. Vehicle emissions were included in the assumed background concentrations for each of the criteria pollutants in the analysis. Background concentrations were assumed to be 20 percent of the relevant standard, a conservative assumption. Because the study area is in attainment for the pollutants that are released primarily from motor vehicles (carbon monoxide and ozone) and because there are no nearby heavily congested traffic areas or major sources or ozone precursors (i.e., hydrocarbons and nitrogen oxides), no potentially significant air quality impacts are expected from the commuter traffic emissions. The transportation analyses for each alternative include emissions impact estimates from trucks (e.g., commercial transport) associated with LANL's operations across the U.S.

Toxic Air Pollutants

The pollutants and laboratory operations that may cause significant air quality impacts at LANL were identified through a progressive series of screening steps, each step involving fewer pollutants that were then screened by methods that involved more rigorous and realistic emission rates and modeling parameters than the step before. This approach, consistent with EPA guidance, focuses detailed analyses only on those chemicals that have a reasonable chance of being of concern. This approach is particularly useful for an installation such as LANL, where the research and development nature of the facility results in usage of a large number of chemicals, potentially released from hundreds of sources spread throughout a large geographic area, and at highly variable but relatively low usage rates.

The first screening step reduced a list of more than 2,000 chemicals purchased by LANL to a set of 382 on the basis of physical and chemical characteristics such as low vapor pressure or low toxicity, and small quantity. The second screening step involved a comparison of a calculated maximum rate derived from health-based standards to the potential emission rate from a TA. In this step, a screening level emission value (SLEV) was developed for each chemical and for each TA where that chemical was used. A SLEV is a theoretical maximum emission rate that, if emitted at that TA over a short-term (8-hour) or long-term (1-year)

period, would not exceed a health-based guideline value (GV) (Table 5.1.4.1–1). This SLEV was compared to the emission rate that would result if all the chemicals purchased for use in the facilities at that TA over the course of 1 year were available to become airborne. Personnel knowledgeable of chemical usage and current and future operations reviewed these comparisons (put in the form of a ratio of SLEV to potential emission rate from the TA) and indicated whether or not it was possible that future chemical usage rates under any alternative could be increased by a factor indicated in these ratios. If there was an indication that usage could potentially be increased by that factor (a qualitative evaluation of whether chemical purchases could be increased by perhaps 10 times or 100 times over current rates), that chemical was referred to the next screening step.

The third step, performed for a set of 13 sources, some of which had multiple chemicals, involved a determination of more realistic emission rates based on actual knowledge of the process where the chemical was used and the modeling was conducted using actual stack parameters. If any chemical failed the screen at this point (a short- or long-term GV was exceeded), it was referred to the health and ecological risk assessment process of the SWEIS.

Additive effects of carcinogenic chemical emissions were also considered by calculating whether a GV could be exceeded in the case of emissions of the same chemical from multiple TAs, and whether a GV could be exceeded by adding the cancer risk from emissions of all carcinogenic chemicals from all TAs.

The EPA ISCST3 model was consistently used in this analysis, except for the third screening step in the case of modeling emissions from high explosives testing operations. In that case, a combination of the Hot Spot and the EPA ISCST3 models was more appropriate for modeling the emissions and conditions created by the detonation of explosives.

TABLE 5.1.4.1–1.—*Guideline Values Applied in the Nonradiological Air Quality Analysis*

Noncarcinogens Short-Term Guideline Values	While no national or State of New Mexico standards have been established for these pollutants, the NMED has developed GVs for determining whether a new or modified source emitting a toxic air pollutant would require a construction permit (20 NMAC 2.72, Subpart IV). These GVs are 8-hour concentrations that are 1/100 of the occupational exposure limits (OELs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or the National Institute of Occupational Safety and Health (NIOSH).
Annual Average Guideline Values	The GVs used in this analysis are the inhalation reference concentrations (RfCs) from EPA's Integrated Risk Information System (IRIS). RfCs are daily exposure levels to the human population (including sensitive subgroups) during a lifetime (70 years) that could occur without appreciable risk of deleterious effects.
Carcinogens	The GVs used in this analysis to estimate potential impacts of carcinogenic toxic air pollutants from LANL operations are based on an incremental cancer risk of one in a million (1.0×10^{-6}) (i.e., one person in a million would develop cancer if exposed to this concentration over a lifetime)—a level of concern established in the *Clean Air Act*. The development of EPA risk estimates for exposure to carcinogens led to the concept of unit risk factors that are associated with exposure over a lifetime to annual average concentrations of chemicals. Therefore, only annual impact analyses of carcinogenic emissions were conducted. The impacts of the releases of carcinogenic toxic air pollutants were considered for more detailed analysis if the estimated combined incremental cancer risk associated with all of the carcinogenic pollutants emitted from LANL facilities at any location is greater than 1.0×10^{-6}. For the purpose of screening individual carcinogens, a cancer risk of 1.0×10^{-8} was established as the GV.

Two sets of receptors (i.e., locations where air quality levels were estimated) were considered for the methodology described above. The first set of receptors includes nearby identified actual locations of concentrated human activity that might be affected from the emissions from LANL facilities. These include: (1) schools, hospitals, parks, and playgrounds within Los Alamos; (2) residences (including those in trailer parks) in all directions surrounding all of LANL facilities in Los Alamos County; and (3) towns, cities, and sensitive national and cultural areas within approximately 50 miles (80 kilometers) of Los Alamos. These receptors are referred to as "sensitive receptors." The second set of receptors includes all of the fence line locations (in 10-degree increments) around each TA to which the public has access. These receptors are referred to as fence line receptors. Theoretical fence line receptors were considered in the comparison to short-term GVs; actual locations of receptors were considered in the comparison to long-term GVs (notably, carcinogens). Details on all aspects of this analysis may be found in appendix B (in volume III).

Of the 382 total pollutants, 35 carcinogenic pollutants were evaluated individually and were also considered in the additive impacts analysis of emissions from all of the TAs. A list of the toxic air pollutants evaluated is in attachment 2 to appendix B.

5.1.4.2 *Radiological Air Quality*

This section presents a discussion of the methods used to estimate the dose from radionuclide air emissions from LANL operations of selected modeled facilities. These methods were used for analysis of all alternatives; however, this information is not repeated in sections 5.2.4, 5.3.4, and 5.4.4. Prior to beginning the modeling of radionuclide air emissions under the SWEIS alternatives, historical data were reviewed for the index years 1990 through 1994. These data were used to verify that the modeled facilities under the SWEIS alternatives captured the majority of the emissions. The facilities listed in Table 5.1.4.2–1 were shown to represent over 99.7 percent of the dose to the LANL hypothetical maximally exposed individual (MEI) during the baseline years. Other facility emissions were not modeled due to their small contributions to the total. Additional information is presented in appendix B.

Air emission modeling and dose calculations were then performed for each facility listed in Table 5.1.4.2–1. The results of this modeling are presented for each of the four SWEIS

TABLE 5.1.4.2–1.—*Facilities Modeled for Radionuclide Air Emissions*

FACILITY	TYPE OF EMISSIONS
TA–3–29 (Chemistry and Metallurgy Research)	Point Emissions
TA–3–66 (Sigma Building)	Point Emissions
TA–3–102 (Machine Shops)	Point Emissions
TA–11 (High Explosives Testing)	Diffuse Emissions
TA–15/36 (Firing Sites)	Diffuse Emissions
TA–16 (Weapons Engineering Tritium Facility)	Point Emissions
TA–18 (Pajarito Site: Los Alamos Critical Experiments Facility)	Diffuse Emissions
TA–21 (TSTA and TSFF)[a]	Point Emissions
TA–48 (Radiochemistry Laboratory)	Point Emissions
TA–53 (LANSCE)[b]	Point and Diffuse Emissions
TA–54 (Area G)	Diffuse Emissions
TA–55 (Plutonium Facility)	Point Emissions

[a] Tritium System Test Assembly and Tritium Science and Fabrication Facility

[b] Five specific sources were modeled from TA–53 (Los Alamos Neutron Science Center). These include the TA–53 Exhaust Stack-2 (ES–2), Exhaust Stack-3 (ES–3), Isotope Production Facility, Low-Energy Demonstration Accelerator, and combined diffuse emissions.

alternatives. For each alternative analyzed, dose estimates were made to three specific receptors. These three receptors include the:

- *Facility-Specific Maximally Exposed Individual (FS MEI)*—Due to the distance between facilities across the LANL, each modeled facility was modeled independently. The FS MEI represents the location corresponding to a specific facility where the modeled dose was greatest. The location of the FS MEI was determined based on distance, direction, and meteorological data for each site. The dose commitments were then calculated at this location from all other modeled facilities; thus, the FS MEI represents the estimated dose to an individual from the specific facility and all other modeled facilities.
- *Site-Wide Maximally Exposed Individual (LANL MEI)*—The LANL MEI is the single highest FS MEI derived as described above. The LANL MEI was shown to be the same as the LANSCE FS MEI under all alternatives. The LANL MEI dose by alternative is presented in the air quality analyses, and the resultant human health risk effects due to these doses are presented in the human health analyses for each alternative.
- *Population Dose Within 50 miles (80 kilometers)*—Population dose estimates were made for the entire population within a 50-mile (80-kilometer) radius of LANL (i.e., the summation of all doses to all people within that radius). The population dose from each facility was modeled independently for each alternative. The total from all facilities for one alternative represents the population dose from that alternative. Dose estimates to the population were derived from both point source and diffuse emissions. The expected excess latent cancer fatalities (LCFs) for the exposed populations are presented in the human health analyses for each alternative. Using a composite of all modeled data, maps were developed showing estimated isodose lines (lines of equal dose) for each alternative. Estimates of dose at particular locations can be identified from these maps.

The results of this modeling were used to support human health impact analyses.

There are two general mechanisms in which radionuclides are dispersed into the ambient air from LANL operations. The first is through forced ventilation systems with pollution control devices through a stack or vent. The second is from diffuse or nonpoint source emissions. Diffuse emissions occur in areas such as firing sites, landfills, unvented buildings, and solid waste management units.

To estimate the dose impact from LANL operations, the facilities that emit the majority of radioactive materials to the air were identified. Twelve facilities were modeled within ten TAs. These facilities and types of radionuclide air emissions are listed in Table 5.1.4.2–1.

Radionuclide emission projections were made by LANL staff based on historical activity levels and corresponding emissions for each of the four alternatives. These emissions were used to model the doses and develop the isodose maps.

Individual and population dose estimates were calculated through the use of air dispersion modeling, which predicts the dispersion and dilution of radionuclide emissions at various locations. Following the release to the atmosphere, a radionuclide concentration at a given location is influenced by many variables including distance, direction, wind speed, wind direction, and others. Once the quantity of a radionuclide a person either ingests, inhales, or is otherwise exposed to is determined, the effective dose equivalent (EDE) is estimated by

applying appropriate dose conversion factors for each radionuclide.

The air dispersion model used for these calculations was the *Clean Air Act* Assessment Package for 1988 (CAP–88). CAP–88 contains a modified Gaussian plume model that estimates the average dispersion of radionuclides released from up to six sources simultaneously. The model may be run on individual sources as well. The sources may be elevated stacks or uniform area (diffuse) sources. The program computes radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food, and intake rates to people from ingestion of food produced in the assessment area. The model calculates the committed effective dose equivalent (CEDE).

This model is approved by the EPA for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61, Subpart H). This standard states: "Emissions of radionuclides to the ambient air from any DOE contiguous site shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 millirem" (40 Code of Federal Regulations [CFR] 61.92). Modeling of the dose to a hypothetical MEI was used to show that facility emissions would not exceed this standard under any of the alternatives.

The locations of the maximum dose estimates from each of the individual facilities emitting radionuclides were identified using estimated emissions and local meteorological conditions. This location is used as the FS MEI, and the dose is calculated from all air exposure pathways. The distance and direction to this location from all emissions points can then be calculated.

Each facility's emissions impacts on other facilities' MEIs were determined. The location of the maximum dose considering all emissions from all facilities, is designated as the LANL MEI.

Population dose estimates to a 50-mile (80-kilometer) radius were generated by CAP–88 using current population data. Composite maps of these calculations were also developed as mentioned. The health effects, predicted as a consequence of the radiological doses to off-site residents and recreational users, as well as those predicted from the population doses, are evaluated in the human health analyses in this chapter.

5.1.5 Ecological Resources, Biodiversity, and Ecological Risk Methodology

The conceptual scope of this impact analysis is the larger regional ecosystem in which the approximately 43-square-mile (111-square-kilometer) LANL site is immersed. LANL facilities, infrastructure, operations, and impacts—positive, negative, and undetermined—are an integral part of the patterns and processes of a complex regional landscape. Weather, topography, soils, plant and animal communities, and canyon systems carrying water from the Jemez Mountains east to the Rio Grande are continuous across the administrative boundaries of LANL, the NPS, U.S. Forest Service (USFS), regional Pueblos, and other regional land stewards. This ecological context has both spatial and temporal dimensions.

The spatial scope of effects analysis is defined by prominent landscape features in the larger region surrounding LANL that approximate ecological boundaries in terms of many processes important to ecosystem function. These geographical boundaries were determined from input from regional land and resource managers and consultants, review of the technical literature, and knowledge and experience of LANL biological science experts. This information was combined with

environmental data from LANL, the State of New Mexico, and federal and private research to define an area that simultaneously includes a reasonably complete suite of representative ecological components as well as conditions that would bound impacts resulting from ongoing LANL operations and evaluated alternatives.

The temporal basis for this analysis extends from about the year 1850 to the present (as described in section 4.5), which captures the genesis and development of current dynamic processes operating in the regional ecosystem. This dimension provides the context necessary for identifying and analyzing impacts in the future.

Effects analysis is based primarily on two measurements of ecological organization: watershed units and major vegetation zones. The identified 14 regional watersheds plus the White Rock Canyon section of the Rio Grande and Cochiti Lake were delineated for effects assessment. Six major plant communities within five elevation-defined vegetation bands across the Pajarito Plateau were defined. Watersheds were overlain with community types to form a landscape grid that facilitated the description and analysis of vegetation and wildlife distributions. This analysis encompasses specific elements of ecosystem composition, structure, and function at the species, local, and regional ecosystem levels.

Biodiversity considerations form an important part of ecological impact assessment. Simply defined as "the variety of life and its processes," components of biodiversity analyzed consist of regional ecosystem diversity, local ecosystem or community diversity, and species diversity. These components are analyzed as part of the analysis of the following major factors contributing to the decline or loss of biodiversity as identified by the Council on Environmental Quality (CEQ 1993):

- Physical alteration of the landscape
- Over harvesting
- Disruption of natural processes
- Introduction of exotic species
- Pollution

Ecological risk is the likelihood that adverse effects may occur or are occurring as a result of exposure to one or more physical, chemical, or biological stressors (EPA 1992). Environmental pollution generated from past and present LANL operations and projected discharges from the four alternatives identified for continued operation of LANL could potentially pose a risk to biotic communities and ecological processes. Qualitative assessments of ecological risk from the four alternatives were based on findings of the Environmental Surveillance Monitoring Program, quantitative risk assessments of three threatened and two endangered species at LANL, and ongoing programs and plans that address mitigation of legacy and operational contaminants.

The impact analysis considered the potential for each alternative to affect habitats, ecological processes, biodiversity, and exposures to toxic chemicals and radionuclides.

5.1.6 Human Health Methodology

The detailed methodology used in evaluating potential consequences of continued operations of LANL on human health (the public and LANL workers) is described in volume III, appendixes B and D, sections B.1.1, B.2.1, and D.2. Estimates were made of the amount of radioactive or hazardous materials to which workers or the public could be exposed based on both site-wide and facility-specific estimates of emissions and effluents. Additionally, information from other resource area analyses (water resources, air quality, geology and soils, and ecological resources) are inputs for the human health analyses. Finally, recent information regarding LANL worker health incidents was used in predicting similar events over the next 10 years.

The radiation dose (for radioactive emissions) to the public and concentrations at receptor locations (for hazardous chemical emissions) from atmospheric emissions are calculated in appendix B, Air Quality (in volume III). The human health analysis translates these doses to their effects on human health. There are other potential exposures from liquid releases through the soil and aquatic pathways. However, the lesser contributions of current and projected LANL operations through environmental contamination in soil, sediment, surface water, and groundwater are so low that they cannot be partitioned from the existing contamination. The existing contamination is highly variable and much larger than annual incremental LANL contributions. This existing contamination consists of naturally occurring radionuclides and metals, weapons testing fallout, and contamination remaining from past operations. The decision was made to calculate the combined risk from the continued operation, plus the existing contamination. This exposure is almost entirely through ingestion of water, soil and sediment, and food. Estimates also were made of the inhalation and direct radiation exposure that can occur from being in the vicinity of radioactively contaminated soil.

Exposures for members of the public and for LANL workers were estimated for all alternatives. Estimates of risk were based on inhalation, ingestion, and dermal absorption pathways. For an individual, the risk value (in terms of excess LCFs) is the increased probability for that individual. Exposure and risk evaluations include individuals who are:

- Workers, site-wide or in a specific facility or specific job classification
- The LANL MEI located north-northeast of the LANSCE facility (TA–53); FS MEIs were also analyzed for the key facilities (appendix B, section B.1.1)
- Off-site residents near LANL (Los Alamos County and non-Los Alamos County residents)
- Resident and nonresident recreational users of the lands within LANL
- Individuals who may receive exposures via special pathways (e.g., smoking locally grown herbs or drinking these in teas, or increased intake of local fishes, or use of contaminated soil/clays in arts and crafts)

The last three of these were evaluated based on exposure scenarios for each of five receptors (Los Alamos County and non-Los Alamos County off-site residents, resident and nonresident recreational users, and individuals exposed through special pathways). In addition, the total inhalation dose and risk to the population within 50 miles (80 kilometers) of LANL were estimated. This risk is presented as the added number of cancer deaths (excess LCFs due to the dose estimated) from LANL operations.

Consequences were estimated by calculating the changes in risk to members of the public or to workers based on risk factors and reference values developed by the International Commission on Radiological Protection (ICRP), EPA, or other authoritative organizations. An estimate of the lifetime risk of dying from cancer due to chronic exposure to radionuclides or chemicals was made to determine human health consequence—that is, it was assumed that an individual received this dose every year for a 72-year lifetime.

An example of how consequence is estimated for radiation exposure would be estimating the excess LCFs over their lifetimes in a worker population as a function of the radiation dose estimated to be received by that population. The LCF is the product of the dose and the risk factor (0.0005 LCF per person-rem for the public and 0.0004 LCF per person-rem for workers) (discussed in appendix D, section D.1, Table D.1.1.2–1). The reader should recognize that these estimates are intended to provide a conservative measure of the potential impacts to be used in the decision-making process, and do not necessarily portray an accurate

representation of actual anticipated fatalities. In other words, one could expect that the stated impacts form an upper bound, and that actual consequences could be less, but probably would not be worse. This is discussed in the primer on the effects of radiation in appendix D, section D.1.1.

For consequence to the public, conservative estimates of potential exposures were made using environmental surveillance data (typically from 1991 to 1996), data from specific contaminated sites, and estimates of operations releases (effluents and emissions) associated with each alternative. The total risk to the public from LANL operations is proportional to the collective dose within the 50-mile (80-kilometer) radius from LANL (that is, to the sum of all the doses to individuals in that population). However, questions may arise about the range of exposures within that population. The most likely exposure to individual members of the public is typically near zero. The upper bound for individual exposure is expressed as the potential dose to the hypothetical MEI. The MEI is assumed to remain in place outdoors without shelter and without taking any protective action for the entire period of exposure. This may be for days during accidents and as long as an entire year for routine operations. In reality, no one would receive a dose approaching that of an MEI, but the concept is useful as an expression of the upper bound of any possible dose to an individual. The ICRP and federal guidance recognize that through limiting the dose to all individual members of the population, the entire population is protected (because the average dose is much less than the maximum dose) (ICRP 1977 and EPA 1987). The EPA uses the concept of MEI to ensure that no member of the public has exceeded specified dose limits. The methodology used to evaluate radiological air doses and chemical exposures from airborne emissions to the public is detailed in chapter 5, section 5.1.4. Also, appendix D (section D.2.) presents a more detailed discussion of methodologies used for estimating human health consequences.

The ingestion of radionuclides, chemicals, and metals was calculated for the total concentrations that exist in the environment, regardless of origin. The concentrations in the environment include naturally occurring radionuclides and chemicals, residual contamination from worldwide fallout and earlier LANL operations, and small quantities of contamination from more recent and ongoing operations. Because it is impractical to impossible to differentiate among these sources for most materials, this SWEIS analysis calculates the total risk from all these sources. This total risk would be affected by the alternatives only to the extent that additional operational and accidental emissions may occur.

The exposures through ingestion were calculated using the 95 percentile upper confidence limit (UCL) concentrations. In calculating the UCL, all samples of zero, negative value, or less than the detection limit were rejected. This significantly increases the average value and the UCL, and especially so when a large fraction of the samples show no detectable contamination.

Estimates of ingestion risk were based on standard assumptions from ICRP and/or EPA. Estimates were made of annual exposures (cancer rates are presumed to depend upon integrated exposure and to be independent of exposure rate). Concentrations of radionuclides and chemicals in environmental media were from the LANL environmental surveillance monitoring data collected from 1991 to 1996 (e.g., LANL 1997d). Background concentrations of radionuclides and chemicals in the soils and sediments and waters in the region around LANL were used to compare to LANL emissions/effluents and contaminated media on site.

Worker consequences were evaluated by estimating the changes that would occur in a specific alternative and determining the increment from actual exposure records at LANL for the base period (1991 through 1995). For example, for worker exposures to chemicals and to nonionizing radiation, and for the consequences of physical hazards (such as electrical hazards), the historical occupational record at LANL was examined and consequences were estimated by alternative, based on changes in the workforce associated with the alternative. No credit was taken for increased safety performance by LANL over that experienced during the base period.

Many of the estimates of consequence (such as risk of excess LCFs) were calculated using mathematical modeling. These results are estimates based on multiple assumptions about toxicity, exposure route, human behavior, and the movement of materials through the environment. Therefore, there are substantial uncertainties inherent in the human health evaluations presented in this chapter. These uncertainties include: model simplification of the actual process by which exposure occurs; the variance associated with sampling and measurements of concentration of chemicals and radionuclides in the environment; the simplifying and conservative assumptions made regarding the receptor location, age, and length of time in the area; and behavioral risk factors. Uncertainty also increases in areas having higher naturally occurring concentrations of some radionuclides and soil metals; the area around LANL has relatively high and extremely variable concentrations of natural uranium and many metal ores. A discussion of uncertainties and their impacts on the use of model results to evaluate consequences is given in appendix D, section D.2.

5.1.7 Environmental Justice Methodology

Because most of the topical analyses in the SWEIS considered potential impacts within a 50-mile (80-kilometer) radius of LANL, that distance was also considered for the environmental justice analysis. The presence of minority and low-income communities within that radius is described in chapter 4 (section 4.7), as is the methodology used to identify these communities. Figures 4.7.1–1 and 4.7.1–2 in chapter 4 illustrate how the area within a 50-mile (80-kilometer) radius was divided into sectors for the environmental justice analysis. It is noteworthy that the majority of the sectors reflect a substantial presence of minority and/or low-income populations. (For the purposes of the SWEIS, a substantial presence means greater than 25 percent of the population is considered to be minority or below the poverty level.) The impacts for each of the individual topical areas are, in essence, overlaid onto this figure to assess the impacts.

The environmental justice analysis is a comparative analysis. In order to determine whether impacts are disproportionate, the impacts in sectors with a substantial presence of minority or low-income populations are compared to the sectors that do not have a substantial presence of these populations. In this case, sectors 1–3 and 6–16, all within a 10-mile (16-kilometer) radius of LANL, do not have a substantial presence of minority or low-income populations and are used for this comparison.

It is presumed that the minority populations have traditional or cultural practices that include subsistence materials different than those of other populations in the area. There is little information regarding such materials and

quantities used, but assumptions are made for the purposes of the human health analyses. These analyses are referred to as special pathways analyses. Because the special pathways may be more viable or important to minority populations, they are of interest in the analyses under Environmental Justice. Thus, this impact area analysis explicitly addresses the potential human health risks due to these special pathways.

5.1.8 Cultural Resources Methodology

For the purposes of impact assessment, cultural resources were grouped into three broad categories: prehistoric archaeological sites, historic resources, and traditional cultural properties (TCPs). Within these three categories, cultural resources were grouped into general types or classes for impact analysis as opposed to analyzing individual resources (e.g., simple and complex Pueblos, scientific laboratories, and ceremonial sites). More detailed information on these resources is included in volume III, appendix E. Data and impact levels occurring from LANL operations during the period of 1991 through 1995 were used as the background or baseline standard to compare any changes resulting from implementation of the four alternatives.

Sources of information used for impacts assessment included systematic archeological surveys of cultural resources present on LANL and recorded in the LANL cultural resource database; consultations with the LANL Cultural Resources Management Team, 23 Native American tribal governments, Hispanic communities, and the State Historic Preservation Office(r) (SHPO); and literature reviews of Native American and Hispanic TCPs. Also, results of the consequence analysis for air quality, surface and groundwater, human health risk, and noise and vibration were used to evaluate impacts to human users of TCPs and other potential impacts to cultural resources.

Impact assessment is based on general sources of effects or types of actions. These consist of the following:

- New construction
- Increased vibrations (from traffic, explosives testing, etc.)
- Increased erosion or siltation
- Shrapnel scatter from firing points
- Explosives (direct hits)
- Radiation hazards (from airborne or waterborne contamination)
- Hazardous material (nonradiological from airborne or waterborne contamination)
- Noise
- Security changes
- Hydrogeologic changes
- Maintenance changes

Impacts were evaluated according to four broad categories that reflect the criteria of effect (36 CFR 800.9) under the *National Historic Preservation Act* (16 U.S.C. §470). These categories consist of destruction/alteration; isolation and restriction of access; introduction of visual, audible, or atmospheric elements out of character with the resource; and neglect leading to deterioration and vandalism. Not all classes of cultural resources would be affected by every category of effect.

Effects to resource categories were evaluated for each of the four alternatives by means of a data matrix. Geographic overlay analysis and detailed project descriptions were used to assist in identifying the numbers and types of cultural resources that might be affected by the alternatives.

5.1.9 SOCIOECONOMICS, INFRASTRUCTURE, AND WASTE MANAGEMENT METHODOLOGY

5.1.9.1 *Socioeconomics*

Employment, Salaries, and Procurement

The primary (direct) and the secondary (indirect) impacts of LANL activities on employment, salaries, and procurement are analyzed in the SWEIS. The primary impacts are projected based on the changes in employment (in terms of full-time equivalents and procurement at LANL, including the full-time, part-time, and temporary employees of UC, Johnson Controls, Inc., Protection Technology of Los Alamos, and technical subcontractors. Changes in employment were projected by subject matter experts for each of the key facilities, and employment for the rest of LANL was assumed to remain the same. The changes in employment are associated with full implementation of each alternative. Although these changes are likely to happen over a few years, the analysis assumes that they occur within a year of the ROD for the SWEIS. The employment projections were made by job category, and the 1996 average annual salary for each job category was used to project annual salaries (LANL 1996a). The LANL annual procurement projections were made based upon historical procurement and the changes in activity levels and employment across alternatives (LANL 1995b, LANL 1996a, and LANL 1997a). Future procurement was distributed among the Tri-County Area (the three counties closest to LANL: Los Alamos County, Rio Arriba County, and Santa Fe County), the remaining New Mexico counties, and areas outside of New Mexico based on the historical distribution of procurement.

Changes in employment and procurement at LANL are expected to result in additional, secondary, changes in employment, salaries, and expenditures in the area, as well as changes in the demands on social services. These secondary impacts occur within a regional economy because jobs added in a primary industry such as LANL create local opportunities for new employment in supporting industries. Analysis of these secondary economic and social impacts of LANL activities across the alternatives utilizes multipliers derived from a 1996 DOE/New Mexico State University study (Lansford et al. 1996). These multipliers are:

- Employment: 2.71
- Salaries: 1.95
- Expenditures/Business Activity: 2.89

These multipliers are used to predict the total LANL socioeconomic impacts in the area. For example, if LANL were to expand employment by 100 full-time workers who would reside in the Tri-County area, the secondary effect of that action would be the addition of 171 new secondary jobs in the Tri-County labor market. On the other hand, if LANL were to reduce employment by 100 full-time workers, the reverberating effect across the Tri-County economy would be the loss of 171 other jobs.

The employment changes result in population changes in the Tri-County region. It should be noted that the 1996 report (reflecting 1995 data) has been updated since this SWEIS analysis was performed. The latest of this series of DOE/ New Mexico State University reports was issued in May 1998 (reflecting 1997 data). The regional multipliers reflected in that recent report are about 5 percent greater than those reflected above. Because these multipliers are used only to determine the secondary socioeconomic impacts and because these changes are relatively small, the impact analyses influenced by these changes were not updated for the issuance of the final SWEIS. If these updated numbers were applied, population increases, housing demand, regional

employment, local government finance, and services values would be slightly higher than presented in the final SWEIS. The DOE does not consider such slight changes to be substantial for the purposes of the SWEIS.

Only LANL changes in employment, incomes, and expenditures were used for this analysis. For example, changes because of tourist and skier visitation to the region were ignored, as were changes in non-LANL construction and retail sales.

Housing

The projections of housing distribution for the four alternatives were made by:

- Determining the potential housing growth for LANL employees in Los Alamos County by adding the county's housing units now under construction, potential housing conversions, and the buildable, vacant, single-family lots (PC 1996a and PC 1997c).
- Distributing the remaining housing growth for LANL employees between Santa Fe and Rio Arriba Counties, based on the availability of buildable land, the presence of utilities, and the presence of developer capital (PC 1996a and PC 1997c).

For analysis of housing, it was assumed that one unit of housing demand would be created for every 2.39 (the average household size) net additions to the area population. This algorithm is based on the relationship of housing units to population for the Tri-County region shown in the 1990 U.S. Census (DOC 1993b). Population projections were based on the 1990 U.S. Census information (DOC 1992 and DOC 1993a), New Mexico Department of Labor information (NMDL 1996), and on a 1994 study done by the University of New Mexico (UNM 1994).

Construction

Construction projects included in each of the SWEIS alternatives are detailed in chapter 3. The employment and salaries associated with LANL construction activities were projected separate from those for LANL operations. On average, field construction labor (the basis for construction employment and salaries) is about 24 percent of the total project cost. Although this percentage can vary substantially from project to project, this average percentage was used for the SWEIS analyses. The total project costs and the salaries estimates are in 1996 constant dollars and are subject to congressional appropriations. The average annual wage for construction workers in northern New Mexico, including supervisory personnel, is $35,000, which is the annual wage assumed for these analyses.

Total project costs were determined based upon the 1997 and 1998 Capital Asset Management Process (CAMP) reports (LANL 1997c) and other NEPA documents that discuss construction projects at LANL. Application of labor expenditures as a percentage of total project cost (24 percent) is the total construction salaries for each alternative. The total construction salary divided by $35,000, produced an estimate of the number of employees who would be engaged in construction at LANL each year for the period 1997 through 2006 for each alternative.

Local Government Finance

Changes in gross receipts tax yields, the key LANL-dependent local government tax revenue, were determined by dividing the 1995 gross receipts tax yields for Los Alamos, Rio Arriba, and Santa Fe Counties and the cities of Santa Fe and Española (NMDFA 1996, NMTR 1995, and NMTR 1996) by population, and multiplying that product by the changes in population (due to both primary and secondary employment changes) resulting from changes in LANL activities across the alternatives.

Services

Education finance impacts across the alternatives were based on calculating enrollment changes induced by LANL activities on total budget requirements. Thus, population changes were converted to school enrollment changes that were then multiplied by $4,009, which is the average New Mexico annual operating cost per public school student (NMDE 1995).

Impacts presented for other services (e.g., police, fire) are qualitative and were based on field interviews and the knowledge of subject matter experts (PC 1996b, PC 1997d, and BH&A 1995).

5.1.9.2 *Infrastructure*

Utilities

LANL annual requirements for electricity and water are projected by alternative based on historical use and on projected activity levels. These projections are considered maximum annual demands. Because most LANL facilities are not individually metered for utility usage (none of these facilities are individually metered for natural gas usage), useful projections could not be made on a facility-by-facility basis. However, the TA–53 facilities and operations discussed in chapter 3 (section 3.5.11) are substantial users of these utilities, and TA–53 is individually metered for electricity and water use. For this reason, electricity and water usage by alternative is projected for LANSCE separate from the rest of LANL facilities. Except for LANSCE electricity and water usage, LANL's utilities usage is not expected to change substantially from the baseline usage described in chapter 4 (section 4.9). Natural gas use is projected to continue at the baseline usage rate, which is the maximum amount used in recent years.

5.1.9.3 *Waste Management*

Radioactive and Hazardous Waste Generation

The generation of waste places a burden on the LANL waste treatment, storage, and disposal infrastructure. For this reason, LANL waste generation by alternative is presented in this section. The waste treatment, storage, and disposal activities could have impacts; those impacts are included in the other sections of this chapter (e.g., radioactive air emissions include those attributable to waste operations). Waste generation projections were based on projected operations as compared to the baseline waste generation. These projections take credit for fully developed and implemented waste minimization/pollution prevention measures, but do not assume implementation of actions that are currently in development or may occur in the future. Every indication is that the waste minimization/pollution prevention program at LANL will continue to reduce the waste that must be managed, so the projections made by alternative are considered conservative.

The report *Waste Management Strategies for LANL* (LANL 1998a) reflects the treatment and disposal of waste at LANL, as well as more detailed information regarding the waste types and applicable treatment processes.

5.1.9.4 *Contaminated Space*

The contamination of space and equipment places a burden on the LANL infrastructure for eventual cleanup, waste handling, and decontamination and decommissioning efforts (at additional cost, as compared to these actions for uncontaminated space and equipment). During the scoping activities for the SWEIS, members of the public suggested that DOE decision-making should consider this burden and requested that changes in contaminated space and equipment by alternative be presented in the SWEIS. For these reasons, the SWEIS

includes estimates of changes in contaminated space and equipment by alternative, as compared to the baseline contaminated space presented in chapter 4 (section 4.9).

In general, the estimation of contaminated spaces was made within plutonium facilities, hot cells, process gloveboxes, and general laboratory areas on a foot print (square footage) basis, and was made by subject matter experts. Future clean-up costs or environmental impacts associated with eventual cleanup of LANL are dependent on the regulations and facility conditions at the time of the cleanup and cannot be predicted; thus, no attempt is made in the SWEIS to translate the contaminated space projections into a cost liability or into eventual cleanup actions and impacts. It is anticipated that such assessments will be made at the time DOE plans for such actions (presumed to be well beyond the 10-year time frame of the SWEIS).

5.1.10 Transportation Methodology

The methods and assumptions described in this analysis were selected to ensure meaningful comparisons among the SWEIS alternatives. In general, assumptions used in this analysis are intended to be conservative enough to ensure that the results do not underestimate the level of transportation risk, but not so conservative that the risk calculation is knowingly orders of magnitude too conservative or such that any differences between alternatives are obscured.

The analyses of both radioactive and hazardous material risks are largely accomplished with standard computer codes; the methodology is documented in more detail in volume III, appendix F. Figure 5.1.10–1 illustrates the basic transportation risk analysis methodology. As indicated in the figure, the overall transportation analysis was approached in two major segments:

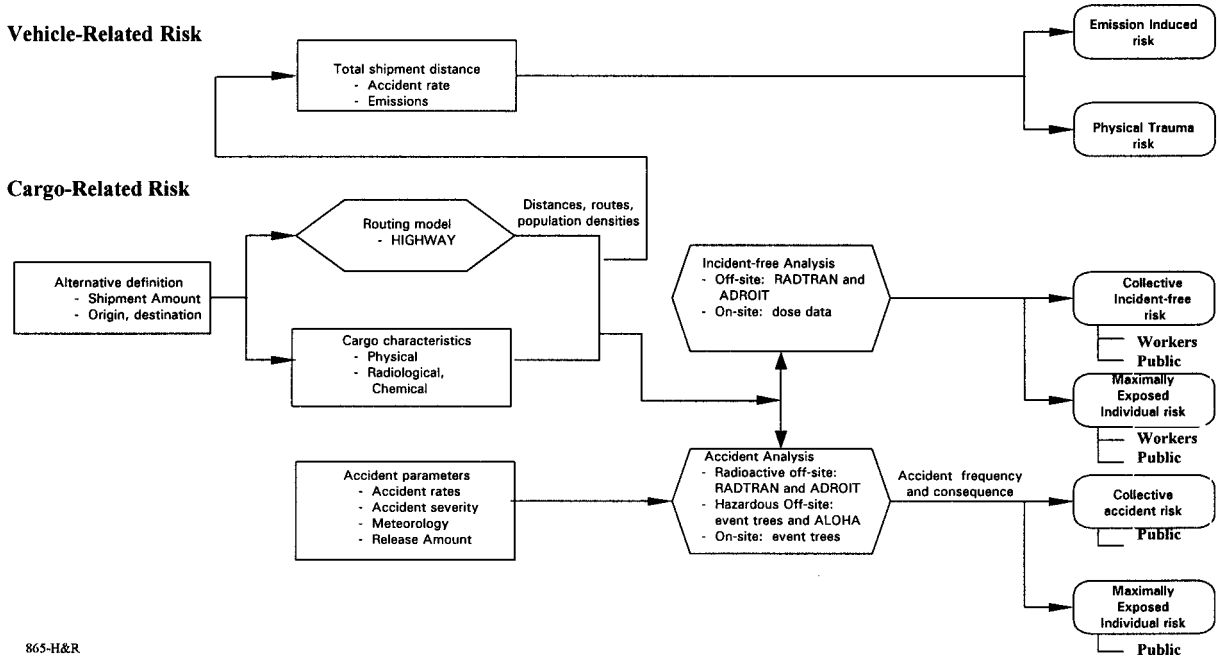

FIGURE 5.1.10–1.—*Transportation Risk Analysis Methodology.*

- Vehicle-related risk includes truck emissions and vehicle accidents (no release of cargo).
- Cargo-related risk includes both incident-free radiation exposure and accidents that could release radioactive or hazardous cargo.

5.1.10.1 *Determination of Shipment Amounts, Materials, and Physical Forms*

The determination of annual radioactive and hazardous chemical shipment amounts, materials, and physical forms, by SWEIS alternative, was intended to ensure that shipments that could contribute significantly to accident risk were projected and analyzed. Shipments of relatively small quantities and of materials that present substantially lesser hazards were not considered in as much detail. Shipments of waste are included in the SWEIS transportation analyses and are also discussed in section F.6.6 in appendix F.

The radioactive material shipment projections by alternative were determined by interviewing DOE and LANL subject matter experts. Historical shipment data, on site and off site, were used to help ensure completeness. On-site shipments of special nuclear material (SNM) at the gram level were not accounted for because their contribution to risk would be minor. The off-site and on-site radioactive material shipments for each SWEIS alternative are listed in appendix F.

The historical hazardous chemical shipments were determined primarily by using existing LANL databases, as well as by using DOE shipment mobility/accountability collection (SMAC) data. Large inventories and bulk shipments were identified from these databases. Through this process and through interviews with subject matter experts, bounding historical material types and quantities were identified. Where possible, future hazardous chemical shipment projections were made by subject matter experts (e.g., future explosive shipments are explicitly related to the alternative descriptions). In many cases, hazardous chemical shipment projections could not be explicitly determined in this manner because many chemicals are purchased in large quantities but are actually used in small quantities over long periods and across the entire site. In such cases, chemical shipment projections were made based on the ratios of projected shipments to historical shipments for materials that were explicitly related to alternative descriptions. This process and the bounding chemical shipments, on site and off site, by alternative are described in detail in appendix F (in volume III).

5.1.10.2 *Shipment Routes and Distances*

LANL shipments projected for each of the SWEIS alternatives include shipments to and from other DOE sites as well as to and from numerous non-DOE (e.g., commercial) sites. Subject matter experts identified DOE sites involved in such shipments. For shipments to sites other than DOE sites, five geographical areas are defined for radioactive material shipments: northeast, southeast, northwest, southwest, and New Mexico. The cities selected as representative of each area are Concord, Massachusetts; Aiken, South Carolina; Richland, Washington; Berkeley, California; and Albuquerque, New Mexico. These cities were chosen as conservatively representative (on the basis of the number of shipments) of the various shipment locations in the geographic area in the 1990 through 1994 baseline. Cargo air shipments are also made to and from the LANL site. Air shipments arrive at the Albuquerque International Airport and are transported by truck or van to LANL or vice versa.

In general, the transportation impacts presented in the SWEIS are reflected on an annual basis

for each of four route segments: from LANL to U.S. 84/285; from U.S. 84/285 to I–25, remainder of New Mexico (all other transportation in the state), and outside New Mexico. Based on the routes established for this analysis, shipment mileage was calculated, and the population density along the route was estimated. The HIGHWAY code (Johnson et al. 1993) was used to determine the distance traveled for each off-site shipment route.

All routes for shipment of radioactive or hazardous material into or out of LANL are conservatively assumed to pass through Santa Fe. The Santa Fe Relief Route (currently being constructed) would replace 6.5 miles (10.5 kilometers) on U.S. 84/285 through Santa Fe to I–25, with 13.8 miles (22.2 kilometers) starting from U.S. 84/285 north of Santa Fe to exit number 276 of I–25, south of Santa Fe. Because of the location where the Relief Route meets I–25, travel on I–25 south of Santa Fe would be reduced by 6 miles (___ kilometers) of highway travel, and travel on I–25 north of Santa Fe would be increased by 6 miles (___ kilometers) of highway travel if the Relief Route were used. The Santa Fe Relief Route between I–25 and the junction of U.S. 84/285 with NM 502 consists of 1.2 miles (1.9 kilometers) of urban highway, 3.9 miles (1.9 kilometers) of suburban highway, and 14.9 miles (24 kilometers) of rural highway. Appendix F (in volume III) includes a detailed comparison of impacts between transportation through Santa Fe and using the proposed Santa Fe Relief Route. (The segments from U.S. 84⁄285 I–25 and the remainder of New Mexico are the only ones that would potentially be affected.) In most of the analyses, the differences are very small; these differences are discussed in the discussion of each type of transportation impact and are presented in more detail in appendix F (section F.7).

5.1.10.3 *Vehicle-Related Risks*

Truck traffic on public highways presents two types of health risks independent of the nature of the cargo: the health effect of air pollutants (primarily diesel fuel combustion products) and the injuries and fatalities caused by truck accidents. Aircraft accidents could also contribute to injuries and fatalities. Because there is no rail service to LANL, rail transport is not addressed.

As described in Figure 5.1.10–1, once the routes, distances, and population densities are determined (as described above), truck emissions and vehicle accident rates must be determined to calculate the vehicle-related risks. These factors are discussed further below.

Truck Emissions

Truck traffic produces air pollution from diesel engine exhaust, fugitive dust generated by the vehicle wake on the highway surface and shoulders, and particulates from tire wear on the paved surface. The primary health effect of diesel fuel combustion is caused by sulfur oxides and particulates, although nitrogen oxides and hydrocarbons are also produced. The health effect of these pollutants is increased sickness (morbidity) and death, generally occurring after a latency period of some years. No analysis was made for increased sickness because no data were available. The health effect has been evaluated by Rao et al. (1982) as 1.6×10^{-7} excess LCFs per truck mile (1.0×10^{-7} fatalities per truck kilometer) in urban areas. The result is limited to urban areas because the available air pollution mortality data were limited to metropolitan population subgroups.

The total number of radioactive and hazardous material shipments made annually under each alternative (detailed in appendix F, section F.5) and the urban mileage per shipment are used to determine the total annual urban mileage for all shipments. This mileage is converted to excess LCFs per year using the conversion factor from Rao et al. 1982, as noted above.

Truck Accidents

Four sets of truck accident rates are used in the analysis: state-specific; route-specific, between I–25 and the LANL site; on-site roads with and without road closure; and the safe secure transport (SST) trailer. To the extent possible, each of these sets of accident rates was determined based on existing accident rate data available from the U.S. Department of Transportation (DOT), the State of New Mexico, and previous on-site transportation risk analyses at LANL. The truck accident rate for closed roads was determined to be 1.44×10^{-8} accidents per mile (8.95×10^{-9} accidents per kilometer) based on an analysis of the types of truck accidents and the LANL site administrative controls (Rhyne 1994b). The accident rate for SST shipments was determined based on the actual SST accident rate for the 9-year period between 1988 and 1996 (7.7×10^{-8} accidents per mile [4.8×10^{-8} accidents per kilometer]) by extrapolating data for varying operating environments of five-axle vans in the appropriate weight range in commercial service (Phillips et al. 1994). The determination of these accident rates and the accident rates used for this analysis are discussed further in volume III, appendix F.

Aircraft Accidents

Air transport associated with shipments to and from LANL is assumed to be by commercial air-cargo carriers (such as Federal Express) to and from the Albuquerque International Airport. (Transport between this airport and LANL is by truck or van.) Shipments are picked up in the carrier's van and taken to an airport, flown to the destination city, and taken to the final destination by the carrier's van. Commercial air-cargo carriers are categorized as large certified air carriers and are assumed to fall in the subcategory of "large nonscheduled service" for which the 1992 accident rate was 7.9×10^{-9} accidents per mile (DOT 1992).

Because the accident rate for similar shipments by truck is much greater (by two orders of magnitude) and this difference is not offset by a comparable difference in the consequences of these accidents, aircraft accidents were screened from further analysis.

5.1.10.4 *Cargo-Related Risks*

In addition to the vehicle-related risks, cargo-related risks are also analyzed in this section. These risks include incident-free radiation exposure, and exposure to radioactive or other hazardous materials due to an accidental release. The estimates of material amounts, physical forms, routing, and population densities along these routes that were described earlier in this section are used in these analyses. The following information presents the methods used to estimate cargo-related risks.

RADTRAN and ADROIT Analyses for Radioactive Materials

Two of the four risk measures illustrated in Figure 5.1.10–1 are modeled by RADTRAN or ADROIT. (These are discussed further in appendix F, section F.4.4.) The RADTRAN code is designed to produce conservative estimates of the radiological dose to workers and the public during incident-free transportation, as well as the radiological risks from potential accidents. RADTRAN is widely accepted and used both in the U.S. and internationally.

The ADROIT code was developed to replicate the RADTRAN incident-free and accident estimates specific to transport using DOE SST trailers. ADROIT end results are very similar to RADTRAN. These codes were applied to the impact analyses for off-site shipments of radioactive materials.

Incident-Free Radiation Exposure. The most important parameter for evaluation of incident-

free radiation exposure is the package exterior radiation level. The transport index (TI) is used in RADTRAN to characterize the exterior radiation field. The TI is defined in 49 CFR 73.403 as "the exposure rate in millirems per hour at a distance of 3 feet (1 meter) from the surface of the package," and DOT regulations limit the value of TI to 10 or less for general commerce shipments. The TIs for LANL's on-site shipments are based on historical measurements. The average truck shipment TI is less than 2, and the average air shipment TI is approximately 0.1.

Annual radiation doses and excess LCFs are calculated for members of the public along the truck route, members of the public traveling on the truck route, members of the public at truck stops, truck and air crew members, and MEIs. All trucks are assumed to pass a residence 98 feet (30 meters) from the highway at a speed of 15 miles (24 kilometers) per hour.

Accidental Release of Radioactive Materials. Radioactive material shipments were evaluated to determine those that would likely present the largest calculated consequence (see appendix F). These are referred to as the bounding material shipments. The bounding radioactive material shipments included in the SWEIS transportation analyses are:

- Off-site shipment of plutonium-238 oxide powder in an SST
- Off-site shipment of americium-241 standards
- On-site shipment of plutonium-238 solution samples (performed with road closures)
- On-site shipment of irradiated targets (performed with road closures)

In addition to these shipments, off-site shipments of contact-handled transuranic (CH TRU) waste, remote-handled transuranic (RH TRU) waste, and plutonium weapon components (pits) are analyzed due to the level of public interest in such shipments that was expressed during scoping for the SWEIS.

In order to determine the frequency terms for these analyses, the frequencies of the shipments listed above were supplemented with the frequencies of other large shipments of similar materials. For example, the number of on-site plutonium-238 solution shipments was increased for analysis by the number of on-site weapons-grade plutonium solution shipments (see volume III, appendix F). Thus, the frequency term includes both plutonium-238 and weapons-grade plutonium shipments.

The impacts of an accidental release of radioactive materials from shipments are based on the accident scenario (and the associated forces on the packages), the fraction of the radioactive material in a package that could be released during an accident of a certain severity, and the fraction of material released that would be dispersed as an aerosol that could be inhaled into the respiratory tract. This information is used to determine the radiation dose that would result from the accident to exposed individuals.

The fraction of the radioactive material in a package that could be released during an accident is referred to as the release fraction. Release fractions vary according to the package type and the accident severity. Type B packages are designed to withstand the forces of severe accidents and, therefore, have smaller release fractions than Type A packaging (see appendix F for more information on packaging). Plutonium packages are designed to even higher standards. The RADTRAN and ADROIT models include the accident severity and the shipment packaging in consequence analyses.

Subsequent to release, dispersion of the material into the atmosphere as an aerosol and, in most cases of interest, inhalation into the respiratory tract (respirable aerosols only) would be required to produce a significant exposure to members of the public. Most solid materials are relatively nondispersible. Conversely, gaseous materials are easily dispersed. Liquid dispersibility depends on the liquid volatility. The aerosolization and respirable fractions

depend on the physical form of the material. RADTRAN and ADROIT include all of these factors to determine respirable release fractions in calculating the accident consequences.

Health Risk Conversion Factors. The health risk conversion factors used throughout this analysis (as in the accident and human health analyses) to estimate the number of expected excess cancer-caused fatalities, from radiological exposures are 0.0005 cases of excess fatal cancer per person-rem for members of the public, and 0.0004 cases per person-rem for workers (ICRP 1991). Cancer-caused fatalities are determined over the lifetimes of exposed populations.

Event Tree Analyses for On-Site Radioactive and All Hazardous Chemical Accidents

Event trees are used for the analyses of on-site and off-site transportation accidents involving hazardous chemical inventories and on-site transportation accidents involving radioactive materials. An event tree is a graphical model for identifying and evaluating potential outcomes from a specific initiating event. The event tree depicts the chronological sequence of events (the accident scenario) that could result from the initiating event. In addition to identifying the accident scenarios, an event tree can also be used to quantify the frequencies of each scenario. The use of event trees for these analyses is explained further in appendix F.

The consequences of hazardous chemical accidents are determined using the Areal Locations of Hazardous Atmospheres (ALOHA™) computer model (NSC 1995), the dense gas dispersion (DEGADIS) model (Havens and Spicer 1985), and hand calculations, depending on the characteristics of the material and release mechanism. The consequences are presented in terms of numbers of fatalities, number of injuries, and impact to the MEI.

Hazardous material shipments were evaluated to determine those that would likely present the largest calculated consequence (see appendix F). These are referred to as the bounding material shipments. The bounding hazardous material shipments included in the SWEIS transportation analyses are:

- Off-site shipment of chlorine
- Off-site shipment of explosives
- Off-site shipment of propane

An examination of historical on-site shipments did not identify any unique materials or shipment risks. The off-site shipments identified above bound the accident risk both on site and off site.

Consequences of on-site radioactive material accidents were analyzed using hand calculations, based on the material and the accident scenario involved.

5.1.11 Accident Analysis Methodology

5.1.11.1 *Introduction*

Accidents are defined as unexpected or undesirable events that lead to the release of hazardous material within a facility or into the environment, exposing workers and the public to hazardous materials or radiation. Any activity therefore poses a certain amount of risk to the adjacent environment and human populations. The objective of this analysis is to characterize the overall risk posed by the operation, creating a context for the decision maker and putting the site in perspective for the public. Secondly, it quantifies the increment in risk among the alternatives, as an input to the decision. Table 5.1.11.1–1 lists the facilities by TA and/or building that were considered in the accident analysis.

TABLE 5.1.11.1–1.—*SWEIS Accident Analysis Facility Listing*

TECHNICAL AREA AND BUILDING NUMBER	FACILITY NAME
TA–0–1109	Potable Water Chlorinator
TA–0–1110	Potable Water Chlorinator
TA–3–29	Chemistry and Metallurgy Research (CMR) Facility
TA–3–66	Sigma Facility
TA–3–476	Toxic Gas Storage Shed
TA–9–21	Analytical Chemistry Building (worker hazard only)
TA–15–312	Dual Axis Radiographic Hydrodyamic Test (DARHT) Facility
TA–16–205	Weapons Engineering Tritium Facility (WETF)
TA–16–411	Assembly Building
TA–18–23	Pajarito Site Kiva #1 (seismic only)
TA–18–32	Pajarito Site Kiva #2 (seismic only)
TA–18–116	Pajarito Site Kiva #3
TA–18–169	Pajarito Site Solution High-Energy Burst Assembly (SHEBA) Building (seismic only)
TA–21–155	Tritium Systems Test Assembly (TSTA)
TA–21–209	Tritium Science and Fabrication Facility (TSFF)
TA–43–1	Health Research Laboratory (HRL) (seismic only)
TA–46–340	Waste Water Treatment Facility (WWTF)
TA–48–1	Radiochemistry Laboratory[a]
TA–50–1	Radioactive Liquid Waste Treatment Facility (seismic only)
TA–50–37	Radioactive Materials Research, Operations, and Demonstration (RAMROD) Facility
TA–50–69	Waste Characterization, Reduction, and Repackaging (WCRR) Facility
TA–54–G	Transuranic Waste Inspectable Storage Project (TWISP) (TA–54–229, TA–54–230, TA–54–231, and TA–54–232); Transuranic Waste Storage Domes (TA–54–48, TA–54–153, TA–54–224, TA–54–226, and TA–54–283); Tritium Waste Sheds (TA–54–1027, TA–54–1028, TA–54–1029, and TA–54–1041)
TA–54–38	Radioactive Assay and Nondestructive Testing (RANT) Facility
TA–54–39	Polychlorinated Biphenyl (PCB) Waste Storage Facility
TA–54–216	Legacy Toxic Gas Storage Facility
TA–55–4	Plutonium Facility
TA–55–185	Transuranic Waste Drum Staging Building
TA–59–1	Occupational Health Laboratory (worker hazard only)

[a] Table G.5.4.4–3 in volume III, appendix G, lists all facilities found to have a moderate or higher vulnerability to wildfire, and therefore, were considered in the site-wide wildfire analysis.

5.1.11.2 *Meaning of Risk and Frequency as Used in This SWEIS*

The word "risk" is defined in the dictionary as the probability that a specific loss or injury will occur. In this SWEIS, DOE couples the consequence of an event with the probability that it will occur, and calls this combination the risk. Note that a high consequence event would not necessarily have significant risk if its probability is very low.

The probability of the accident is typically expressed as a frequency; that is, an accident with a frequency of 0.001 per year has a probability of occurring once in 1,000 years and twice in 2,000 years. This is only another way of saying that the probability of the accident occurring in any particular year is 1 in 1,000.

For many events, the risk can be expressed mathematically as the product of the consequence and its probability. In illustration, if the expected public consequence of an accident at a particular facility is one cancer per accident, and if the accident has a probability of occurring once in 1,000 years, then the continuing risk presented by that accident is (1 x 1/1000) or 0.001 cancer per year. This product of consequence and probability is called "societal risk" in this SWEIS. It permits the ready comparison of accidents and alternatives without the burden of the details. The details of the analyses are presented in volume III, appendix G.

5.1.11.3 *Characterization of the Risk from Accidents*

Characterization includes a consideration of the type of the accident (e.g., fire, explosion, spill, leak, depressurization, criticality, etc.), the initiator (e.g., human error, chemical reaction, earthquake, strong wind, flood, vehicle accident, mechanical failure, etc.), and the material-at-risk (MAR) (e.g., plutonium, tritium, toxic chemical, explosives, inflammable gas, etc.). Characterization also considers the type of consequences of the accident (e.g., immediate fatalities, prompt reversible and irreversible health effects, latent cancers—some of which lead to eventual death and are referred to as fatal) and the magnitude of the consequences (e.g., to workers only, to hypothetical members of the public, to a few, some or many real individuals off site). Finally, characterization considers the likelihood that an accident will occur.

LANL is a complex and diverse site, and there is a wide range of accident scenarios that can be hypothesized, with a wide range of likelihoods and a wide range of realistic and imagined consequences. To characterize the accident risk at LANL, this analysis has deliberately chosen a range of types of accidents and a range of consequences, including accidents involving materials for which the public has shown concern. This analysis does not attempt to identify every possible accident, but instead selects accidents that characterize or dominate the risk to the public and workers from site operations. It thereby provides an objective context for the public to evaluate the risk posed by site operations, and a context for the decision among alternatives. It also allows the decision maker to consider whether mitigation measures are needed to reduce risk.

By identifying the locations of appreciable quantities of hazardous material, the accidents associated with these materials can be assessed. By grouping these accidents according to their likelihood or frequency, and the magnitude of their consequences, it is possible to select accidents for further characterization and qualitatively portray their relative risk. The accidents selected for this detailed analysis are those with bounding consequences as well as those that characterize the risk of operating LANL.

5.1.11.4 *Determining the Increment in Risk Among Alternatives*

If an accident is not reasonably foreseeable—that is, it is incredible—DOE does not consider that it contributes substantially to the risk of operating LANL (DOE 1993). If, on the other hand, a hazardous material has a reasonable chance of being involved in an accident, then the consequences and the likelihood of the accident are considered.

Specific accidents that contribute substantially to, or envelop the risk, are considered risk-dominant accidents or bounding accidents. They are not exceeded by other accidents analyzed or believed to be possible that involve that inventory. For instance, there may be a number of accidents that could disperse plutonium, with different initiators or different mitigation, but they are represented by the risk-dominant accident involving plutonium dispersal. This accident also may bound the consequences for other facilities that may have more sensitive site characteristics (such as larger populations), but have lesser inventories than those addressed by the analyses.

This suite of accidents was derived from consideration of the current operations plus currently planned changes. These constitute the baseline (No Action Alternative) condition that serves as a reference from which to evaluate the alternatives. Changes in locations, changes in MAR, and changes in types of operations were considered among the alternatives. These differences were then used to determine the changes to the probability and consequences of the accidents. In each of the sections discussing the impacts of the alternatives, the risk, as well as the change in risk from the No Action Alternative, is given in the summary tables.

5.1.11.5 *Methodology for Selection of Accidents for Analysis*

The analysis began with the establishment of the baseline risk from current operations, plus planned activities, that together constitute the No Action Alternative. The baseline was established by a process of safety documentation review, interviews with facility management, physical inspections ("walkdowns") of facilities, and discussions with facility management. Changes in the baseline risk were estimated for the Expanded Operations Alternative, the Reduced Operations Alternative, and the Greener Alternative to ascertain the human health impacts of the alternatives.

Assessing the human health consequences of accidents for the alternatives is a four-step process. The first step was to identify a broad spectrum of potential accident scenarios. These scenarios were obtained from available site-specific safety and environmental documents, from programmatic documents, from discussions with facility management, and from physical inspections (walkdowns) of the facilities.

The second step in the process used screening techniques to identify the specific scenarios that contribute significantly to risk (i.e., the scenarios that contribute an appreciable fraction of the total risk). Due to the large number of potential accident scenarios that could impact human health, it is impractical to evaluate them all in detail. This is a common problem encountered in risk assessments, and the standard approach (which was adopted here) is to apply rough bounding calculations during the screening steps. The calculations are performed to progressively greater degrees of detail until it becomes clear that the accident is either not risk-significant or requires a detailed analysis in order to determine the frequency and consequences of the accident (i.e., its risk).

Rigorous evaluations (the third step in the process) were only performed for the potentially risk-dominant scenarios identified in step two—that is, those which had a frequency of 10^{-6} or above and led to off-site consequences beyond insignificant.

The fourth step in assessing the human health impact of accidents for the alternatives was to carefully evaluate the effect of the alternatives on the accident scenarios. The important considerations involved in this evaluation were whether the alternative would result in the elimination of some accidents and the addition of others, whether the alternative would result in an increase or decrease in the frequency of some accidents, and whether the alternative would result in an increase or decrease in the amount of hazardous materials released. The results of the analysis indicate that, while a number of accidents are potentially affected by the alternatives, few of them are significant to public or worker risk.

It is important to recognize that as a result of several factors (the nature of the activities performed, the design features of the facilities at which the activities are performed, the conditions under which the activities are performed, and the location of the facility vis a vis the public), accidents are more likely to impact facility workers than they are to impact the public. This is true even though at LANL the public has access to many areas of the laboratory via roadway. Even for facility workers, the consequences in many cases would be dependent on the use by facility workers of personal protective equipment (PPE) and on the effectiveness of emergency response and mitigation actions taken to limit consequences (e.g., the timeliness of evacuation from the facility).

5.1.11.6 *Conservatism in the Analyses*

At all steps, when faced with uncertainties, the analysts selected the most probable or conservative value for accident probability and the quantity of hazardous materials released. Accepted models and expected atmospheric dispersion parameters were used in the modeling. Exposure conditions (location, time in the plume) were used that would maximize exposure of the total population and of individuals. Concentration planning guidelines appropriate to the public were used to evaluate impacts from chemical accidents. A conservative risk factor for excess LCFs was used to calculate radiological health effects; whereas, the true risk factor may be considerably less, as described in appendix D, section D.1 (in volume III). The resulting estimates of risks are quite conservative.

Despite the conservatism, some accident scenarios originally thought plausible were found by analysis to have a probability of less than 10^{-6} per year, (i.e., to be incredible). These accidents are retained in the appendix to preserve the information they contain, in illustration of the range of the analyses, and in demonstration of the conservativeness of the screening.

5.1.11.7 *Accident Scenario Screening and Selection*

Spectrum of Potential Accidents

Potential accident scenarios were first selected based on facility safety documentation review. Facility walkdowns and discussions with operations personnel also were undertaken to ensure a comprehensive look at the possible accidents. In this manner, scenarios from the safety documentation were validated and other scenarios added to make a comprehensive list.

For the facility walkdowns, a pre-visit facility walkdown/interview data collection form was prepared for each facility to facilitate the collection of a consistent set of facility data and transmitted to facility representatives. Preparation of the forms benefited from the experience of previous accident evaluations (including safety analyses, probabilistic risk assessments, and process hazard analyses). In addition, relevant DOE handbooks and standards were considered, as described in volume III, appendix G.

During and subsequent to the walkdowns, revised safety documentation was provided by the facility representatives. This documentation was subsequently reviewed, and a draft data collection document was prepared for each facility.

Identification of Accident Scenarios

Two primary types of data sources were used for radiological accident analysis: (1) safety documentation, including safety assessments (SAs), hazard analyses (HAs), process hazard analyses (PrHAs), probabilistic risk assessments (PRAs), and safety analysis reports (SARs); and (2) facility walkdown/interview data collection forms.

Where a facility had current safety documentation, that documentation was used to define accident scenarios. Owing to differences in scope between safety documentation and NEPA accident analyses, some supplementation of the safety documentation was necessary in a few instances in order to provide the required NEPA coverage (this was especially true in the area of seismically initiated sequences). The facility walkdowns were used to further evaluate the accident scenarios identified in the safety documentation, to evaluate whether additional accident scenarios were possible that were not included in the safety documentation, to evaluate whether there were accident frequency or accident consequence mitigation capabilities present that were not credited in the safety documentation, and to assess the impacts of the SWEIS alternatives on the accident scenarios. This latter consideration included whether accident frequencies or MAR could increase or decrease across the alternatives, and whether any accident scenario existed in one or some but not in all alternatives.

Documentation relied upon for the radiological facility accident analysis included the following:

- The LANL seismic hazard evaluation (Wong et al. 1995) and the LANL aircraft crash hazard evaluation (LANL 1996d)
- Basis for Interim Operation (BIO)
- Operational safety requirements
- Technical safety requirements Environmental assessments (EAs)
- EISs
- Facility descriptions (LANL 1998b)

Based on the results of the review of facility safety documentation and the facility walkdown/interview data collection process, a large suite of accident scenarios was identified and grouped by MAR (e.g., weapons-grade plutonium, source material plutonium, tritium, highly enriched uranium [HEU], depleted uranium (DU), etc.) for further consideration.

Accident Initiator Screening

Section G.3 in appendix G (in volume III) describes the comprehensive screening and evaluation of various accident types and initiators.

Accident types and accident initiators that could produce an accident with a frequency in excess of 10^{-7} per year when realistically estimated, or a frequency in excess of 10^{-6} per year when conservatively estimated, were treated as “credible” and “reasonably foreseeable.” Of course, accidents with frequencies less than this were not dismissed without considering whether they were capable of producing worse consequences than credible earthquakes, which affect the entire LANL site. It is also not plausible that many individual, but unlikely, accidents could rival earthquakes in risk, and so such accidents were not retained for detailed analysis.

Summary of Consequence Screening for Chemical Accidents

Thirty-seven chemicals were identified in the 1992 LANL database that met the following criteria:

- Has a time-weighted-average (TWA) less than 2 parts per million
- Is found in readily dispersible form (i.e., a gas or liquid)
- Has a boiling point less than 212 degrees Fahrenheit (°F) (100 degrees Celsius [°C]) and a vapor pressure greater than 0.5 millimeter mercury

These 37 chemicals were modeled for release of their largest 1992 inventory, using adverse dispersion conditions and the ALOHA™ code, which is described in appendix G, section G.2.3. The 10 releases that exceeded the Emergency Response Planning Guideline (ERPG)–3 at 328 feet (100 meters) distance were retained for further analysis. To these were added another eight chemicals of interest.

Releases of the actual inventories of these 18 chemicals at 78 locations were then modeled to see which would exceed the ERPG–3 concentration under conservative daytime dispersion conditions. In this modeling:

- Release was at surface level.
- Gases were released over 10 minutes.
- Liquids were spilled instantaneously and then evaporated from a puddle 0.4 inch (1 centimeter) deep.

The releases that exceeded the ERPG–3 concentration were examined with consideration of:

- Whether there is a large work force nearby or there is public exposure
- If a heavy gas, whether the public is protected by intervening canyons
- Whether the consequences are less than a release of the chemical from a different facility
- Whether the consequences are less than those of another chemical released from the same facility

With these considerations, a number of releases were selected and retained for detailed analysis. Formaldehyde was also retained as it represents the largest LANL inventory of a readily dispersible chemical carcinogen. These final selections are shown in Table 5.1.11.7–1.

Summary of Consequence Screening for Radiological Accidents

To facilitate radiological facility accident screening, integrated population exposure was established as an evaluation criterion. Consequences were calculated for the release of a unit of material and multiplied by the source term magnitude to obtain approximate consequences for screening. The calculations were performed with the Melcor Accident Consequence Code System (MACCS) 2 (as described in appendix G, section G.2.4), for both ground level releases and elevated releases.

Population distributions for the screening and detailed analysis calculations were created from the 1990 Census data for residential populations, and 1996 LANL workforce populations by TA. LANL workforce populations were included by centering the total TA population in the direction where there is the largest concentration of that TA's population. This is a conservative and approximate method because it results in some double counting of facility workers who have residences within the 50-mile (80-kilometer) radius of LANL.

With these releases and frequency estimates, a number of scenarios were selected and retained for further detailed analysis, as listed in Table 5.1.11.7–1. Several accidents scenarios that might or should have been screened out are listed in Table 5.1.11.7–2. They were, at first,

TABLE 5.1.11.7–1.—*Dominant Accidents at LANL*

PROCESS HAZARD ACCIDENTS	
CHLORINE RELEASES	
CHEM–01	Single cylinder release of chlorine (150 pounds) from a potable water chlorinator (TA–00–1109, bounding) due to equipment failure or human error during chlorine cylinder replacement or maintenance activities.
CHEM–03	Single cylinder release of chlorine (150 pounds) from toxic gas cylinder storage facility (TA–3–476) due human error during cylinder handling or cylinder deterioration due to unintended long-term exposure to weather.
CHEM–06	Chlorine gas release (150 pounds) from a process line at the Plutonium Facility (TA–55–4) due to mechanical damage to a supply manifold.
HIGHLY ENRICHED URANIUM RELEASE	
RAD–03	Reactivity excursion accident at Pajarito Site Kiva #3 (TA–18–116) with Godiva-IV outside the kiva, vaporizing part of the HEU fuel and melting the remainder.
PLUTONIUM RELEASES	
RAD–09	TRU waste drum failure or puncture at TA–54, Area G (bounding).
RAD–13	Plutonium melting and release accident at Pajarito Site Kiva #3 (TA–18–116).
RAD–15	Plutonium release from a laboratory and wing fire at the CMR Building.
MANMADE HAZARD ACCIDENTS	
CHLORINE RELEASE	
CHEM–02	Multiple-cylinder chlorine release (1,500 pounds) due to explosion or unsuppressed fire affecting a toxic gas storage facility (TA–3–476).
SELENIUM HEXAFLUORIDE AND SULFUR DIOXIDE RELEASE	
CHEM–04	Single cylinder release of toxic gas (selenium hexafluoride, historical bounding chemical) from the legacy toxic gas storage facility (TA–54–216) due to random cylinder failure or a forklift accident.
CHEM–05	Multiple cylinder release of toxic gas (sulfur dioxide, historical bounding chemical) from the legacy toxic gas storage facility (TA–54–216) due to a fire, a propane tank BLEVE, or a propagating random failure.
TRITIUM RELEASE	
RAD–05	Aircraft crash with explosion and/or fire at TA–21 resulting in a tritium oxide release.
PLUTONIUM RELEASE	
RAD–01	Plutonium release due to container storage area fire involving TRU waste drums (TA–54–38).
RAD–07	Plutonium release due to container storage area fire involving TRU waste drums (TA–50–69).
RAD–08	Aircraft crash with explosion and/or fire at the TRU waste dome area at TA–54 (TA–54–229, TA–54–230, TA–54–231, and TA–54–232).
RAD–16	Aircraft crash with explosion and/or fire at CMR Building resulting in a plutonium release.

TABLE 5.1.11.7–1.—*Dominant Accidents at LANL*-Continued

NATURAL PHENOMENA HAZARD ACCIDENTS	
MULTIPLE RELEASES OF HAZARDOUS MATERIAL	
SITE–01	Site-wide earthquake, resulting in damage to low capacity structure or internal components at multiple facilities.
SITE–02	Site-wide earthquake, resulting in damage to moderate capacity structures or internal components at multiple facilities.
SITE–03	Site-wide earthquake, resulting in structural damage or collapse to all facilities.
SITE–04	Site-wide wildfire, consuming combustible structures and vegetation.
RAD–12	Plutonium release from a seismically initiated event.

TABLE 5.1.11.7–2.—*Incredible Accidents That Were Analyzed*

PROCESS HAZARD ACCIDENTS	
RAD–04	Inadvertent detonation of a plutonium-containing assembly at or near the DARHT Facility firing point, resulting in an elevated, explosive-driven release of plutonium (TA–15).
RAD–10	Plutonium release from a degraded storage container in the Plutonium Facility (TA–55–4) vault during container retrieval.
RAD–11	Catastrophic containment failure after detonation of a plutonium-containing assembly at the DARHT firing point (TA–15), resulting in a ground-level release of plutonium.
RAD–14	Plutonium release from ion exchange column thermal excursion at TA–55–4 (the screening process identified this as the most likely initiator of a glovebox fire).
MANMADE HAZARD ACCIDENTS	
RAD–02	Plutonium release due to natural gas pipeline failure near TA–3–29, with no immediate ignition, ingestion of gas into facility, followed by explosion and fire.
RAD–06	Aircraft crash with explosion and/or fire at TA–50–37, resulting in a plutonium release from TRU waste drums.

considered credible accidents because of the conservatism applied in the original estimates of event frequency. However, after a more detailed evaluation of the accident progression, the events were found to be incredible. These scenarios are retained in appendix G for the information they contain.

Addition of Site-Wide Wildfire to the Accident Scenarios

Site-wide wildfires escaped consideration in the draft SWEIS. At the same time, there was a general recognition of the threat to LANL, as evidenced by the multiple agency cooperation in an ongoing fuel reduction effort. This oversight was brought to DOE's attention during the public hearings on the draft SWEIS, and an analysis began with input from the Española District of the Santa Fe National Forest (SFNF), the Bandelier National Monument (BNM) of the NPS, the Los Alamos Fire Department, and LANL departments and personnel. The final analysis appears as SITE–04.

The frequency of a large wildfire moving onto the LANL site was estimated to be 0.1, or one chance in 10 years. The extent of the subsequent fire and its consequences can vary widely according to the ensuing meteorological conditions. The SITE–04 analysis conservatively assumes that all combustible structures and vegetation over the western part of LANL are burned. The resulting public exposures were estimated for each facility, using (when available) existing calculations of public exposure from fire at that facility. Although the summed exposures from all buildings is modest, the frequency of the accident is high; as a result, the public risk places this accident in Table 5.1.11.7–1, "Dominant Accidents at LANL."

5.1.11.8 *Detailed Accident Evaluations*

The probability of a release (expressed as an annual frequency) of the hazardous material was calculated from the accident progressions in each of the scenarios retained for detailed analysis. The accident analysis included a step-by-step analysis of the initiating events and of the barriers that need to fail before a substantial amount of material can be made available for atmospheric transport to downwind receptors. The details are provided in volume III, appendix G.

Toxic chemical source terms were evaluated by looking at the release mechanisms to determine the amount and rates of material released, release heights, and other source term parameters for input to calculations of the atmospheric concentrations.

For radiological accidents, there are two source terms: the initial (prompt) source term and the subsequent, continuing suspension source term. The initial source term is the radioactive material driven airborne at the time of the accident. The suspension source term is the radioactive material that becomes airborne subsequent to the accident as a result of evaporation, winds, or other processes. For both of these terms, the characteristics of the release were evaluated to determine the amount of material available for atmospheric transport and the parameters that influence its dispersion. For most DOE nonreactor facilities, the dose from inhalation exposure dominates the overall dose from accidents.

DOE Handbook 3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vols. I & II, December 1994 (DOE 1994), was used as the primary reference for calculation of radiological source terms. To maintain consistency across the accident analyses, DOE Handbook 3010-94 source term methodology has been applied to

the aircraft crash accidents, although there is a separate DOE Standard 3014-96 that covers aircraft crashes (DOE 1996b).

Human Health Impact of Accidents

The final step in the process is the determination of human health impacts resulting through exposures. For chemical accidents, the concentrations of chemicals at various distances were made with ALOHA™, as described in appendix G, section G.2.1, and compared to the ERPGs. Once concentrations were determined using the ALOHA™ code, demographic data were used to determine the number of people exposed above each ERPG level. ERPGs are concentrations associated with different levels of reversible and serious health effects.

For radiological accidents, the effects on the surrounding populations were calculated using the MACCS2, as described in appendix G, section G.2.4. MACCS2 determines the expected collective doses to the population within a 50-mile (80-kilometer) radius of the accident, and then computes the acute fatalities and excess LCFs for this population. MACCS2 uses risk factors of about 0.0005 excess LCF per person-rem for the general population. Doses to the MEIs at specific off-site locations are used to characterize the maximum possible risk to an individual member of the public.

The resulting human health impacts are described in the following sections.

- No Action Alternative, section 5.2.11
- Expanded Operations Alternative, section 5.3.11
- Reduced Operations Alternative, section 5.4.11
- Greener Alternative, section 5.5.11

5.1.11.9 *Worker Accident Screening*

Analysis of worker accidents (other than the transportation and physical safety hazards discussed in the SWEIS transportation risk and human health analyses, respectively) was performed to provide estimates of potential health effects from chemical and radiological exposure for involved workers. (For purposes of this SWEIS, workers within the TA where the accident occurs are defined as “involved workers,” and other on site LANL employees are defined as “noninvolved workers.”) Worker accident analysis need not be either as extensive or detailed as the public accident analysis because worker health risk from industrial accidents (falls, electrical shock, crushing, etc.) dominates over worker health risk from exposure in radiological and chemical accidents.

Worker accidents were reviewed qualitatively in order to arrive at a list of accidents that is representative of the accident potential at LANL under the four alternatives. The process used was similar to the analysis of accidents with public impact. The purpose of the separate worker accident screening was to identify whether there are accident scenarios that could have greater consequence to workers than the worker consequences associated with the public accident scenarios.

Data to support the accident analysis were obtained from a variety of sources, both facility- and site-specific, as well as from industrial and nuclear generic databases and compilations. Data sources, detailed in appendix G, included safety and hazard analysis documentation, data forms generated during the facility walkdowns, LANL SWEIS alternatives documentation, and Occupational Safety and Health Administration (OSHA) Form 200 Injury/Illness Reports for LANL and other DOE facilities.

The summary listing identified over 600 potential worker accident scenarios. Potential worker accident scenarios were then sorted by material hazard and initiators and ranked according to relative risk. Risk was qualitatively assigned on the basis of the frequency and consequence ranking matrix for

hazard evaluation described in section G.1 of appendix G. The array of worker accidents was not dissimilar from the array of accidents with public impact, so that the worker accident component of the selected public accidents also provides a representative picture of the worker accident potential. There are, however, some accidents that pose a risk to workers but not to the public. An example is the medical research at TA–43–1, field work on small mammal capture and blood sampling, where the exposures to workers are localized and the exposure to the population from a release would be mitigated by environmental attenuation. Another exception is energetic hazards, where potential hazardous sources do not involve the public.

The ranked worker accident scenarios were then compared to the public impact accidents with comparable risk rankings. From the review of the chemical and radiological accidents selected for detailed quantification of public risk and a screen of these accidents against the worker accidents, the following worker accidents were selected for more detailed evaluation (also listed in Table 5.1.11.9–1).

- Inadvertent high explosives detonation
- Biohazard contamination of a single worker
- Inadvertent criticality event
- Inadvertent exposure to electromagnetic radiation (x-rays, accelerator beam, laser, or radiofrequency [RF] source)

5.1.11.10 *Detailed Worker Accident Evaluations*

The worker accidents were qualitatively assessed because exposure can vary widely based on the exact sequence of the accident. One of the bounding parameters is the length of time that a worker is exposed to a hazardous material. Rapid evacuation, sheltering, and donning of protective equipment can greatly reduce a worker's exposure. Prompt medical treatment can also reduce the consequences. Therefore, worker accidents can be only qualitatively assessed for both the likelihood of the accident and its impact on individual workers. The human health results for the workers are provided in the following sections.

- No Action Alternative, section 5.2.11
- Expanded Operations Alternative, section 5.3.11
- Reduced Operations Alternative, section 5.4.11
- Greener Alternative, section 5.5.11

5.1.11.11 *Uncertainties and Sensitivities*

In principle, one could estimate the uncertainty associated with each step of the analysis for each accident scenario, and predict the uncertainty in the results (frequency, source term, consequences, risk, etc.). However,

TABLE 5.1.11.9–1.—*Dominant Worker Accidents at LANL*

PROCESS HAZARD ACCIDENTS	
WORK–01	Worker fatality due to inadvertent high explosives detonation.
WORK–02	Worker illness or fatality due to inadvertent biohazard contamination.
WORK–03	Multiple worker fatality due to inadvertent nuclear criticality event.
WORK–04	Worker injury or fatality due to inadvertent electronic radiation exposure (x-ray, accelerator beam, laser, or radiofrequency source exposure).
WORK–05	Worker exposure to plutonium released from a degraded storage container in the plutonium (TA–55–4) vault during container retrieval.

conducting such a full-scale quantitative uncertainty analysis is neither practical nor a standard practice for a study of this type. Instead, the analysis is intended to ensure, through judicious selection of release scenarios, models, and parameters, that the results represent and give a reasonable estimate of the actual risks.

This is accomplished by making conservative assumptions at each step of the calculations. The models, model parameters, and release scenarios are selected in such a way that most intermediate results and the final estimate of impacts are almost certainly greater than what would be expected should the events actually occur. That is, there is a small chance that the actual risk is greater than presented, but a very large chance that the actual risk is less.

Often, there are no differences between accident impacts among the alternatives, largely as a result of conservative approaches used in accident frequency and public consequence. The inventories used in the analyses are typically those of permitted or administrative limits (i.e., controls on the maximum amounts of material that can be processed at one time and/or in storage), rather than operational values (i.e., the actual amount of material needed to perform the task). The operational values would be more likely to change among the alternatives. The administrative limits or inventories are selected so that the analyses are sufficiently conservative and bounding to cover maximum possible operational values. The accident frequencies depend upon the accident initiators, such as an aircraft crash, earthquake, or wildfire. These particular initiators are independent of the operations and of inventory; therefore, the frequency or likelihood of such an event remains constant among the alternatives. In the few cases of accidents in which the frequency depends upon operations, the variation in frequency among the alternatives does not necessarily translate into a significant change in the risk of an environmental release to the public because the value of a release is very small. Likewise, the risk to workers is affected by the change in frequency of the operations; but, the consequence of a single accident remains the same. These details for specific accidents appear in volume III, appendix G.

5.1.11.12 Summary of Methodology for Supplement Analysis, SSM PEIS

The DOE is preparing a Supplement Analysis for the SSM PEIS (DOE 1996d) in accordance with an order issued by the U.S. District Court for the District of Columbia, resulting from a lawsuit filed against the DOE (chapter 1, section 1.5.2). The Supplement Analysis will: (1) assess the significance of recent seismic studies at LANL and (2) re-examine the plausibility of a building-wide fire at TA–55. With respect to the seismic analyses, the Supplemental Analysis will reflect the differences between DOE's understanding of seismic risk at the time the SSM PEIS and its ROD were prepared and the understanding of seismic risk at the completion of recent seismic studies (the last studies are expected to be finalized in March 1999). This analysis will reflect the difference, if any, in terms of both the frequency of the bounding seismically induced accident and the consequences of such an accident. This difference will then be examined for significance with respect to DOE's assignment of the pit production mission to LANL, as reflected in the SSM PEIS ROD.

With respect to the building-wide fire analyses, two types of accident scenarios will be considered: process and natural phenomena events. In addition, an analysis of the plausibility of a building-wide fire due to sabotage will be included in the Supplement Analysis. The process events will look at various classes of fire initiation (e.g., flammable material, electrical fires, equipment malfunctions, etc.). These process scenarios

will be compared to historical data for glovebox and laboratory fires from the DOE complex, as well as from industry data to ensure a complete understanding of possible ways that fires could start at TA–55. These fires then will be analyzed for ways in which they could propagate throughout the Plutonium Facility (PF)–4 complex (including analyses for potential failure of the various barriers to fire propagation). These considerations of how and where a fire could start and then spread to envelop the entire PF–4 facility will be developed into an analysis of a building-wide fire at the LANL Plutonium Facility (PF–4 at TA–55).

The natural phenomena event that will be considered as part of the Supplement Analysis will be the seismically induced fire at TA–55. This analysis will look at the fragility of gloveboxes, cable trays, flammable gas cabinets, etc., in order to compare to postulated ground accelerations. Essentially, the analysis will examine the means to start fire in TA–55 through the seismically induced damage of material or equipment in the building. The analysis then will consider the spread of the fire throughout the building because of damaged fire barriers or the presence of material that is no longer contained because of damage from ground accelerations.

The plausibility of a building-wide fire due to sabotage will be examined, consistent with existing DOE threat guidance regarding sabotage and the tools and analyses routinely used to assess vulnerability to sabotage events. The nature of such analyses is that the result will be presented in terms of the potential that the attempted sabotage would be defeated; that is, the potential for the attempt to be detected and prevented or controlled prior to the saboteur's objective being met. This analysis is likely to be classified, in accordance with U.S. laws, due to the highly sensitive nature of information regarding LANL security features and their performance.

5.2 IMPACTS OF THE NO ACTION ALTERNATIVE

5.2.1 Land Resources

5.2.1.1 *Land Use*

Common to all four alternatives are ongoing environmental restoration activities. These include the decontamination and demolition of facilities and cleanup of land disposal sites located across LANL. Upon completion of restoration activities, these individual sites could be made available for different uses. It is currently estimated that these restoration actions would be ongoing over most of LANL for about the next 10 years. As sites are remediated, it is currently planned that the newly available site land uses would revert to the current land use category of the surrounding TA location. In the case of environmental restoration sites, this would change these areas back to Research and Development or Explosives land use categories from the Waste Disposal land use category designation. Because most of the sites are relatively small in size, this reversion will not result in significant land use acreage changes overall within the different categories of use. In the case of those TAs located next to the Los Alamos townsite, current evaluation of these areas reveals that they are not likely to undergo total decontamination or demolition and evacuation within the foreseeable future, so, accordingly, their land use category designations would not be expected to change within that time frame.

No changes to land use categories are anticipated from activities that are unique to this alternative. Activities identified for the key facilities under this alternative would occur primarily within existing facilities or within near proximity to them in disturbed areas and within the same type of land use category.

5.2.1.2 *Visual Resources*

Common to all four alternatives analyzed are environmental restoration activities that include the decontamination and demolition of facilities and cleanup of land disposal sites located across LANL. Upon completion of restoration activities, these sites will undergo soil stabilization through such efforts as vegetation reseeding or the installation of a site covering such as asphalt or concrete, dependent upon the identified future site uses. There will be a time period from the onset of site remediation through final site restoration when the viewshed will be minimally altered by the introduction of heavy equipment and vehicles and by any subsequent areas left bare of vegetation. Although some sites could be bare of vegetation or only sparsely covered for several subsequent growing seasons, this effect would be temporary and minor overall in nature. These sites are usually rather small in size and some may already be within developed, disturbed, or cleared areas.

No major changes to visual resources are anticipated from activities that are unique to the No Action Alternative. Construction activities identified for the key facilities under this alternative would occur within near proximity to existing buildings and parking areas in already disturbed locations. There would be a minimum of clearing activities required and these would be limited to a few acres. Fugitive dust generation during construction would be minimal and temporary. It would not be expected to change the overall air quality, nor would the ongoing operations at these facilities once they were initiated. There could be some changes at LANL's key facilities under this alternative that add to use of artificial nighttime personnel safety lighting around buildings and parking lots. These light sources would usually shed areas of localized light within the immediate vicinity of the building area and would not be expected to pose an adverse effect to wildlife in the area. Use of these additional

light fixtures could result in an extremely slight increase in overall LANL area levels of light pollution that is unlikely to result in an expanded visibility of LANL by nighttime viewers located across the Rio Grande Valley.

5.2.1.3 *Noise*

Common to all four alternatives is LANL's continued contribution to the background noise generation with the Los Alamos County area. This background noise level is expected to remain at or near current levels for most of the foreseeable future regardless of the alternative that is implemented. There is no single representative measurement of ambient noise available for the LANL site. The upper regulatory limit for levels of noise experienced over a 16-hour period for workers is 80 decibels (dB) on the A-weighted frequency scale (dBA) (29 CFR 1910.95). Adverse permanent health effects are not expected to occur with levels of sound occurring constantly for up to 16 hours that are lower than that upper bounding regulatory limit. It is not anticipated that the background levels of noise associated with LANL activities under any of the four alternatives would approach this upper limit sound level based upon estimates of potential levels of site activities associated with each alternative relative to the existing environment.

The levels of noise and short-range ground vibrations generated by environmental restoration activities are consistent with those produced by most construction activities. Heavy equipment use, such as the operation of bulldozers, loaders, backhoes, and portable generators, typically produces noise with mean levels ranging from 81 to 85 dBA. For a comparison with these noise levels, normal conversation is usually conducted at a sound level of about 60 dBA (DOE 1995a). If heavy machinery were to be operated over a 16-hour period so that it produced noise at levels above 80 dBA constantly, it would be considered to be unsafe for workers. However, these noises are generally produced for short time periods or even sporadically. While occasional short spurts of site activities may result in noise levels in excess of 80 dBA, these are expected to be well within the levels of noise considered to be safe for likely exposure time durations of one-half hour (100 dBA) to one hour (96 dBA). Hearing protection is provided and worn by workers, as appropriate according to their standard operating procedures to afford them greater hearing protection. Additionally, some minor interior and outdoor construction activities are common across all alternatives. Noise produced by these activities would be mostly noticed by LANL workers at the site performing those activities; these workers would also be provided with hearing protection as part of their standard operating procedures.

Noise from these LANL construction-type activities may be somewhat noticeable to nearby members of the public, especially in the case of off-site environmental restoration activities. Because these activities are conducted during the daytime hours for short continuous durations, it is unlikely that the noise levels and ground vibrations produced by these activities would be sufficient to result in an adverse impact to the public. Nor are the noise levels likely to adversely affect sensitive wildlife receptors or their habitat. If certain sensitive wildlife species are found to occupy habitat areas near locations where these types of activities need to occur, or if the occupancy status of these habitat areas is unknown, it may be necessary to plan these activities so that they take place outside of the species' breeding seasons or else other special protective measures would need to be planned and implemented (e.g., hand digging).

Similarly, it is unlikely that workers, the public, or sensitive wildlife receptors would be adversely impacted by explosives testing that is common to some degree over the four alternatives. Workers are allowed to experience up to 100 impulsive/impact noise events at a maximum of 140 dBA per day and are kept

away from harmful noise levels and air blasts by gated exclusion zones that control their entry into explosives firing site detonation points. The public is not allowed within the fenced TAs that have firing sites, and as mentioned in chapter 4 (section 4.1), noise levels produced by explosives tests are sufficiently reduced at locations where the public would be present to preclude hearing damages. Various studies are currently underway to gain an understanding of the effect of noises on sensitive wildlife species. The continued well-being of LANL's resident and long-term migratory populations of these sensitive species indicates that the level of noise generated by explosives testing under the No Action Alternative would at least be tolerated by these particular species.

Implementing the No Action Alternative would be expected to result in the previously discussed effects common to all alternatives. There would be no other anticipated effects unique to this alternative.

5.2.2 Geology and Soils

The information provided from the geology and soils sections feeds into several other sections within the SWEIS, such as human health, accidents, and ecological risk.

5.2.2.1 *Seismic Events or Volcanic Eruptions*

LANL operations under the No Action Alternative do not include activities that could trigger seismic events or volcanic eruptions (e.g., underground nuclear tests, operation of injection wells). Therefore, it is unlikely that operations under the No Action Alternative will have any geological impacts. Geologic hazards that are important components of accident scenarios are discussed in section 5.1.11.

5.2.2.2 *Slope Stability/Soil Erosion*

LANL operations under the No Action Alternative do not include any new activities that would result in any additional slope stability impacts. As discussed in section 4.2, the potential for rockfall and landslides and the historic downward cutting or erosion of surface water streams in the LANL regions, which results in steep canyon walls, will continue over time. These processes may destabilize supporting rocks. These processes will continue under the No Action Alternative; however, no new facilities near the canyon walls are planned. New rock catchers similar to those installed at TA–2 for the Omega West reactor should not be necessary under the No Action Alternative. All new activities that will disturb soils, such as environmental restoration activities, will continue to use mitigative measures (e.g., plastic lined trenches and the construction of flow barriers) to minimize the effect of surface runoff and soil erosion.

5.2.2.3 *Soils*

Soils in the area around LANL contain chemicals and radioactive materials, including those that are naturally occurring as well as those due to past LANL activities and worldwide fallout. These have the potential to affect human health and the environment. Most of the soil contamination due to LANL operations occurred as a result of past practices. (This contamination is referred to as "legacy contamination.") These past practices were associated with surface impoundments and disposal areas; experimental reactors; inactive firing sites; aboveground and underground storage tanks; PCB transformers; incinerators; chemical processing; shop machining that resulted in radioactive waste; and operations to develop, fabricate, and test explosive components for nuclear weapons. Although most of these activities are still ongoing at LANL, with the exception of underground testing, environmental regulations have become

more stringent, and management of LANL operations is more proactive in minimizing such contamination.

Under the No Action Alternative, as sites are remediated, legacy soil contamination will be reduced. Legacy contamination is being addressed by the LANL Environmental Restoration (ER) Project, which is described in chapter 2 (section 2.1.2.5) of the SWEIS. In the future, consistent with the trend analyses discussed in chapter 4 (section 4.2.3.1), most radionuclides in soils, particularly tritium and uranium, from both on-site and off-site areas should continue to decrease. Contaminants such as DU, beryllium, lead, copper, and others are produced at firing sites and are of potential concern for deposition in sediments and soils. ER data to date show no appreciable difference between sediment samples and off-site samples (volume III, appendix D, Table D.3.4–1). Although a similar study is not available for soils because sediments are narrow bands of canyon bottom deposits that can be transported by surface water, this indicates that off-site deposition from runoff resulting from past firing site activities is minimal. Section 4.3.1.4 presents more information on sediments. When comparing LANL historical levels of firing sites activities with the No Action Alternative, historical levels during the time of peak activity (1980 to 1985) were approximately 2.8 times greater than proposed for the No Action Alternative (LANL 1995d). As a result, ongoing operations under the No Action Alternative should have little potential to contribute substantially to soil contamination, and as more remedial actions projects are completed, the overall levels of soil contamination will be reduced.

5.2.2.4 *Mineral Resources*

Although there is the potential that sand, gravel, and pumice deposits may exist within the LANL boundaries as discussed in section 4.2.4, the No Action Alternative will not affect the availability of these materials for mining purposes. The disturbed area for new construction activities associated with the new facilities or environmental restoration are small in comparison to the overall 43 square miles (111 square kilometers) of land that LANL occupies and, as discussed in section 5.1.1, are not in land use areas designated for mining activities.

5.2.3 Water Resources

5.2.3.1 *Surface Water*

The primary sources of potential impacts to surface water at LANL are the NPDES outfalls and transport of sediments contaminated from historic LANL activities. For the No Action Alternative, there are no new activities that will result in changes in stormwater runoff.

The volumes of effluent discharged into each watershed for the No Action Alternative are given in Table 5.2.3.1–1. In volume III, appendix A, Table A.1–1 presents a more detailed table of the NPDES outfalls for all four alternatives by facility (key and non-key), watershed, and location. In all of the alternatives there are no outfall discharges into the Barrancas, Bayo, Potrillo, Frijoles, Ancho, and Chaquehui watersheds. Ancho and Chaquehui canyons have baseline flows but no projected flows for the alternatives. Pueblo and Guaje watersheds have 1 million gallons (3.8 million liters) or less per year. For the No Action Alternative, 55 outfalls from key and non-key facilities discharge into eight separate watersheds. The estimated total discharge into all watersheds under the No Action Alternative is 261 million gallons (988 million liters) per year. This is an increase from the index effluent volume of 233 million gallons (882 million liters) discharged, as reflected in section 4.3. The number of outfalls remains constant across the alternatives.

TABLE 5.2.3.1–1.—*NPDES Discharges by Watershed Under the No Action Alternative*[a]

WATERSHED	#OUTFALLS		DISCHARGE, MGY					
			KEY FACILITIES		NON-KEY		TOTALS	
	INDEX	NA	INDEX	NA	INDEX	NA	INDEX	NA
Ancho	2	0	0.1	0.0	0.0	0.0	0.1	0.0
Cañada del Buey	3	3	0.0	0.0	6.4	6.4	6.4	6.4
Chaquehui	1	0	0.0	0.0	5.8	0.0	5.8	0.0
Guaje	7	7	0.0	0.0	0.7	0.7	0.7	0.7
Los Alamos	12	8	19.2	30.6	0.5	0.2	19.7	30.8
Mortandad	12	7	42.0	29.6	10.9	5.1	52.9	34.7
Pajarito	17	11	8.4	1.8	0.8	0.8	9.2	2.6
Pueblo	1	1	0.0	0.0	1.0	1.0	1.0	1.0
Sandia	11	8	4.4	42.7	103.5	127.9	107.9	170.6
Water	21	10	29.5	14.1	0.0	0.0	29.5	14.1
Totals	87	55	103.6	118.8	129.6	142.0	233.2	260.9

MGY = millions of gallons per year, NA = No Action Alternative

[a] NPDES Information Sources: Index information was provided by the Surface Water Data Team Reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Outfall flow projections for the alternatives were based on the outfalls remaining as of November 1997. Additional outfalls may be eliminated in the future, as discussed in the *Environmental Assessment for Effluent Reduction* (DOE 1996e), as well as several other outfalls that may be closed as part of LANL's ongoing outfall reduction program.

NPDES outfall effluent quality during the 10-year period analyzed (1997 through 2006) is expected to be similar to or improved over the effluent quality discharged during the period 1991 through 1995. LANL actions to improve compliance with permit conditions are continually being taken, including elimination of outfalls, improvements and corrective actions at specific outfalls, and implementation and completion of the Waste Stream Characterization Program and Corrections Project. Furthermore, several of the outfalls contain stormwater only; the cleanups at ER Project sites that will occur during the period of the SWEIS may result in improvement in the quality of the effluent in outfalls containing stormwater. As can be seen from Table 5.2.3.1–1, as of November 1997, 32 of the 87 index NPDES outfalls will be reduced to zero flow, resulting in 55 outfalls for the No Action Alternative (this is the case for all the alternatives). As the LANL outfall reduction program continues, it is anticipated that even more outfalls will be eliminated. No new outfalls are anticipated under any of the alternatives.

Another improvement to outfall effluent quality (in relation to the period 1991 through 1995) has occurred as a result of the improvements made at the High Explosives Wastewater Treatment Facility (HEWTF) (DOE 1995b). The new HEWTF, completed in October 1997, came on-line in February 1998 and will minimize the use of water in high explosives processes and will treat all remaining high explosives-contaminated wastewater at the new treatment facility. These changes will improve the quality of effluent from the HEWTF outfalls across the alternatives.

Improvements are also planned for outfall 051 at the TA–50 RLWTF. The effluent from the RLWTF have exceeded the DOE-Derived

Concentration Guide (DCG) for the public for the radionuclides americium-241, cesium-137, tritium, plutonium-238 and plutonium-239, and strontium-90 during the period 1990 through 1995 (LANL 1992, LANL 1993, LANL 1994, LANL 1995c, LANL 1996b, and LANL 1996c). A treatment system will be operational by early 1999 that will reduce concentrations of all of the above radionuclides, except tritium. Table 5.2.3.1–2 lists, for the above radionuclides, the average concentrations from 1990 through 1995 effluent, the predicted concentrations following treatment upgrades, and the DOE-DCGs for the public. The newly installed treatment system will result in concentrations of these radionuclides in effluent that will meet the DOE-DCGs for the public.

For liquid radioactive effluents, the "as low as reasonably achievable" (ALARA) and "best available technology" (BAT) processes are adopted, to determine the appropriate level of treatment. If discharges are below the DCGs reference values at the point of discharge to a surface waterway, generally no further treatment is required due to cost benefit considerations. Because the average tritium concentration (311,203 picocuries per liter) is well below the DOE-DCG (2,000,000 picocuries per liter), no further treatment of tritium was considered necessary. In addition, there is currently no practical treatment technology for tritium removal from the dilute concentrations present in the RLWTF effluent.

The effluent from the RLWTF has also exceeded the New Mexico Water Quality Control Commission (NMWQCC) standard for nitrate as nitrogen of 10 milligrams per liter. A nitrates removal system is being installed as part of the RLWTF improvements that will be operational by mid 1999. This new system will reduce the nitrates concentration levels below the NMWQCC standard.

As discussed in chapter 4 (section 4.3.1.2), LANL conducts a variety of construction, maintenance, and environmental activities that result in excavation or fill within water courses, which are waters of the U.S. under Section 404 of the *Clean Water Act*. These activities are done pursuant to 404 permits issued by the Army Corps of Engineers and certified per Section 401 by NMED. Each permit is issued pursuant to one or more specific nationwide permits. These include relevant permit conditions to protect water quality and wildlife that must be complied with by LANL and its construction contractors. The NMED also adds conditions as a part of its Section 401 certification that require application of "best management practices" to ensure satisfaction of New Mexico stream standards. Under the No

TABLE 5.2.3.1–2.—*TA–50 Radionuclide Summary*

RADIONUCLIDE	AVERAGE CONCENTRATIONS 1990 TO 1995[a]	PREDICTED CONCENTRATION AFTER TREATMENT[b]	DOE-DCG (PUBLIC)
Americium-241	155	25	30
Cesium-137	804	80	3,000
Tritium	311,203	311,203	2×10^6
Plutonium-238	66	17	40
Plutonium-239	28	27	30
Strontium-90	659	66	1,000

Note: All results are given in picocuries per liter.
Sources: [a] LANL 1992, LANL 1993, LANL 1994, LANL 1995c, LANL 1996b, and LANL 1996c; [b]Vance et al., 1996

Action Alternative, LANL will continue to comply with these permit requirements and use "best management practices" to ensure satisfaction of New Mexico stream standards.

As discussed under section 5.1.2, Water Resources Methodology, only the canyons with increased flows over the index are discussed in detail. It is assumed that for canyons with NPDES flows that are the same or reduced from the index flows, the impact will be negligible. Canyons that have an increase in outfall flows over the index are Los Alamos and Sandia Canyons. In Los Alamos Canyon the overall increase in flow of 11 million gallons (42 million liters) per year from the index is from the outfalls associated with the LANSCE Facility. In order to assess potential impacts, one needs to identify the types of contaminants that could originate from these outfalls and what type of contaminants may be transported off the site. The LANSCE outfalls with increased flow are 03A–047, 03A–048, and 03A–049. These outfalls are of the type containing cooling tower blowdown, evaporative coolers, chillers, condenser and air washer blowdown (Table 4.3.1.3–2 and Figure 4.3.1.3–1 in chapter 4 [legend numbers 18, 19, and 20] provide information regarding type and location, respectively). The primary noncompliance issues associated with these outfalls are for arsenic. LANL is in the process of designing a long-term corrective action that should help to eliminate future exceedances of arsenic. Corrective actions being evaluated include use of nontreated redwood and replacement of the wooden cooling towers with new units constructed of steel, fiberglass, and plastic. In 1996, outfalls 03A–048 and 03A–049 had a total of six arsenic exceedances; however, 1996 surface water monitoring stations for Los Alamos Canyon show levels of arsenic of less than 3 micrograms per liter, which is substantially less than the EPA drinking water standard of 50 micrograms per liter.

Elevated concentrations of tritium and other radionuclides have been detected in surface water samples in Los Alamos Canyon since the beginning of surveillance measurements in the mid 1960's. An industrial liquid waste treatment plant at TA–21 discharged effluent containing radionuclides into DP canyon, a tributary to Los Alamos Canyon, from 1952 to 1986. After 1986, the treated effluent was diverted to the TA–50 RLWTF. Up until 1989, Los Alamos Canyon received discharges containing radionuclides from the LANSCE Facility. In 1993, a cooling water leak was discovered at the Omega West Reactor (OWR). The OWR was shut down in 1992. The leak may have been occurring since beginning operation in 1956. The leak was repaired in 1993 soon after being discovered (LANL 1995c). However, the 1996 radiochemical analyses of runoff from Los Alamos Canyon (LANL 1997d) were well below the DOE-DCGs for the public. Within Los Alamos Canyon there are some relatively small areas that are being evaluated by the ER Project (chapter 2, section 2.1.2.5), where sediments may contain contaminants such as radionuclides, chemicals, and metals that are at higher levels than the LANL screening action levels (SALs). SALs are a benchmark for the potential for human health risk and are derived from toxicity data using a risk assessment approach (section 4.2.3.1). The ER Project plans to either remediate these areas or temporarily stabilize them until remediation, or permanently stabilize them such that potential transport of these contaminated sediments would be minimal. The reach in the vicinity of the LANSCE outfalls 03A–047, 03A–048, and 03A–49, is ephemeral and intermittent.

Table 4.3.1.1–1 in chapter 4 shows that the total volume of water at station E030, which is in the vicinity of these outfalls, was 160 million gallons (606 million liters) per water year in 1995. This is large in comparison to the additional 11 million gallons (42 million liters) identified in the No Action Alternative. Based

on surface water monitoring results, particularly for arsenic and radiochemical analysis, and the relatively small increases in flow in Los Alamos Canyon as compared to the naturally occurring flows, the impacts to surface water from the increased flow in Los Alamos Canyon should be negligible.

Sandia Canyon has a small drainage area that heads at TA–3. Currently, under baseline conditions, the canyon primarily receives water from the cooling tower at the TA–3 power plant. These effluents support a continuous flow in a short reach of the upper part of the canyon (Figure 4.3.1.3–1); but, only during summer thundershowers does stream flow reach the LANL boundary at State Road 4, and only during periods of heavy thunderstorms or snowmelt does surface flow from Sandia Canyon extend beyond the LANL boundary.

In Sandia Canyon for the No Action Alternative, out of the total 63 million gallons per year (238 million liters) increase from the index, approximately 24 million gallons (91 million liters) per year are associated with outfalls from the cooling tower at TA–3, particularly outfall 01A–001, identified as 27 in Figure 4.3.1.3–1. All effluent from the TA–46 Sanitary Wastewater Systems Consolidation (SWSC) Facility is pumped to a reuse tank adjacent to the TA–3 power plant. When the power plant is in operation, water is drawn from the tank as makeup for the power plant cooling towers, where it is either lost to the air through evaporation or discharged to Sandia Canyon via the power plant outfall 01A–001. Outfall 13S, the original outfall for the TA–46 SWSC Facility, is located at the TA–46 SWSC Facility but is not used. However, the SWSC effluent, prior to being pumped over to TA–3, must meet the NPDES discharge limits for 05S (Table 4.3.1.3–2 shows NPDES effluent limits). The additional 24 million gallons (91 million liters) per year flow at TA–3 includes the increase flow projected from the SWSC plant. The additional outfall flow at TA–3 will support the continuous flow in the upper part of the canyon. The remaining 39 million gallons (148 million liters) per year increase in flow is from another LANSCE outfall, 03A–113 at TA–53, identified as 21 in Figure 4.3.1.3–1. The effluent water quality from both outfalls 01A–001 and 03A–113 is similar to the outfalls discussed previously for cooling towers. In 1996, both outfalls 01A–001 and 03A–113 were in compliance with the NPDES permit, and the radiochemical results of runoff from Sandia Canyon were well below the DOE-DCG for the public. Within Sandia Canyon, there are some relatively small areas that are being evaluated by the ER Project (chapter 2, section 2.1.2.5) where sediments may contain contaminants such as radionuclides, chemicals, and metals that are at higher levels than the LANL SALs. The ER Project plans to either remediate these areas or stabilize them such that potential transport of these contaminated sediments should be minimal.

Figure 4.3.1.3–1 in chapter 4 shows that the flow in Sandia Canyon is ephemeral and intermittent in the vicinity of outfall 03A–113, and Table 4.3.1.1–1 shows that the total volume of water at perimeter downstream station E–125 in Sandia Canyon was less than 2 million gallons (4 million liters) per year. Increased flow from outfall 03A–113 of 39 million gallons (148 million liters) per year may be sufficient to support a continuous flow for a short reach in the vicinity of the outfall. However, transport of contaminants off the site should be negligible.

For additional information on changes in NPDES outfall flows for each outfall for all the alternatives see volume III, appendix A.

5.2.3.2 *Groundwater*

Groundwater quantity and quality impacts to the three areas of groundwater under the Pajarito Plateau (alluvial, intermediate perched, and main aquifer) that may result from implementing the alternatives over the next

10 years were evaluated. As discussed under section 5.1.2, Water Resources Methodology, only the canyons with increased flows over the index are discussed in detail. It is assumed that for canyons with NPDES flows that are the same or reduced from the index flows, the impact will be negligible.

In order to better understand the extent of the effects of LANL activities on groundwater, more monitoring wells are being installed. Once constructed, the new monitoring wells should provide data for researchers to gain better understanding of how contaminants are transported from discharge sites. Because of the many questions concerning the hydraulic characterization of the Pajarito Plateau, such as recharge mechanisms for the main aquifer and the lack of hydrogeologic detail, LANL personnel prepared a Hydrogeologic Workplan that was approved by NMED in 1998 (LANL 1998d). The first of these wells to be installed is R-9 located in lower Los Alamos Canyon near the intersection of NM 501 and NM 4. On December 10, 1997, LANL personnel found preliminary indications of low levels of tritium in two perched groundwater zones. The water in which the tritium contamination was detected lies several hundred feet above the main aquifer, and the tritium levels were below the Safe Drinking Water Standards established by the EPA. LANL has previously detected extremely low level of tritium in the deep aquifer at several existing wells. Potential impacts to groundwater for the No Action Alternative are based on the most current information available.

Alluvial Groundwater

Alluvial groundwater aquifers may vary in size, dry out, or develop in locations where they previously did not exist in response to variations in seasonal snowmelt and thunderstorm runoff and LANL NPDES-permitted discharges into the canyons (LANL 1994). Of all LANL operational factors that may affect shallow groundwater quality and quantity, variations in NPDES discharges are the most significant. The canyons that may have an overall increase in alluvial groundwater volumes as a direct result of increased NPDES outfall volumes are Los Alamos and Sandia Canyons. Quantification of alluvial groundwater volume changes is not possible due to the high degree of uncertainty in many parameters (e.g., snowmelt, rainfall, infiltration rates, evaporation rates, canyon dimensions, storage capacity of alluvium). However, increases or decreases in discharges should result in similar changes in groundwater volumes.

In terms of changes in specific outfalls, the outfalls at the TA–50 RLWFT and the TA–16 HELWTF are worthy of further discussion and are described below.

Technical Area–50 Radioactive Liquid Waste Treatment Facility. The TA–50 RLWTF, which discharges into Mortandad Canyon will have several improvements over the next 10 years. Although historic discharges have been in compliance with existing NPDES permit requirements agreed upon by the EPA and LANL, improvements in discharge quality are necessary to meet more stringent requirements coming into effect over the next several years. Improvements in treatment technology (ultrafiltration/reverse osmosis) should allow compliance with the DOE-DCGs for the public for radionuclides by early 1999. Compliance for nitrate to within the new groundwater discharge limits established by NMED will be operational by mid 1999. Tritium activity in the discharge from the RLWTF will not be affected by the improved treatment technologies (section 5.2.3.1).

LANL projections for discharges from the RLWTF into Mortandad Canyon under the No Action Alternative are 6.6 million gallons (25 million liters) per year, as compared to the RLWTF index volume of 5.5 million gallons (21 million liters) per year. This flow rate is similar to that experienced in previous years, and no substantial changes to the volume of

groundwater stored in the alluvium are anticipated.

Technical Area–16 S-Site Springs. The new HELWTF will be fully operational in mid 1998, resulting in a reduction in NPDES discharges of approximately 16 million gallons (61 million liters) per year into Canyon de Valle, a tributary to Water Canyon. This may reduce or eliminate flow in springs at S-Site.

The water quality discharging from the S-Site springs, some of which may have been contaminated by high explosives compounds and VOCs from past NPDES discharges, will likely improve due to the new HELWTF. The new plant will reduce the amount of water used in high explosives processing by 99 percent, and solvents will be extracted prior to high explosives processing rather than being discharged into Canyon de Valle.

Perched Groundwater

The Water Canyon Gallery has not been used as a source of potable water since 1991 and has not been used for boiler makeup water at TA–16 since 1994. LANL does not plan to use Water Canyon Gallery as a potable or industrial source over the next 10 years under any of the alternatives. The Water Canyon Gallery is on USFS land, and it is expected that it would only be used for wildlife watering.

Evaluations of impacts to intermediate perched groundwater quantity and quality resulting from operation changes under the alternatives are qualitative, because groundwater flow and contaminant pathways to the intermediate perched groundwater bodies are not well characterized nor understood. Chemical radionuclides in the vicinity of the outfalls with increased flow under the No Action Alternative are minimal. The type of outfalls that have increased flow are primarily from cooling tower blowdown, evaporative coolers, etc. The impacts to perched groundwater should be negligible. However, it is possible that NPDES discharges to Los Alamos and Sandia Canyons contribute to recharge to the intermediate perched groundwater and contaminant transport beneath Los Alamos and Sandia Canyons. The increase NPDES discharges to Los Alamos and Sandia Canyons may contribute to the transport of contaminants off the site. Environmental monitoring of the perched groundwater will continue, and as new wells are installed the information obtained will be used to better understand the effects of LANL on groundwater quality.

Main Aquifer Water Quality

As mentioned at the beginning of this section, new wells are being installed to better understand recharge to the main aquifer. Extremely low levels of tritium have been detected in the main aquifer (chapter 4, sections 4.3.2.2 and 4.3.2.3) and this trend will most likely continue under the No Action Alternative. Environmental monitoring of the main aquifer will continue, and as new wells are installed the information will be used to better understand the effects of LANL on groundwater quality in the main aquifer. The impacts resulting from the increased NPDES outfall flows, under the No Action Alternative, to the main aquifer water quality should be negligible.

Public Water Supply

DOE has groundwater rights to about 1,805 million gallons (6,830 million liters) per year from the main aquifer. These rights provide water, including drinking water, to LANL, Los Alamos County, and the NPS (for BNM). A conservative projection of maximum LANL water use under the No Action Alternative is 712 million gallons (2,695 million liters) per year. Los Alamos County and the NPS did not provide projections, but in 1994 the county used about 958 million gallons (3,626 million liters) from this water right, and the NPS used about 5 millions gallons

(19 million liters). Based on this information, it is expected that the water requirements of this community can be met within the existing water rights from the main aquifer.

For the purposes of modeling drawdown of the main aquifer, water usage was projected annually. The total water usage from DOE water rights was projected to average 1,593 million gallons (6,030 million liters) per year under the No Action Alternative, with a maximum annual use of 1,620 million gallons (6,130 million liters) and a minimum annual use of 1,534 million gallons (5,880 million liters).

The USGS MODFLOW model for north-central New Mexico (Frenzel 1995) was used to predict water level changes at the top of the main aquifer for the alternatives. The model includes DOE supply wells, wells for the city of Santa Fe public supply system, discharges from the Santa Fe sewage treatment plant, and 200 private and industrial wells in Santa Fe County. Details of the conceptual model, assumptions, uncertainties and limitations, and input parameters for the groundwater model are described in volume III, appendix A.

The model results reflect water level changes at the top of the main aquifer across the alternatives, given continued draw from the aquifer by DOE, Española, and Santa Fe. Table 5.2.3.1–3 shows predicted water level changes at the surface of the main aquifer during the period from 1997 through 2006 for the No Action Alternative. These changes are not all due to LANL operations; the changes for the on-site well fields and the Guaje well field are largely attributable to LANL operations and Los Alamos County. Although the water use modeled includes water use in Española and Santa Fe, the differences between the alternatives are due only to LANL operations. Springs in White Rock Canyon in the vicinity of the Buckman well field may actually increase in flow due to rising groundwater levels (from 0.1 to 3.8 feet [.03 to 1.2 meters]). The rising water levels result from the continuing recovery

TABLE 5.2.3.1–3.—*Maximum Water Level Changes at the Top of the Main Aquifer Under the No Action Alternative (1997 Through 2006)*

WATER LEVEL CHANGE IN FEET[a,b]	
AREA OF CONCERN ON SITE	
Pajarito Well Field	-13.2
Otowi Well Field (Well 0-4)	-12.9
AREA OF CONCERN OFF SITE	
DOE - Guaje Well Field	-8.7
Santa Fe Water Supply	
Buckman Well Field	+21.6
Santa Fe Well Field	-20.6
San Juan Chama Diversion	0.0
Springs	
White Rock Canyon Springs, Maximum Drop	0.0
White Rock Canyon Springs, Maximum Rise	+1.0
Other Springs (Sacred, Indian)	+3.8
San Ildefonso Pueblo Supply Wells	
West of Rio Grande:	
Household, Community Wells	+0.6
Los Alamos Well Field	+3.8
East of Rio Grande:	
Household, Community Wells	0.0

[a] Negative value (-) indicates water level drop; positive value (+) indicates water level rise.

[b] Also, the water level changes projected by the regional MODFLOW model represent average changes over a whole grid-cell (i.e., a square that is a mile on a side). They are, for the most part, not predictive of the water level changes at any single point within the cell (for example, a supply well). Pumping wells have characteristic "cones of depression" where the water surface reflects an inverted cone, and water levels at the well may be quite difference from levels even a few ten's of feet away. Whether any individual well would exhibit water level changes consistent with the predicted grid-cell average change is a function of, for example, its location within the grid-cell; proximity to other pumped wells; and the individual well operation, construction, and hydraulics. Hence, the water level changes predicted by the model can only be considered qualitatively and not be considered as finite changes.

in the vicinity of the Los Alamos well field, which was shut down in 1992, and recovery in the vicinity of Santa Fe's Buckman well field, which will be shut down in 1999. Operations of both well fields are independent of the alternatives and significantly affect water levels in the main aquifer in the vicinity of the Rio Grande. Therefore, the water level changes and the resulting impacts to White Rock Canyon Springs are identical across the alternatives.

In comparison to the thicknesses of the eight model layers (total = 5,600 feet [1,707 meters]), the maximum drawdown predicted for DOE well fields represents a reduction of main aquifer saturated thickness of less than 1 percent. Water use projections indicate that the total volume of water to be withdrawn from DOE well fields from 1997 through 2006 is less than 0.1 percent of the main aquifer volume (22 trillion gallons [83 trillion liters]) of water in storage beneath the Pajarito Plateau. In summary, the drawdowns in DOE well fields are minimal relative to the total thickness of the main aquifer, and the volume of water to be used over the period from 1997 through 2006 is negligible relative to the volume of water in storage.

5.2.4 Air Quality

This section describes the estimated air quality impacts from LANL operations under the No Action Alternative. The discussion includes estimated impacts from nonradiological and radiological air emissions. Additional detail and information on the material in this section is included in volume III, appendix B.

5.2.4.1 *Nonradiological Air Quality Impacts*

The results of the Expanded Operations Alternative analysis of criteria pollutants demonstrate that the highest estimated concentration of each pollutant would be below the standards established to protect human health with an ample margin of safety. For criteria pollutants, the No Action Alternative emission rates are lower than those under the Expanded Operations Alternative. Therefore, criteria pollutant emissions under the No Action Alternative are also expected to be below these levels.

For toxic air pollutants, the bounding analyses (based on the emission rates under the Expanded Operations Alternative) indicate that the only pollutant emissions with the potential to exceed the guideline values under any SWEIS alternative are the emissions from High Explosives Firing Site (HEFS) operations and the additive risk from all the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center. Emissions from the firing site operations under the No Action Alternative are projected to be one-third the emissions projected under the Expanded Operations Alternative. Linear extrapolation of pollutant concentrations based on this difference in emissions results in concentrations that are below the GVs. Therefore, the pollutants released from LANL firing site operations under the No Action Alternative are not expected to cause air quality impacts that would affect human health.

As discussed in section 5.3.4.1, the combined cancer risk due to all carcinogenic pollutants from all TAs is dominated by the chloroform emissions from the HRL. Under the No Action Alternative, chloroform use is projected to be similar to current usage (about 55 pounds per year [17 liters per year], or about 15 percent less than projected under the Expanded Operations Alternative). Assuming that 100 percent of the chloroform used is emitted (and assuming no change in other carcinogenic pollutant emissions as compared to those under the Expanded Operations Alternative), the estimated combined incremental cancer risk at the Los Alamos Medical Center is slightly above the guideline value of 1.0×10^{-6}. Because it is known that less than 100 percent of the

chloroform used is emitted (as much as 25 pounds per year [8 liters per year] are disposed of as liquid chemical waste), the incremental cancer risk under the No Action Alternative would be less than the GV.

Based on the information discussed above, pollutants released under the No Action Alternative are not expected to cause air quality impacts that would affect human health and the environment.

5.2.4.2 *Radiological Air Quality Impacts*

Facility-Specific Maximally Exposed Individual

Table 5.2.4.2–1 shows the distance and direction and estimated dose to each FS MEI under the No Action Alternative. The highest FS MEI dose under this alternative was calculated to be 3.11 millirem per year, which is 31.1 percent of the regulatory limit (which is 10 millirem per year for the air pathway).

LANL Maximally Exposed Individual

The location of the highest dose from all facility emissions was 2,625 feet (approximately

TABLE 5.2.4.2–1.—*Facility-Specific Maximally Exposed Individual Information—No Action Alternative*

FACILITY	MEI DISTANCE feet (meters)	DIRECTION	DOSE[a] (mrem/yr)
TA–3–29 (CMR Building)	3,576 (1,090)	North	0.43
TA–3–66 (Sigma Building)	3,560 (1,085)	North	0.43
TA–3–102 (Machine Shops)	3,379 (1,030)	North	0.34
TA–11 (High Explosive Testing)	4,298 (1,310)	South	0.31
TA–15/36 (Firing Sites)	7,415 (2,260)	Northeast	2.26
TA–16 (WETF)	2,886 (880)	South-Southeast	0.31
TA–18 (Pajarito Site: LACEF)	2,821 (860)	Northeast	1.73
TA–21 (TSTA and TSFF)	1,050 (320)	North	1.41
TA–48 (Radiochemistry Laboratory)	2,920 (890)	North-Northeast	1.66
TA–53 (LANSCE)[b]	2,625 (800)	North-Northeast	3.11
TA–54 (Area G)[c]	1,197 (365)	Northeast - LANL Boundary	0.75
	5,331 (1,625)	Southeast - White Rock	0.43
TA–55 (Plutonium Facility)	3,691 (1,125)	North	1.66

[a] For each FS MEI, the total dose was calculated by adding the contributions from each modeled facility. Note that an MEI is assumed not to leave or to take protective measures.
[b] This is also the location of the LANL MEI. Five specific sources were modeled from TA–53. These include the TA–53 ES–2, ES–3, IPF, LEDA and combined diffuse emissions.
[c] Two FS MEI locations were considered for TA–54, because Area G borders San Ildefonso Pueblo land. The first is an MEI location at the LANL boundary, 1,197 feet (365 meters) northeast of Area G. No person from the Pueblo currently is known to live along this boundary. The second is an actual MEI location in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

800 meters) north-northeast of LANSCE. This location defines the LANL MEI. The dose to this location from all facility emissions was calculated to be 3.11 millirem per year.

Population Dose

The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated for emissions from all facilities and found to be 13.59 person-rem per year. The values reported for population doses for this alternative, as well as the other alternatives, are higher than has been reported in the recent annual environmental reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. (For example, LANSCE and firing site operations currently planned are higher than achieved in recent years.) The material throughput at the different facilities under the various alternatives is presented in chapter 3 (section 3.6).

An examination of the detailed data contained in appendix B (volume III) reveals that most (52 percent) of the collective population dose comes from emissions from the TA–15/36 firing sites. This is in contrast to the dose delivered to the LANL MEI, most of whose dose comes from LANSCE. The reason is that the firing site emits long-lived uranium isotopes; whereas, the LANSCE facility emits short-lived air activation products that decay quickly. Collectively, diffuse emissions (including those from TA–15/36) account for 52.8 percent of the population dose under the No Action Alternative.

Isodose Maps

Isodose maps present the estimated doses within a 50-mile (80-kilometer) radius from LANL. These isodose maps are shown in Figures 5.2.4.2–1 and 5.2.4.2–2. The isodose lines represent the summation of all modeled emissions and their subsequent estimated annual doses. Due to the summation, the resulting lines do not necessarily match individual wind rose patterns. This is due to the multiple facilities that contribute to the summed doses, as well as the distances displayed in the figure. To determine the dose at a specific location, individuals need only find the location on these maps and interpolate between the isopleths.

5.2.5 Ecological Resources, Biodiversity, and Ecological Risk

This section discusses potential impacts to ecological resources (including wetlands), biodiversity, and ecological risk. Under the No Action Alternative, LANL operations would continue at their currently planned level. Construction activities would be limited largely to those required to maintain facilities for currently authorized activities. Because of this continuation of current operational levels, there would not be any appreciable change to landscape features.

Ecological Resources and Biodiversity

A continuation of the current LANL facility operation and planned actions as reflected in DOE management plans that implement currently assigned programs would enhance present biological resources (including protected and sensitive species), ecological processes, and biodiversity. This enhancement would result largely from ongoing actions and plans whose objectives are to eliminate or reduce pollutants that could potentially pose a risk to biological systems, and biological management plans that would be incorporated into existing LANL operations to protect and enhance its biological resources. Key actions and plans and their objectives are briefly stated as follows:

- *Environmental Restoration Project.* Objectives are to remediate potentially contaminated sites resulting from historic

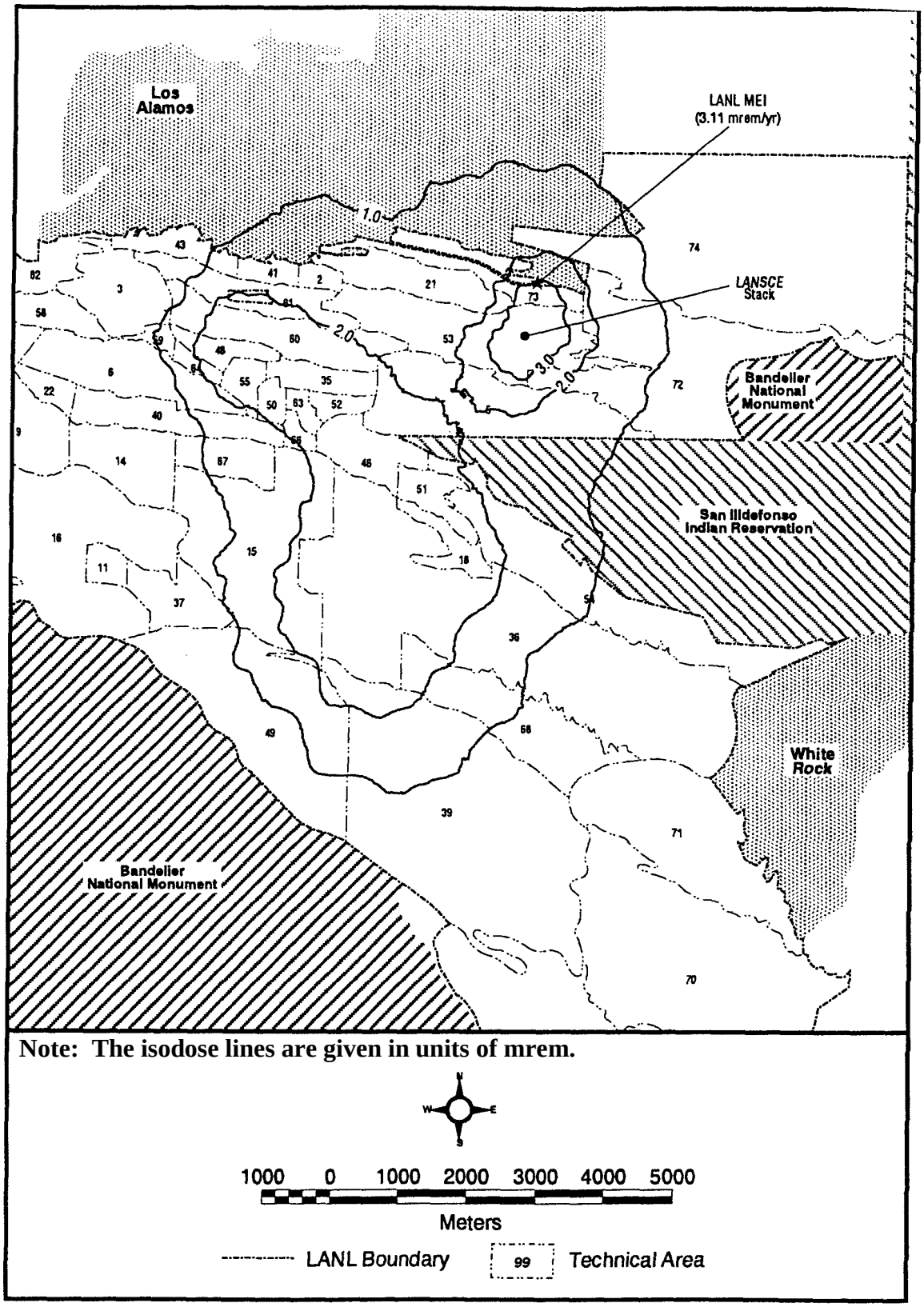

FIGURE 5.2.4.2–1.—*Isodose Map Showing Doses Greater Than 1 Millirem per Year for the No Action Alternative.*

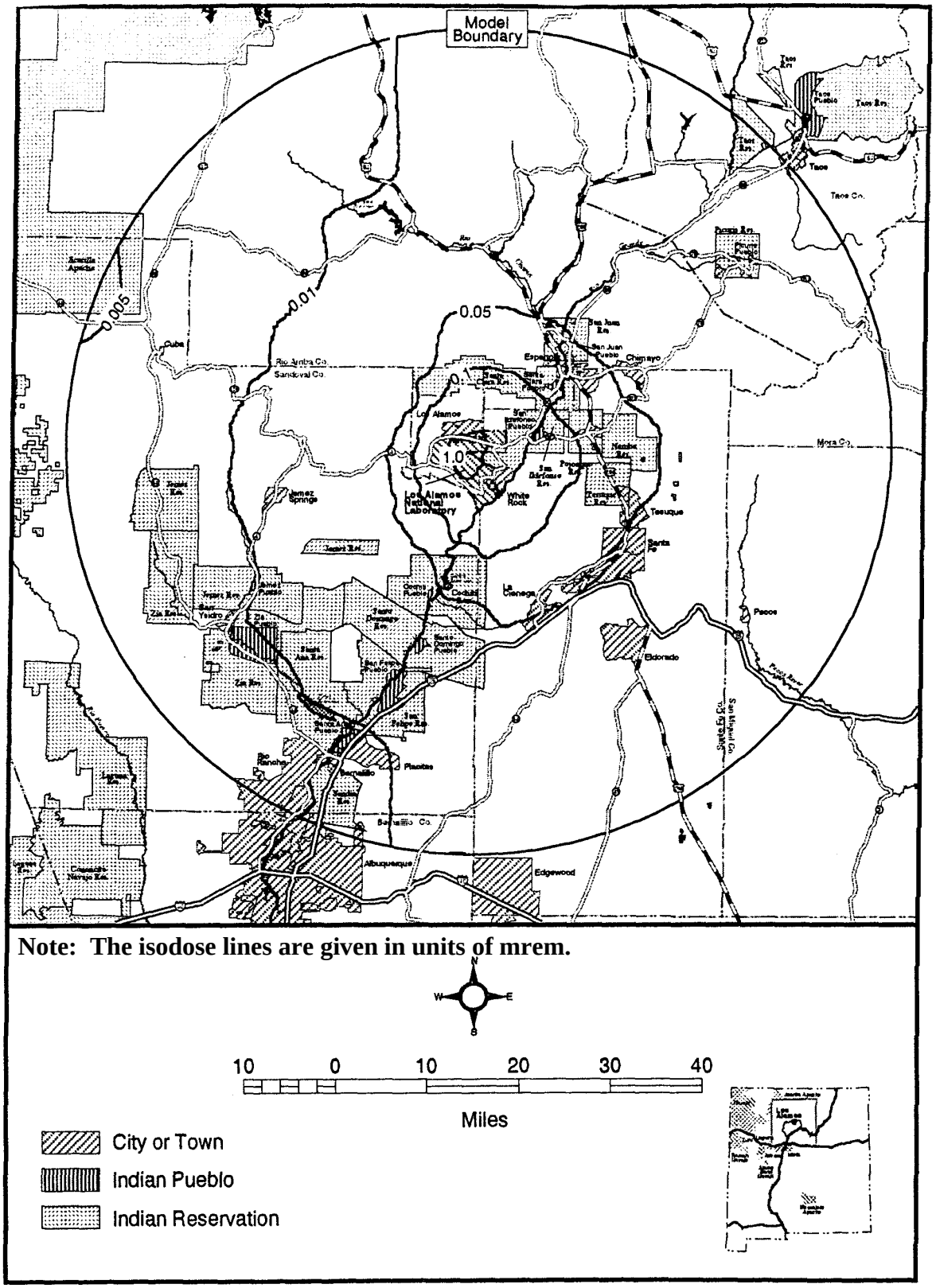

FIGURE 5.2.4.2–2.—***Isodose Map Showing Doses Less Than 1 Millirem per Year for the No Action Alternative.***

treatment, storage, and disposal practices at LANL; meet the environmental clean-up requirements of the *Resource Conservation and Recovery Act* (RCRA) (42 U.S.C. §6901); and decontaminate and decommission facilities previously contaminated by radioactive and hazardous materials, such restorations can result in ecological disturbance during individual actions.

- *Waste Stream Characterization Program and Outfall Reduction Program.* Objectives are to reduce the possibility that LANL activities could produce wastewater discharges into the ecosystem.
- *Construction of a New High Explosives Wastewater Treatment Facility.* Objectives are to further improve outfall effluent quality by reducing the amount of water used in high explosives (HE) processing, eliminating non-HE industrial wastewater, preventing contamination of stormwater, and treating all HE-contaminated wastewater.
- *Completion of New Wastewater Treatment System at the TA–50 RWLTF.* Objective is to reduce radionuclide and nitrate concentrations in the treatment plant effluent.
- *Threatened and Endangered Species Habitat Management Plan.* Objectives are to identify the combined effects of many LANL projects on threatened, endangered, or sensitive species; provide long-range planning information for all future LANL projects; and develop long-range management measures to protect habitat for these species (see chapter 4, section 4.5.1.6).
- *Initiate Natural Resources Management Plan.* Objectives will be to determine conditions and to recommend management measures that will restore, sustain, and enhance the biological quality and ecosystem integrity at LANL within the context of a dynamic Pajarito Plateau ecosystem (see section 4.5.1.6).

In addition to these continuing actions and plans, studies are underway to make a more quantitative assessment of trophic level transport of radionuclides of interest. These assessments would refine measures being taken for protection of biological resources should any concerns arise.

These ongoing programs and planning actions would not only benefit resources on LANL but would contribute to a more regionalized management strategy, thereby improving the current fragmented and compartmentalized management by five or more agencies. A regionalized management strategy would significantly lessen the decline or loss of regional biological diversity resulting from anthropogenic disturbances (e.g., risk of catastrophic wildfire, erosion, elk overpopulation, and habitat loss and fragmentation). The roots of these environmental issues predate LANL, yet are common to (or sensitive to) all alternatives evaluated in the SWEIS. Their resolution is to be found through a philosophy of environmental stewardship, permanent interagency coordination, and development of a joint planning and management program.

The presence of LANL, with its highly restricted access and limited planned land disturbing activities, would continue to provide habitat and protection for a rich diversity of plants and animals, including an appreciable number of threatened, endangered, and other sensitive species. The presence of measures to protect threatened and endangered species (e.g., habitat protection, access and activity restrictions, and noise and light restrictions), combined with surveys and studies associated with the stated Threatened and Endangered Species Management Plan, would continue to protect and conserve these protected species.

Terrestrial and Wetland Habitat

Common to the No Action, Reduced Operations, and Greener Alternatives, is the

absence of activities that would result in the loss of terrestrial habitat. Further, a reduction in the number of wetlands as a consequence of outfall reduction would reduce wetland habitat under all four SWEIS alternatives.

As demonstrated in Table 5.2.3.1–1 of section 5.2.3, Water Resources, there would be a reduction in the number of outfalls over the index period and an increase in the volume of effluent discharged by some remaining outfalls. This reduction includes many of the 27 outfalls proposed for closure and evaluated in the *Environmental Assessment for Effluent Reduction* (DOE 1996e), as well as several others that have been closed as part of LANL's Outfall Reduction Program. While it is possible that not all 27 closures discussed under effluent reduction may be realized, this is the planned reduction, as reflected in the *Environmental Assessment for Effluent Reduction*. Thus, the elimination of 27 outfalls is used as the bounding case for the purposes of this SWEIS. The number of outfalls remains constant across all four alternatives.

The elimination of industrial effluent from up to 27 outfalls could result in a decrease of approximately 8.6 acres (3.5 hectares) of wetlands. Most of these are linear riparian wetlands that vary in size from 0.001 acre (0.0004 hectares) to 4.4 acres (1.8 hectares). Many wetlands associated with outfalls have other water sources that have contributed to the establishment and maintenance of the wetlands. Consequently, some outfalls would continue to have the same plant species in about the same proportions as they do now. Other outfall wetlands would experience a moderate amount of replacement of vegetation with species that require less water. Still, many would undergo a more pronounced change in character, with a high degree of replacement by other species requiring less water. The reduction would result in a localized die-off of aquatic invertebrates and possibly some small numbers of small mammals and amphibians with limited ranges. These species would be replaced with those characteristic of drier habitats. There would be very localized decrease in biodiversity. Cessation of some watering sources may cause some localized displacement of large- and medium-sized animals. However, because larger mammals can travel to other available water sources, daily and seasonal movement may only change slightly.

The possible loss of up to 8.6 acres (3.5 hectares) of wetlands associated with the elimination of industrial effluent from up to 27 outfalls, combined with about 5 acres (2 hectares) from past and planned LANL actions could result in the cumulative loss of about 13.6 acres (5.5 hectares). Because there are about 161 wetlands covering about 50 acres (20 hectares) within LANL boundaries, about 36.4 acres (14.7 hectares) or 73 percent of all wetlands would still remain available for wildlife use. The cumulative effect of these actions on large mammals, such as deer and elk, would be changes in animal distribution and patterns of movement. As industrial effluent from outfalls continues to be eliminated over the next 3 to 5 years, these large mammals would adapt and utilize other available water sources, both natural and human caused. Any measurable effects of a continuing reduction in outfalls could be a local reduction in elk density at LANL, but this would not likely alter the overall pattern of elk movement, use, and numbers in the Jemez Mountains.

An increase in the quantity of discharge from remaining outfalls under the No Action Alternative, specifically in Sandia and Los Alamos Canyons, is within historic fluctuations, which are governed by project types and operational levels. This increase would not be expected to significantly affect channel morphology nor associated biological features. An increase in flow holds the potential for the expansion of existing wetlands. However, because of the narrow canyon floors and steep canyon sides, this potential may be only marginal. There could be a small increase in opportunity for wildlife watering.

The biological and ecological consequences of a wildfire on LANL are potentially significant. LANL and surrounding lands are generally forested areas with high fuel loading. Although fire is a natural part of biological systems, anthropogenic influences such as grazing, logging, and fire suppression have produced conditions that can have pronouced 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., the Water Canyon, La Mesa, Dome, and Oso Complex fires), the potential for wildfires encroaching on LANL exists. Biological and ecological consequences of a severe wildfire involving LANL would result from loss of habitat soil erosion, sedimentation, and increased risk from contaminants. The loss of forest or woodland habitat would result in a temporary loss of habitat for a broad spectrum of animals. As vegetation is re-established, an altered community of animal species would 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 to threatened and endangered species (e.g., the Mexican spotted owl) from a wildfire would 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. Perhaps the most significant impact to threatened and endangered species that could be precipitated by a wildfire is the general disturbance caused by the fire-fighting effort itself (e.g., fire-fighting crews, aircraft, and vehicular traffic).

Increased runoff resulting from the burning of vegetation cover would result in a commensurate increase in water channel scouring, enlargement, and headcutting. This process and any accompanying sedimentation would have the potential to degrade or remove the limited riparian vegetation on LANL. Wetlands associated with water courses could also 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 impact of legacy contaminants transported to downstream riverine and lake ecosystems is unknown, but there could potentially be an increase in ecological risk. A more extensive discussion of the biological effects of a wildfire at LANL can be found in volume III, appendix G, Accident Analysis.

Ecological Risk

As stated (in sections 5.2.2.3, 5.2.3.1, 5.2.4.1, and 5.2.4.2), ongoing operations under the No Action Alternative have little potential to contribute substantially to soil, water, and air contamination. Contaminants such as DU, beryllium, lead, copper, and others are produced at firing sites and are of potential concern for conveyance in sediments. However, the estimated soil concentrations from future air concentrations at the firing sites would be at orders of magnitude less than those in the average background or maximum legacy contamination. Also, as more remedial action

projects are completed, the overall levels of soil and water contamination would be reduced.

Because of the absence of increased levels of contamination, there would not be an incremental change in ecological risk. There are no projected differences in firing site emissions among the No Action, Reduced Operations, and Greener Alternatives.

5.2.6 Human Health

The consequences of implementing the No Action Alternative on public health and worker health are presented below. The methodologies used to evaluate consequences are summarized in section 5.1.6 and detailed in appendix D, section D.2. Detailed discussions of the results are presented in appendix D, sections D.3 and D.4. There is a discussion of the terminology used in the human health evaluation presented in appendix D, section D.1. "Risk," as used in the Human Health Consequences section, refers to the probability of toxic or cancer mortality consequences under the specific exposure scenarios analyzed.

5.2.6.1 *Public Health*

The consequences of continued operations of LANL on public health under the No Action Alternative are presented below. The evaluation is presented in four topics: (1) the consequences of external radiation and airborne radioactivity from LANL operations; (2) consequences of chemical emissions from LANL facilities; (3) consequences of ingestion of local foodstuffs, water, and incidental intake of soils and sediments to residents, to recreational users of the canyon lands on or near LANL, and to special receptors (traditional Native American and Hispanic life styles) and; (4) a summary of consequences to the public along transportation routes (summarized from the analyses in section 5.2.10). (Risks from accidents are discussed in section 5.2.1.1.)

Regional Consequences of Airborne Radioactivity Inhalation and Immersion

As shown in section 5.2.4.2, the doses from airborne radioactive emissions from LANL were estimated to a 50-mile (80-kilometer) radius from LANSCE (the central point assumed for LANL emissions). Both facility-specific and site-wide doses were calculated (volume III, appendix B).

The location of the highest potential dose from all emissions, called the LANL MEI, was estimated to be 2,625 feet (approximately 800 meters) north-northeast of LANSCE (TA–53). This location is within the LANL reservation, and the dose to the MEI at this location is estimated to be 3.11 millirem per year, which is 0.9 percent of the backgound dose (about 360 millirem per year). This location borders the Los Alamos townsite and is a conservative estimate for a MEI from LANL-wide emissions.

Table 5.2.6.1–1 summarizes the LANL MEI dose and presents the corresponding risk of excess LCF to the MEI. These risks are presented on a lifetime basis, assuming that the LANL MEI received the estimated dose of 3.11 millirem each year for a 72-year life. The excess LCF risk was estimated to be 0.0001 over a lifetime.

The isodose maps showing both the estimated dose near LANL and to a 50-mile (80-kilometer) radius of LANL are provided as Figures 5.2.4.2–1 and 5.2.4.2–2. The collective dose to the population that lives within the 50-mile (80-kilometer) radius is given in Table 5.2.6.1–1, estimated to be 13.6 person-rem per year of operation with an estimated lifetime excess LCF risk of about 0.0068 per year of operation. (As summarized in appendix D, the lifetime risk of dying from cancer in the U.S. is more than 23 percent for men and more than 20 percent for women. Based on this rate, approximately 40,000 people

TABLE 5.2.6.1–1.—*Estimated Public Health Consequences for LANL Maximally Exposed Individual and the Population Within 50-Mile (80-Kilometer) Radius of LANL for the No Action Alternative*

PARAMETER	LANL MEI	50-MILE RADIUS POPULATION
Dose	3.11 millirem per year	13.59 person-rem per year
Excess LCF	0.00011 per lifetime (72 year)	0.0068 per year of operation

within the 50-mile [80-kilometer] radius of LANL would be expected to die from cancer.)

A level of 1 millirem per year is a benchmark used as a screen for negligible individual consequences (NCRP 1993). In the No Action Alternative, there are six facilities with FS MEIs estimated to receive at least a 1 millirem per year dose, based on contributions from all facilities to these locations (volume III, appendix B):

- LANSCE, 3.11 millirem per year to the FS MEI
- HE Testing Sites (TA–15 and TA–36), 2.26 millirem
- Pajarito Site (TA–18), 1.73 millirem
- Radiochemistry Laboratory (TA–48), 1.66 millirem
- Plutonium Facility (TA–55), 1.66 millirem
- Tritium System Test Assembly (TSTA) and Tritium Science and Fabrication Facility (TSFF) (TA–21), 1.41 millirem

External Radiation: Two Special Cases

One contribution to public dose results from jogging or hiking the access road north of TA–21 and is attributable to cesium-137 known to be on the ground within the TA in Area F (LANL 1997d). The MEI dose is not expected to change from that currently estimated as an EDE of 2.9 millirem per year (chapter 4, section 4.6). For this MEI, the excess LCF risk over a lifetime from that dose would be about 1.4×10^{-6} per year of operation, assuming that the MEI exposure was equivalent to about 24, 4-hour days per year, a very conservative estimate.

Another contribution to public dose would result from TA–18 “road-open” operations (that is, undertaken at TA–18 for which roads are not closed). About four exposures per year would be expected for the MEI (who is assumed to be passing TA–18 on Pajarito Road at the time of maximum radiation flux during an experiment) out of the 100 operations per year at TA–18. The maximum dose to the MEI per operational event was estimated 4.75 millirem. Assuming that a maximum of four events would contribute to the MEI, the annual projected MEI EDE dose would be 19 millirem per year. This would result in a lifetime excess LCF risk of about 9.5×10^{-6} per year of operation.

Nonionizing Radiation

The only uncontained nonionizing radiation source in use or planned for LANL is the microwave transmitter in TA–49. It is extremely unlikely that a member of the public would be exposed to this source. However, the consequence of a 1-second exposure at the shortest distance a person could get to the transmitter was examined (volume III, appendix D, section D.2.2.2). The consequence to a person exposed at 1,640 feet (500 meters) is negligible, elevating body temperature approximately 0.04°F (0.02°C) and not affecting biochemical processes.

Consequences of Airborne Chemical Emissions

For the nonradiological (chemical) air quality analysis, a screening was conducted for each TA within LANL to identify potential chemical emissions under normal operations of the four alternatives that would need to be assessed for public health consequences. In the analysis of the Expanded Operations Alternative (which had the greatest emissions out of the four alternatives), four TAs involved in HE testing were identified (TA–14, TA–15, TA–26, and TA–39) for public health consequence analysis for three specific chemicals (beryllium, lead, and DU). While these operations result in emissions of other chemicals as well (aluminum, copper, iron, tantalum, and tungsten), the health effects of these other emissions were not analyzed in detail because their toxicity reference doses and estimated concentrations in air are relatively low. The emissions of the three chemicals analyzed were evaluated for potential human health effects under each of the SWEIS alternatives. (Sections 5.1.4 and 5.2.4, and appendix B, section B.2.3, include additional information regarding nonradiological air emissions screening and analysis.)

Hazard indices (HIs) were calculated for two of the three metals evaluated quantitatively (lead and uranium). An HI equal to or above 1 is considered consequential from a human toxicity standpoint. For the No Action Alternative, the worst-case HI for lead did not exceed one in a million (10^{-6}). For DU, the worst-case HI did not exceed 1 in 100,000 (10^{-5}).

Beryllium has no established EPA reference concentration for inhalation from which to calculate the HI. Beryllium was evaluated as a carcinogen, however. The excess LCF rate for beryllium under the No Action Alternative was estimated to be less than 3.6×10^{-7} per year; that is, none.

Carcinogenic Risk from Air Emissions

The screening process described in volume III, appendix B, identified no individual carcinogenic chemical air emission that required analysis for public health consequences. For carcinogens, an estimate also was made of the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs (appendix B, attachment 6).

This was found to be less than 1 in 1 million for the No Action Alternative because projected emissions for this alternative are far less than those analyzed for the Expanded Operations Alternative (which was only slightly above the screening GV of 1×10^{-6}). Thus, it is expected that a negligible increase in incremental combined cancer risk will result from the No Action Alternative.

Consequences of Ingestion to Residents, Recreational Users, and Special Pathways Receptors

The risk to public health from ingestion of water, foodstuffs, and from incidental ingestion of soils and sediments was estimated from environmental surveillance data within and surrounding LANL. The risk of toxicity and carcinogenicity will continue to be dominated by existing concentrations of radionuclides and chemicals in environmental media due to naturally occurring materials, fallout and other anthropogenic sources affecting the region, and historical operations (including emissions/ effluents, and accidental spills and releases). In addition, the potential for short-term exposures to contaminated sites at LANL, identified in the LANL ER Project, was evaluated using the ER database from LANL (appendix D, section D.3.5, Tables D.3.5–5 and D.3.5–6).

The consequences of ingestion were estimated for hypothetical individuals based on five exposure scenarios (as discussed in 5.1.6). The consequences estimated are based on

95th percentile values of detected analytes for the periods of environmental surveillance data sets available for the 1990's. The estimates were also made using the worst-case (95th percentile) uptake rates for the specific food components.

The LANL-wide maximum hypothetical risk from ingestion is the non-Los Alamos County resident who is also a resident recreational user of LANL lands and is also subject to the exposures in the special pathways analyzed. This composite hypothetical risk was used to represent the LANL-wide MEI dose from ingestion because it contains the maximum number of potential pathways for ingestion risk.

Tables 5.2.6.1–2 and 5.2.6.1–3 summarize the total radiological annual ingestion dose and excess LCF to members of the public. Per Table 5.2.6.1–3, the total worst-case ingestion doses for the off-site resident of Los Alamos County and non-Los Alamos County resident are 0.011 and 0.017 rem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose ranges up to 0.001 rem per year, according to the amount of time spent in the canyons (see footnote b in Table 5.2.6.1–3). If the individual has traditional Native American or Hispanic lifestyles, the values found in the final columns of the table should be used in place of the values in the first columns for off-site residents. Per the values in the final columns, these "special pathways receptors" can have worst-case 3.1 millirem per year additional dose. The associated excess LCF risks for the off-site residents are 8.6×10^{-6} per year of exposure and 9.1×10^{-7} per year of exposure for the individual who is also an avid recreational user. The worst-case doses are for a 95th percentile intake of the 95th percentile contamination level, referred to as the UCL. Ingestion pathway calculations included all radionuclides detected in the media. This includes natural background, weapons testing fallout, and previous releases. The actual contribution from continued operations at LANL is only a small fraction of this value. These values apply to the baseline and to all four alternatives. The data and analyses for these calculations are in appendix D, section D.3.3.

Estimates were made of the potential risk from metals exposure to public health using environmental surveillance data in the mid 1990's monitoring of metals in groundwater, surface water, soils and sediments, vegetables, fruit (Los Alamos County only) and fish (appendix D, section D.3.3 and associated tables). Table 5.2.6.1–4 identifies HI values of 1 for any of the MEIs, and excess LCF risks exceeding 10^{-6} to these MEIs via ingestion pathways.

Arsenic was identified as having an HI greater than 1 in groundwater within the water supplies of Los Alamos County and San Ildefonso Pueblo. Excess LCF risks are elevated also (Table 5.2.6.1–4). Elevated excess LCF risk from arsenic was estimated for worst-case consumption of incidental soils, sediments, surface water, and NPDES discharges by some residents and recreational users of LANL. While the risk associated with arsenic ingestion is greater than 10^{-6} per year in many pathways, the arsenic is not associated with LANL discharges. Arsenic is endemically present in the geology and soils and groundwaters and surface waters of the region in which New Mexico is located (volume III, appendix D, section D.3.4).

Beryllium has no HI for ingestion exceeding 1. However, the excess LCF rate estimated from worst-case ingestion of waters and soils is elevated (Table 5.2.6.1–4). While the risk associated with beryllium ingestion is greater than 10^{-6} in several pathways, the beryllium concentrations in waters, soils, and sediments are typical of those in background in the northern New Mexico region. Based on the environmental surveillance data from LANL, the portion of beryllium associated with LANL operations is not a significant contributor to

TABLE 5.2.6.1–2.—*Average Public Radiological Dose and Potential Consequences by Ingestion Pathways, All Alternatives*[f]

EXPOSURE PATHWAY	RECEPTOR[a]									
	OFF-SITE RESIDENT LOS ALAMOS COUNTY		OFF-SITE RESIDENT NON-LOS ALAMOS COUNTY		NONRESIDENT RECREATIONAL USER[b]		RESIDENT RECREATIONAL USER[b]		SPECIAL PATHWAYS RECEPTORS[c]	
	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr
Produce • Fruit • Vegetables	 0.00064 0.00098	 3.2×10^{-7} 4.9×10^{-7}	 0.00046 0.0013	 2.3×10^{-7} 6.7×10^{-7}	--	--	--	--	--	--
Meat (Cattle: Free Ranging Steer)	--	--	0.00027	1.4×10^{-7}	--	--	--	--	--	--
Milk	0.000073	3.7×10^{-8}	0.00005	2.5×10^{-8}	--	--	--	--	--	--
Fish	--	--	0.000054	2.7×10^{-8}	--	--	--	--	0.00019	9.4×10^{-8}
Honey	7.4×10^{-7}	3.7×10^{-10}	1.3×10^{-8}	6.3×10^{-12}	--	--	--	--	--	--
Elk	0.000077[d]	3.9×10^{-8}	0.00005[d]	2.6×10^{-8}	--	--	--	--	0.000034[e]	1.7×10^{-8}
Deer	0.000018	9.0×10^{-9}	0.00038	1.9×10^{-7}	--	--	--	--	--	--
Pinyon Nuts	--	--	0.000016	7.7×10^{-9}	--	--	--	--	0.00013	6.5×10^{-8}
Indian Tea (Cota)	--	--	--	--	--	--	--	--	0.00075	3.8×10^{-7}
Groundwater	0.0014	7.2×10^{-7}	0.0042	2.1×10^{-6}	--	--	--	--	--	--
Surface Water • Creeks • NPDES Discharge	--	--	--	--	 0.00017 0.000022	 8.6×10^{-8} 1.1×10^{-8}	 0.00046 0.000059	 2.3×10^{-7} 3.0×10^{-8}	--	--
Soils	0.000078	3.9×10^{-8}	0.000078	3.9×10^{-8}	1.2×10^{-6}	5.9×10^{-10}	3.1×10^{-6}	1.6×10^{-9}	--	--
Sediments	0.00065	3.3×10^{-7}	0.00065	3.3×10^{-7}	0.000016	8.3×10^{-9}	0.000044	2.2×10^{-8}	--	--
Sum Ingestion Dose/Risk	0.0039	2.0×10^{-6}	0.0075	3.8×10^{-6}	0.00021	1.0×10^{-7}	0.00057	2.8×10^{-7}		

TABLE 5.2.6.1–2.—*Average Public Radiological Dose and Potential Consequences by Ingestion Pathways, All Alternatives*[f] -Continued

[a] Receptor is a hypothetical person who has an average (50th percentile) intake of the 95th UCL concentration in every medium.
[b] The nonresident recreational user lives in Los Alamos County or a neighboring county, and is in the Los Alamos canyons 12 visits per year for 6 hours per visit. The resident recreational user lives in Los Alamos County or a neighboring county, and is in the Los Alamos canyons 24 visits per year of 8 hours per visit.
[c] Special pathways receptors are those with traditional Native American or Hispanic lifestyles. See text.
[d] Elk muscle.
[e] Elk heart and liver.
[f] Because almost all public ingestion is from naturally occurring radionuclides, weapons testing fallout, and contamination from past operations, the ingestion dose is not affected by the alternatives. See section 5.1.6.

TABLE 5.2.6.1–3.—*Worst-Case Public Radiological Dose and Potential Consequences by Ingestion Pathways, All Alternatives*[f]

EXPOSURE PATHWAY	RECEPTOR[a]									
	OFF-SITE RESIDENT LOS ALAMOS COUNTY		OFF-SITE RESIDENT NON-LOS ALAMOS COUNTY		NONRESIDENT RECREATIONAL USER[b]		RESIDENT RECREATIONAL USER[b]		SPECIAL PATHWAYS RECEPTORS[c]	
	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr
Produce • Fruit • Vegetables	 0.0026 0.0027	 1.3×10^{-6} 1.3×10^{-6}	 0.0016 0.004	 8.2×10^{-7} 2.0×10^{-6}	--	--	--	--	--	--
Meat (Cattle: Free Ranging Steer)	--	--	0.00067	3.4×10^{-7}	--	--	--	--	--	--
Milk	0.0002	9.8×10^{-8}	0.00014	6.8×10^{-8}	--	--	--	--	--	--
Fish	--	--	0.00017	8.5×10^{-8}	--	--	--	--	0.00046	2.3×10^{-7}
Honey	2.6×10^{-6}	1.3×10^{-9}	4.5×10^{-8}	2.2×10^{-11}	--	--	--	--	--	--
Elk	0.00019[d]	9.4×10^{-8}	0.00013[d]	6.4×10^{-8}	--	--	--	--	0.000034[e]	1.7×10^{-8}
Deer	0.000044	2.2×10^{-8}	0.00091	4.5×10^{-7}	--	--	--	--	--	--
Pinyon Nuts	--	--	0.000016	7.7×10^{-9}	--	--	--	--	0.00013	6.5×10^{-8}
Indian Tea (Cota)	--	--	--	--	--	--	--	--	0.0026	1.3×10^{-6}
Groundwater	0.0023	1.2×10^{-6}	0.0067	3.4×10^{-6}	--	--	--	--	--	--
Surface Water • Creeks • NPDES Discharge	--	--	--	--	 0.00028 0.000036	 1.4×10^{-7} 1.8×10^{-8}	 0.00074 0.000096	 3.7×10^{-7} 4.8×10^{-8}	--	--
Soils	0.00031	1.6×10^{-7}	0.00031	1.6×10^{-7}	4.7×10^{-6}	2.4×10^{-9}	0.000012	6.3×10^{-9}	--	--
Sediments	0.0026	1.3×10^{-6}	0.0026	1.3×10^{-6}	0.000066	3.3×10^{-8}	0.00018	8.8×10^{-8}	--	--
Sum Ingestion Dose/Risk	0.011	5.5×10^{-6}	0.017	8.6×10^{-6}	0.00039	1.9×10^{-7}	0.0010	5.1×10^{-7}		

TABLE 5.2.6.1–3.—*Worst-Case Public Radiological Dose and Potential Consequences by Ingestion Pathways, All Alternatives*[f]-Continued

[a] Receptor is a hypothetical person who has a worst-case (95th percentile) intake of the 95th UCL concentration in every medium.
[b] The nonresident recreational user lives in Los Alamos County or a neighboring county, and is in the Los Alamos canyons 12 visits per year for about 6 hours per visit. The resident recreational user lives in Los Alamos County or a neighboring county, and is in the Los Alamos canyons 24 visits per year of 8 hours per visit.
[c] Special pathways receptors are those with traditional Native American or Hispanic lifestyles. See text.
[d] Elk muscle.
[e] Elk heart and liver.
[f] Because almost all public ingestion is from naturally occurring radionuclides, weapons testing fallout, and contamination from past operations, the ingestion dose is not affected by the alternatives. See section 5.1.6.

TABLE 5.2.6.1–4.—*Metals Exposure and Risk via Ingestion Pathways and Hypothetical Receptors Used to Evaluate Potential Public Health Consequence, All Alternatives*

EXPOSURE PATHWAY		RECEPTOR									
		OFF-SITE RESIDENT LOS ALAMOS COUNTY		OFF-SITE RESIDENT NON-LOS ALAMOS COUNTY		NON-RESIDENT RECREATIONAL USER		RESIDENT RECREATIONAL USER		SPECIAL PATHWAYS RECEPTORS[c]	
	CHEMICAL	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr
Produce											
• Fruit[a]	Arsenic	< 1	0.000084	NA	NA	NA	NA	NA	NA	NA[c]	NA[c]
	Beryllium	< 1	0.00014								
	Lead	1.5	b								
• Vegetables	Arsenic	2.2	0.00099								
	Beryllium	< 1	0.00023								
	Lead	18	b								
Fish	Arsenic			< 1	0.00033					3.2	0.0014
	Beryllium	NA	NA	< 1	0.0002	NA	NA	NA	NA	< 1	0.013
	Lead			< 1	b					6.8	b
	Cadmium			< 1	$< 10^{-6}$					1.4	1.3×10^{-6}
Groundwater	Arsenic	4.5	0.002	2.5	0. 0011	NA		NA		NA[c]	
	Beryllium	< 1	0.00036	< 1	0.003						
Surface Water	Arsenic	NA	NA	NA	NA	< 1	1.9×10^{-6}	< 1	5.0×10^{-6}	NA[c]	NA[c]
	Beryllium					< 1	0.000045	< 1	0.00012		
NPDES Discharge	Arsenic					< 1	4.8×10^{-6}	< 1	0.000013		
Soils	Arsenic	< 1	0.000033	< 1	0.000033	< 1	$< 10^{-6}$	< 1	$< 10^{-6}$	NA[c]	NA[c]
	Beryllium	< 1	0.000024	< 1	0.000024	< 1	$< 10^{-6}$	< 1	$< 10^{-6}$		

TABLE 5.2.6.1–4.—*Metals Exposure and Risk via Ingestion Pathways and Hypothetical Receptors Used to Evaluate Potential Public Health Consequence, All Alternatives*-Continued

EXPOSURE PATHWAY		RECEPTOR									
		OFF-SITE RESIDENT LOS ALAMOS COUNTY		OFF-SITE RESIDENT NON-LOS ALAMOS COUNTY		NON-RESIDENT RECREATIONAL USER		RESIDENT RECREATIONAL USER		SPECIAL PATHWAYS RECEPTORS[c]	
	CHEMICAL	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr
Sediments	Arsenic	< 1	0.00013	< 1	0.00013	< 1	$< 10^{-6}$	< 1	$< 10^{-6}$	NA[c]	NA[c]
	Beryllium	< 1	0.000026	< 1	0.000026	< 1	$< 10^{-6}$	< 1	1.2×10^{-6}		

[a] No data were available on regional metals concentrations in store bought fruit. Metals data are provided for homegrown fruit in Los Alamos County only. There were data for fruits raised within the LANL reservation, although there are no receptors affected because these fruits are not used as food sources.

[b] Lead is considered a potential human carcinogen but no slope factor has been established by EPA to estimate carcinogenic risk because there are so few data supporting its development. Many studies indicate a link between lead uptake in children and elevated blood lead levels in children associated with learning disabilities and other physiological impacts. The estimate of HI presented here was made for a standard adult male (approximately 71.8 kilograms).

[c] Special pathways receptors are those who have additional risk because of traditional Native American or Hispanic lifestyles. There are no receptors for pinto beans, sweet corn, and zucchini grown in an environmental restoration study site in Los Alamos County.

NA = Not applicable

beryllium concentrations in the immediate area of LANL (appendix D, section D.3.4).

Dose from Ingestion of Water from Supply Wells

The radiation doses from ingestion of water from supply wells for off-site Los Alamos County residents (Table D.3.3–1) and San Ildefonso (Table D.3.3–5) run from about 1 to 7 millirem per year, mostly due to naturally occurring uranium. (The concentrations used in these analyses include contribution from background.)

Consequences to the Public Along Transportation Routes

Section 5.2.10 details the analysis of transportation consequences. Public health consequences include the dose and excess LCF risk associated with routine, accident-free transportation. Table 5.2.10–2 shows the population dose and excess LCF for normal (accident-free) off-site shipments throughout the U.S. The population dose and excess LCF associated with exposures occurring during stops for transportation segments near LANL are provided in Table 5.2.6.1–5. Doses associated with living along and sharing routes with these shipments are detailed in Table 5.2.10–2, and are less than those associated with stops. Risks associated with accidents during transportation are also discussed in section 5.2.10.

5.2.6.2 *Worker Health*

Worker risks associated with continued operations of LANL include radiological (ionizing and nonionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the No Action Alternative are given below and detailed in appendix D, section D.2.2.

TABLE 5.2.6.1–5.—*Radiation Doses and Excess LCF Risks Estimated to the Public at Stops During Transportation of Materials from LANL*

ROUTE SEGMENT	PERSON-REM PER YEAR (AT STOPS)	EXCESS LCF RISK PER YEAR
LANL to U.S. 84/285	3.2	0.0016
U.S. 84/285	3.3	0.0016

Radiological Consequences

Ionizing Radiation Consequences. Table 5.2.6.2–1 summarizes the projected doses and associated excess LCF risks from implementation of the No Action Alternative for continued operations of LANL.

The collective worker dose under the No Action Alternative is conservatively projected to be approximately twice that measured in 1993 to 1995. In terms of the average non-zero dose to an individual worker, the No Action Alternative is conservatively projected to result in 0.14 rem per year, as compared with 0.097 rem per year, 1993 to 1995 (chapter 4, section 4.6.2.2). The estimated excess LCF risk over a lifetime is 0.000054 per year of operation.

Nonionizing Radiation Consequences. It is expected that there will continue to be negligible effects to LANL worker health from nonionizing radiation sources including ultraviolet sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves (including the large station at TA–49). (See volume III, appendix D, section D.2.2.2 for methodology used to estimate nonionizing radiation from LANL operations to humans and wildlife and for the estimated results.)

TABLE 5.2.6.2–1.—*Worker Ionizing Radiation Annual Doses and Associated Lifetime Excess LCF Risks Under the No Action Alternative*

LANL Collective Worker Dose (person-rem per year)	446
Estimated Excess LCF Risk (across the worker population) per year of operation	0.18
Average Non-Zero Worker Dose (rem per year)	0.14
Estimated Excess LCF Risk (average worker > 0 dose)	0.000054

Chemical Exposure Consequences

There have been no chemical exposures resulting in hospitalization or extended medical care at LANL in the 1990's (section 4.6.2.1). This section examines the occasional reportable, but minor, chemical exposure likely during normal operations at LANL. Because beryllium operations in support of DOE missions are being concentrated at LANL, the consequences to workers are discussed as a special case below.

It is anticipated that there will continue to be a few chemical exposures annually, such as to:

- Airborne asbestos
- Lead paint particulates
- Crystalline silica
- Fuming perchloric acid, hydrofluoric acid
- Skin contact with acids or alkalis

Based on the performance for the index period (1990 to 1996), there would be expected to be a reportable chemical exposures of one to three incidents per year at LANL, using the current worker population of approximately 9,000 individuals.

Under the No Action Alternative, it is expected that there will be a worker population of approximately 10,000 individuals, approximately 10 percent higher than index period employment levels. For the purposes of the SWEIS, it is assumed that there is negligible additional benefit of the Chemical Hygiene Program at LANL over the period analyzed, and that the rate of chemical exposures continues at the index period rates. Therefore, it is expected that reportable chemical exposures from continued operations would continue at a rate of one to three injuries per year over the next 10 years.

Beryllium Processing Consequences. Beryllium exposure of workers is a potential risk of operating the Beryllium Technology Center (BTC), Building 3-141, in the Sigma Complex. Other uses of beryllium at LANL are metals applications and present little risk. The worker risks associated with HE testing applications of beryllium at LANL are the same as that for the public MEI and are presented in section 5.2.6.1 above. There is additional risk at BTC because of powders processing. This risk is primarily from aerosol and small particulate inhalation (chapter 4, section 4.6). The BTC is configured as a clean facility; that is, it has the appearance and characteristics of a surgical theater. The consequences to the workers are minimized by multiple and redundant engineering controls, and workers are monitored though LANL's Industrial Hygiene (IH) Program. The engineering controls include: (1) flexible and robust heating, ventilation, and air conditioning (HVAC) systems supporting a variety of processing enclosures that capture aerosols and particulates at their point of generation in the process; (2) physical separation of higher hazard operations; (3) in-BTC IH monitoring laboratory allowing immediate detection of potential exposures to aerosols and particulates; (4) access limited to beryllium workers only;

and (5) waste minimization and contamination control via use of in-facility laundry and facility-wide filtration systems. It is not anticipated that consequences to workers would be measurable; that is, no sensitization to beryllium would be detected using the LANL IH monitoring program.

Physical Safety Hazards

Table 5.2.6.2–2 compares the projected reportable cases of accidents and injuries estimated to occur during normal operations (including from building modifications, maintenance and construction) for the No Action Alternative and that experienced during the index period. The No Action Alternative is expected to result in an increase in reportable accidents and injuries proportional to increases in worker population. These incidents are considered to be normal consequences of normal operations of LANL. These estimates of accident rate conservatively assume that the aggressive Health and Safety Program underway at LANL does not achieve any reduction in the accidents and injuries rate.

The consequences of these accidents and injuries are expected to be similar to those experienced in the past, and typically are those associated with health response and recovery from acute trauma. Therefore, the consequences include physical pain and therapy/treatment for recovery such as those associated with bone setting, shoulder dislocation reset, and subsequent physical therapy. Some injuries may also result in continuing consequences to the worker that could affect productivity or lifestyle, such as motor skill loss due to nerve damage or cardiovascular debilitation resulting from electrical shock.

TABLE 5.2.6.2–2.—*Projected Annual Reportable Worker Accidents and Injuries for Normal Operations in the No Action Alternative Compared with the Index Period*

PARAMETER ESTIMATED	PARAMETER VALUE AND UNITS
Projected Worker Population	Approximately 10,000
Projected Reportable Accidents and Injuries	460/year
Change from Index (1993 to 1996)	+ 10%

5.2.7 Environmental Justice

As indicated in sections 5.2.1 and 5.2.2, no substantive adverse impacts to land resources or geology and soils are anticipated for the continued operation of LANL under the No Action Alternative. Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated for these impact areas. The potential impacts to surface water, groundwater, and ecological resources associated with the No Action Alternative would affect all communities in the area equally (see sections 5.2.3 and 5.2.5 for additional information on the potential for impacts to these resources). Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated to be associated with these resource areas.

Contaminants in air emissions decrease in concentration (and thus in impact) with distance from LANL. This is illustrated in Figure 5.2.7–1, which projects the dose from radiological air emissions within 50 miles (80 kilometers) of LANL. Similarly, the concentrations of chemical contaminants from air emissions at LANL decrease as the distance from LANL increases. Thus, impacts due to air emissions are equal to or lower in the sectors with substantial minority and/or low-income populations than they are in sectors 1–3 and 6–16, and such impacts do not disproportionately impact the minority or low-income populations. (See section 5.2.4

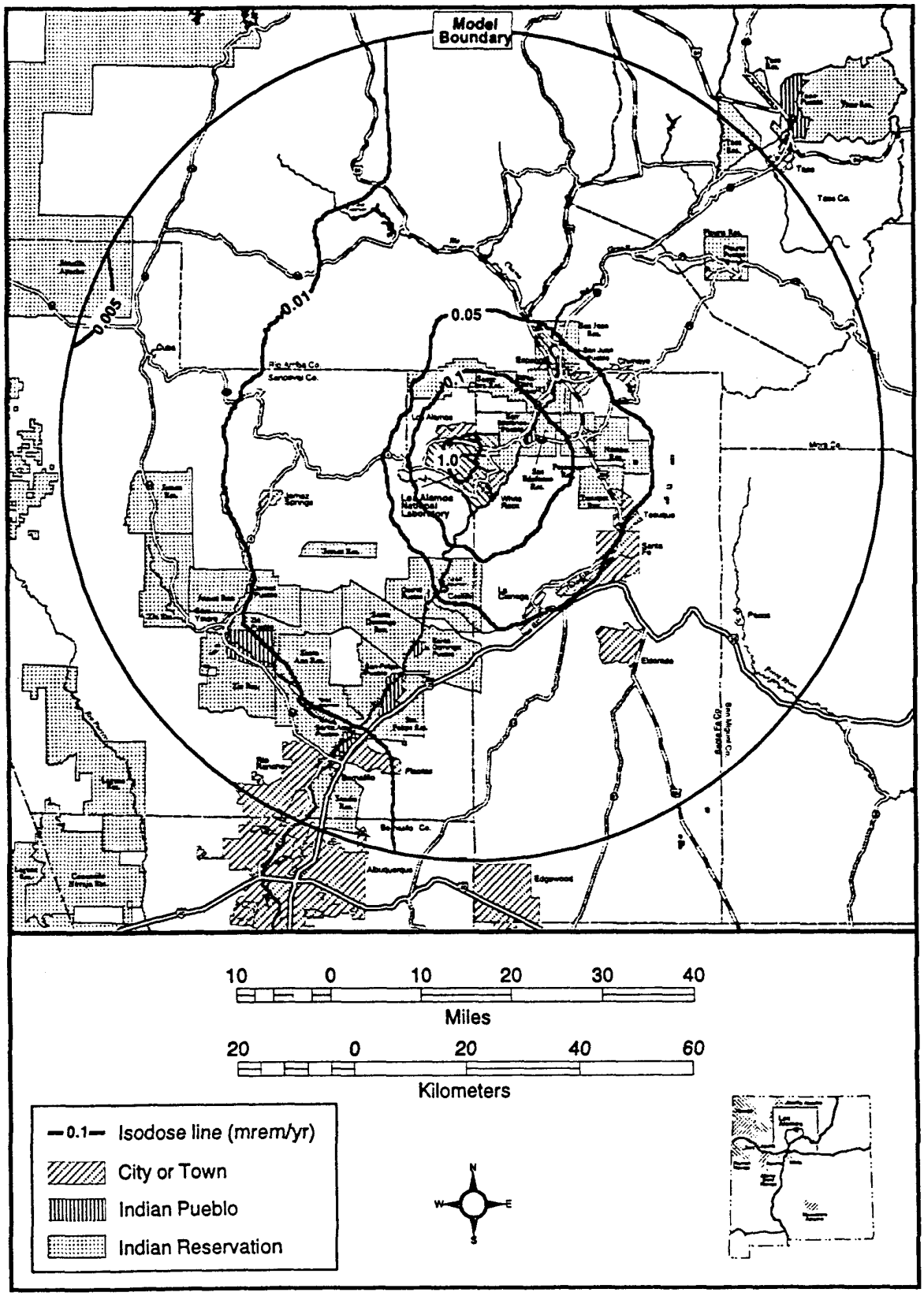

FIGURE 5.2.7–1.—***Isodose Lines from Airborne Releases for the No Action Alternative Within 50 Miles (80 Kilometers) of LANL.***

regarding the impacts anticipated for air emissions under the No Action Alternative.)

The air pathway is one example of the analysis of potential human health impacts. As presented in section 5.2.6, there is minimal potential for LANL operations to adversely affect human health for off-site residents or recreational users in the area around LANL under the No Action Alternative. The human health analysis also includes an analysis of exposures through special pathways, including ingestion of game animals, fish, native vegetation, surface waters, sediments, and local produce, absorption of contaminants in sediments through the skin, and inhalation of plant materials. The special pathways have the potential to be important to the environmental justice analysis, because some of these pathways may be more important or viable for the traditional or cultural practices of minority populations in the area. However, human health effects associated with these special pathways would not present disproportionately high or adverse impacts under the No Action Alternative.

As shown in section 5.2.10, impacts to public health from transportation on the site and from LANL to U.S. 84/285 are estimated to be 0.0016 excess LCFs per year from incident-free transportation and 0.040 deaths or injuries per year from transportation accidents. Impacts from transportation on route segments that pass through minority or low-income communities (particularly the segment on U.S. 84/285 to I–25) are estimated to be 0.0016 excess LCFs per year from incident-free transportation and 0.090 deaths or injuries per year from transportation accidents. Therefore, no high and adverse impact is expected to a member of the general public or to a member of a minority or low-income population due to transportation in the vicinity of LANL.

5.2.8 Cultural Resources

Impacts to prehistoric resources, historic resources, and TCPs are summarized in Table 5.2.8–1 and are discussed below. A brief statement regarding impacts to spiritual aspects follows these discussions. Common to all alternatives, coordination would be accomplished with the SHPO in compliance with Section 106 of the *National Historic Preservation Act* for any individual undertakings.

5.2.8.1 *Prehistoric Resources*

Impacts to prehistoric resources could potentially result from three general sources: shrapnel (material fragments) and vibration caused by high explosives testing at 13 existing firing sites, release of hazardous material (nonradioactive), and release of radioactive material.

Shrapnel and vibration from high explosives testing at 13 firing sites could potentially affect three types of prehistoric sites: cavate (cave) pueblos, rock shelters, and overhangs. Freestanding prehistoric (or pueblo) walls are not typically found on LANL; rather, LANL resources include a number of stable mounds of varying heights that were formed by collapsed walls and earth. Much of the material released by explosive tests is either aerosolized or reduced to millimeter size, dust-like particles upon detonation. However, some larger fragments are also released. Studies of hydrodynamic tests at Los Alamos have shown that fragments produced from explosive tests are released according to a well known fragmentation distribution. Based on fragmentation distributions for a series of computer studies of the breakup of various weapons systems during hydrodynamic tests (tests of mock-up nuclear packages during which high explosives are detonated) with different quantities of high explosives (up to 500 pounds of explosives), almost all particles

TABLE 5.2.8–1.—*Projected Impacts to Prehistoric Resources, Historic Resources, and TCPs Under the No Action Alternative*

ACTION TYPE	PUEBLO STRUCTURES	ERODED PUEBLOS/ RUBBLE/ ARTIFACT SCATTER	CAVATE PUEBLOS/ ROCK ART/ SHELTERS/ OVERHANGS	TRAILS/ STEPS/ STONE ARRANGE -MENTS	U.S. TERRITORIAL HOMESTEAD SITES	NUCLEAR ENERGY ERA (1943 TO 1989) BUILDINGS, DISTRICTS, AND SITES)	TRADITIONAL CULTURAL PROPERTIES (TCP)				
							CEREMONIAL AND ARCHAEOLOGICAL SITES	NATURAL FEATURES	ETHNOBOTANICAL GATHERING SITES	ARTISAN MATERIALS GATHERING SITES	SUBSISTENCE FEATURES
New Construction (buildings, facilities, etc.)	Negligible (construction is within existing buildings)										
Modifications in Facility Layout (roads, parking lots, pits)	Negligible (policy and procedures in place to avoid or minimize impacts)										
Modification of Existing Buildings (changing building function)	Negligible (policy and procedures in place to avoid or minimize impacts)					Negligible (policy and procedures in place to avoid or minimize impacts) for facilities continuing to operate. Potential for neglect for any facilities/operations that are discontinued.	Negligible (policy and procedures in place to avoid or minimize impacts).				
Change in Hydrology (surface and groundwater quality and quantity; erosion and siltation rates)	None						Traditional communities have indicated that water quality degradation produces adverse impacts: damage, introduction of elements out of character with the setting, and isolation of TCPs. Assessment of impacts to site specific TCPs is not possible because their locations and nature are not known.				
Explosives Impacts (shrapnel scatter)	Negligible (no resources sensitive to these impacts are located near enough to be impacted).		Minor effect—more quantitative study required to refine impacts.		None		Adverse impacts may be produced from destruction of or damage to the TCP, introduction of elements out of character with the setting, and/or isolation of sites within or near firing site hazard zones. Assessment of impacts to site specific TCPs is not possible because their specific locations and nature are not known.				
Explosives Impacts (vibration)	None		Potential for low level of impact.		None		Potential for disturbance. Assessment of impacts to site specific TCPs is not possible because their specific locations and nature are not known.		None		
Explosives (noise)	None						Explosives noise at any TCP may be considered as adverse due to the introduction of elements out of character with the setting of the TCP.				
Hazardous Material (non-radiological)	Legacy contaminants present the greatest concern. There is insufficient data available to evaluate this impact or to assess the additive effects of ongoing operations. However, contamination due to ongoing operations is projected to be small compared to legacy contamination and the background concentrations of hazardous materials in the area.					Potential for future operations to add contaminants that may limit preservation options.	All forms of hazardous materials near TCPs are considered by traditional communities as adverse impacts, producing damage, alteration, introduction, and isolation. Assessment of impacts to site specific TCPs is not possible because their specific locations and nature are not known.				
Radiation Hazards	Legacy contaminants present the greatest concern. There is insufficient data available to evaluate this impact or to assess the additive effects of ongoing operations. However, contamination due to ongoing operations is projected to be small compared to legacy contamination and the background concentrations of hazardous materials in the area.					Potential for future operations to add contaminants that may limit preservation options.	Traditional communities have stated that radioactive contamination of TCPs produces adverse impacts due to destruction, alternation, introduction of elements out of character with the TCP, and isolation. Assessment of impacts to site-specific TCPs is not possible because their specific locations and nature are not known.				
Security (fencing, lighting, monitoring)	Continued security at LANL will restrict access by the general public, and in essence, provide protection to these resources.						Continued restricted access by traditional communities to TCPs within security areas. Security measures also restrict access to these resources by other members of the public, and thus provide some measure of protection to TCPs.				

fall within 800 feet (244 meters) of the firing site and no particles are observed outside of 1,200 feet (366 meters).

Of the identified 23 cavate pueblos, rock shelters, and overhangs within the 1,200-foot (366-meter) radius of the firing sites, eight are within the 800-foot (244-meter) radius and 15 are within the 800- to 1,200-foot (244- to 366-meter) radius. Probability calculations that a fragment of firing debris would fall within 1 square foot (0.9 square meter) placed at the center of each archeological site indicate a likelihood of 0.07 or 7 in one hundred at 100 feet (30 meters), 0.000005 or 5 in 1 million at 800 feet (244 meters), and 0.0000002 or 2 in 10 million at 1,200 feet (366 meters). The influence of topographical variations and vegetation that may shield sites is not considered in these probabilities.

Physical impacts to cultural resources at firing sites from either explosion-generated fragments or vibration have not been well studied. However, the findings of October 1997 field observations of eight cultural resource (cavate/ rock shelter/overhang) sites located within an 800-foot (244-meter) radius of active firing sites did not reveal any visible effects that could be attributable to fragments or vibration caused by past and current firing site activities (LANL 1997b). Based on these qualitative observations, the probability for cultural sites to be affected by firing site activities is low.

Studies of firing site generated ground vibrations conducted at LANL demonstrated that explosive amounts as high as 500 pounds would not induce vibrations that would affect structures at BNM. Any impacts caused by higher amounts of explosives is not known and would require further analysis.

Accumulated hazardous and radioactive materials at firing sites, contiguous areas, and any additive amounts resulting from No Action operational levels have the potential to limit access to archeological sites for future study. The extent of this potential is not known because of the scarcity of data. However, no instances of restricted access because of health-threatening levels of hazardous or radioactive materials are known to date. In addition, LANL's environmental monitoring and soil survey program has not identified firing sites as restricted to access because of any accumulated hazardous or radioactive materials. Additional data are needed for future studies regarding the preservation of prehistoric resources because isolating a site from access for future study would be an adverse impact.

Security levels would be maintained under the No Action Alternative. Security levels (and, thus, levels of protection for cultural resources) vary depending on the types of activities at a particular location. Surveillance of public access roads within LANL has been effective in protecting prehistoric resources, and archaeological sites within limited public access areas have been fenced or gated to prevent vandalism.

5.2.8.2 *Historic Resources*

Impacts to historic resources could potentially result as a consequence of additional contributions of hazardous and radioactive materials to what is currently present in some Nuclear Energy Period (1943 to 1989) buildings. Some contamination does exist in several buildings, a feature that was inherent in their past function and handling techniques. Investigations are currently ongoing to determine the extent of contamination and relationship to National Register of Historic Places (NRHP) eligibility. In cases where buildings have been demolished, mitigation measures (e.g., photographing, recording, and documenting of the property) have been accomplished in coordination with the SHPO. While the rules for implementing the *National Historic Preservation Act* (16 U.S.C. §470) do not preclude a site from being eligible for or listed on the NRHP because of contamination,

additional contamination could potentially exceed some threshold level that would impede or slow down the process of evaluating the site for eligibility. However, numerous safeguards (e.g., strict hazardous materials handling and disposal procedures) are currently employed that minimize or preclude contamination. Therefore, the likelihood that additional contamination would significantly impact current levels of contaminants is considered negligible.

Many historic structures, particularly Nuclear Energy Period buildings, are not being actively utilized and, consequently, are not being actively maintained.

5.2.8.3 *Traditional Cultural Properties*

The Pajarito Plateau contains a high density of cultural resources and active traditional sites. These resources are significant to numerous Native American tribes and Hispanic groups, and represent areas of spiritual importance and traditional use. Many of these cultural sites are archaeological remains that are affiliated with several contemporary Native American tribes who consider them TCPs. Other tangible and intangible cultural resources in the LANL area contain no archaeological remains, but still retain cultural significance because of their use in traditional beliefs and practices. Overall, the traditional groups consulted considered all archaeological sites, human burials, shrines, rivers and water sources, trails, plants, animals, and minerals to be TCPs because these resources are integral to their traditional and cultural lifestyles.

Actions that may be perceived as impacting TCPs both on and adjacent to LANL consist of changes in hydrology features (surface and groundwater quality and quantity, erosion and siltation rates), explosives impacts (shrapnel, vibration, and noise), hazardous materials (nonradioactive), radiation hazards, and security features. Changes in hydrology features are viewed as adverse, damaging or altering features, and introducing elements that are out of character with the setting. Impacts resulting from explosives testing, presence of hazardous materials, and radiation hazards are viewed in much the same way—having the potential for damaging or altering features, introducing elements out of character with the setting, and limiting access to areas for conducting traditional or ceremonial activities. Security measures are viewed as limiting access to areas for conducting traditional or ceremonial activities; however, these same security measures may protect these TCPs from vandalism or other damage.

A detailed assessment of impacts to TCPs (other than archeological sites) is not possible because site-specific locations are not known. However, a continuation of activities at the No Action Alternative level is not anticipated to alter existing conditions and procedures are present that permit some limited access to restricted areas.

Spiritual Entities

The effect(s) that the continued presence and operation of LANL may have on any “unseen” or “spiritual” entities is unknown. The very esoteric nature of this issue precludes an assessment that would adequately reflect individual beliefs or faith.

5.2.9 Socioeconomics, Infrastructure, and Waste Management

This section describes the social, economic, infrastructure, and waste generation impacts of activities at LANL under the No Action Alternative.

5.2.9.1 *Socioeconomic Impacts*

Employment, Salaries, and Population

The primary (direct) impacts to employment, salaries, and population are presented in Table 5.2.9.1–1 for the LANL workforce only. The secondary (indirect) impacts and the total population changes projected are presented in Table 5.2.9.1–2 for the Tri-County area. For the purposes of the SWEIS, it is assumed that these changes take place within a year of the ROD for the SWEIS.

Housing

The population changes anticipated in the Tri-County area, reflected in Table 5.2.9.1–2, are projected to result in demand for 559 additional (new) housing units. The distribution of this demand in the three counties is projected to be: 130 additional units in Los Alamos County; 201 additional units in Rio Arriba County; and 228 additional units in Santa Fe County.

In Los Alamos County, the projected housing demand can be accommodated from absorption of apartment vacancies and the inventory of houses for sale and new construction. Beyond 130 units, no new housing units can be anticipated because of the absence of buildable land in private ownership. This constraint upon supply would be expected to exert an upward pressure on rents and house prices.

The projected housing demand in Rio Arriba and Santa Fe Counties can be accommodated without significant pressure on rents and house sales prices. Both counties possess a sufficient inventory of finished lots and parcels, have access to adequate mortgage capital, and have sufficient entrepreneurial developer talent to absorb the demand.

Construction

Table 5.2.9.1–3 contains the results of the analysis of construction spending, labor salaries, and labor employment for the period fiscal year 1997 through fiscal year 2006. Construction activities associated with this alternative are expected to draw workers already present in the Tri-County area who historically have worked from job to job in the region. Thus, this employment is not expected to influence socioeconomic factors.

Local Government Finance

Under this alternative, the Tri-County annual gross receipts tax yields would be expected to increase by $1.2 million. This increase would be matched by increases in service levels adequate to meet public demand.

Services

Annual school enrollment in the Tri-County area would increase by 227 students. Additional annual funding assistance of about $910,000 from the State of New Mexico would be required for school operations because of these enrollment increases.

In Los Alamos, the school district can absorb the anticipated new enrollment levels. This school district has excess capacity because of its discretionary policy of accepting out-of-district students who are the children of LANL employees and subcontractors. In Rio Arriba County and the cities of Española and Santa Fe, adequate classroom capacity exists because of recent school construction projects.

The demand for police, fire, and other municipal services would be expected to increase in proportion to the increase in gross receipts tax yields, as discussed above. However, any changes in local government services tend to be inelastic in the short-term and typically are responsive only after the completion of at least one full budget cycle.

TABLE 5.2.9.1–1.—*Summary of Primary LANL Employment, Salaries[a], and Procurement Under the No Action Alternative[b]*

	LOS ALAMOS COUNTY	RIO ARRIBA COUNTY	SANTA FE COUNTY	TRI-COUNTY TOTAL	OTHER NEW MEXICO COUNTIES	NEW MEXICO TOTAL	OUTSIDE NEW MEXICO	TOTAL
Employees	4,995	2,090	2,032	9,117	664	9,781	196	9,977
Difference[c]	160	171	195	526	56	582	20	602 (+ 6%)
Salaries ($M)	264.2	52	85.4	401.6	19	420.7	10.1	430.8
Difference[c]	9.6	7	11.1	27.7	2.7	30.4	1.5	31.9 (+8%)
Procurement ($M)	217.1	1.7	21	239.8	123.8	363.6	236.7	600.2
Difference[c]	1.4	0.0	0.3	1.7	1.4	3.1	5	8.1 (+ 1%)

[a] Salaries are for UC employees only; subcontractor salaries (Johnson Controls, Inc.; Protection Technology of Los Alamos, etc.) are included in the procurement dollars.
[b] Reflects projected locations of employee residences and LANL procurement activities.
[c] Difference is as compared to fiscal year 1996. Percent difference is shown in parentheses in the far right (TOTAL) column.

TABLE 5.2.9.1–2.—*Summary of Total Tri-County Employment, Salaries, Business Activity, and Population Changes Under the No Action Alternative*

	PRIMARY CHANGE	SECONDARY CHANGE	TOTAL TRI-COUNTY CHANGE	TRI-COUNTY PRIMARY WORKER CHANGE[a]	TRI-COUNTY SECONDARY WORKER CHANGE[b]	TOTAL TRI-COUNTY WORKER CHANGE	TOTAL TRI-COUNTY POPULATION CHANGE[c]
Employment/ Population	526	899	1,425	421	270	691	1,337 (+ 1%)
Personal Incomes	$27 million	$26 million	$53 million (< +1%)				
Annual Business Activity	$2 million	$4 million	$6 million (< +1%)				

Note: Percentages in parentheses are the percentage change that the number represents. These are provided for total population change, total personal income change, and total annual business activity change.
[a] This is the number of direct workers moving to the Tri-County area, assuming that 80 percent of new LANL employees are from outside this area.
[b] This is the number of secondary workers moving to the Tri-County area, assuming that 30 percent of secondary employment is from outside this area.
[c] This is the total population increase in the Tri-County area, assuming that, on average, each worker moving to the area increases the population by 1.935.

TABLE 5.2.9.1–3.—*Construction Spending, Labor Salaries, and Labor Employment Numbers Under the No Action Alternative (Fiscal Year 1997 Through 2006)*

YEAR	CONTRACT $M	LABOR $M	EMPLOYEES
1997	63	15	432
1998	187	45	1,282
1999	208	50	1,426
2000	219	53	1,502
2001	210	50	1,440
2002	120	29	823
2003	91	22	624
2004	90	22	617
2005	109	26	747
2006	108	26	741

$M = dollars given in millions
Sources: DOC 1996, PC 1997a, and PC 1997b

5.2.9.2 *Infrastructure Impacts*

Annual electricity use projected under the No Action Alternative is a total of 717 gigawatt-hours, 372 gigawatt-hours for LANSCE, and 345 gigawatt-hours for the rest of LANL. The peak electrical demand is projected to be 108 megawatts, 58 megawatts for LANSCE and 50 megawatts for the rest of LANL[1]. The supply of electricity to the Los Alamos area (which includes LANL, the communities of Los Alamos and White Rock, and BNM) is provided by two 115 kilovolt transmission lines (contractually limited to 72 megawatts during winter months when El Vado and Abiquiu hydroelectric output is negligible, and to about 94 megawatts during the spring and early summer months) and supplemented by the LANL steam/power plant at TA–3 (with an operating capacity of about 12 megawatts in the summer and about 15 megawatts in the winter) (DOE 1997). The existing supply of electricity to the Los Alamos area is not sufficient year-round to meet the projected peak electrical demand for LANL operations under this alternative; thus, periods of brown-outs are anticipated unless measures are taken to increase the supply of electricity to the area. (See sections 1.6.3.1 and 4.9.2 regarding ongoing efforts to increase electrical power supply to this area.) This situation is exacerbated by the additional electrical demand for BNM, and the communities of Los Alamos and White Rock. (While these organizations did not provide use projections, their historical usage is reflected in chapter 4, section 4.9.2.)

Natural gas use is projected to be 1,840,000 decatherms annually. The gas delivery capacity to the Los Alamos area is between approximately 9,000,000 and about 11,000,000 decatherms per year (Kumar 1997). Although electrical demand may increase natural gas demand for the generation of electricity at TA–3, demand should continue to be dominated by heating requirements and is not expected to exceed this projection.

LANL water use projected under the No Action Alternative is a total of 712 million gallons (2.7 billion liters) per year, 218 million gallons (825 million liters) per year for LANSCE, and 494 million gallons (1.9 billion liters) per year for the rest of LANL. This is well within DOE water rights, about 1,806 million gallons (6.9 billion liters) per year; however, this water right also provides for water used by Los Alamos County and BNM. Based on existing information regarding non-LANL water use, the water demands of this community can be met within the existing water rights. (Water demand is also discussed in section 5.1.3.) The peak water requirements for the area were determined to be 7,300 gallons (27,740 liters) per minute; the firm rated capacity of the

1. These values include the proposed Strategic Computing Complex (SCC) Project annual electricity and peak electrical demand for a 50-TeraOp operation and are reflected in all the alternatives. The SCC project was as an interim action to the SWEIS.

delivery system is 7,797 gallons (29,629 liters) per minute (Lundberg 1997).

The projected water use for the proposed Strategic Computing Complex (SCC) project is not reflected in the total number for LANL water use projections (for any of the alternatives) because DOE and LANL are committed to no net increase of water usage when the SCC project becomes operational at a 50-TeraOp level in approximately fiscal year 2002. The estimated water use for the SCC without water conservation would have been 120 gallons (450 liters) per minute or 63 million gallons (240 million liters) per year. The SCC project intends to make full use of the treated sanitary wastewater effluent from the TA–46 SWSC plant to meet its goal of no net increase of water usage (Holt 1998).

5.2.9.3 *Waste Management*

The annual and 10-year total generation projections for radioactive and hazardous waste are reflected in Table 5.2.9.3–1. These projections include waste from key facilities, all other LANL facilities, waste management facilities, the ER Project, and construction activities. Liquid waste is not projected by radioactive facility because measurements of individual contributions are not made for all facilities. The total amount of radioactive liquid waste (RLW) projected for receipt at TA–50 is 6.6 million gallons (25 million liters) per year for this alternative.

The other environmental impacts from waste management activities are presented elsewhere in this document. The impacts associated with the specific operations of the waste management facilities are found in the various impact areas analyzed in this document; all other facilities and specific effluents and source terms for the key facilities are summarized in chapter 3 (section 3.6) for waste management facilities (principally at TA–50 and TA–54). Transportation of waste, for example, is included in the analysis of transportation impacts of the various alternatives (volume III, appendix F, section F.6.6). The transportation of low-level radioactive waste (LLW) for off-site disposal and the expansion of Area G were the only variables identified from the review of waste management strategies. The differences between these strategies are reflected in the differences between the alternatives. (Expanded Operations is the only alternative that includes expansion of on-site disposal.)

Much of LANL TRU and chemical waste, as well as a portion of the LLW, would be treated and shipped off the site for disposal. (As noted in chapter 4, section 4.9.3.3, LANL receives small amounts of TRU waste from other sites. Some of that waste is from nondefense activities and is currently ineligible for disposal at the Waste Isolation Pilot Plant [WIPP]. Under all alternatives, such nondefense TRU waste would be stored at LANL pending the development of disposal options.) LANL is capable of meeting applicable WAC, and off-site disposal capacities are much greater than LANL's waste volumes.

5.2.9.4 *Contaminated Space*

The activities reflected in the No Action Alternative are projected to increase the total contaminated space at LANL by 63,000 square feet (5,853 square meters), as compared to the baseline established for the SWEIS as of May 1996 (section 4.9.4). The majority of this increase is due to implementation of actions that have already received a review in accordance with NEPA but that had not been implemented at the time the baseline was established (including the Nuclear Materials Storage Facility [NMSF] at TA–55; introduction of tritium into TA–16 Building 450 for neutron tube target loading; implementation of the low-energy demonstration accelerator [LEDA] and IPF at TA–53; size-reduction at the Waste Characterization, Reduction, and Repackaging [WCRR] Facility; and treatment research and

TABLE 5.2.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the No Action Alternative*[a]

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL RADIOACTIVE WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR
Plutonium Facility Complex	TA–55	5,250	52,500	688	6,880	12	120	124	1,240	36	360
Tritium Facilities[c]	TA–16 & 21	1,100	11,000	450	4,500	2	20	NA	NA	NA	NA
Chemical and Metallurgy Research Building[d]	TA–3	7,970	79,700	1,380	13,800	16.4	164	18.7	187	8.1	81
Pajarito Site	TA–18	4,000	40,000	145	1,450	1.5	15	NA	NA	NA	NA
Sigma Complex	TA–3	5,500	55,000	420	4,200	2	20	NA	NA	NA	NA
Materials Science Laboratory	TA–3	600	6,000	0	0	0	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	3,800	38,000	10	100	0.4	4	NA	NA	NA	NA
Machine Shops	TA–3	142,000	1.42×10^6	280	2,800	0	0	NA	NA	NA	NA
High Explosives Processing Facilities	TA–8, 9, 11, 16, 28 & 37	11,000	110,000	11	110	0.2	2	NA	NA	NA	NA
High Explosives Testing Facilities	TA–14, 15, 36, 39, 40	25,200	252,000	300	3,000	0.3	3	0.2	2	NA	NA
Los Alamos Neutron Science Center	TA–53	16,600	166,600	156	1,560	1	10	NA	NA	NA	NA
Health Research Laboratory[e]	TA–43	7,050	70,500	14	140	2.7	27	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	2,000	20,000	170	1,700	2	20	NA	NA	NA	NA
Radioactive Liquid Waste Treatment Facility[f]	TA–50 & 21	2,200	22,000	150	1,500	0	0	21	210	0	0
Waste Treatment, Storage, and Disposal Facilities[f]	TA–54 & 50	920	9,200	174	1,740	4.0	40	27	270	0	0
Non-Key Facilities		651,000	6.51×1^6	520	5,200	30	300	0	0	0	0
Environmental Restoration Project[g]		2×10^6	2×10^7	4,257	42,570	548	5,480	11	110	0	0
Grand Total[h]		2.886×10^6	2.886×10^7	9,130	91,300	622	6,220	202	2,020	44	440

NA indicates that this facility does not routinely generate these types of waste.

[a] Radioactive liquid waste generation is not projected by facility (see text in section 5.2.9.3, Radioactive and Hazardous Waste Generation).

[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under the *Toxic Substance Control Act*. Biomedical waste is also included in this category of waste.

[c] These projections include 4,000 cubic meters of LLW due to backlogged waste.

[d] These LLW projections include 4,000 cubic meters of LLW generation anticipated due to the CMR Building Upgrades, Phase II.

[e] These projections include 10,000 kilograms of chemical waste, 250 kilograms of biomedical waste (a special form of chemical waste), 44 cubic meters of LLW, and 24 cubic meters of low-level radioactive mixed waste associated with ongoing efforts to remove obsolete and contaminated equipment.

[f] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities.

[g] The ER Project is projected to generate 11 cubic meters per year of TRU and mixed TRU waste together. All of this waste is presented under the TRU waste columns.

[h] Grand totals have been rounded.

TRU waste characterization at the Radioactive Materials Research, Operations, and Demonstration [RAMROD] Facility at TA–50).

5.2.10 Transportation

The transportation impacts projected for the No Action Alternative are summarized in this section. More detailed information regarding these impacts is included in volume III, appendix F.

5.2.10.1 *Vehicle-Related Risks*

Truck Emissions in Urban Areas

For the No Action Alternative, the projected risk is 0.032 excess LCF over a lifetime per year of operation. Use of the Santa Fe Relief Route would have a very small effect on this risk (it would change to 0.031 excess LCF per year). The only difference is that the Santa Fe Relief Route would have 1.2 miles (1.9 kilometers) less of urban highway mileage. Approximately 65 percent of the risks are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments.

Truck Accident Injuries and Fatalities

The impacts projected for the No Action Alternative are presented in Table 5.2.10.1–1 (additional information on these analyses is provided in appendix F, section F.6.3). Use of the Santa Fe Relief Route would reduce the risks of accidents, injuries, and fatalities by almost one-half of those indicated for the segment from U.S. 84/285 to I–25 due to the assumption that the accident rate on the Santa Fe Relief Route would be much lower than for the route through Santa Fe. Use of the Santa Fe Relief Route would not substantially change the risks of accidents, injuries, and fatalities on the remainder of New Mexico segment, as compared to the risks reflected for this segment in Table 5.2.10.1–1. Approximately 65 percent of the impacts are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. Again, all shipments are assumed to result in a return by an empty truck.

5.2.10.2 *Cargo-Related Risks*

Incident-Free Radiation Exposure

The incident-free radiation exposure impacts projected for the off-site shipments under the No Action Alternative are presented in Table 5.2.10.2–1; note that the total is the total dose and risk throughout the U.S. attributable to LANL operations, and that this total is dominated by the segments outside New Mexico. The aircraft segment is for overnight carrier service; the truck segment to/from the

TABLE 5.2.10.1–1.—*Truck Accident Injuries and Fatalities Projected for LANL Shipments Under the No Action Alternative*

ROUTE SEGMENT	NUMBER OF ACCIDENTS PER YEAR	NUMBER OF INJURIES PER YEAR	NUMBER OF FATALITIES PER YEAR
On-Site	0.015	0.0031	0.00015
LANL to U.S. 84/285	0.17	0.035	0.0017
U.S. 84/285 to I–25	0.41	0.086	0.0041
Remainder of New Mexico	0.67	0.64	0.072
Outside New Mexico	3.2	3.0	0.30
Total	4.5	3.8	0.38

TABLE 5.2.10.2–1.—*Incident-Free Population Dose and Lifetime Excess LCFs for Off-Site Shipments per Year of Operation Under the No Action Alternative*

ROUTE SEGMENT	TRUCK OR AIR CREW		NONOCCUPATIONAL (PUBLIC)					
			ALONG ROUTE		SHARING ROUTE		STOPS	
	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	5.9	0.0024	0.032	0.000016	0.51	0.00026	3.2	0.0016
U.S. 84/285 to I–25	7.9	0.0032	0.38	0.00019	3.6	0.0018	3.3	0.0016
Remainder of New Mexico	45	0.018	0.1	0.00005	1.7	0.00085	24	0.012
Outside New Mexico	410	0.16	2.8	0.0014	24	0.012	180	0.09
Aircraft	2.4	0.0012	NA	NA	NA	NA	NA	NA
Totals	470	0.19	3.3	0.0017	30	0.015	210	0.11

NA = Not applicable

airport is included in the truck results. In general, use of the Santa Fe Relief Route would result in only small changes in this type of impact. Truck crew doses and nonoccupational doses for people at rest stops would increase due to the increased length of the Santa Fe Relief Route for many of the radioactive material shipments (those north-bound on I–25). Nonoccupational doses for people sharing the road would decrease due to the lower traffic density projected for the relief route.

The MEI dose occurs between LANL and I–25 and is 0.0003 rem.

Driver Doses from On-Site Shipments of Radioactive Materials. The projected collective radiation dose for LANL drivers under the No Action alternative is 4.184 person-rem. This collective dose would be expected to result in 0.00167 excess LCF among these drivers.

The average individual driver dose is projected to be 0.174 rem per year, which is well below the DOE radiation protection limit of 5 rem per year.

Transportation Accidents

The following discussion addresses the potential impacts of accidents leading to the release of either radioactive or hazardous material being transported in support of LANL operations under the No Action Alternative. Results are given for both off-site and on-site shipments.

Off-Site Radioactive Materials Shipments. The RADTRAN and ADROIT codes were used to analyze accident impacts for the bounding off-site radioactive material shipments. The MEI doses calculated with RADTRAN do not vary by alternative and are given in Table 5.2.10.2–2. The population dose and corresponding excess LCF per year for these shipments are presented in Table 5.2.10.2–3 for these accidents. ADROIT results that are separated into frequency and consequence components are not readily available. The product, MEI dose risk, can be presented in terms of excess LCF per year; for the No Action Alternative, the MEI dose risk due to plutonium-238 oxide and due to pit shipments were each less than 1×10^{-10} excess LCF per year.

TABLE 5.2.10.2–2.—*MEI Doses and Associated Frequencies for Off-Site Radioactive Materials Accidents*

ROUTE SEGMENT	SHIPMENT TYPE					
	AMERICIUM-241		CH TRU		RH TRU	
	MEI DOSE (rem)	FREQUENCY PER TRIP	MEI DOSE (rem)	FREQUENCY PER TRIP	MEI DOSE (rem)	FREQUENCY PER TRIP
LANL to U.S. 84/285	59	1.8×10^{-7}	21	6.4×10^{-8}	0.16	6.0×10^{-9}
U.S. 84/285 to I–25	59	2.5×10^{-7}	21	7.4×10^{-8}	0.16	5.6×10^{-9}
Remainder of New Mexico	59	9.9×10^{-7}	21	1.4×10^{-6}	0.16	1.3×10^{-7}
Rest of U.S.	59	0.000011	NA	NA	NA	NA

NA = Not available; CH TRU = contact-handled TRU waste; RH TRU = remote-handled TRU waste

TABLE 5.2.10.2–3.—*Bounding Radioactive Materials Off-Site Accident Population Risk for the No Action Alternative*

ROUTE SEGMENT	ANNUAL POPULATION DOSE RISK AND EXCESS LCF RISK						
	SHIPMENT TYPE						
	AMERICIUM -241	CH TRU	RH TRU	PLUTONIUM -238	PITS	TOTAL	
	person-rem/year	person-rem/ year	person-rem/ year	person-rem/ year	person-rem/ year	person-rem/ year	excess LCF/ year
LANL to U.S. 84/285	0.015	0.0014	3.1×10^{-6}	4×10^{-7}	2×10^{-6}	0.016	8.0×10^{-6}
U.S. 84/285 to I–25	0.24	0.019	0.000042	1×10^{-6}	0.00001	0.26	0.00013
Remainder of New Mexico	0.031	0.012	0.000026	4×10^{-7}	4×10^{-6}	0.043	0.000022
Rest of U.S.	2.5	NA	NA	4×10^{-6}	0.00002	2.5	0.0012

NA = Not available; CH TRU = contact-handled TRU waste; RH TRU = remote-handled TRU waste

The use of the Santa Fe Relief Route would reduce the projected population dose (and therefore the excess LCFs per year) by about one-third for the U.S. 84/285 to I–25 segment, as compared to use of the route through Santa Fe. This difference is primarily due to the difference in population density along these routes. (The lower traffic density on the relief route is also a factor.) The use of the Santa Fe Relief Route would increase the projected population dose (and therefore the excess LCFs per year) for the remainder of New Mexico segment to about double that identified if the route through Santa Fe is used. This difference is due to the increase (6 miles [9.7 kilometers] more) in the distance traveled on I–25 for north-bound shipments.

On-Site Radioactive Materials Shipments. The bounding on-site shipments involving radioactive materials are the transport of plutonium-238 solution from the CMR to TA–55 and the transport of irradiated targets from the LANSCE to TA–48. Both types of shipments are made with the roads closed to all people except personnel directly involved in the transport. Therefore, no member of the public would be expected to be involved in the postulated truck accident or to be a bystander after the postulated truck accident.

The MEI dose is calculated using the following assumptions. In the case of plutonium-238 solution, it is assumed that a person would stand very close to the evaporating liquid for 10 minutes before being warned away. In the case of the irradiated target cask failure, a narrow radiation beam would be produced that would be lethal after 10 minutes of continuous exposure at a distance of 6 feet (1.8 meters) from the cask, and it is assumed that a person would stand in this beam for 10 minutes.

The resulting MEI doses, frequencies, and MEI risks per year of operation are given in Table 5.2.10.2–4. The bounding Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility or Pulsed High-Energy Radiation Machine Emitting X-Rays (PHERMEX) shipment accidents could result in an off-site MEI dose of 76 rem and fatalities to LANL truck crews and other individuals within 80 feet (24 meters) of the explosion (DOE 1995b). The frequency of such shipments has been added to the frequency of irradiated target shipments.

Hazardous Materials Shipments. The bounding hazardous materials shipments for transportation accident analyses are major chlorine shipments (toxic), major propane shipments (flammable), and major explosives shipments. The consequences of an accident involving a major explosives shipment is bounded by the consequences of an accident involving a major propane shipment, so the frequency of explosives shipments was added to the frequency of propane shipments (rather than analyzing them separately).

Accidental Chlorine Release. The probability of the bounding accidental chlorine release (event) was determined from event trees by

TABLE 5.2.10.2–4.—*MEI Doses and Frequencies for Bounding On-Site Radioactive Materials Accidents Under the No Action Alternative*

SHIPMENT TYPE	EVENT FREQUENCY PER YEAR	MEI DOSE	MEI RISK
Plutonium-238 Solution	8.8×10^{-8}	8.7 rem	7.7×10^{-7} rem/year (3.1×10^{-10} excess LCF per year)
Irradiated Targets	3.1×10^{-6}	acute fatality	3.1×10^{-6} fatalities per year

using 1-ton (908-kilogram) container failure thresholds (Rhyne 1994a) and force magnitude probabilities (Dennis et al. 1978). (Although LANL is not expected to store or handle chlorine containers this large, they have in the past, and the risks associated with transport of this size container bound the risks of toxic material shipments.) The ALOHA™ computer model (NSC 1995) was used to estimate release rates from the 1-ton (908-kilogram) container, and the DEGADIS (Havens and Spicer 1985) model was used to predict downwind chlorine concentrations following the postulated release. (A separate version of DEGADIS is used because the version incorporated in ALOHA™ does not readily provide time variation of downwind concentrations.)

The number of fatalities or injuries associated with the bounding chlorine accident would depend on the population density and the ability of people to avoid harmful exposure by going indoors or leaving the affected area. The ability of people to avoid harmful exposure (to escape) would depend on various factors; an escape fraction of 0.98 is used for all route segments. This fraction is based on analysis of a transportation accident producing fatal releases of ammonia (Glickman and Raj 1992) and should be applicable to chlorine because the same dispersion coefficients apply, resulting in similar plume shapes and gradients of concentration. For both, there will be objectionable odor a short time prior to concentrations that have serious effects. The plumes tend to be visible and of modest transverse dimension, with very objectionable odor and strong respiratory irritation at their edges, permitting recognition and urging prompt escape on foot. The projected frequencies, consequences and risks associated with major chlorine accidents under the No Action Alternative are presented in Table 5.2.10.2–5.

The use of the Santa Fe Relief Route would result in about one-third the risk of fatalities and one-tenth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight increase in this risk of injuries and fatalities on the remainder of New Mexico segment because of the extra 6 miles (10 kilometers) traveled on I–25 for northbound traffic (chlorine shipments are all assumed to travel north on I–25).

Accidental Propane Release. The bounding consequence from a propane release would be the generation of a fireball. The fireball would likely occur too soon after the postulated truck accident for evacuation to be effective. The fireball would have a radius of about 148 feet (45 meters) and would burn for about 3 seconds. Many people would be protected by buildings or automobiles for this short duration. It is assumed that 50 percent of the available population would be shielded from the fireball, 10 percent would be fatalities, and the remainder would be injured (Geffen et al. 1980). In addition, fatal second-degree burns might be experienced out to a radius of 620 feet (189 meters). The percentages of available people that would be exposed to the radiant heat flux are assumed to be 0.16 percent, 12 percent, and 19 percent in urban, suburban, and rural areas, respectively (Geffen et al. 1980).

The number of people that would be affected depends on the population density. The projected frequencies, consequences, and risks associated with major propane accidents under the No Action Alternative are presented in Table 5.2.10.2–6.

The use of the Santa Fe Relief Route would result in about one-third the risk of fatalities and one-fifth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight decrease in the risk of injuries and fatalities on the

TABLE 5.2.10.2–5.—*Frequencies, Consequences, and Risk for a Major Chlorine Accident Under the No Action Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000028	0.065	0.24	8.6×10^{-6}	0.000032
	Suburban	4.6×10^{-6}	1.5	5.6		
U.S. 84/285 to I–25	Rural	0.000022	0.053	0.2	0.00029	0.0011
	Suburban	0.000047	3.0	11		
	Urban	0.000014	11	40		
Remainder of New Mexico	Rural	0.00016	0.015	0.056	0.000052	0.00019
	Suburban	0.000017	1.5	5.5		
	Urban	2.8×10^{-6}	8.4	32		
Remainder of U.S.	Rural	0.0012	0.028	0.1	0.0012	0.0047
	Suburban	0.0003	1.6	6.1		
	Urban	0.00007	10	39		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

TABLE 5.2.10.2–6.—*Frequencies, Consequences, and Risk for a Major Propane Accident Under the No Action Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	9.8×10^{-6}	0.28	1.1	9.7×10^{-6}	0.000039
	Suburban	1.7×10^{-6}	4.2	17		
U.S. 84/285 to I–25	Rural	7.5×10^{-6}	0.23	0.92	0.00015	0.0006
	Suburban	0.000017	8.4	34		
	Urban	5.0×10^{-6}	1.8	7.3		
Remainder of New Mexico	Rural	0.000065	0.15	0.6	0.00012	0.00048
	Suburban	0.000021	5.1	20		
	Urban	2.6×10^{-6}	1.5	6.1		
Remainder of U.S.	Rural	0.000083	0.09	0.36	0.000067	0.00027
	Suburban	0.000011	4.8	19		
	Urban	5.4×10^{-6}	1.9	7.5		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

remainder of New Mexico segment because of the 6 miles (10 kilometers) reduction in distance traveled on I–25 for southbound traffic (propane shipments are all assumed to travel south on I–25).

5.2.11 Accident Analysis

Transportation accidents for the No Action Alternative are addressed in section 5.2.10. High-frequency (greater than 1 in 100) occupational accidents for the No Action Alternative are addressed in section 5.2.6.

5.2.11.1 *Multiple Source Release of Hazardous Material from Site-Wide Earthquake and Wildfire*

Site-Wide Earthquake

Earthquakes are site-wide in nature. They are the only credible initiator that can release material from multiple facilities at the same time. Three scenarios have been postulated for site-wide earthquake-initiated releases. Each of the scenarios has a different magnitude earthquake that results in different degrees of damage and consequences. In addition, RAD–12 is a facility-specific accident scenario, discussed in the DARHT EIS (DOE 1995a), that is earthquake-initiated (by a very large earthquake) but has a substantially different probability for the scenario than is reflected in the site-wide scenario. The estimates for both structural damage to LANL facilities and the amount of material released are conservative. Earthquakes dominate the radiological accident risk.

Table 5.2.11.1–1 is a summary of the annual frequency of earthquake and wildfire scenarios and their consequences. For radiological releases, the consequences are expressed as excess LCFs, per year, in excess of the normal incidence of fatal cancers. Comparisons to the incidence of fatal cancers in the surrounding population can be made to evaluate the risk from these accidents relative to the public's inherent cancer risk. Overall, it should be noted that for the scenarios hypothesized for both SITE–01 and SITE–02, the number of excess LCFs is within the normal fluctuation in cancer fatalities from one year to the next. As noted in section 5.2.6, and in appendix D, section D.1.2.1, the lifetime risk of dying from cancer in the U.S. is more than 23 percent for men and more than 20 percent for women; based on this rate, approximately 40,000 people within the 50-mile (80-kilometer) radius of LANL would be expected to die from cancer.

Table 5.2.11.1–2 is a summary of the risk from exposure to toxic chemicals as a result of the site-wide accidents. (RAD–12 is not reflected on this table because this scenario does not involve the release of toxic chemicals.) Chemical exposure is evaluated as the expected number of people exposed annually to concentrations greater than a given ERPG–2 or ERPG–3.

For earthquakes, one can expect fatalities among workers and the public caused directly by the earthquake itself, irrespective of any releases. Many of the office buildings, including such facilities as the administration complex or off-site office buildings, etc., would be expected to suffer substantial damage from higher frequency, lower magnitude earthquakes. Therefore, the population effects resulting from exposures to hazardous materials are thought to be a small or modest increment to the human and material impacts directly attributable to the earthquake.

Site-Wide Wildfire

The frequency of a large fire encroaching on LANL is estimated as the joint probability of ignition in the adjacent forests, high extreme fire danger with a failure to promptly extinguish the fire, and a 3-day period of favorable meteorological conditions. (See volume III,

TABLE 5.2.11.1–1.—*Summary of Radiological Risks from Earthquake-Initiated and Wildfire Accident Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	FREQUENCY (EVENT PER YEAR)[a,e]	CONSEQUENCE MEASURES[b,c,d,f]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
NATURAL PHENOMENA			
SITE–01 Moderate earthquake on the Pajarito Fault or a large earthquake in the Rio Grande Rift zone, resulting in structural damage and/or severe internal damage to comparatively low capacity facilities.	Approximately 0.0029 per year (i.e., one such event in approximately 350 years); considered an unlikely event	Approximately 16 excess LCFs Mean population dose approximately 27,726 person-rem MEI doses 20 rem	0.046
SITE–02 Large earthquake on the Pajarito Fault, resulting in structural damage and/or severe internal damage to low and moderate capacity facilities.	Approximately 0.00044 per year (i.e., one such event in approximately 2,300 years); considered an unlikely event	Approximately 24 excess LCFs Mean population dose approximately 41,340 person-rem MEI dose ≤ 34 rem	0.011
SITE–03[g] Very large earthquake on the Pajarito Fault and perhaps the Embudo Fault, resulting in structural damage to essentially all facilities.	Approximately 0.000071 per year (i.e., one such event in approximately 14,000 years); considered an extremely unlikely event	Approximately 134 excess LCFs Mean population dose approximately 210,758 person-rem MEI dose 247 rem	0.0095
SITE–04 Large wildfire encroaching on Los Alamos, consuming combustible structures and vegetation.	Approximately 0.1 per year (i.e., one such event in approximately 10 years); considered a likely event.	Approximately 0.34 excess LCFs Mean population dose approximately 675 person-rem MEI dose < 25 rem	0.034
RAD–12[h] Plutonium release from a seismically initiated event	Approximately 1.5×10^{-6} per year (about one such event in about 1,000,000 years); considered an extremely unlikely event	18 excess LCFs Mean population dose approximately 35,800 person-rem MEI dose 138 rem	0.000027

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure.
[e] The frequency is more correctly described as the probability of occurrence in any 12-month period. See detailed explanation under Meaning of Risk and Frequency in volume III, appendix G, section G.1.
[f] Impacts, in terms of LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.
[g] There is a potential for fault rupturing to occur at the CMR Building (TA–3–29) at a somewhat lower frequency than the SITE–03 earthquake (estimated at 1 to 3×10^{-5}/year). Should this occur in association with the SITE–03 earthquake, a conservative estimate results in an additional 133,833 person-rem population dose (increasing excess LCFs by 99), and an increase to the MEI of 134 rem.
[h] This accident was analyzed in the DARHT EIS (DOE 1995a), and because it is an earthquake-initiated event, it is presented here for consistency.

TABLE 5.2.11.1–2.—*Summary of Chemical Exposure Risks from Site-Wide Accident Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a,d]	CONSEQUENCE MEASURE[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
NATURAL PHENOMENA			
SITE–01 Moderate earthquake on the Pajarito Fault or a large earthquake in the Rio Grande Rift zone, resulting in structural damage and/or severe internal damage to comparatively low capacity facilities.	Approximately 0.0029 per year (i.e., one such event in approximately 350 years); considered an unlikely event.	Several tens of people exposed at or above ERPG–2 or –3 levels at distances to a substantial fraction of a mile from multiple sources.	0.058
SITE–02 Large earthquake on the Pajarito Fault, resulting in structural damage and/or severe internal damage to low and moderate capacity facilities.	Approximately 0.00044 per year (i.e., one such event in approximately 2,300 years); considered an unlikely event.	Approximately 100 people exposed above ERPG–2 or 3 levels to a distance of about one mile from multiple sources.	0.044
SITE–03 Very large earthquake on the Pajarito Fault and perhaps the Embudo Fault, resulting in structural damage to essentially all facilities.	Approximately 0.000071 per year (i.e., one such event in approximately 14,000 years); considered an extremely unlikely event.	Approximately 100 people exposed above ERPG–2 or –3 levels to a distance of about 1 mile from the sources.	0.0071
SITE–04 Wildfire consuming vegetation and combustible structures	Approximately 0.1 per year.	Approximately 11 people exposed above the ERPG–2 level from a formaldehyde release.	1.1

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] The frequency is more correctly described as the probability of occurrence in any 12-month period. See detailed explanation under Meaning of Risk and Frequency in volume III, appendix G, section G.1.

appendix G for a complete discussion of the accident analysis.) The postulated scenario is quite credible in view of the present density and structure of fuel surrounding and within LANL and the townsite, and the historical occurrence of three major fires in the past 21 years.

This analysis has shown that these fire-favorable weather conditions occur on the order of once per year; the ignition sources are prevalent; and fire-fighting capability is hampered by limited accessibility. Therefore, this site-wide accident analysis concludes that a major fire, as described, is not only credible but also likely. The probability is on the order of 0.1 per year (1 every 10 years), a frequency that is identical for all alternatives. Although the probability of occurrence is 0.1 per year, the conditions for occurrence exist at least once every year.

The analysis for the joint probability of occurrence of weather and fire danger conditions and the fuel loading provides a conservative but realistic assessment of the potential for the occurrence of a wildfire scenario that will impact LANL facilities, buildings, and land.

The analysis conservatively assumes that all combustible structures and vegetation over the western part of LANL are burned. The public exposures were estimated separately for airborne radionuclides and beryllium from burning vegetation and soils, and from radiological and chemical releases from burning facilities. When available, existing analyses from facility fires were used; otherwise, new model calculations were run.

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 quite different; one entails aircraft fuel that challenges waste containers. At present, the fuel loading within the dome structures is small, so that RAD–08 results very conservatively bound the consequences of a wildfire at TA–54. This facility and the others that contribute public exposure in the wildfire scenario are being considered for actions to reduce the external wildfire fuel.

Another 189 person-rem results from total release of the tritium inventory at the Weapons Engineering Tritium Facility (WETF), including 44.5 ounces (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.

Because the frequency of the site-wide wildfire is 0.1 per year, the radiological risk (product of the frequency and consequence) from this accident is exceeded only by the site-wide earthquake. On the other hand, no excess LCFs are expected from the event. (See Table 5.2.11.1–1 for a summary of the wildfire analysis.) There would be unquantified health effects from smoke inhalation and possible fatalities from fighting the fires. There would be substantial impact from impairment of mission and from the loss of buildings at LANL and in the townsite. This impact is not evaluated, just as it is not evaluated for earthquakes.

5.2.11.2 *Plutonium Releases from Manmade and Process Hazards at LANL*

A summary of the frequency and consequences for plutonium releases is given in Table 5.2.11.2–1. These releases reflect a variety of initiators depending on the type of activities or manmade hazards in the area, such as an aircraft crash. The consequences indicate that no excess LCFs are expected from any of the plutonium accident scenarios.

Due to the low consequences and frequencies, these accidents do not pose a significant risk to the public.

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between the Rocky Flats Plant and TA–55–4 is presented in volume III, appendix G, section G.4.1.2.

Substantial differences exist between the nuclear facililty and operations being conducted in TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiences detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including enhanced seismic resistance and fire containment.

5.2.11.3 *Highly Enriched Uranium Release from Process Hazard Accident at LANL*

The site has only a few accident scenarios involving uranium among those with the highest risks evaluated. This is due to the difference in specific activity between plutonium and HEU. Of accidents releasing HEU, RAD–03 is dominant. The postulated source term was 16 pounds (7.2 kilograms) of uranium. The excess LCFs are estimated at less than 1; that is, no cancer fatality is expected. Details of the accident analysis can be found in appendix G. The results are summarized in Table 5.2.11.3–1.

5.2.11.4 *Tritium Release from a Manmade Hazard Accident*

The scenario initiated by an aircraft crash event is the dominant accident that involves tritium. In this scenario, the entire inventory of tritium at TSTA or TSFF is converted by fire to tritiated water. This is a conservative assumption because water is readily absorbed by the body; whereas, gaseous tritium is not. Nevertheless, for this accident, no excess LCFs are expected to occur, as indicated in Table 5.2.11.4–1.

5.2.11.5 *Chemical Releases from Manmade and Process Hazard Accidents at LANL*

For the chlorine releases, on-site personnel could be exposed to concentrations in excess of ERPG–2. Chlorine has a highly objectionable odor, which prompts sheltering and escape; however, personnel can be quickly overcome when exposed to high concentrations. Details for each accident are found in volume III, appendix G. The results are summarized in Tables 5.2.11.5–1 and 5.2.11.5–2.

5.2.11.6 *Worker Accidents at LANL*

Worker accidents are characterized by higher frequencies and potential for prompt fatalities. Generally, the fatalities would be a consequence of the accident itself, such as a detonation of high explosives. Chemical and radiological exposures to workers depend heavily on the response to an event, such as putting on protective equipment and exiting the area. Accidents that affect workers only are summarized in Table 5.2.11.6–1. Table 5.2.11.6–2 summarizes the effects to workers from the accidents associated with public impacts. Additional details can be found in the appendix G, Accident Analysis.

TABLE 5.2.11.2–1.—*Summary of Radiological Consequences for Plutonium Release Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a,e]	CONSEQUENCE MEASURES[b,c,d,f]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
MANMADE HAZARDS			
RAD–01 Plutonium release from RANT Facility transuranic waste container storage area fire.	Approximately 0.0016 per year (i.e., one event in approximately 600 years); considered an unlikely event	Approximately 0.04 excess LCF Mean population dose approximately 72 person-rem MEI at nearest public access (on Pajarito Road): approximately 46 rem, at most exposed residence: approximately 4 rem	0.000064
RAD–07 Plutonium release from WCRR Facility transuranic waste container storage area fire.	0.00015 per year (i.e., one in 7,000 years); considered an unlikely event	Approximately 0.7 excess LCF Mean population dose: approximately 1,300 person-rem MEI dose at closest public access (Pajarito Road): approximately 74 rem, MEI at habitation: approximately 4 rem	0.00011
RAD–08 Plutonium release from TWISP transuranic waste storage domes due to aircraft crash and fire.	4.3×10^{-6} per year (i.e., one event in approximately 200,000 years); considered an extremely unlikely event	Approximately 0.2 excess LCF Mean population dose: approximately 400 person-rem MEI at nearest public access (Pajarito Road and nearest border with White Rock): 22 rem	8.6×10^{-7}
RAD–16 Plutonium release due to aircraft crash at the CMR Building.	Approximately 3.5×10^{-6} per year (i.e., one event in approximately 300,000 years)	Approximately 0.03 excess LCF Mean population dose: approximately 56 person-rem, no expected excess LCFs; MEI at closest public access, approximately 3 rem, approximately 0.03 rem at nearest habitation	1×10^{-7}

TABLE 5.2.11.2–1.—*Summary of Radiological Consequences for Plutonium Release Scenarios at LANL—No Action Alternative*-Continued

SCENARIO DESCRIPTION	LIKELIHOOD[a,e]	CONSEQUENCE MEASURES[b,c,d,f]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
PROCESS HAZARD ACCIDENTS			
RAD–09 Plutonium release due to transuranic waste drum failure or puncture (for "high" and typical activity in drum).	0.0041per year (i.e., one in approximately 250 years for high-activity drum) 0.4 per year (i.e., one in 2.5 years for typical drum)	0.12 excess LCF from high activity drum Mean population dose for release: approximately 230 person-rem MEI (high activity drum) at closest access (Pajarito Road) approximately 23 rem; approximately 0.86 rem at closest habitation. 0.0022 excess LCF from typical activity drum Mean population dose: approximately 4.4 person-rem MEI (typical activity drum) at closest access (Pajarito Road) approximately 0.41 rem; approximately 0.86 rem at closest habitation	0.00049 0.0009
RAD–13 Plutonium release from flux trap irradiation experiment at TA–18.	0.000016 per year (i.e., one event in approximately 65,000 years)	Approximately 0.08 excess LCF Mean population dose: approximately 160 person-rem MEI at closest public access (Pajarito Road): approximately 120 rem; at closest habitation: approximately 0.12 rem.	1.3×10^{-6}
RAD–15 Plutonium release from CMR. (1) Laboratory Fire (2) Wing Fire	(1) 0.000036 per year (2) 0.000032 per year	(1) Approximately 0.0023 excess LCF Mean population dose: approximately 4.5 person-rem MEI approximately 4.1 rem (2) Approximately 0.85 excess LCF Mean population dose: approximately 1,700 person-rem MEI approximately 91 rem	(1) 8.3×10^{-8} (2) 2.7×10^{-5}

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure.
e The frequency is more correctly described as the probability of occurrence in any 12-month period. See detailed explanation under Meaning of Risk and Frequency in volume III, appendix G, section G.1.
[f] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

TABLE 5.2.11.3–1.—*Summary of Radiological Consequences from Highly Enriched Uranium Release Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d,e]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
RAD–03 Highly enriched uranium release from power excursion accident with Godiva-IV outside Kiva #3.	3.4×10^{-6} per year	Approximately 0.06 excess LCF Mean population dose: approximately 110 person-rem MEI at nearest public access (Pajarito Road) Approximately 150 rem; at nearest habitation approximately 0.5 rem	2×10^{-7}

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure. The MEI dose is provided for an individual located on Pajarito Road at a distance of 160 feet (50 meters) from the facility, even through Pajarito Road would be closed to the public during outdoor operations.
[e] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

TABLE 5.2.11.4–1.—*Summary of Radiological Consequences from Tritium Release Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d,e]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
RAD–05 Tritium oxide release due to aircraft crash at TSFF.	5.3×10^{-6} per year (i.e., one accident in 190,000 years).	Approximately 0.012 excess LCF Mean population dose: 24 person-rem MEI approximately 0.01 rem[f]	6.4×10^{-8}

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure.
[e] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation
[f] This is at 1,200 feet (360 meters) distance. The closest public access would likely be involved in the crash.

TABLE 5.2.11.5–1.—*Summary of Chlorine Exposure Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
PROCESS HAZARD ACCIDENTS			
CHEM–01 Chlorine release (150 pounds [68 kilograms]) from potable water treatment station, due to human error during cylinder changeout or maintenance, or due to random hardware failures.	Approximately 0.0012 per year (i.e., one such event in approximately 800 years)	For the risk-dominant large leak scenario, an average of approximately 43 persons exposed above ERPG–2 levels, and approximately 12 persons exposed above ERPG–3 levels, to distances of up to a few tenths of a mile.	0.052
CHEM–02 Multiple cylinder (1,500 pounds [680 kilograms]) from toxic gas storage shed at gas plant, due to fire or aircraft crash.	Approximately 0.00013 per year (i.e., one in approximately 8,500 years)	Average of 292 people within LANL (ranging from none to 1,000 depending upon wind direction) exposed at or above ERPG–2 or –3 levels; town protected by canyon from highest concentrations.	0.038
CHEM–03 Chlorine release (150 pounds [68 kilograms]) from toxic gas storage shed at gas plant, due to random failure or human errors during cylinder handling.	Approximately 0.00012 per year (i.e., one in approximately 8,000 years)	An average of approximately 263 exposed above ERPG–2 levels; or 239 above ERPG–3 levels, at distances to a fraction of a mile, all within LANL; town protected by canyon from highest concentrations.	0.032
CHEM–06 Chlorine gas release outside Plutonium Facility.	Approximately 0.063 per year (i.e., one event in approximately 16 years)	Average number exposed at or above ERPG–2 doses is approximately 102, and above ERPG–3, approximately 7 at ranges to a fraction of a mile.	6.426

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.

TABLE 5.2.11.5–2.—*Summary of Chemical Exposure Scenarios—No Action Alternative*

SCENARIO	DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
CHEM–04	Bounding single container release of toxic gas (selenium hexafluoride) from waste cylinder storage.	Approximately 0.004 per year (i.e., one in about 250 years)	Average number of off-site persons exposed above ERPG–2 level is zero; toxic effects generally limited to the source's TA (TA–54).	0
CHEM–05	Bounding multiple cylinder release of toxic gas (sulfur dioxide) from waste cylinder storage.	Approximately 0.00051 per year (i.e., one event in approximately 7,000 years)	Under conservative daytime conditions, no one outside the source area (TA–54) would see levels above ERPG–2. Under least favorable conditions, 13 persons could be exposed above ERPG–3 levels.	0

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.

TABLE 5.2.11.6–1.—*Summary of Worker Accident Scenarios at LANL—No Action Alternative*

SCENARIO	DESCRIPTION	FREQUENCY[a]	NUMBER OF WORKER CASUALTIES PER ACCIDENT
WORK–01	Inadvertent detonation of high explosives.	0.001 to 0.01 per year (i.e., one in approximately 100 to 1,000 years)	1 to 15 fatalities or injuries.
WORK–02	Biohazard contamination of a single worker.	0.01 to 0.1 per year (i.e., one in approximately 10 to 100 years)	One diagnosed infection.
WORK–03	Inadvertent criticality at CMR Facility, Critical Experiments Facility, or Plutonium Facility.	< 0.0001 per year (i.e., one in more than 10,000 years)	Substantial doses to those few workers in the immediate vicinity, with possible fatalities from acute exposures.
WORK–04	Inadvertent exposure of workers to electromagnetic radiation.	0.01 to 0.1 per year (i.e., one in approximately 10 to 100 years)	Typically one, rarely several, casualties.
WORK–05	Plutonium release from degraded storage container at Plutonium Facility.	0.23 per year for exposure to workers	Significant but nonlethal doses to one or two workers.

[a] Accident likelihood estimates are conservative, given the information available.

TABLE 5.2.11.6–2.—*Summary of Consequences to Workers at Origination Facilities for Accident Scenarios*

SCENARIO	DESCRIPTION	FACILITY WORKER CONSEQUENCES
SITE–01	Moderate earthquake on the Pajarito Fault or a large earthquake in the Rio Grande Rift zone resulting in structural damage and/or severe internal damage to comparatively low capacity facilities.	Workers in buildings that are structurally damaged or that suffer partial or total collapse (unusual, but possible) could be injured or killed. Worldwide experience with very severe earthquakes indicates that a priori predictions of the numbers of injuries and fatalities are not possible. The experience clearly indicates that large numbers of fatalities (i.e., many hundreds to thousands of deaths) are not commonly experienced except under special conditions. These special conditions include severe earthquakes with large numbers of persons in severely substandard structures that suffer complete collapse. Modern structures do not often experience such failures, even in very severe earthquakes. Other circumstances under which large numbers of fatalities could occur include seismically induced, widespread fires. Other impacts to workers could include delayed emergency response (including medical assistance) and indirect effects from releases of hazardous materials (both inside facilities and to the environment).
SITE–02	Large earthquake on the Pajarito Fault resulting in structural damage and/or severe internal damage to comparatively moderate capacity facilities.	See SITE–01.
SITE–03	Very large earthquake on the Pajarito Fault and perhaps the Embudo Fault resulting in structural damage to essentially all facilities.	See SITE–01.
SITE–04	Site-wide wildfire consuming combustible buildings and vegetation.	Most workers would be evacuated before the fire front arrives. However, there are possible fatalities from fighting the fire. There would be effects from smoke inhalation that are not predictable or quantified.
CHEM–01	Chlorine release (up to 150 pounds [68 kilograms]) from potable water treatment station due to human error during cylinder changeout or maintenance, or due to random hardware failures.	For the cylinder rupture event, it is unlikely that workers will be present because the nature of the event is assumed to occur at random rather than as a result of worker activity. Even with very prompt response by workers inside the building when the release occurs, severe injury or fatality is possible with large chlorine leak rates. The number of injuries and fatalities depends on the exact number and location of workers at the facility at the time of the event. For small leak rates, the likelihood of injury or death is low due to the “self-annunciating” nature of the event.
CHEM–02	Multiple cylinder (1,500 pounds [680 kilograms]) from toxic gas storage shed at gas plant due to fire or aircraft crash.	Workers present at the gas plant facility (TA–3–170 and environs) could be injured or killed, depending upon wind direction and wind speed. However, the chlorine gas and fire causing the release will be readily visible, and escape from the plume, even on foot, is likely. Workers attempting to fight the fire without personal protective equipment could be overcome by chlorine gas.

TABLE 5.2.11.6–2.—*Summary of Consequences to Workers at Origination Facilities for Accident Scenarios*-Continued

SCENARIO	DESCRIPTION	FACILITY WORKER CONSEQUENCES
CHEM–03	Chlorine release (150 pounds [68 kilograms]) from toxic gas storage shed at gas plant due to random cylinder failure or multiple human errors during cylinder handling.	Gas plant workers who are directly involved in handling the cylinders of chlorine could be exposed to ERPG–2 or ERPG–3 concentrations for the human error contributor to this event. In the case of random failures, it is unlikely that workers will be in the immediate vicinity of the cylinder. Gas plant workers could be exposed to high concentrations of chlorine if located outdoors, but these employees would be able to evacuate the area rapidly which would tend to reduce exposure consequences.
CHEM–04	Bounding single container release of toxic gas (selenium hexafluoride) from waste cylinder storage.	There are typically four or five employees in the area during normal work hours. Injuries or fatalities could occur due to exposures as well as missiles from cylinder rupture. Workers are trained to leave the area in the event of a gas release. Consequences would depend on wind speed and direction.
CHEM–05	Bounding multiple cylinder release of toxic gas (sulfur dioxide) from waste cylinder storage.	See CHEM–04.
CHEM–06	Chlorine gas release outside Plutonium Facility.	Air intakes at TA–55–4 are on the west end of the building about 18 feet above the ground and the chlorine release location is on the north side of the building at ground level. In addition, there is an isolation valve in the intake ductwork. Thus, it is unlikely that chlorine will be drawn into the building. Personnel located outdoors could be exposed to ERPG–2 and ERPG–3 concentrations of chlorine, but these employees would be able to evacuate the area rapidly that would tend to reduce exposure consequences.
RAD–01	Plutonium release from RANT facility TRU waste container storage area fire.	There are about a dozen employees at the facility during day shift who could be at risk of plutonium inhalation as a result of this fire. However, the employees would be expected to take shelter or evacuate the area, which would reduce exposures. No lethal exposures would be expected.
RAD–03	HEU release from power excursion accident with Godiva-IV outside Kiva #3.	Personnel would not be located outdoors during an experiment leading to this accident. The TA–18 control building provides 40% attenuation of gamma radiation, and ventilation systems would be secured in the event of an accident, minimizing the air exchange rate with the outdoors. No acute fatalities are expected for this accident.
RAD–05	Tritium oxide release due to aircraft crash at TSFF or TSTA.	An aircraft crash into the building could result in severe injuries or deaths to nearly all the occupants of the building. Nearby workers not within the facility could also be injured or killed as a result of the crash dynamics, explosion, fire, missiles, etc. Workers not directly affected by the aircraft crash could be exposed to tritium oxide, but the release plume would be elevated and may “skip over” the immediate crash site before returning to the ground at some distance.
RAD–07	Plutonium release from WCRRF TRU waste container storage area fire.	There are typically five WCRR Facility workers present during normal operations. The postulated accident would not result in an immediate release, providing time for implementation of evacuation or other protective measures. No fatal exposures are expected.

TABLE 5.2.11.6–2.—*Summary of Consequences to Workers at Origination Facilities for Accident Scenarios*-Continued

SCENARIO	DESCRIPTION	FACILITY WORKER CONSEQUENCES
RAD–08	Plutonium release from TWISP TRU waste storage domes due to aircraft crash and fire.	A small number of workers may be present during normal operations and could be directly affected by crash dynamics, explosion, fire, missiles, etc. Workers not directly affected by the aircraft crash could be exposed to plutonium, but the release plume would be elevated and may "skip over" the immediate crash site before returning to the ground at some distance.
RAD–09	Plutonium release due to TRU waste drum failure or puncture.	The accident would result in an immediate dispersal of plutonium to the area where the work is being performed. The dose to the worker would be dependent on ambient conditions and the speed with which protective actions could be taken (e.g., evacuation). No acute fatalities are expected for this accident.
RAD–10	Plutonium release from degraded storage container at Plutonium Facility (same as WORK–05, except that RAD–10 results in a release to the public, which was determined to be incredible).	See WORK–05.
RAD–13	Plutonium release from flux trap irradiation experiment at TA–18.	See RAD–03.
RAD–15	Plutonium release from hydride-dehydride glovebox fire.	From one to three workers may be present during the operations. These workers could be killed or injured due to the direct effects of a laboratory fire, or could be exposed to plutonium particulates via inhalation. Other workers could be affected by smoke inhalation. Workers outside the facility would not be expected to be impacted due to redundant trains of HEPA filtration between the accident location and the outside environment.
RAD–16	Plutonium release due to aircraft crash at the CMR Building.	An aircraft crash into the building could result in severe injuries or deaths to nearly all the occupants of the building. Nearby workers not within the facility could also be injured or killed as a result of the crash dynamics, explosion, fire, missiles, etc. Workers not directly affected by the aircraft crash could be exposed to plutonium, but the release plume would be elevated and may "skip over" the immediate crash site before returning to the ground at some distance.

5.3 IMPACTS OF THE EXPANDED OPERATIONS ALTERNATIVE

The DOE's Preferred Alternative is the Expanded Operations Alternative, with the exception that pit manufacturing would not be implemented at a 50 pits per year level, single shifts, but only at a level of 20 pits per year in the near term.

5.3.1 Land Resources

5.3.1.1 *Land Use Impacts*

Under the Expanded Operations Alternative, changes to the current overall land use categories are not expected from activities that are unique to this alternative, with the exception of a change to the land use designation at TA–67 if that site is chosen for the development of a new LLW disposal facility, as described in volume II, part I.

In the case of selecting that alternative, a roadway would be cleared and constructed from the R-Site Road to the TA–67 site; the combined total action would result in the clearing of about 60 acres (24 hectares) of forested land and a change in the current designation of that area from the Explosives land use category to a land use category of Explosives/Waste Disposal. The preferred alternative for the expansion of the TA–54/Area G LLW Disposal Area, expansion into Zones 4 and 6, would remove about 41 acres (17 hectares) from its current use as undeveloped wildlife habitat. Another alternative for the expansion of the LLW disposal site, the development of the North Site at TA–54, would remove about 49 acres (20 hectares) from that site's current use as undeveloped wildlife habitat. These changes at TA–54 would not alter the designated category of land use of Waste Disposal because the entirety of Mesita del Buey has been categorized for waste management and disposal activities usage.

Construction of a road between TA–55, the Plutonium Facility, and the TA–3, Chemistry and Metallurgy Research (CMR) Building area, to support pit production activities under the Expanded Operations Alternative (this applies to all project-specific siting and construction [PSCC] alternatives on this subject, as described in volume II, part II) would remove a small amount of acreage (about 7 acres [3 hectares]) from its current use as undeveloped, previously disturbed vegetated wildlife habitat; however, this would not alter the designated land use category of Research and Development use. Under the Preferred Alternative, at the 20 pits per year production rate, this road would not be constructed, and the corresponding land use impacts would not be incurred.

Other activities identified for this alternative also would occur, primarily within existing facilities or near to them and within the same type of land use category areas.

An increase in population in the Tri-County area due to an increase in employment would result in an increase in recreational use of surrounding lands and facilities. As shown in Table 5.3.9.1–2, there could be an estimated increase of about 4,230 individuals, or about 2.5 percent. This population level is within historical fluctuations due to changing laboratory activity levels. This increase in recreational use would likely include hiking, fishing, hunting, picnicking, camping, and skiing. Many of these activities, including visitation of archeological sites, would take place on adjacent lands administered by the SFNF and the NPS. This increase, while small, would contribute to increased recreational, wildlife, and cultural resource management measures being taken by these agencies to balance increasing numbers of visitors and accompanying noise and activity with natural and cultural resource needs.

5.3.1.2 *Visual Impacts*

The Expanded Operations Alternative would be expected to include the same effects as discussed under the No Action Alternative. Additionally, under this alternative there would be an expansion of the Area G LLW disposal landfill site at TA–54 or the construction and use of a new LLW disposal site and roadway at TA–67, and the construction of a roadway between TA–55 and TA–3, together with the possible construction of an add-on to the existing Plutonium Facility 4 at TA–55 or a new building nearby within the security fenced area at TA–55. The Area G landfill expansion would not be visible from Pajarito Road. However, the Area G landfill expansion would be visible from San Ildefonso land; Zones 4 and 6 are both farther away from the LANL boundary and would be less visible than the existing Area G landfill site, while the North Site is closer to the LANL boundary and would be more visible than the existing landfill site to people located on San Ildefonso land. The TA–67 landfill site would be visible from Pajarito Road, but would not be visible from San Ildefonso land.

Construction at the TA–67 site would change the view scape of the mesa top from that of forest to industrial development. Portions of the TA–55 to TA–3 roadway and its security fencing may be visible to motorists along Pajarito Road. The new roadway would be constructed in an already developed area and so would not significantly change the view scape of that area. Construction of an add-on to the Plutonium Facility or construction of a new building nearby would not alter the view scape of the TA–55 Plutonium Facility area because that area is already heavily developed.

Under the Expanded Operations Alternative there would be additional perimeter security floodlighting placed along the new roadway leading from TA–55 to TA–3, and around the new building within TA–55 if that alternative is chosen. This would result in very minor effects at the TA–55 and TA–3 area because of the limited area and length of the roadway. At the 20 pits per year production rate, the Preferred Alternative, these impacts would not be incurred because the road would not be constructed.

Similarly, additional perimeter security floodlighting would be placed around the Area G landfill expansion area or the TA–67 landfill area, both of which would be lighted for nighttime security purposes. The effect of additional lighting at the Area G landfill would be slightly noticeable during the night, especially to workers in the nearby areas. Nighttime lighting of the TA–67 area with both security floodlighting and parking lot safety lighting would be noticeable to LANL workers and potentially to off-site viewers because there are currently no areas along the Pajarito mesa that are similarly lighted. Additionally, such lighting might result in a short-term adjustment of wildlife use of the TA–67 site area. Use of these additional light fixtures at both the TA–54 and TA–67 locations and the TA–55 area could result in a slight increase in overall LANL area levels of light pollution, but is unlikely to result in a significantly expanded nighttime visibility of LANL from locations across the Rio Grande Valley.

Potential effects to the BNM and Dome Wilderness viewsheds would be similar to that of other area neighbors. Additional light sources could result in a slight increase in overall LANL levels of light pollution. Newly lighted areas may be visible to viewers at higher elevations at certain vantage points, but would not likely result in any appreciable expansion of the nighttime visibility of LANL as viewed from far distances. Expansion of the TA–54 Area G into Zones 4 and 6 would likely result in a minimal perception of clearing enlargement from BNM or Dome Wilderness vantage points due to forest growth between the vantage point and site location, the TA–54 site location on a mesa somewhat sloped to the southeast (away from these neighboring areas), and the amount

of disturbance present in the general site area. A newly constructed disposal site at TA–67 would similarly be expected to result in a minimal perception of clearing enlargement from BNM or Dome Wilderness vantage points due to the forest growth between the vantage point and the site location, the TA–67 site location on a mesa somewhat sloped toward the southeast, and to the elevation of the TA–67 site relative to the neighboring vantage points in question. The construction of a roadway between TA–55 and TA–3 (which would not be constructed for the 20 pits per year production rate, the Preferred Alternative) would not likely be seen from off-site vantage points because of its relatively small size and the surrounding forest growth. If a vantage point exists from which the road can be viewed, it would likely result in little added viewshed impact given its location along Pajarito Road and the general state of development in the TA–3, TA–59, and TA–55 areas. An increase in the frequency of explosives should not affect the BNM and Dome Wilderness viewsheds.

5.3.1.3 *Noise*

Under the Expanded Operations Alternative there would be a slight increase in the amount of interior and outdoor construction activities at LANL. These would individually be within the level of effects described for the No Action Alternative, but may be ongoing for a longer total period of time. The construction of either the Area G landfill expansion or a new replacement facility within TA–67 would result in levels of sound and short-range ground vibrations that would be no different than those associated with current Area G landfill activities. Workers would be primarily affected by these noises, although motorists may occasionally hear low levels of equipment noises along Pajarito Road under certain climatic conditions. The construction of the roadway between TA–55 and TA–3 for pit production implementation would be short term and consistent with routine construction activities associated with road construction. Road construction would not be performed for a 20 pits per year production rate, the Preferred Alternative. Other planned construction activities under this alternative are mostly small-scale outdoor activities or interior to existing buildings, or the construction of an add-on to an existing building, or construction of a new building within close proximity to others. Effects of these construction activities would be primarily limited to involved workers and are not likely to result in any adverse effect to sensitive wildlife species or their habitat within the vicinity.

The primary noise, airblast waves, and ground vibration impacts from the implementation of this alternative would be generated by the increased number of HE tests, although these explosions and the resulting noise would still be occasional (rather than continuous) events. These would individually not result in effects that would be different than the effects currently generated whenever there is a HE test. The effects of these activities on cultural resources in the vicinity of the tests are addressed in section 5.3.8. It is not expected that such tests would adversely affect off-site sensitive receptors (e.g., those at BNM or at White Rock). Noises heard at that distance would be similar to thunder in intensity, and airblast and ground vibrations are not expected to be present off site of LANL at intensities great enough to adversely affect real properties. It is uncertain if any sensitive wildlife species would be adversely affected by additional numbers of “thunder-like” explosives testing events over that represented by the No Action Alternative. This is unlikely, however, given their continued presence in areas over the country that are known to be within higher-than-average lightning event areas.

5.3.2 Geology and Soils

Potential impacts for the Expanded Operations Alternative on geology and soils would be

essentially the same as those for the No Action Alternative. LANL historical levels of firing site activities were 1.2 times greater than proposed for the Expanded Operations Alternative (LANL 1995d). For the same reasons as discussed under the No Action Alternative, the Expanded Operations Alternative should have little potential to contribute substantially to soil or sediment contamination. The expansion of Area G, TA–54, would temporarily result in slightly more disturbed soils than the other alternatives. This, however, would not have a significant impact on soil erosion or geology in the area because: (1) only a few disposal cells are open at any one time and (2) after a disposal cell is filled and closed, it is then revegetated. Because Zone 4 is currently designated for LLW disposal and Zone 6 is designated for solid waste management, this land is not available to be mined for mineral resources. These impacts would not change for other PSSC alternatives.

5.3.3 Water Resources

5.3.3.1 *Surface Water*

Table 5.3.3.1–1 shows the total flow from the NPDES outfalls for each of the major watersheds under the Expanded Operations Alternative. The estimated total gallons discharged into all watersheds equals 278 million gallons (1,052 million liters) under the Expanded Operations Alternative. This is an increase from the index effluent volume of 233 million gallons (882 million liters).

NPDES outfall effluent quality during the period of the SWEIS (1997 through 2006) is

TABLE 5.3.3.1–1.—*NPDES Discharges by Watershed Under the Expanded Operations Alternative*[a]

WATERSHED	#OUTFALLS		DISCHARGE (MGY) KEY FACILITIES					
			KEY FACILITIES		NON-KEY FACILITIES		TOTALS	
	INDEX	EXPANDED	INDEX	EXPANDED	INDEX	EXPANDED	INDEX	EXPANDED
Ancho	2	0	0.1	0.0	0.0	0.0	0.1	0.0
Cañada del Buey	3	3	0.0	0.0	6.4	6.4	6.4	6.4
Chaquehui	1	0	0.0	0.0	5.8	0.0	5.8	0.0
Guaje	7	7	0.0	0.0	0.7	0.7	0.7	0.7
Los Alamos	12	8	19.2	44.6	0.5	0.2	19.7	44.8
Mortandad	12	7	42.0	32.3	10.9	5.1	52.9	37.4
Pajarito	17	11	8.4	1.8	0.8	0.8	9.2	2.6
Pueblo	1	1	0.0	0.0	1.0	1.0	1.0	1.0
Sandia	11	8	4.4	42.8	103.5	127.9	107.9	170.7
Water	21	10	29.5	14.2	0.0	0.0	29.5	14.2
Totals	87	55	103.6	135.7	129.6	142.0	233.2	277.8

MGY: millions of gallons per year

[a] NPDES Information Sources: Index information was provided by the Surface Water Data Team Reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Outfall flow projections for the alternatives were based on the outfalls remaining as of November 1997. Additional outfalls may be eliminated in the future, as discussed in the *Environmental Assessment for Effluent Reduction* (DOE 1996e), as well as several other outfalls that may be closed as part of LANL's ongoing outfall reduction program.

expected to be the same under this alternative as described for the No Action Alternative, including the radionuclide concentrations in effluent from TA–50, as presented in Table 5.3.3.1–1. In volume III, appendix A, Table A.1–1 presents a more detailed table of the NPDES outfalls for all four alternatives by facility (key and non-key), watershed, and location. Similar to the No Action Alternative, the canyons that have an increase in outfall flow over the index are Los Alamos Canyon and Sandia Canyon. The increase in flow for Sandia Canyon is the same as that discussed for the No Action Alternative. The potential impacts from the increase in flow of 25 million gallons (95 million liters) per year in Los Alamos Canyon should be minimal for the same reasons as discussed in the No Action Alternative.

Under the Expanded Operations Alternative, a dedicated transportation corridor approximately 1 mile (1.6 kilometers) in length would be constructed between TA–55 and TA–3, parallel to Pajarito Road. It would occupy an area of approximately 7 acres (2.8 kilometers). This nearly paved surface would result in slightly more stormwater runoff. Construction activities at LANL employ engineering controls to prevent contamination of stormwater runoff. The effects at this slight increase in stormwater runoff should be minimal in terms of both erosion and sediment transport. At the 20 pits per year production rate (Preferred Alternative), the road would not be constructed.

5.3.3.2 *Alluvial Groundwater*

The increases in NPDES outfall discharges (as compared to the No Action Alternative) are expected to result in proportionally greater alluvial groundwater volumes.

The values listed above illustrate that under the Expanded Operations Alternative, the volume of effluent discharged into Mortandad Canyon from RLWTF (9.3 million gallons [35 million liters] per year) would approach double that of the RLWTF index volume of 5.5 million gallons (21 million liters) per year. Such an increase may substantially increase the volume of groundwater stored in the alluvium, raising the groundwater table and extending the groundwater body farther down the canyon. Previous estimates of water stored in the alluvium in Mortandad Canyon range from 4 to 8 million gallons (15 to 30 million liters). The capacity for additional storage is unknown. Also unknown are the rates of infiltration into the tuff below and the volume lost to evaporation. If evaporation rates or infiltration rates into the underlying tuff beneath the alluvium are sufficiently low, it is possible that increasing the discharge volume may eventually result in groundwater resurfacing as seeps or springs farther down the canyon. However, it is important to note that this is unlikely because under past conditions of maximum discharge (up to 13 million gallons [50 million liters] per year) at RLWTF, no springs or wetlands were created.

Another important factor to consider is that the overall flow from NPDES outfalls into Mortandad Canyon will be decreased from the baseline by 16 million gallons (61 million liters) per year. The majority of the outfalls with reduced flows are TA–48 and TA–35, and they are either just upstream or close to the RLWTF outfall.

The impacts to alluvial groundwater quality should be minimal; however, any additional groundwater could increase infiltration into the tuff below the alluvium. The potential for groundwater migration down the Guaje Mountain Fault zone, located approximately one-quarter mile (0.4 kilometer) downstream of RLWTF outfall, may also increase. Increased infiltration through the tuff or the fault zone may allow more rapid transport of contaminants to the main aquifer. As discussed in the No Action Alternative, tritium and nitrate have been detected in the main aquifer beneath Mortandad Canyon, indicating that migration pathways possibly do exist (LANL 1992, LANL 1993,

LANL 1994, and LANL 1995c). LANL will continue to monitor downstream of the RLWTF the main aquifer and alluvial groundwater for any indicators of potential problems.

As discussed for the No Action Alternative, the new HELWTF became fully operational in 1998 and water quality will likely improve in Canyon de Valle near TA–16.

5.3.3.3 *Perched Groundwater*

Groundwater flow and contaminant pathways to the intermediate perched groundwater bodies are not well characterized nor understood. It is possible that the increased NPDES discharges to Los Alamos and Sandia Canyons under this alternative could increase recharge of the intermediate perched groundwater and contaminant transport beneath these canyons.

5.3.3.4 *Main Aquifer*

Recharge mechanisms to the main aquifer are uncertain. However, for the same reasons as discussed under the No Action Alternative, impacts resulting from increased NPDES outfall flows to the main aquifer water quality should be negligible under the Expanded Alternative.

A conservative projection of LANL water use under the Expanded Operations Alternative is 759 million gallons (2,873 million liters) per year. Los Alamos County and the NPS did not provide projections, but in 1994 the County used about 958 million gallons (3,626 million liters) from this water right and the NPS used about 5 million gallons (19 million liters). Based on this information, it is expected that the water requirements of this community can be met within the existing water rights from the main aquifer; however, projected use may approach 100 percent of the existing water rights to the main aquifer under this alternative.

For the purposes of modeling drawdown of the main aquifer, annual water use projections were made. The total water usage from DOE water rights was projected to average 1,724 million gallons (6,525 million liters) per year under the Expanded Operations Alternative, with a maximum annual use of 1,751 million gallons (6,628 million liters) and a minimum annual use of 1,665 million gallons (6,302 million liters).

The model results reflect water level changes at the top of the main aquifer across the alternatives, given continued draw from the aquifer by DOE, Española, and Santa Fe. Table 5.3.3.4–1 shows predicted water level changes at the surface of the main aquifer during the period from 1997 through 2006 for the Expanded Operations Alternative; as noted in section 5.2.3.1, these changes are not all due to LANL operations. Although the water use modeled includes water use in Española and Santa Fe, the differences between the alternatives are due only to LANL operations. The impacts to the volume of water in the main aquifer under this alternative are very similar to those described for the No Action Alternative; the drawdowns in DOE well fields are minimal relative to the total thickness of the main aquifer, and the volume of water to be used over the period from 1997 through 2006 is negligible relative to the volume of water in storage.

Details of the conceptual model, assumptions, uncertainties and limitations, and input parameters for the groundwater model are described in volume III, appendix A.

5.3.3.5 *Area G*

In 1997, a draft Performance Assessment (PA) and Composite Analysis (CA) were prepared for the current solid LLW disposal facility, Area G. The PA was approved by DOE in October 1998 (LANL 1998c). The purpose of the PA is to determine if Area G disposal of LLW generated and projected since September 26, 1988, would result in radiation doses to members of the public that exceed performance objectives specified by DOE

TABLE 5.3.3.4–1.—*Maximum Water Level Changes at the Top of the Main Aquifer Under the Expanded Operations Alternative (1997 Through 2006)*

WATER LEVEL CHANGE IN FEET[a,b]	
AREA OF CONCERN ON SITE	
Pajarito Well Field	-15.6
Otowi Well Field (Well 0-4)	-15.2
AREA OF CONCERN OFF SITE	
DOE - Guaje Well Field	-9.3
Santa Fe Water Supply	
Buckman Well Field	+21.6
Santa Fe Well Field	-20.6
San Juan Chama Diversion	0.0
Springs	
White Rock Canyon Springs, Maximum Drop	0.0
White Rock Canyon Springs, Maximum Rise	+1.0
Other Springs (Sacred, Indian)	+3.8
San Ildefonso Pueblo Supply Wells	
West of Rio Grande	
Household, Community Wells	+0.6
Los Alamos Well Field	+3.8
East of Rio Grande	
Household, Community Wells	0.0

[a] Negative value (-) indicates water level drop; positive value (+) indicates water level rise.

[b] Also, the water level changes projected by the regional MODFLOW model represent average changes over a whole grid- cell (i.e., a square that is a mile on a side). They are, for the most part, not predictive of the water level changes at any single point within the cell (for example, a supply well). Pumping wells have characteristic "cones of depression" where the water surface reflects an inverted cone, and water levels at the well may be quite different from levels even a few ten's of feet away. Whether any individual well would exhibit water level changes consistent with the predicted grid-cell average change is a function of, for example, its location within the grid-cell; proximity to other pumped wells; and the individual well operation, construction, and hydraulics. Hence, the water level changes predicted by the model can only be considered qualitatively and can not be considered as finite changes.

Order 5820.2A and the report, *Interim Format and Content Guide and Standard Review Plan for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments* (DOE 1996c). In a complementary fashion, the CA is used to evaluate options for ensuring that exposures from all waste disposed of at Area G will not impart doses to future members of the public in excess of specified limits. Together, the PA and CA provide a comprehensive evaluation of the potential radiological exposures to future members of the public from past, present, and future waste disposal at Area G. The PA includes as part of the "future disposal of waste at Area G" the expansion of Area G, as discussed in volume II, part I of this SWEIS. Doses are projected beyond 1,000 years after facility closure, which is assumed to occur in 2044. These results are compared with performance objectives. The results of the PA in terms of surface water and groundwater impact are summarized in the following paragraphs. While the PA and CA are specific to Zone 4 at Area G, the geologic features of the entire Mesita del Buey have essentially identical site characteristics, and the PA and CA results for Zone 4 would be applicable to the Zone 6 and North Site locations as well. While there are some differences between the characteristics between the Zone 4 and TA–67 sites, these are sufficiently similar that the PA and CA results would be expected to be applicable to TA–67; the one potential exception to this statement is that the fault underlying part of TA–67 could introduce some additional issues regarding the use of TA–67 for waste disposal (Newell 1998).

Flooding of the disposal facility is not a major concern due to the natural inclination for runoff from the mesa into canyon; temporary ponding within disposal pits, however, has occurred. A recent field study at Area G demonstrated that disposal cells covers are subject to sheet erosion, with only small, localized rill occurring infrequently. The expansion of Area G would temporarily result in slightly more disturbed

soils. This, in turn, would result in slightly more stormwater runoff.

Observation wells and moisture-access holes were drilled in Cañada del Buey and Pajarito Canyon to determine if perched water existed within canyon alluvium and, if present, if it extended beneath Mesita del Buey. Wells in Cañada del Buey were essentially dry, and it was concluded that perched water in Pajarito Canyon, adjacent to Mesita del Buey, is confined to the alluvium in the stream and does not extend to the flank of the canyon.

It was concluded that the main aquifer is the only source capable of serving municipal and industrial water needs, and the PA results show that the design of Area G takes advantage of the natural ability of the site to contain radioactivity (Purtyman 1995). The very dry host rock effectively decouples radioactivity in LLW from the main aquifer for thousands of years. The groundwater performance objective is a maximum effective dose equivalent of 4 millirem per year to any member of the public from the consumption of drinking water drawn from wells outside of the land-use boundary. The groundwater protection analysis from the PA and CA resulted in peak annual doses within 1,000 years at the point of maximum exposure, the east-southeast boundary of Area G and Parjarito Canyon, of 7.5×10^{-8} and 0.000035 millirem, respectively. These doses are more than 100,000 times smaller than the dose performance objectives.

5.3.4 Air Quality

5.3.4.1 *Nonradiological Air Quality Impacts*

Criteria Pollutants

As stated in section 5.1.4, estimates of future emission rates were based on the operations anticipated under the Expanded Operations Alternative—the worst-case alternative with respect to emission rates from the combustion sources. The results of the Expanded Operations Alternative analysis of criteria pollutants demonstrate that the highest estimated concentration of each pollutant would be below the standards established to protect human health with an ample margin of safety. These results are presented in Table 5.3.4.1–1.

Toxic Air Pollutants

In all but two cases, the estimated pollutant concentrations were below the corresponding GVs established for this analysis. GVs are the levels established to screen emission rates for further analysis. The two cases where estimated emission rates were above GVs and were referred to the human health and ecological risk assessment processes are:

- Emissions from HE Firing Site operations at TA–14, TA–15, TA–36, TA–39, and TA–40 (appendix B, attachment 13); the estimated concentration of a pollutant is greater than its GV for the following releases:
  - DU, beryllium, lead, aluminum, copper, tantalum, tungsten, and iron from TA–15
  - DU, beryllium, lead, copper, and iron from TA–36
  - Beryllium, lead, aluminum, and copper from TA–39
  - DU and lead from TA–14
  - Copper from TA–40
- The additive emissions from all of the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center (appendix B, attachment 6)

The combined incremental cancer risks associated with releases of all carcinogenic pollutants from all TAs at the receptor locations where these impacts actually occur are slightly above GV of 1.0×10^{-6} only at the two locations within the LANL medical center: 1.17×10^{-6} at

TABLE 5.3.4.1–1.—*Results of Criteria Pollutants Analysis (Expanded Operations Alternative)*

POLLUTANT	TIME PERIOD	MAXIMUM ESTIMATED CONCENTRATIONS ($\mu g/m^3$)	ASSUMED BACKGROUND CONCENTRATIONS[a] ($\mu g/m^3$)	TOTAL POLLUTANT CONCENTRATIONS ($\mu g/m^3$)	NEW MEXICO CONTROLLING AMBIENT AIR QUALITY STANDARDS[b] ($\mu g/m^3$)
Carbon Monoxide	1 hour	2,712	2,350	5,062	11,750
	8 hours	1,436	1,560	2,996	7,800
Nitrogen Dioxide	24 hours	90[c]	29	119	147
	Annual	9	15	24	74
Sulfur Dioxide	3 hours	254	205	459	1,025
	24 hours	130	41	171	205
	Annual	18	8	26	41
Total Suspended Particulates	24 hours	18	30	48	150
	Annual	2	12	14	60
PM_{10}	24 hours	9	30	39	150
	Annual	1	10	11	50
Lead	3 months (calendar quarter)	0.00007	0.30	0.30	1.5

[a] No data exist for background values. It was conservatively assumed that background concentrations were 20 percent of the corresponding standard. As there are almost no other combustion sources in and around Los Alamos, the background concentrations would be much less than the 20 percent assumed concentrations.

[b] New Mexico Ambient Air Quality standards, for some of the pollutants, are stated in parts per million (ppm). These values were converted to micrograms per cubic meter ($\mu g/m^3$), with appropriate corrections for temperature and pressure (elevation) following New Mexico Dispersion Modeling Guidelines (NM 1996).

[c] New Mexico Air Quality Bureau accepts Ozone Limiting Method (OLM) to more accurately determine nitrogen dioxide (NO_2) concentrations. The 24-hour maximum modeled concentration for nitrogen oxide was 520 $\mu g/m^3$. This concentration, when modeled using OLM, is only 90 $\mu g/m^3$ of NO_2.

an air intake duct, and 1.07×10^{-6} at an operable window.

The major contributors to the estimated combined cancer risk values are chloroform, formaldehyde, and trichloroethylene from TA–43, the HRL, and multiple sources for methylene chloride. The estimated maximum cancer risk for each of these individual pollutants is 9×10^{-7}, 5×10^{-8}, 7×10^{-8}, and 7×10^{-8}, respectively. Of these, the relative contribution of chloroform emissions alone to the combined cancer risk value is more than 87 percent (conservatively assuming that 100 percent of the chloroform used is emitted). The impacts of TA–43 emissions are due to a combination of relatively high emission rates, close proximity between receptors and sources, and the elevation of the receptors.

5.3.4.2 *Radiological Air Quality Impacts*

This section addresses the radiation dose to the FS MEI, LANL MEI and the population dose from LANL radionuclide air emissions under the Expanded Operations Alternative.

Facility-Specific Maximally Exposed Individual

MEI dose estimates are shown in Table 5.3.4.2–1. This table shows the highest FS MEI dose is 5.44 millirems per year, which is 54.4 percent of the regulatory limit for the air pathway. The EPA regulatory limit would not be exceeded from emissions of these facilities under the Expanded Operations Alternative.

TABLE 5.3.4.2–1.—*Facility-Specific Information—Expanded Operations Alternative*

FACILITY	DOSE[a] (mrem/yr)
TA–3–29 (CMR)	1.32
TA–3–66 (Sigma Building)	1.32
TA–3–102 (Machine Shops)	1.02
TA–11 (High Explosive Testing)	0.73
TA–15/36 (Firing Sites)	4.99
TA–16 (WETF)	0.70
TA–18 (Pajarito Site: LACEF)	4.39
TA–21 (TSTA and TSFF)	2.55
TA–48 (Radiochemistry Laboratory)	3.67
TA–55 (Plutonium Facility)	3.67
TA–53 (LANSCE)[b]	5.44
TA–54 (Boundary)[c]	1.81
TA–54 (White Rock)	1.07

[a] For each FS MEI, the total dose was calculated by adding the contributions from each modeled facility. An MEI does not leave or take protective measures.

[b] This is also the LANL MEI. Five specific sources were modeled from TA–53. These include the TA–53 ES-2, ES-3, IPF, LEDA and combined diffuse emissions.

[c] Two FS MEI locations were considered for TA–54 because Area G is bordering San Ildefonso Pueblo land. The first is a MEI location at the LANL boundary, 1,197 feet (365 meters) northeast of Area G. No person from the Pueblo currently is known to live along this boundary. The second is an actual MEI location in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

LANL Maximally Exposed Individual

The location of the LANL MEI (2,625 feet [approximately 800 meters] north-northeast of TA–53) was shown to be identical to the FS MEI with the highest dose under the Expanded Operations Alternative. The LANL MEI dose was also calculated to be 5.44 millirems per year.

Population Dose. The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated to be 33.09 person-rem per year. TA–15/36 accounts for 64.1 percent of this dose (collective diffuse emissions, including those from these TAs, account for 64.5 percent of this dose). The values reported for population doses for this alternative, as well as the other alternatives, is higher than has been reported in the recent annual environmental reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. The material throughput at the different facilities under the various alternatives is presented in chapter 3 (section 3.6).

Isodose Maps. The isodose maps for the Expanded Operations Alternative are shown in Figures 5.3.4.2–1 and 5.3.4.2–2.

Pit Production. The impacts listed above are influenced only slightly by pit production activities. At the CMR Building, there are two types of contributions: (1) analytical chemistry support and (2) activities moved from TA–55 to the CMR Building under the "CMR Building Use" Alternative for pit production. At a pit production rate of 80 pits per year, regardless of the PSSC alternative, analytical chemistry support is projected to contribute about 13 microcuries per year to the total CMR Building air emissions (which are projected to be about 760 microcuries per year under the Expanded Operations Alternative).

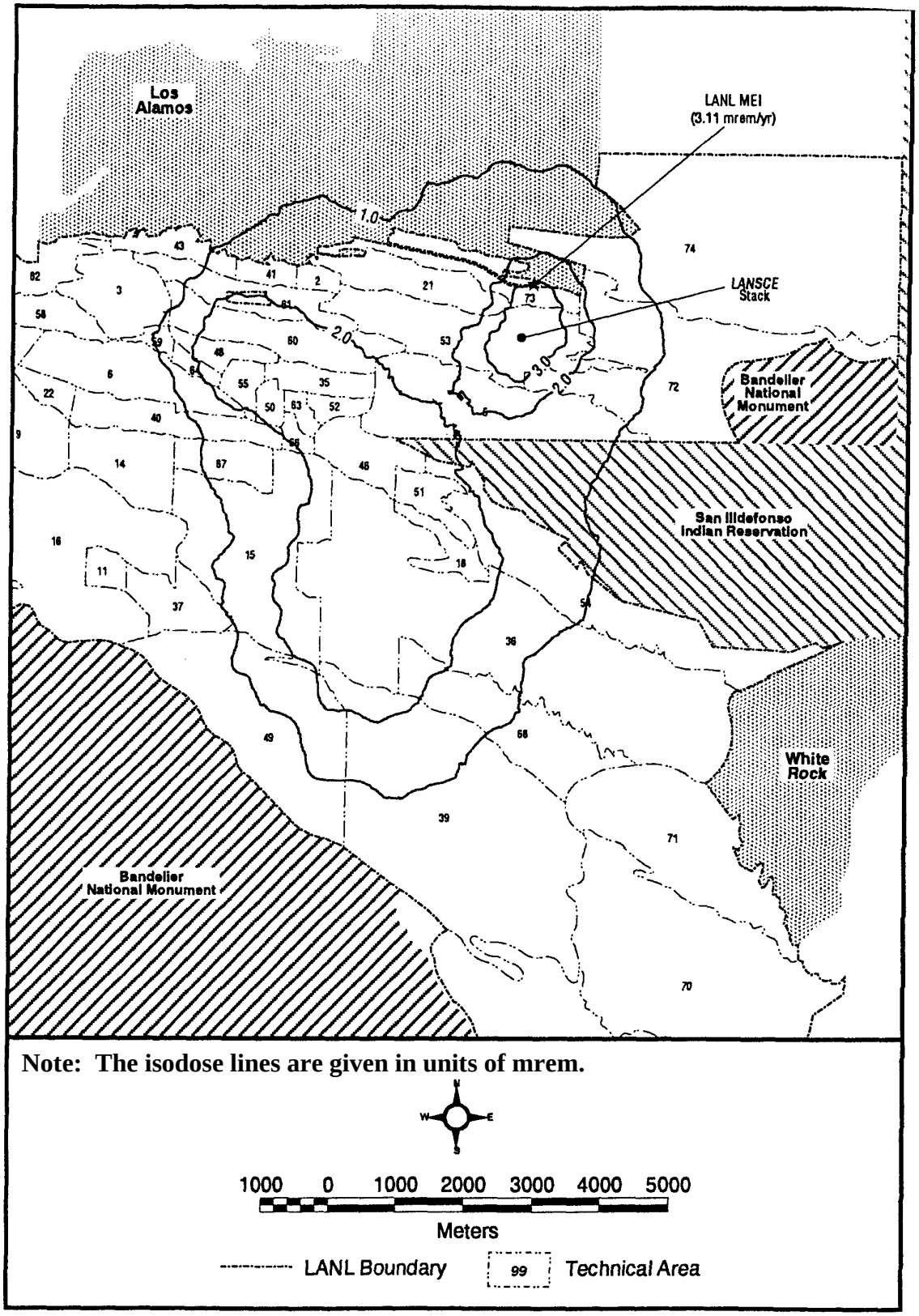

FIGURE 5.3.4.2–1.—*Isodose Map Showing Doses Greater Than 1 Millirem per Year for the Expanded Operations Alternative.*

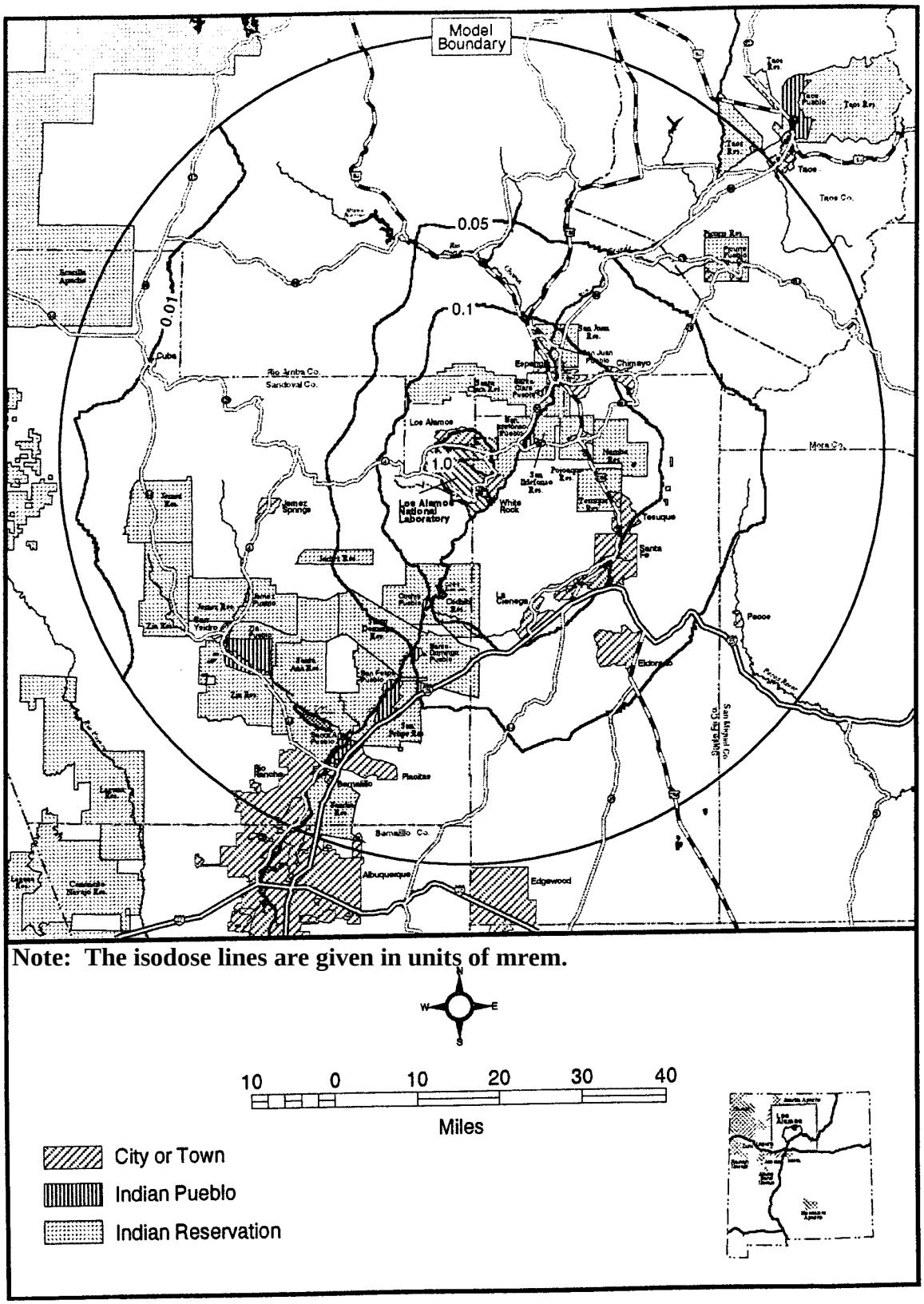

FIGURE 5.3.4.2–2.—*Isodose Map Showing Doses Less Than 1 Millirem per Year for the Expanded Operations Alternative.*

At a pit production rate of 20 pits per year (Preferred Alternative), the analytical chemistry contribution to air emissions is projected to be about 3 microcuries per year (or about a quarter of the 80 pits per year contribution to emissions).

Under the Brownfield and TA–55 Add-on Alternatives, as well as at the 20 pits per year production rate (Preferred Alternative), the analytical chemistry contribution to air emissions is the only contribution directly attributable to pit production. However, under the PSSC "CMR Building Use" Alternative (at 80 pits per year), activities that contribute to air emissions are moved from TA–55 to the CMR Building. The total contribution of these activities to CMR Building emissions is projected to be about 25 microcuries per year (as compared to the CMR Building total emissions of 760 microcuries). Thus, the CMR Building radioactive air emission rates directly attributable to pit production work at LANL do not substantially influence the FS MEI dose, the LANL MEI dose, the population dose, or the isodose maps.

At TA–55, there are two types of activity contributions important to understanding pit production impacts: (1) pit production work within TA–55 and (2) activities that would be moved to the CMR Building under the PSSC "CMR Building Use" Alternative. The pit production work at LANL contributes about 11 microcuries per year to air emissions at the 80 pits per year rate; at the 20 pits per year rate (Preferred Alternative), the contribution would be about 3 microcuries per year. For the PSSC "CMR Building Use" Alternative, activities that contribute about 25 microcuries per year in emissions (under the Expanded Operations Alternative level of operations) are transferred to the CMR Building. Under the Brownfield and TA–55 Add-on PSSC Alternatives, as well as at the 20 pits per year rate (Preferred Alternative), those activities would remain at TA–55 (and those emissions would remain at TA–55).

The PSSC "CMR Building Use" Alternative results in total TA–55 particulate radioactive air emissions of about 27 microcuries per year. At the 20 pits per year rate (Preferred Alternative), the total TA–55 particulate air emissions would be about 44 microcuries per year. The radioactive particulate air emissions associated with TA–55 operations, including those associated with pit production activities, are substantially smaller than emissions throughout LANL that contribute substantially to the LANL MEI, the population dose, and the isodose map contours. While the TA–55 MEI dose could change slightly depending on the PSSC alternative selected (or as compared to that at the 20 pits per year rate, the Preferred Alternative), such changes would not be expected to be substantial for the following reasons:

- The 25 microcuries per year associated with activities that might move to the CMR Building under the PSSC "CMR Building Use" Alternative, is a small amount compared to other radioactive air emissions in the area.
- Whether those emissions (25 microcuries per year) occur at the CMR Building or at TA–55, they contribute to the TA–55 MEI dose. (Of course, their contribution to the TA–55 MEI dose is greater as a TA–55 emission than as a CMR Building emission.)
- The TA–55 MEI dose has substantial contributions from other facilities in the area—99 percent of the TA–55 MEI dose under the PSSC "CMR Building Use" Alternative is due to facility emissions other than those of TA–55. (See volume III, appendix B, Table B.1.2.1.–2.)

In short, the TA–55 radioactive air emissions differences due to the different PSSC alternatives (or the 20 pits per year rate, the Preferred Alternative) are not expected to result in substantial changes in the impacts reflected above.

5.3.4.3 *Project-Specific Siting and Construction Analyses*

As noted in volume II, part I, the expansion of Area G into Zones 4 and 6 would generate dust particles and vehicle exhaust during construction, in addition to the operational impacts discussed above. Additionally, trees cleared from the area may be chipped and burned on site. These construction impacts would be mitigated through dust suppression methods such as misting, and any burning would be performed under an open burning permit such that air quality standards would not be violated. These construction activities would not be expected to degrade the quality of air in residential areas. The impacts would be similar under any of the alternatives considered in this PSSC analysis, with the potential for increased clearing and wood burning associated with the TA–67 alternative.

As discussed in volume II, part II, the construction activities associated with the enhancement of pit manufacturing would not be expected to change radiological air emissions. Nonradiological emissions associated with this construction activity would be expected, but would not exceed regulatory standards and would not be expected to impact workers or the public. The impacts would be similar under any of the alternatives considered in this PSSC analysis. (Note that the nonradiological emission impacts associated with these construction activities would not be incurred at the 20 pits per year production rate, the Preferred Alternative.)

5.3.5 Ecological Resources, Biodiversity, and Ecological Risk

Impacts to ecological resources and biodiversity resulting from implementation of the Expanded Operations Alternative would be similar to that of the No Action Alternative, even considering the chemical emissions that exceeded GVs, as discussed in section 5.3.4. Ongoing LANL facility operation and planned actions would enhance current biological resources (including protected and sensitive species), ecological processes, and biodiversity. There would be a small habitat loss due to the expansions of pit manufacturing and Area G's disposal area, as discussed in section 5.3.5.1. Impact to wetlands as a consequence of outfall reduction and an increase in effluent discharges would be approximately the same as for the No Action Alternative. While effluent quantities would be higher than No Action, the potential for expansion of wetlands would remain low.

There would be an increase in the frequency of explosives testing associated with Expanded Operations. However, the noise and vibration associated with individual testing events would be the same as currently experienced, and no adverse impacts to animals, including threatened and endangered species, are anticipated from this increase in testing frequency.

As with the No Action Alternative, Expanded Operations would have little potential to contribute substantially to soil, water, and air contamination. The projected slight increase in deposition of contaminants resulting from an increase in the frequency of explosives testing would be small relative to historical deposition rates. Consequently, there would not be a discernible change from the No Action level of ecological risk. Again, the continued cleanup of legacy contamination is expected to reduce the contribution of past (legacy) LANL operations to ecological risk.

5.3.5.1 *Project-Specific Siting and Construction Analyses*

The proposals to expand pit manufacturing operations and expand Area G's LLW disposal area are integral components of expanded operations. These two components of expanded

operations involve removal and disturbance of habitat as a consequence of facility construction.

The removal of vegetation (primarily ponderosa pine-Gambel oak woodland) due to the proposed road connecting TA–3 with TA–55 would remove a small amount of habitat for small mammals and birds, and the possible erection of a mile-long security fence could alter large mammal movement along Pajarito Road. This habitat loss would be small, and altered large animal movement should not appreciably affect animal behavior and habitat use. Disturbance to wildlife utilizing adjacent habitat due to construction noise and activity would be minor and short term. Under the Preferred Alternative, at the 20 pits per year production rate, this would not be built, so these impacts would not be incurred.

Both the peregrine falcon and the bald eagle could utilize the area proposed for the road as part of their overall foraging area. A preliminary model for Mexican spotted owl habitat indicates that fragmented patches of potential nesting/roosting habitat exists within 0.2 mile (0.32 kilometer) of the proposed connector road, and the road area includes foraging habitat. The bald eagle is not likely to be adversely affected by the very small loss of low use foraging habitat, and the loss of less than 0.05 percent of foraging habitat available for the peregrine falcon on LANL is not likely to result in an adverse effect. The Mexican spotted owl is not likely to be adversely affected because of the fragmented nature of potential nesting/roosting habitat, current high level of noise and disturbance in the area, and very small reduction (0.06 percent) of available foraging habitat within LANL boundaries. Because these impacts are related to the road, if the road is not built under any of the PSSC alternatives, these impacts would not be incurred. (Also, under the Preferred Alternative at 20 pits per year production rate, at the road would not be built and these impacts would not be incurred.)

The phased expansion of Area G would involve the gradual removal of approximately 41 acres (16 hectares) of pinyon-juniper woodland. This removal would change or eliminate bird and small mammal habitat in direct proportion to the acreage disturbed. Because of the local and regional abundance of this community type and partial ground cover restoration following pit closure, wildlife habitat loss and disturbance would be small. Disturbance resulting from construction noise and activity would be minor and short term. No new impacts to large mammals are anticipated. Area G is part of the LANL-wide foraging habitat for the peregrine falcon and a nest site is located more than 3 miles (4.8 kilometers) away. Implementation of the proposed action would not affect nesting habitat nor would the eventual loss of up to 41 acres (16 hectares) (0.05 percent) of available foraging habitat on LANL adversely affect the peregrine falcon. The nature of these impacts would be the same for any of the PSSC alternatives considered, with the only difference being the acreage involved (volume II, part I).

5.3.6 Human Health

The consequences of implementation of the Expanded Operations Alternative on public health and worker health are presented below. As discussed in section 5.1.6 and in volume III (appendix G, section G.1), “risk,” as used in the SWEIS human health analysis, refers to the probability of toxic or cancer mortality under the specific exposure scenarios analyzed.

5.3.6.1 *Public Health*

The consequences of continued operations of LANL on public health under the Expanded Operations Alternative are presented below for the same topics discussed in section 5.2.6.1.

Regional Consequences of Airborne Radioactivity Inhalation and Immersion

The LANL MEI was estimated to be 2,625 feet (approximately 800 meters) north-northeast of LANSCE (TA–53). This location is within the LANL reservation, and the dose to the MEI at this location is 5.44 millirem per year (section 5.3.4.2), corresponding to a 72-year lifetime dose of 390 millirem. This location borders the Los Alamos townsite and is a conservative estimate for a MEI from LANL emissions. The background total effective dose equivalent (TEDE) dose in the Los Alamos area is estimated to be 360 millirem per year (section 4.6.1.1); thus, the dose to the MEI is 1.5 percent of the background dose.

Table 5.3.6.1–1 summarizes the LANL MEI dose and presents the corresponding risk of excess LCF to the MEI. These risks are presented on a lifetime basis, assuming that the LANL MEI received the estimated dose of 5.44 millirem each year for a 72-year life. The excess LCF risk was estimated to be 0.0002 over a lifetime.

The isodose maps showing both the estimated dose near LANL and within a 50-mile (80-kilometer) radius of LANL are given in Figures 5.3.4.2–1 and 5.3.4.2–2. The population dose within the 50-mile (80-kilometer) radius is also given in Table 5.3.6.1–1, estimated to be 33.1 person-rem per year. As reflected in the table, the annual operations excess LCF risk was estimated to be about 0.017.

In the Expanded Operations Alternative, there are 11 facilities with FS MEIs receiving a dose that would exceed 1 millirem per year (volume III, appendix B):

- LANSCE, 5.44 millirem per year to the FS MEI
- HE Testing Sites (TA–15 and TA–36), 4.99 millirem
- Pajarito Site (TA–18), 4.39 millirem
- Radiochemistry Laboratory (TA–48). 3.67 millirem
- Plutonium Facility (TA–55), 3.67 millirem
- TSTA and TSFF (TA–21), 2.55 millirem
- Area G (at LANL boundary), 1.81 millirem
- CMR Building, 1.32 millirem
- Sigma, 1.32 millirem
- Area G (at White Rock), 1.07 millirem
- Machine Shop, 1.02 millirem

External Radiation: Two Special Cases

As discussed in section 5.2.6.1, one contribution to public dose results from jogging or hiking for 96 hours on the access road north of TA–21 and is attributable to cesium-137 known to be on the ground within the TA. The MEI dose is not expected to change under the Expanded Operations Alternative from that estimated under the No Action Alternative (an EDE of 2.9 millirem per year and an excess LCF risk of about 1.4×10^{-6} per year).

Another contribution to public dose, as discussed in section 5.2.6.1, would result from TA–18 "road-open" operations. At the 95 percent confidence level, six exposures per

TABLE 5.3.6.1–1.—*Estimated Public Health Consequences for LANL MEI and the Population Within a 50-Mile (80-Kilometer) Radius of LANL for the Expanded Operations Alternative*

PARAMETER	LANL HYPOTHETICAL MEI	50-MILE (80-KILOMETER) RADIUS POPULATION
Dose	5.44 millirem/year	33.09 person-rem/year
Excess LCF	0.000196/lifetime (72 year)	0.017/year of operations

year of 4.75 millirem each would be expected for the MEI out of the 150 operations per year at TA–18 under the Expanded Operations Alternative. This would result in an annual projected MEI EDE of 28.5 millirem per year. The lifetime excess LCF risk for this dose is about 0.0000142 per year of operation.

Nonionizing Radiation

The only uncontained nonionizing radiation source in use or planned for LANL is the microwave transmitter in TA–49. The consequence of a public exposure to this source under the Expanded Operations Alternative is the same as for the No Action Alternative; as discussed in section 5.2.6.1, this consequence is negligible.

Consequences of Airborne Chemical Emissions

In the analysis of the Expanded Operations Alternative, four technical areas involved in HE testing were identified (TA–14, TA–15, TA–26, and TA–39) to require public health consequence analysis for specific chemicals (beryllium, lead, and DU). As discussed in section 5.2.6.1, other chemical emissions from HE testing operations were not analyzed in detail because their toxicity reference values and estimated concentrations in air were minor, as compared to those emissions analyzed in detail. Hazard indices were calculated for two of these three metals. An HI equal to or above 1 is considered consequential from a human toxicity standpoint. For the Expanded Operations Alternative, the worst-case HI for lead did not exceed 1.5 in 100,000 (0.000015). For DU, the worst-case HI did not exceed 6.5 in 100,000 (0.000065).

Beryllium has no established EPA reference dose from which to calculate the HI. Beryllium was evaluated as a carcinogen, however. The excess LCF for beryllium under the Expanded Operations Alternative was estimated to be 3.6×10^{-7} per year.

Carcinogenic Risk from Air Emissions

The screening process described in volume III, appendix B, identified no individual carcinogenic chemical air emission that required analysis for public health consequences. For carcinogens, an estimate also was made of the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs. The risk factors used are conservative, and represent the upper bound of the risk. The carcinogenic risk is also uncertain, and could be much smaller, as discussed in appendix D, section D.1.1.8.

This incremental combined cancer risk to the public due to all carcinogenic pollutants from all TAs exceeded the 1.0×10^{-6} GV level at two locations at the Los Alamos Medical Center: receptor site 175, the air duct 39 feet (12 meters) above grade (1.17×10^{-6}), and receptor site 180, an operable window 5 yards (1.5 meters) above grade (1.07×10^{-6}) (section 5.3.4.1 and appendix B, attachment 6, Table D). The incremental combined cancer risk estimated under the Expanded Operations Alternative for these two locations are dominated by the contribution estimated for chloroform emissions from HRL, next to the Los Alamos Medical Center.

The sensitivity of the incremental combined cancer risk analysis to chloroform is so great that the realism of the assumptions made for chloroform emissions estimation were examined. The assumptions were found to be unrealistic because the screening analysis assumed that 100 percent of the chloroform used was emitted into the air outside HRL. Records at HRL indicate that at least 50 percent of the annual usage of chloroform is disposed as liquid waste and could not be, therefore, released to the air. Using the more realistic but maximum concentrations of chloroform that could be emitted into the air, the incremental combined cancer risk at the two receptor locations at Los Alamos Medical Center would be 7.3 to 7.4×10^{-7}. This value is below the GV

for human health consequences from carcinogenic air emissions. No further analysis was conducted because any further analysis would simply reduce the estimated incremental combined cancer risk toward more realistic levels. It is believed that negligible increase in incremental combined cancer risk will result from the Expanded Operations Alternative.

Consequences of Ingestion to Residents, Recreational Users, and Special Pathways Receptors

The risk to the public from ingestion under the Expanded Operations Alternative does not differ from that associated with the No Action Alternative; this is because most of the risk is attributable to the existing levels of contamination in water and soils in the area. This is discussed further in sections 5.1.6 and 5.2.6.1. Tables 5.2.6.1–2 and 5.2.6.1–3 summarize the total radiological annual ingestion dose and excess LCF to members of the public. Per Table 5.2.6.1–3, the total worst-case ingestion doses for the off-site resident of Los Alamos County and non-Los Alamos County resident are 0.011 and 0.017 rem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose ranges up to 0.001 rem per year, according to the amount of time spent in the canyons (see footnote b in Table 5.2.6.1–3). If the individual has traditional Native American or Hispanic lifestyles, the values found in the final columns of the table should be used in place of the values in the first columns for off-site residents. Per the values in the final columns, these "special pathways receptors" can have worst-case 3.1 millirem per year additional dose. The associated excess LCF risks for the off-site residents are 8.6×10^{-6} per year of exposure and 9.1×10^{-7} per year of exposure for the individual who is also an avid recreational user. These worst-case doses are for a 95th percentile intake of the 95th percentile contamination level, referred to as the UCL. Ingestion pathway calculations included all radionuclides detected in the media. This includes natural background, weapons testing fallout, and previous releases. The actual contribution from continued operations at LANL is only a small fraction of this value. These values apply to the baseline and to all four alternatives. The data and analyses for these calculations are in appendix D, section D.3.3. Table 5.2.6.1–3 summarizes the risk associated with metals ingestion to MEIs in the LANL region, which does not vary among alternatives. The risk factors used are conservative and represent the upper bound of the risk. The carcinogenic risk also is uncertain and could be much smaller, as discussed in appendix D, section D.1.1.8.

Consequences to the Public along Transportation Routes

Section 5.3.10 details the analysis of transportation consequences. Public health consequences include the dose and excess LCF risk associated with routine, accident-free transportation. Table 5.3.10–2 shows the population dose and excess LCF for normal (accident-free) off-site shipments. The population dose and excess LCF associated with exposures occurring during stops for transportation segments near LANL is provided in Table 5.3.6.1–2. Doses associated with living along and sharing routes with these shipments are detailed in Table 5.3.10–2, and are less than those associated with stops. Risks associated with accidents during transportation also are discussed in section 5.3.10.

5.3.6.2 *Worker Health*

Worker risks associated with continued operations of LANL include radiological (ionizing and nonionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the Expanded Operations Alternative are given below and detailed in volume III, appendix D, section D.2.2.

TABLE 5.3.6.1–2.—*Radiation Doses and Excess LCF Risks Estimated to the Public at Stops During Transportation of Materials and Wastes from LANL Under the Expanded Operations Alternative*

ROUTE SEGMENT	PERSON-REM PER YEAR (AT STOPS)	EXCESS LCF RISK PER YEAR
LANL to U.S. 84/285	4.0	0.0020
U.S. 84/285	4.2	0.0021

Radiological Consequences

Ionizing Radiation Consequences. Table 5.3.6.2–1 summarizes the projected doses and associated excess LCF risks from implementation of the Expanded Operations Alternative.

The collective worker dose under the Expanded Operations Alternative is conservatively projected to be approximately four times that measured in 1993 to 1995. In terms of the average non-zero dose to an individual worker, the Expanded Operations Alternative is expected to result in 0.24 rem per year for Expanded Operations Alternative, as compared with 0.097 rem per year, 1993 to 1995. The estimated lifetime excess LCF risk is 0.000096 per year of operation.

Of the total worker radiation dose under this alternative (833 person-rem per year), about 220 person-rem per year is associated with pit production activities, regardless of the PSSC alternative selected. (This is an increase of about 150 person-rem per year over the exposures for such activities under the No Action Alternative.) Under the Preferred Alternative, at the 20 pits per year rate, the pit production contribution would be about 90 person-rem per year, and the total worker exposure would be about 704 person-rem per year (with a corresponding 15 percent decrease in the estimated excess LCF risk).

Nonionizing Radiation. It is expected that there will continue to be negligible effects to LANL worker health from nonionizing radiation sources, including ultraviolet sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves (including the large station at TA–49). (Also see volume III, appendix D, section D.2.2 for evaluation used to estimate nonionizing radiation from LANL operations to humans and wildlife and section D.4, for estimated results.)

Chemical Exposure Consequences

It is anticipated that there will continue to be a few exposures annually, particularly exposures to:

- Airborne asbestos
- Lead paint particulates
- Crystalline silica
- Fuming perchloric acid, hydrofluoric acid
- Skin contact with acids or alkalis

TABLE 5.3.6.2–1.—*Annual Worker Doses and Associated Lifetime Excess LCF Risks Under the Expanded Operations Alternative*

LANL Collective Worker Dose (person-rem/year)	833
Estimated Excess LCF Risk (across the worker population) per year of operation	0.33
Average Non-Zero Worker Dose (rem/year)	0.24
Estimated Excess LCF Risk (average worker > 0 dose)	0.000096

Under the Expanded Operations Alternative, it is expected that there will be a worker population of approximately 11,000 individuals, approximately 22 percent higher than index period employment levels. For the purposes of the SWEIS, it is assumed that there is negligible additional benefit of the chemical hygiene program at LANL over the period analyzed, and that the rate of chemical exposures continues at the index period rates. Therefore, it is expected that reportable chemical exposures from continued operations would increase over the next 10 to 15 years to a total of two to five reportable chemical exposures per year.

Beryllium Processing Consequences. It is anticipated that beryllium operations under the Expanded Operations Alternative would be 50 to 60 percent higher than in the No Action Alternative. However, it is not anticipated that consequences to workers would be measurable, that is, no sensitization to beryllium would be detected using the LANL IH monitoring program.

Physical Safety Hazards

Table 5.3.6.2–2 compares the projected reportable accidents and injuries estimated for normal operations occurring under the Expanded Operations Alternative and that experienced during the index period. The Expanded Operations Alternative is expected to result in an increase in reportable cases due to increases in worker population. These incidents are considered within the consequences of normal operations of LANL because of the relatively higher frequency of occurrence than major accidents (section 5.3.11). These results assume that the aggressive Health and Safety Program underway at LANL does not achieve any additional reduction in reportable cases.

The consequences of these accidents and injuries are expected to be similar to those experienced in the past, and typically are those

TABLE 5.3.6.2–2.—*Projected Annual Reportable Accidents and Injuries for the Expanded Operations Alternative Compared with the Index Period*

PARAMETER ESTIMATED	PARAMETER VALUE AND UNITS
Projected Worker Population	Approximately 11,000
Projected Reportable Accidents and Injuries	507/year
Change from Index (1993 to 1996)	+21 %

associated with health response and recovery from acute trauma. Therefore, the consequences include physical pain and therapy/treatment for recovery such as those associated with bone setting, shoulder dislocation reset, and subsequent physical therapy. Some injuries may also result in continuing consequences to the worker that could affect productivity or lifestyle, such as motor skill loss due to nerve damage or cardiovascular debilitation resulting from electrical shock or electrocution.

Project-Specific Siting and Construction Analyses

As discussed in volume II, parts I and II, workers involved in the construction activities associated with the expansion of the LLW disposal area and the enhancement of pit manufacturing operations would be exposed to risks typical of construction activities (e.g., back injuries, being crushed beneath heavy equipment, electrical hazards, etc.). These risks are mitigated by administrative controls and personal protective equipment, as needed. These risks are essentially the same under each of the alternatives considered in these PSSC analyses.

As discussed in volume II, part II, workers involved in the construction activities

associated with the enhancement of pit manufacturing operations would receive about 45 person-rem due to radiation exposures associated with work inside TA–55, PF–4, and another 1.2 person-rem due to radiation exposures associated with work inside the CMR Building under the PSSC "CMR Building Use" Alternative. This means that 0.018 total excess LCFs (out of the entire construction workforce for the period of construction activity) would be expected due to the construction activity in these facilities. These impacts would not be expected for the other PSSC alternatives because they do not involve construction within operating nuclear facilities. Under the Preferred Alternative, equipment installation associated with establishing pit production at the 20 pits per year level would result in a small fraction of the exposure described above.

5.3.7 Environmental Justice

As indicated in sections 5.3.1 and 5.3.2, no substantive adverse impacts to land resources or geology and soils are anticipated for the continued operation of LANL under the Expanded Operations Alternative. Thus, no disproportionately high and adverse impacts to minority or low-income communities are anticipated for these impact areas. The potential impacts to surface and groundwater and ecological resources associated with the Expanded Operations Alternative would affect all communities in the area equally. (See sections 5.3.3 and 5.3.5 for additional information on the potential for impacts to these resources.) Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated to be associated with these resource areas.

Figure 5.3.7–1 reflects the dose from radiological air emissions within 50 miles (80 kilometers) of LANL under the Expanded Operations Alternative. As discussed in section 5.2.7, impacts due to air emissions are equal to or lower in the sectors with substantial minority and/or low-income populations than they are in sectors 1–3 and 6–16, and such impacts are not disproportionately high or adverse with respect to the minority or low-income populations. (See section 5.3.4 regarding the impacts anticipated for air emissions under the Expanded Operations Alternative.)

The air pathway is one example of the analysis of potential human health impacts. As presented in section 5.3.6, there is minimal potential for LANL operations to adversely affect human health for off-site residents or recreational users in the area around LANL under the Expanded Operations Alternative. Similarly, the special pathways have little potential to impact human health under this alternative. Thus, the Expanded Operations Alternative would not present disproportionately high or adverse impacts to human health in minority or low-income communities (section 5.3.6.1).

As shown in section 5.3.10, impacts from on-site transportation and from LANL to U.S. 84/285 are estimated to be 0.0020 excess LCFs per year from incident-free transportation and 0.082 deaths and injuries per year from transportation accidents. Impacts from transportation on route segments that pass through minority or low-income communities (particularly the segment from U.S. 84/285 to I–25) are estimated to be 0.0021 excess LCFs per year from incident-free transportation and 0.18 deaths and injuries per year from transportation accidents. Therefore, no high and adverse impact is expected to either a member of the general public or to a member of a minority or low-income population due to transportation in the vicinity of LANL transportation routes.

As noted in volume II of the SWEIS, none of the alternatives for the Expansion of Area G (part I of volume II) or for the Enhancement of Pit Manufacturing Operations (part II of volume II) would be expected to have high and adverse

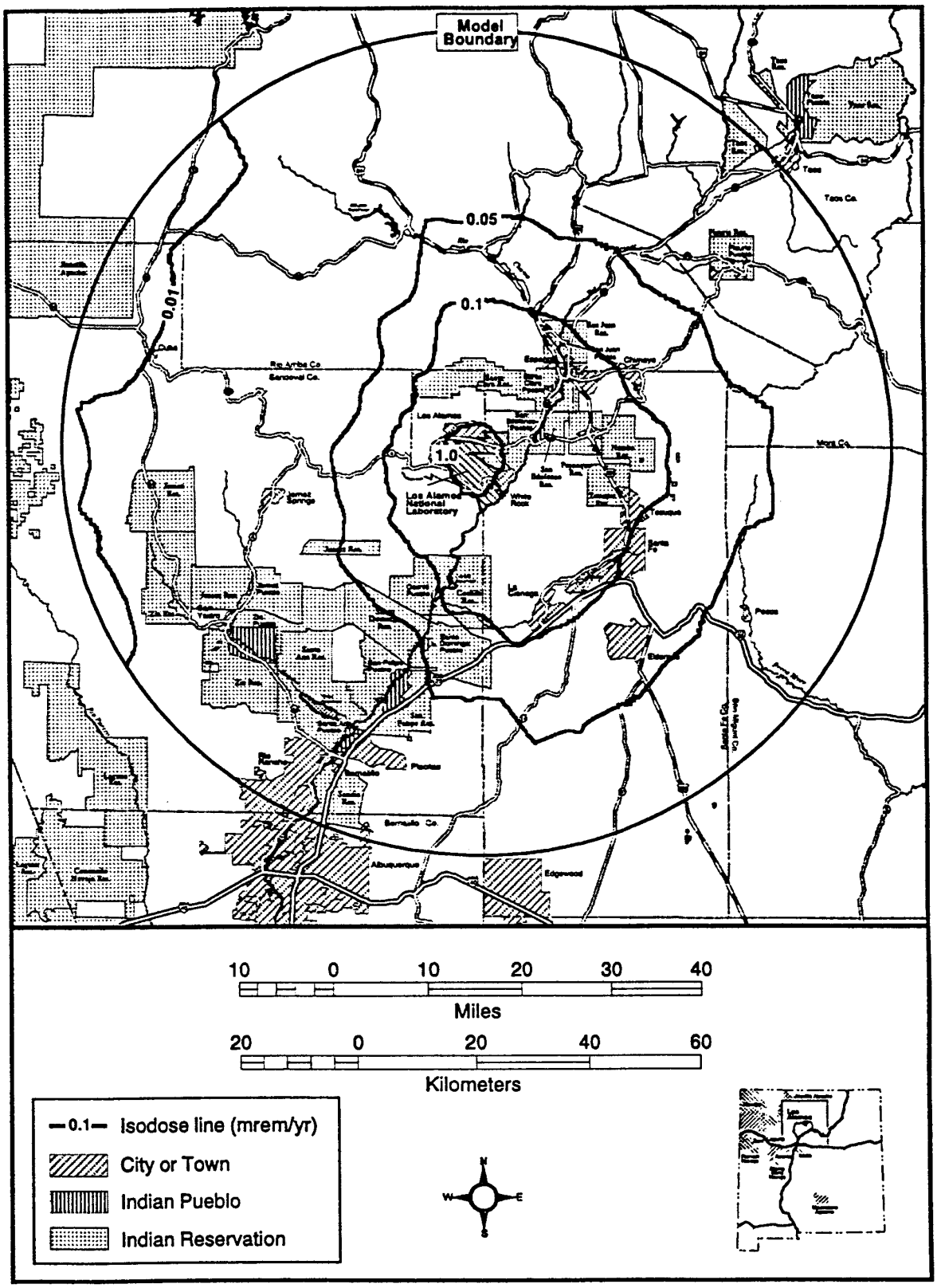

FIGURE 5.3.7–1.—*Isodose Lines from Airborne Releases for the Expanded Operations Alternative Within 50 Miles (80 Kilometers) of LANL.*

health or environmental effects to any populations. Thus, no environmental justice impacts are projected for siting and construction activities under this alternative. This would be true for any of the PSSC alternatives considered.

5.3.8 Cultural Resources

Impacts to prehistoric resources, historic resources, and TCPs are summarized in Table 5.3.8–1 and are discussed below. Note that any construction impacts associated with construction of the road between TA–55 and TA–3 (associated with pit production activities) would not be incurred at the 20 pits per year production rate, the Preferred Alternative.

5.3.8.1 *Prehistoric Resources*

Impacts to prehistoric resources as a consequence of implementing the Expanded Operations Alternative would be similar to those resulting from the No Action Alternative, with the only differences in operational impacts being due to frequency or intensity (e.g., increased radiological air emissions) of the impacts. However, the Expanded Operations Alternative also includes construction measures associated with the Expansion of Area G LLW Disposal Area that could potentially impact 15 prehistoric sites located at Zones 4 and 6 that have been determined eligible for inclusion in the NRHP. The other construction action included in the Expanded Operations Alternative, Enhancement of Pit Manufacturing Operations, includes construction that is in close proximity to one NRHP-eligible archaeological site and one historic site that is ineligible for the NRHP but would not affect these sites.

A data recovery plan has been prepared for the eight sites at Zone 4 and accepted by the SHPO. Consultation would have to be accomplished with the four Accord Pueblos, as well as any culturally affiliated or interested Pueblos. An accompanying data recovery plan would be prepared for the remaining seven sites at Zone 6. The recovery plan would include concerns resulting from consultation with the Accord Pueblos as well as any other Native American or Hispanic community with identified TCP and *Native American Graves Protection and Repatriation Act* (NAGPRA) (25 U.S.C. §3001) concerns. The New Mexico SHPO would review the data recovery plan for Zone 6 prior to implementation of any mitigation measures and would be requested to concur in a determination of no adverse effect before the start of project construction.

Should any historic resources (i.e., prehistoric, historic, and TCPs) be inadvertently discovered during the expansion of Area G, construction activities in the immediate vicinity of the property would cease until their significance and ultimate disposition is determined in consultation with the New Mexico SHPO, Indian tribes with the closest known cultural affiliation, and the Advisory Council on Historic Preservation. For purposes of compliance with Section 3(d) of the NAGPRA, inadvertent discovery of human remains and funerary objects (associated and unassociated), would result in the cessation of construction activities, protection of the discovered items, notice of the discovery sent to the Indian tribes with the closest known cultural affiliation, and direction asked for treatment and disposition of the human remains or funerary objects. The 30-day delay period following official certification that notification of the accidental discovery has been received by the agency or tribe would be followed.

An increase in the frequency of explosives testing under the Expanded Operations Alternative would correspondingly increase the potential for shrapnel impacts to those sites that are vulnerable. Similarly, a higher frequency of testing could accelerate vibration damage to susceptible sites. There would not be an increase in the magnitude of explosive tests with the Expanded Operations Alternative. As with the No Action Alternative, no impacts to resources at BNM are expected due to

TABLE 5.3.8–1.—*Projected Impacts to Prehistoric Resources, Historic Resources, and Traditional Cultural Properties Under the Expanded Operations Alternative*

ACTION TYPE	PUEBLO STRUCTURES	ERODED PUEBLOS/ RUBBLE/ ARTIFACT SCATTER	CAVATE PUEBLOS/ ROCK ART/ SHELTERS/ OVERHANGS	TRAILS/ STEPS/ STONE ARRANGE-MENTS	U.S. TERRITORIAL/ HOMESTEAD SITES	NUCLEAR ENERGY ERA (1943–1989) BUILDINGS, DISTRICTS, AND SITES)	TRADITIONAL CULTURAL PROPERTIES (TCP)				
							CEREMONIAL AND ARCHAEOLOGICAL SITES	NATURAL FEATURES	ETHNOBOTANICAL GATHERING SITES	ARTISAN MATERIAL GATHERING SITES	SUBSISTENCE FEATURES
New construction (buildings, facilities, etc.)	15 National Register eligible sites affected. It is anticipated that a determination of no adverse effect would be achieved based on a data recovery plan which would be developed in consultation with the NM SHPO, ACHP, and four Accord Pueblos. Procedures in place to address historic properties inadvertently discovered during construction.				Negligible (Policy and procedures in place to avoid or minimize impacts)		Consultation with four Accord Pueblos to identify and mitigate any potential adverse effects, including human remains and funerary objects.				
Modifications in facility layout (roads, parking lots, pits)	Same as the No Action Alternative										
Modification of existing buildings (changing building function)	Same as the No Action Alternative										
Change in hydrology (surface and groundwater quality and quantity; erosion and siltation rates)	Same as the No Action Alternative										
Explosives impacts (shrapnel scatter)	Similar to the No Action Alternative. The increased frequency of explosive testing could mean accelerated damage to resources.										
Explosives impacts (vibration)	Similar to the No Action Alternative. The increased frequency of explosive testing could mean accelerated damage to resources.										
Explosives (noise)	None (Same as No Action Alternative.)						Similar to the No Action Alternative. The increased frequency of explosive testing could mean accelerated damage to resources.				
Hazardous material (nonradiological)	Similar to the No Action Alternative. The increased emissions could increase potential for adverse effects.						Similar to the No Action Alternative. The increased emissions could increase potential for adverse effects.				
Radiation hazards	Similar to the No Action Alternative. The increased emissions could increase potential for adverse effects.						Similar to the No Action Alternative. The increased emissions could increase potential for adverse effects.				
Security (fencing, lighting, monitoring)	Same as the No Action Alternative										

explosion-generated ground vibrations from explosives as high as 500 pounds (227 kilograms). As stated, further research is necessary to quantitatively assess impacts from higher amounts of explosives.

In the event that unforeseen circumstances arise in the design of construction features associated with the enhancement of pit manufacturing operations that could affect the one NRHP-eligible site, appropriate mitigation measures, including data recovery, would be designed and implemented in consultation with the New Mexico SHPO and concerned Native American communities.

5.3.8.2 *Historic Resources*

Impacts to historic resources would be comparable to those for the No Action Alternative.

5.3.8.3 *Traditional Cultural Properties*

Impacts would be similar to those for the No Action Alternative (subsection 5.2.8) with the exception of construction activities associated with the expansion of Area G low-level waste disposal and enhancement of pit manufacturing. As stated, consultation would be accomplished with the Accord Pueblos as well as any culturally affiliated or interested Pueblos and tribes. Any concerns expressed would result in actions to negate or minimize any adverse impacts to TCPs associated with construction related actions. These impacts would be similar for any of the PSSC alternatives considered.

An increased level of operation resulting in increased production of shrapnel, vibrations, noise, hazardous materials, and radioactive hazardous could further increase any adverse affect to TCPs.

Construction and operational activities associated with the expansion of Area G and the enhancement of pit manufacturing is not expected to affect surface or groundwater quality—a traditional natural resource identified by some tribal groups. The potential for soil erosion during construction and operations would be avoided or minimized by measures such as fences, mulching, berms, slope contouring, trenching, and revegetation. Planned disposal practices at Area G (e.g., isolation of the closed burial pits) would minimize the potential for water running across and off the site and conveying erosional products to water drainages. Contamination of groundwater from the expansion of Area G is highly unlikely because of the natural resistance that Bandelier tuff has to fluid migration and the distance to area aquifers.

Spiritual Entities

As with the No Action Alternative, no assessment of impacts to “unseen” or “spiritual” entities was attempted.

5.3.9 Socioeconomics, Infrastructure, and Waste Management

This section describes the social, economic, and infrastructure impacts of activities at LANL under the Expanded Operations Alternative.

The socioeconomic and infrastructure aspects of all construction under the Expanded Operations Alternative, including the two projects discussed in volume II of the SWEIS, are included in the analyses and discussions in this section.

5.3.9.1 *Socioeconomic Impacts*

Employment, Salaries, and Population

The primary (direct) impacts of the Expanded Operations Alternative on employment, salaries, and population are presented in Table 5.3.9.1–1 for the LANL workforce only.

TABLE 5.3.9.1–1.—*Summary of Primary LANL Employment, Salaries[a], and Procurement Under the Expanded Operations Alternative[b]*

	LOS ALAMOS COUNTY	RIO ARRIBA COUNTY	SANTA FE COUNTY	TRI-COUNTY TOTAL	OTHER NEW MEXICO COUNTIES	NEW MEXICO TOTAL	OUTSIDE NEW MEXICO	TOTAL
Employees	4,995	2,604	2,657	10,256	828	11,084	267	11,351
Difference[c]	160	685	820	1,665	220	1,885	91	1,976 (+21%)
Salaries ($M)	264.4	74.7	123.2	462.3	27.8	490.1	15.6	505.6
Difference[c]	9.8	29.7	48.9	88.4	11.5	99.8	6.9	106.7 (+27%)
Procurement ($M)	221	1.9	21.9	244.8	128.3	373	253.6	626.6
Difference[c]	5.3	0.2	1.2	6.8	5.9	12.5	22	34.5 (+6%)

[a] Salaries are for UC employees only; subcontractor salaries (Johnson Controls, Inc., Protection Technology of Los Alamos, etc.) are included in the procurement dollars.
[b] Reflects projected locations of employee residences and LANL procurement activities.
[c] Difference is as compared to fiscal year 1996. Percent difference is shown in parentheses in the far right (TOTAL) column.

The secondary (indirect) impacts and the total population changes projected are presented in Table 5.3.9.1–2 for the Tri-County area. These changes are assumed to occur within a year of the ROD for the SWEIS. Note that about 260 of the total LANL employment listed is for pit production operations. Under the Preferred Alternative, at the 20 pits per year rate, pit production employment is estimated to be about 100 full-time equivalent employees (FTEs). This difference is a small fraction of total employment under the Expanded Operations Alternative, so impacts at the 20 pits per year level (Preferred Alternative) would not be substantially different than those presented in the remainder of the socioeconomics analyses in this section.

Housing

The population changes anticipated in the Tri-County area, as presented in Table 5.3.9.1–2, are projected to result in demand for 1,770 additional (new) housing units. The distribution of this demand in the three counties is projected to be: 130 additional units in Los Alamos County; 739 additional units in Rio Arriba County; and 901 additional units in Santa Fe County.

In Los Alamos County, the projected housing demand can be accommodated from absorption of apartment vacancies and the inventory of houses for sale and new construction. Beyond 130 units, no new housing units can be anticipated because of the absence of buildable land in private ownership. This constraint upon supply would be expected to exert an upward pressure on rents and house prices.

The projected housing demand in Rio Arriba and Santa Fe Counties can be accommodated without significant pressure on rents and house sales prices. Both counties possess a sufficient

TABLE 5.3.9.1–2.—*Summary of Total Tri-County Employment, Salaries, Business Activity, and Population Changes Under the Expanded Operations Alternative*

	PRIMARY CHANGE	SECONDARY CHANGE	TOTAL TRI-COUNTY CHANGE	TRI-COUNTY PRIMARY WORKER CHANGE[a]	TRI-COUNTY SECONDARY WORKER CHANGE[b]	TOTAL TRI-COUNTY WORKER CHANGE	TOTAL TRI-COUNTY POPULATION CHANGE[c]
Employment/ Population	1,665	2,847	4,512	1,332	854	2,186	4,230 (+2.5%)
Personal Incomes	$88 million	$84 million	$172 million (< +1%)				
Annual Business Activity	$7 million	$13 million	$20 million (< +1%)				

Note: Percentages in parentheses are the percentage change that the number represents. These are provided for total population change, total personal income change, and total annual business activity change.

[a] This is the number of direct workers moving to the Tri-County area, assuming that 80 percent of new LANL employees are from outside this area.

[b] This is the number of secondary workers moving to the Tri-County area, assuming that 30 percent of secondary employment is from outside this area.

[c] This is the total population increase in the Tri-County area, assuming that, on average, each worker moving to the area increases the population by 1.935.

inventory of finished lots and parcels, have access to adequate mortgage capital, and have sufficient entrepreneurial developer talent to absorb the demand.

Construction

Table 5.3.9.1–3 contains the results of the analysis of construction spending, labor salaries, and labor employment for the period fiscal year 1997 through fiscal year 2006. To some extent, construction under this alternative would draw workers already present in the Tri-County area who have historically worked from job to job in the region. To the extent that the Expanded Operations Alternative adds construction workers to the Tri-County area, this would be a seasonal occurrence. Thus, these construction activities are expected to only marginally affect general business activity, personal income levels, and employment levels.

TABLE 5.3.9.1–3.—*Construction Spending, Labor Salaries, and Labor Employment Numbers Under the Expanded Operations Alternative (Fiscal Year 1997 Through 2006)*

YEAR	CONTRACT $M	LABOR $M	EMPLOYEES
1997	63	15	432
1998	187	45	1,282
1999	224	54	1,536
2000	251	60	1,721
2001	264	63	1,810
2002	215	52	1,474
2003	216	52	1,481
2004	139	33	953
2005	109	26	747
2006	108	26	741

$M = dollars given in millions

Source: (DOC 1996, PC 1997a, and PC 1997b)

Local Government Finance

Under this alternative, the Tri-County annual gross receipts tax yields would be expected to increase by $3.7 million. This increase would be matched by increases in service levels adequate to meet public demand.

Services

Annual school enrollment in the Tri-County area would be expected to increase by 719 students. Additional annual funding assistance of about $2.88 million from the State of New Mexico would be required for school operations because of these enrollment increases.

In Los Alamos, the school district can absorb the anticipated new enrollment levels. This school district has excess capacity because of its discretionary policy of accepting out-of-district students who are the children of LANL employees and subcontractors. In Rio Arriba County and the cities of Española and Santa Fe, adequate classroom capacity exists because of recent school construction projects.

The demand for police, fire, and other municipal services would be expected to increase in proportion to the increase in gross receipts tax yields, as discussed above. However, any changes in local government services tend to be inelastic in the short term and typically are responsive only after the completion of at least one full budget cycle.

5.3.9.2 *Infrastructure Impacts*

Annual electricity use projected under the Expanded Operations Alternative is a total of 782 gigawatt-hours, 437 gigawatt-hours for LANSCE and 345 gigawatt-hours for the rest of LANL. The peak electrical demand is projected to be 113 megawatts, 63 megawatts for LANSCE and 50 megawatts for the rest of LANL[1]. The existing supply of electricity to the Los Alamos area is not sufficient year-round to meet the projected electrical peak demand for LANL operations under this alternative; thus, periods of brownouts are anticipated unless measures are taken to increase the supply of electricity to the area. (Sections 1.6.3.1 and 4.9.2 discuss ongoing efforts to increase electrical power supply to this area.) This situation is exacerbated by the additional electrical demand for BNM and the communities of Los Alamos and White Rock. (While these organizations did not provide use projections, their historical usage is reflected in section 4.9.2 of chapter 4.)

Natural gas use is projected to be 1,840,000 decatherms annually, the same as projected under the No Action Alternative. Although electrical demand may increase natural gas demand for the generation of electricity at TA–3, demand should continue to be dominated by heating requirements and is not expected to exceed this projection.

Water use projected under the Expanded Operations Alternative is a total of 759 million gallons (2.9 billion liters) per year, 265 million gallons (1 billion liters) per year for LANSCE, and 494 million gallons (1.9 million liters) per year for the rest of LANL. This is well within DOE water rights, about 1,806 million gallons (6.8 million liters) per year; however, this water right also provides for water used by Los Alamos County and BNM. Based on existing information regarding non-LANL water use, the water demands of this community can be met within the existing water rights. (Water demand is also discussed in section 5.3.3.) The peak water requirements are the same as identified under the No Action Alternative.

1. These values include the proposed SCC Project annual electricity and peak electrical demand for a 50-TeraOp operation and are reflected in all the alternatives. The SCC project was as an interim action to the SWEIS.

These impacts have a minimal contribution from pit production activities. Thus, these impacts would not be substantially different regardless of which PSSC alternative is selected (nor would they be substantially different for pit production at the 20 pits per year rate, the Preferred Alternative).

5.3.9.3 *Waste Management*

The annual and 10-year total generation projections for radioactive and hazardous waste are reflected in Table 5.3.9.3–1. Radioactive liquid waste is not projected by facility because measurements of individual contributions are not made for all facilities. The total amount of radioactive liquid waste projected for receipt at TA–50 is ___ million gallons (35 million liters) per year for this alternative. These projections include waste from key facilities, all other LANL facilities, waste management facilities, the ER Project, and construction activities. In addition to the volumes reflected in Table 5.3.9.3–1, the "CMR Building Use" Alternative, discussed in the PSSC Analysis for Enhancement of Plutonium Pit Manufacturing Operations (volume II, part II), would generate an additional 427 cubic meters (559 cubic yards) of TRU waste, 288 cubic meters (377 cubic yards) of TRU mixed waste, 1,193 cubic meters (1,560 cubic yards) of LLW, and 31 cubic meters (41 cubic yards) of low-level radioactive mixed waste (LLMW) waste during construction activity. Neither of the other alternatives discussed in this PSSC are expected to generate any radioactive waste. (Under the Preferred Alternative, at the 20 pits per year rate, a fraction of the waste generation projected for the PSSC "CMR Building Use" Alternative would be incurred; this is a small portion of the totals generated for each of these waste types, so impacts would not be substantially different for construction to achieve this lower rate.) The PSSC analysis for the expansion of Area G (volume II, part I) reflects that no radioactive waste generation is expected under any of the alternatives analyzed. Pit production operations contribute little to waste generation, with the exception of TRU waste generation (which would increase by about 3,535 cubic feet [100 cubic meters] per year). Under the Preferred Alternative, at the 20 pits per year rate, this increase would be about 530 cubic feet (15 cubic meters) per year.

Under this alternative, LLW would be treated and disposed of on the site in an expanded Area G (see volume II, part I). As discussed for the No Action Alternative, much of LANL TRU and chemical waste would be treated and shipped off site for disposal; nondefense TRU waste from other sites would be stored at LANL pending the development of disposal options. As with the No Action Alternative, LANL is capable of meeting applicable waste acceptance criteria, and off-site disposal capacities are much greater than LANL's waste volumes.

5.3.9.4 *Contaminated Space*

The activities reflected in the Expanded Operations Alternative are projected to increase the total contaminated space at LANL by 73,000 square feet (6,782 square meters) over the next 10 years, as compared to the baseline established for the SWEIS as of May 1996 (chapter 4, section 4.9). The majority of this increase is due to implementation of actions that have already been reviewed under NEPA, but which had not been implemented at the time the baseline was established, as discussed in the No Action Alternative (section 5.2.9). Additional construction and operations in LANSCE (TA–53) and the Machine Shops (TA–3) result in an additional 5,000 square feet (460 square meters) in each of these facilities under this alternative.

Selection of either the Brownfield or TA–55 add-on alternatives from the PSSC Analysis of the Enhancement of Plutonium Pit Manufacturing (volume II, part II) would result in an additional 15,300 square feet (1,420 square meters) of contaminated space.

TABLE 5.3.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Expanded Operations Alternative*[a]

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR
Plutonium Facility Complex	TA–55	8,340	83,400	740	7,400	13	130	310	3,100	102	1,020
Tritium Facilities[c]	TA–16 & TA–21	1,700	17,000	480	4,800	3	30	NA	NA	NA	NA
Chemistry and Metallurgy Research Building[d]	TA–3	11,200	112,000	1,860	18,600	19.6	196	46.6	466	20.4	204
Pajarito Site	TA–18	4,000	40,000	145	1,450	1.5	15	NA	NA	NA	NA
Sigma Complex	TA–3	10,000	100,000	960	9,600	4	40	NA	NA	NA	NA
Materials Science Laboratory	TA–3	600	6,000	0	0	0	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	3,800	38,000	10	100	0.4	4	NA	NA	NA	NA
Machine Shops	TA–3	474,000	4.74×10^6	606	6,060	0	0	NA	NA	NA	NA
High Explosives Processing Facilities	TA–8, 9, 11, 16, 28 & 37	13,000	130,000	16	160	0.2	2	NA	NA	NA	NA
High Explosives Testing Facilities	TA–14, 15, 36, 39, 40	35,300	353,000	940	9,400	0.9	9	0.2	2	NA	NA
Los Alamos Neutron Science Center[e]	TA–53	16,600	166,600	1,085	10,850	1	10	NA	NA	NA	NA
Health Research Laboratory[f]	TA–43	13,280	132,800	34	340	3.4	34	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	3,300	33,000	270	2,700	3.8	38	NA	NA	NA	NA
Radioactive Liquid Waste Treatment Facility[g]	TA–50 & TA–21	2,200	22,000	160	1,600	0	0	30	300	0	0
Waste Treatment, Storage, and Disposal Facilities[g]	TA–54 & TA–50	920	9,200	174	1,740	4	40	27	270	0	0
Non-Key Facilities		651,000	6.51×10^6	520	5,200	30	300	0	0	0	0
ER Project[h]		2×10^6	2×10^7	4,257	42,570	548	5,480	11	110	0	0
Grand Total[i]		3.2493×10^6	3.2493×10^7	12,240	122,400	633	6,330	425	4,250	122	1,220

TABLE 5.3.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Expanded Operations Alternative*[a]-Continued

NA indicates that this facility does not routinely generate these types of waste.

[a] Radioactive liquid waste generation is not projected by facility (see text in section 5.3.9.3).

[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under the *Toxic Substance Control Act*. This waste category also includes biomedical waste.

[c] These projections include 141,000 ft^3 (4,000 m^3) of LLW due to backlogged waste.

[d] These LLW projections include 141,000 ft^3 (4,000 m^3) of LLW generation anticipated due to the CMR Building Upgrades, Phase II.

[e] These projections include 228,000 ft^3 (6,450 m^3) of LLW due to the construction of the new Long-Pulse Spallation Source Facility and 86,000 ft^3 (2,450 m^3) of LLW due to upgrades to Areas A5 and A6, as well as reduced operational waste generation during these construction activities.

[f] These projections include 22,000 lbs (10,000 kg) of chemical waste, 550 lbs (250 kg) of biomedical waste (a special form of chemical waste), 1,560 ft^3 (44 m^3) of LLW, and 850 ft^3 (24 m^3) of LLMW associated with ongoing efforts to remove obsolete and contaminated equipment.

[g] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities.

[h] The ER Project is projected to generate 390 ft^3 (11 m^3) per year of TRU and mixed TRU waste together. All of this waste is presented under the TRU waste columns.

[i] Grand totals have been rounded.

The "CMR Building Use" Alternative from that PSSC Analysis, utilizes existing unused space in the CMR Building, would use existing nuclear space, and thus would not incrementally increase the contaminated space at LANL facilities.

Although not considered "contaminated space" for the purposes of this SWEIS, selection of the PSSC Preferred Alternative (expansion of Area G into Zones 4 and 6) would result in disposal of LLW in up to 41 acres (17 hectares) of land not previously used for disposal. Selection of the North site alternative or the TA–67 alternative would result in disposal of LLW in 49 acres (20 hectares) or 50 acres (21 hectares), respectively, of land not previously used for disposal.

5.3.10 Transportation

The transportation impacts projected for the Expanded Operations Alternative are summarized in this section. On-site and off-site shipments under this alternative are greater than these under the No Action Alternative (with the exception that no LLW is shipped off the site for disposal). More detailed information regarding these shipments and the impacts is included in volume III, appendix F.

5.3.10.1 *Vehicle-Related Risks*

Truck Emissions in Urban Areas

For the Expanded Operations Alternative, the projected impact from vehicle emissions is 0.066 excess LCF over a lifetime of operation per year. Use of the Santa Fe Relief Route would have a very small effect on this risk (it would change to 0.064 excess LCF per year). The only difference is that the Santa Fe Relief Route would have 1.2 miles (2 kilometers) less of urban highway mileage. Approximately 65 percent of excess LCFs are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments.

Truck Accident Injuries and Fatalities

The impacts projected for the Expanded Operations Alternative are presented in Table 5.3.10.1–1. (Additional information is provided in appendix F, section F.6.3.) Use of the Santa Fe Relief Route would reduce the risks of accidents, injuries, and fatalities by almost one-half of those indicated for the segment from U.S. 84/285 to I–25 due to the assumption that the accident rate on the Santa Fe Relief Route would be much lower than for the route through Santa Fe. Use of the Santa Fe Relief Route would not substantially change the risks of accidents, injuries, and fatalities on the remainder of the New Mexico segment, as compared to the risks reflected for this segment in Table 5.3.10.1–1. Approximately 65 percent of the impacts are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. Again, all shipments are assumed to result in a return by an empty truck.

5.3.10.2 *Cargo-Related Risks*

Incident-Free Radiation Exposure

The incident-free radiation exposure impacts projected for the off-site shipments under the Expanded Operations Alternative are presented in Table 5.3.10.2–1; as noted in section 5.2.10.2, the total is the dose throughout the U.S., and is dominated by the segments outside of New Mexico. The aircraft segment is for overnight carrier service; the truck segment to and from the airport is included in the truck results. In general, use of the Santa Fe Relief Route would result in only small changes in this type of impact. Truck crew doses and nonoccupational doses for people at rest stops would increase due to the increased length of the Santa Fe Relief Route for north-bound shipments carrying the radioactive material. Nonoccupational doses for people sharing the road would decrease due to the lower traffic density projected for the relief route.

TABLE 5.3.10.1–1.—*Truck Accident Injuries and Fatalities Projected for LANL Shipments Under the Expanded Operations Alternative*

ROUTE SEGMENT	NUMBER OF ACCIDENTS PER YEAR	NUMBER OF INJURIES PER YEAR	NUMBER OF FATALITIES PER YEAR
On Site	0.033	0.007	0.00033
LANL to U.S. 84/285	0.34	0.071	0.0034
U.S. 84/285 to I–25	0.82	0.18	0.0082
Remainder of New Mexico	1.4	1.3	0.15
Outside New Mexico	6.4	6.0	0.62
Total	9.0	7.6	0.78

TABLE 5.3.10.2–1.—*Incident-Free Population Dose and Lifetime Excess LCFs for Off-Site Shipments per Year of Operation Under the Expanded Operations Alternative*

ROUTE SEGMENT	TRUCK OR AIR CREW		NONOCCUPATIONAL					
			ALONG ROUTE		SHARING ROUTE		STOPS	
	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year
LANL to U.S. 84/285	7.4	0.003	0.04	0.00002	0.65	0.00032	4.0	0.002
U.S. 84/285 to I–25	10	0.004	0.49	0.00024	4.6	0.0023	4.2	0.0021
Remainder of New Mexico	55	0.022	0.12	0.000062	2.1	0.001	30	0.015
Outside New Mexico	510	0.2	3.5	0.0018	30	0.015	230	0.12
Aircraft	2.4	0.0012	NA	NA	NA	NA	NA	NA
Total	580	0.23	4.2	0.0021	37	0.019	270	0.14

NA = Not applicable

MEI dose occurs between LANL and I–25 and is 0.00038 rem per year of operation.

Driver Doses from On-Site Shipments of Radioactive Materials

The projected collective radiation dose for LANL drivers under the Expanded Operations Alternative is 10.292 person-rem. This collective dose would be expected to result in 0.00412 excess LCFs over a lifetime per year of operation among these drivers.

The average individual driver dose is projected to be 0.429 rem per year, which is well below the DOE radiation protection limit of 5 rem per year.

Transportation Accidents

The following discussion addresses the potential impacts of accidents leading to the release of either radioactive or hazardous material being transported in support of LANL operations under the Expanded Operations Alternative. Results are given for both off-site and on-site shipments.

Off-Site Radioactive Materials Shipments

The MEI doses calculated with RADTRAN do not vary by alternative and are given in Table 5.2.10.2–2. The population dose and corresponding lifetime excess LCF per year of operation for these shipments are presented in Table 5.3.10.2–2 for these accidents. ADROIT results separated into frequency and consequence components are not readily available. The product, MEI dose risk, can be presented in terms of excess LCF per year; for the Expanded Operations Alternative, MEI dose risk due to plutonium-238 oxide and due to pit shipments were each about 1×10^{-10} excess LCF per year.

The use of the Santa Fe Relief Route would reduce the projected population dose (and therefore, the excess LCFs per year) to about one-third for the U.S. 84/285 to I–25 segment, as compared to use of the route through Santa

TABLE 5.3.10.2–2.—*Bounding Radioactive Materials Off-Site Accident Population Risk for the Expanded Operations Alternative*

ROUTE SEGMENT	ANNUAL POPULATION DOSE RISK AND EXCESS LCF RISK						
	SHIPMENT TYPE						
	AMERICIUM -241	CH TRU	RH TRU	PLUTONIUM -238	PITS	TOTAL	
	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	0.016	0.0019	3.8×10^{-6}	1×10^{-6}	6×10^{-6}	0.018	9.0×10^{-6}
U.S. 84/285 to I–25	0.25	0.024	0.000053	2×10^{-6}	0.00002	0.27	0.00014
Remainder of New Mexico	0.033	0.016	0.000033	1×10^{-6}	8×10^{-6}	0.049	0.000024
Rest of U.S.	2.7	NA	NA	8×10^{-6}	0.00004	2.7	0.0014

NA = Not available

Fe. This difference is primarily due to the difference in population density along these routes. (Lower traffic density projected on the relief route is also a factor.) The use of the Santa Fe Relief Route would increase the projected population dose (and, therefore, excess LCFs per year) for the remainder of New Mexico segment to about double that identified if the route through Santa Fe is used. This difference is due to the increase (6 miles [10 kilometers] more) in the distance traveled on I–25 for north-bound shipments.

On-Site Radioactive Materials Shipments

The MEI doses, frequencies, and MEI risks due to the bounding on-site shipments involving radioactive materials are given in Table 5.3.10.2–3. As noted in section 5.2.10.2, the frequency of the bounding DARHT and PHERMEX shipments has been added to the frequency of irradiated target shipments.

Hazardous Materials Shipments

The bounding hazardous materials shipments for accident analyses are major chlorine shipments (toxic), major propane shipments (flammable), and major explosives shipments. The consequences of an accident involving a major explosives shipment is bounded by the consequences of an accident involving a major propane shipment, so the frequency of explosives shipments was added to the frequency of propane shipments (rather than analyzing them separately).

TABLE 5.3.10.2–3.—*MEI Doses and Frequencies for Bounding On-Site Radioactive Materials Accidents Under the Expanded Operations Alternative*

SHIPMENT TYPE	EVENT FREQUENCY PER YEAR	MEI DOSE	MEI RISK
Plutonium-238 Solution	1.7×10^{-7}	8.7 rem	1.4×10^{-6} rem/year (5.8×10^{-10} excess LCF/year)
Irradiated Targets	3.2×10^{-6}	acute fatality	3.2×10^{-6} fatalities/year

Accidental Chlorine Release

The projected frequencies, consequences, and risks associated with major chlorine accidents under the Expanded Operations Alternative are presented in Table 5.3.10.2–4.

The use of the Santa Fe Relief Route would result in about one-sixth the risk of fatalities and injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight increase in the risk of fatalities and injuries on the remainder of New Mexico segment because of the extra 6 miles (10 kilometers) traveled on I–25 for northbound traffic (chlorine shipments are all assumed to travel north on I–25).

Accidental Propane Release

The projected frequencies, consequences, and risks associated with major propane accidents under the Expanded Operations Alternative are presented in Table 5.3.10.2–5.

The use of the Santa Fe Relief Route would result in slightly less risk of fatalities and about one-third of the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in about half the risk of injuries and fatalities on the remainder of New Mexico segment because of the 6 miles (10 kilometers) reduction in distance traveled on I–25 for southbound traffic (propane shipments are all assumed to travel south on I–25).

TABLE 5.3.10.2–4.—*Frequencies, Consequences, and Risk for a Major Chlorine Accident Under the Expanded Operations Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000062	0.065	0.24	0.000019	0.000072
	Suburban	0.00001	1.5	5.6		
U.S. 84/285 to I–25	Rural	0.000048	0.053	0.2	0.00064	0.0024
	Suburban	0.0001	3.0	11		
	Urban	0.000032	11	40		
Remainder of New Mexico	Rural	0.00036	0.015	0.056	0.00011	0.00042
	Suburban	0.000038	1.5	5.5		
	Urban	6.2×10^{-6}	8.4	32		
Remainder of U.S.	Rural	0.0026	0.028	0.1	0.0028	0.01
	Suburban	0.00066	1.6	6.1		
	Urban	0.00016	10	39		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

TABLE 5.3.10.2–5.—*Frequencies, Consequences, and Risk for a Major Propane Accident Under the Expanded Operations Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000022	0.28	1.1	0.000022	0.000086
	Suburban	3.7×10^{-6}	4.2	17		
U.S. 84/285 to I–25	Rural	0.000017	0.23	0.92	0.00033	0.0013
	Suburban	0.000037	8.4	34		
	Urban	0.000011	1.8	7.3		
Remainder of New Mexico	Rural	0.00014	0.15	0.6	0.00026	0.0011
	Suburban	0.000046	5.1	20		
	Urban	5.8×10^{-6}	1.5	6.1		
Remainder of U.S.	Rural	0.00018	0.09	0.36	0.00015	0.00059
	Suburban	0.000023	4.8	19		
	Urban	0.000012	1.9	7.5		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

Traffic Impacts from the Project-Specific Siting and Construction Analyses

The PSSC analyses in volume II (parts I and II) identify relatively minor increases in on-site traffic due to the construction associated with these two projects (Expansion of Area G and Enhancement of Plutonium Pit Manufacturing). The impact analyses identified in this section would not be expected to change due to these types of changes; the conservatism built into these analyses is considered adequate to address these relatively minor and transitory changes.

The alternatives examined for the Enhancement of Plutonium Pit Manufacturing did not reflect any variation in construction traffic across the alternatives. However, much of the on-site operational transportation examined in this section of the SWEIS may be reduced to approximately the No Action levels if the Brownfield or Add-on to TA–55 alternatives were selected. This is because such alternatives would not have the same level of transportation between TA–55 and CMR Building, and this would result in a reduction in driver doses from on-site transportation of radioactive materials to approximately the levels identified in the No Action Alternative for this type of impact. The frequency of on-site transportation accidents would also be reduced in this case. Under the Preferred Alternative, at the 20 pits per year rate, transportation impacts for on- and off-site transportation would be similar to, but slightly less than, the impacts presented in this section. (At this lower rate, there would be fewer shipments between TA–55 and the CMR Building, as well as fewer shipments to and from Oak Ridge and Pantex.) The selection of the "CMR Building Use" Alternative from this PSSC analysis would be expected to result in the operational impacts described in this section.

The alternatives examined for the expansion of Area G did not reflect any variation in construction traffic across the alternatives, except that a new burial site (other than at TA–54) would be expected to require increased construction activity and traffic, with a slightly higher probability of a traffic accident involving workers. This could result in a slightly higher probability of worker injury or death than is presented in this section of the SWEIS.

5.3.11 Accident Analysis

Transportation accidents for the Expanded Operations Alternative are addressed in section 5.3.10. High-frequency (greater than 1 in 100) occupational accidents for the Expanded Operations Alternative are addressed in section 5.3.6.

5.3.11.1 *Multiple Source Release of Hazardous Material from Site-Wide Earthquake and Wildfire*

The risks from these accidents are driven primarily by the frequency and magnitude of an earthquake and wildfire in the area. Because the same types of operations will be conducted in the same facilities, and the inventories of MAR will be about the same; there are no substantial changes between the No Action and the Expanded Operations Alternatives. Therefore, there is no change in risk among the alternatives from site-wide earthquakes. Tables 5.2.11.1–1 and 5.2.11.1–2 show these results.

5.3.11.2 *Plutonium Releases from Manmade and Process Hazards at LANL*

A summary of the frequency and consequences for plutonium releases is given in Table 5.3.11.2–1. These releases reflect a variety of initiators depending on the type of activities or manmade hazards in the area, such as an aircraft crash.

For these accidents there are minor variations in such activities as the handling of drums, the

TABLE 5.3.11.2–1.—*Summary of Radiological Consequences for Plutonium Release Scenarios at LANL—Expanded Operations Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a,f]	CONSEQUENCE MEASURES[b,c,d,e,g]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
MANMADE HAZARDS			
RAD–01 Plutonium release from RANT Facility transuranic waste container storage area fire.	Approximately 1,600 per year (i.e., one event in approximately 600 years); considered an unlikely event	Approximately 0.04 excess LCF Mean population dose approximately 72 person-rem MEI at nearest public access (on Pajarito Road) approximately 46 rem, at most exposed residence approximately 4 rem	0.000064 No change in likelihood or severity among the alternatives.
RAD–07 Plutonium release from WCRRF transuranic waste container storage area fire.	0.0003 per year (i.e., one in 3,000 years); considered an unlikely event	Approximately 0.7 excess LCF Mean population dose: approximately 1,300 person-rem MEI dose at closest public access (Pajarito Road) approximately 74 rem, MEI at habitation: approximately 4 rem	0.00021 No change in the severity of the accident from the No Action Alternative. Likelihood increases, as compared to No Action.
RAD–08 Plutonium release from TWISP transuranic waste storage domes due to aircraft crash and fire.	4.3×10^{-6} per year (i.e., one event in approximately 200,000 years); considered an extremely unlikely event	Approximately 0.2 excess LCF Mean population dose: approximately 400 person-rem MEI at nearest public access (Pajarito Road and nearest boarder with White Rock): 22 rem	8.6×10^{-7} No change in the likelihood or severity of the accident from the No Action Alternative.
RAD–16 Plutonium release due to aircraft crash at the CMR Building.	Approximately 3.5×10^{-6} per year (i.e., one event in approximately 300,000 years)	Approximately 0.03 excess LCF Mean population dose: approximately 56 person-rem, no expected excess LCFs; MEI at closest public access, approximately 3 rem, approximately 0.03 rem at nearest habitation	1.05×10^{-7} No change in the likelihood or severity of the accident from the No Action Alternative.
PROCESS HAZARD ACCIDENTS			
RAD–09 Plutonium release due to transuranic waste drum failure or puncture (for "high" and typical activity in drum).	0.0049 per year (i.e., one in approximately 250 years for high-activity drum); 0.49 per year (i.e., one in 2 years for typical drum)	0.12 excess LCF from high activity drum Mean population dose for release approximately 230 person-rem MEI (high activity drum) at closest access (Pajarito Road) approximately 23 rem; approximately 0.86 rem at closest habitation 0.0022 excess LCF from typical activity drum Mean population dose approximately 4.4 person-rem MEI (typical activity drum) at closest access (Pajarito Road) approximately 0.41 rem; approximately 0.86 rem at closest habitation	0.00059 No change in the severity of the accident from the No Action Alternative. 0.0011 No change in the severity of the accident from the No Action Alternative.

TABLE 5.3.11.2–1.—*Summary of Radiological Consequences for Plutonium Release Scenarios at LANL—Expanded Operations Alternative*-Continued

SCENARIO DESCRIPTION	LIKELIHOOD[a,f]	CONSEQUENCE MEASURES[b,c,d,e,g]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
RAD–13 Plutonium release from flux trap irradiation experiment at TA–18.	0.000016 per year (i.e., one event in approximately 65,000 years)	Approximately 0.08 excess LCF Mean population dose approximately 160 person-rem MEI at closest public access (Pajarito Road), approximately 120 rem; at closest habitation approximately 0.12 rem.	0.0000013 No change in the likelihood or severity of the accident from the No Action Alternative.
RAD–15 Plutonium release from CMR Building. (1) Laboratory Fire	(1) 0.000036 per year	(1) Approximately 0.088 excess LCF Mean population dose approximately 175 person-rem MEI at nearest public access (Diamond Road) approximately 0.41 rem; approximately 0.48 rem at closest habitation	(1) 3.2×10^{-6} Accident severity changes due to an increase in the amount of material.
(2) Wing Fire	(2) 0.000032 per year	(2) Approximately 1.7 excess LCF Mean population dose: approximately 3,400 person-rem MEI at nearest public access (Diamond Road) approximately 91 rem; approximately 90 rem at closest habitation	(2) 0.000054 Accident severity changes due to an increase in the amount of material.

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure.
[e] The symbol ~ means approximately.
[f] The frequency per year is more correctly described as the probability of occurrence in any 12-month period. See detailed explanation under Meaning of Risk and Frequency in volume III, appendix G, section G.1.
[g] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

number of trips, and the number of experiments. These changes tend to increase or decrease the risk by 10 to 20 percent. These changes do not alter the overall risk profile for the site or substantially alter the relative ranking of each of these accidents.

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between the Rocky Flats Plant and TA–55–4 are presented in volume III, appendix G, section G.4.1.2.

Substantial differences exist between the nuclear facility and operations being conducted in TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiencies detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including enhanced seismic resistance and fire containment.

5.3.11.3 *Highly Enriched Uranium Release from Process Hazard Accident*

As discussed in section 5.2.11.3, this accident is the dominant accident for the release of HEU. Because the number of pulse operations would increase for the Expanded Operations Alternative, the frequency of the scenario will increase. The associated risk is reflected in Table 5.3.11.3–1.

5.3.11.4 *Tritium Release from a Manmade Hazard Accident at LANL*

As presented in section 5.2.11.4, the aircraft crash event is the dominant accident that involves tritium. Because no changes in operations or inventories from the No Action Alternative are expected, the frequency and consequences of this scenario under the Expanded Operations Alternative are the same as presented under the No Action Alternative in Table 5.2.11.4–1.

5.3.11.5 *Chemical Releases from Manmade and Process Hazard Accidents at LANL*

For the chlorine releases, on-site personnel could be exposed to concentrations in excess of ERPG–2. Chlorine has a highly objectionable odor, which prompts sheltering and escape; however, personnel can be quickly overcome when exposed to high concentrations. There is a small increase in risk for chemical accidents over the No Action Alternative. These results are shown in Tables 5.3.11.5–1 and 5.3.11.5–2.

5.3.11.6 *Worker Accidents*

Because the Expanded Operations Alternative includes the same types of activities that were considered for the No Action Alternative with no changes in the frequency or amounts of materials used in these activities, an individual worker is subject to the same risk. Therefore, the frequencies and consequences of worker accidents under the Expanded Operations Alternative are the same as those reflected in Table 5.2.11.6–1.

TABLE 5.3.11.3–1.—*Summary of Radiological Consequences from Highly Enriched Uranium Release Scenarios at LANL—Expanded Operations Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d,e]	SOCIETAL RISK (EXCESS LATENT FATALITIES PER YEAR)
RAD–03 Highly enriched uranium release from power excursion accident with Godiva-IV outside Kiva #3.	4.3×10^{-6} per year	Approximately 0.06 excess LCF Mean population dose: approximately 110 person-rem MEI at nearest public access (Pajarito Road) Approximately 150 rem; at nearest habitation approximately 0.5 rem	2.6×10^{-7}

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure. The MEI dose is provided for an individual located on Pajarito Road at a distance of 160 feet (50 meters) from the facility, even through Pajarito Road would be closed to the public during outdoor operations.
[e] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

TABLE 5.3.11.5–1.—*Summary of Chlorine Exposure Scenarios at LANL—Expanded Operations Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
PROCESS HAZARD ACCIDENTS			
CHEM–01 Chlorine release (150 pounds [68 kilograms]) from potable water treatment station, due to human error during cylinder changeout or maintenance, or due to random hardware failures.	Approximately 0.0013 per year (i.e., one such event in approximately 800 years)	For the risk-dominant large leak scenario, an average of approximately 43 persons exposed above ERPG–2 levels, and approximately 12 persons exposed above ERPG–3 levels, to distances of up to a few tenths of a mile.	0.056 Small change in the likelihood or severity of the accident from the No Action Alternative.
CHEM–02 Multiple cylinder (1,500 pounds [680 kilograms]) from toxic gas storage shed at Gas Plant, due to fire or aircraft crash.	Approximately 0.00015 per year (i.e., one in approximately 8,000 years)	Average of 292 people within LANL (ranging from none to 1,000 depending upon wind direction) exposed at or above ERPG–2 or –3 levels; town protected by canyon from highest concentrations.	0.044 (Frequency increases by 14% from the no action alternative; no change in severity)
CHEM–03 Chlorine release (150 pounds [68 kilograms]) from toxic gas storage shed at Gas Plant, due to random failure or human errors during cylinder handling.	Approximately 0.00012 per year (i.e., one in approximately 8,000 years)	An average of approximately 263 exposed above ERPG–2 levels; or 239 above ERPG–3 levels, at distances to a fraction of a mile, all within LANL; town protected by canyon from highest concentrations.	0.032 No change in likelihood or severity over the No Action Alternative.
CHEM–06 Chlorine gas release outside Plutonium Facility.	Approximately 0.063 per year (i.e., one event in approximately 16 years)	Average number exposed at or above ERPG–2 doses is approximately 102, and above ERPG–3, approximately 7 at ranges to a fraction of a mile.	6.426 No change in likelihood or severity over the No Action Alternative.

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.

TABLE 5.3.11.5–2.—*Summary of Chemical Exposure Scenarios—Expanded Operations Alternative*

SCENARIO	DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
CHEM–04	Bounding single container release of toxic gas (selenium hexafluoride) from waste cylinder storage.	Approximately 0.004 per year (i.e., one in about 250 years)	Average number of off-site persons exposed above ERPG–2 level is zero; toxic effects generally limited to the source's TA (TA–54).	0 No changes in frequency or severity from the No Action Alternative.
CHEM–05	Bounding multiple cylinder release of toxic gas (sulfur dioxide) from waste cylinder storage.	Approximately 0.00051 per year (i.e., one event in approximately 2,000 years)	Under conservative daytime conditions, no one outside the source area (TA–54) would see levels above ERPG–2. Under least favorable conditions, 13 persons could be exposed above ERPG–3 levels.	0 No changes in frequency or severity from the No Action Alternative.

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.

5.4 IMPACTS OF THE REDUCED OPERATIONS ALTERNATIVE

5.4.1 Land Resources

5.4.1.1 *Land Use*

Changes to land use and land use categories under the Reduced Operations Alternative would be the same as for the No Action Alternative.

5.4.1.2 *Visual Resources*

Changes to visual resources under the Reduced Operations Alternative would be the same as for the No Action Alternative.

5.4.1.3 *Noise*

Changes to noise levels, air blasts and ground vibrations associated with high explosives testing under the Reduced Operations Alternative would be the same as for the No Action Alternative. The total of LANL activities would decrease with a corresponding slight decrease in total noise producing events, which would reduce the potential to impact workers.

5.4.2 Geology and Soils

Potential impacts for the Reduced Operations Alternative on geology and soils would be the same as those for the No Action Alternative.

5.4.3 Water Resources

5.4.3.1 *Surface Water*

Table 5.4.3.1–1 shows the total flow from the NPDES outfalls for each of the major watersheds under the Reduced Operations Alternative. In volume III, appendix A, Table A.1–1 presents a more detailed table of the NPDES outfalls for all four alternatives by facility (key and non-key), watershed, and location. The estimated total gallons discharged into all watersheds equals 218 million gallons (825 million liters) under the Reduced Operations Alternative. This is a decrease from the index effluent volume of 233 million gallons (882 million liters).

NPDES outfall effluent quality during the period of the SWEIS (1997 through 2006) is expected to be the same under this alternative as described for the No Action Alternative, including the radionuclide concentrations in effluent from TA–50, as presented in Table 5.2.3.2–2. The only canyon that has an increase in outfall flow over the baseline is Sandia Canyon. The projected increase in flow to Sandia Canyon is slightly more than one-half that projected for the No Action Alternative. The potential impacts resulting from this increase in flow in Sandia Canyon should be the same as discussed under the No Action Alternative. For the Reduced Operations Alternative, there are no new activities that would result in changes in stormwater runoff.

5.4.3.2 *Alluvial Groundwater*

The relative decreases in NPDES outfall discharges (as compared to No Action) are expected to result in proportionally lower alluvial groundwater volumes.

The projected discharge from RLWTF into Mortandad Canyon under the Reduced Operations Alternative is 5.3 million gallons (20 million liters) per year, about the same as the RLWTF index volume of 5.5 million gallons (21 million liters) per year.

The new HELWTF will likely result in improved water quality to Canyon de Valle, as discussed in the No Action Alternative.

TABLE 5.4.3.1–1.—*NPDES Discharges by Watershed Under the Reduced Operations Alternative*[a]

WATERSHED	# OUTFALLS		FLOWS (MGY)					
			KEY FACILITIES		NON-KEY		TOTALS	
	INDEX	REDUCED	INDEX	REDUCED	INDEX	REDUCED	INDEX	REDUCED
Ancho	2	0	0.1	0.0	0.0	0.0	0.1	0.0
Cañada del Buey	3	3	0.0	0.0	6.4	6.4	6.4	6.4
Chaquehui	1	0	0.0	0.0	5.8	0.0	5.8	0.0
Guaje	7	7	0.0	0.0	0.7	0.7	0.7	0.7
Los Alamos	12	8	19.2	16.4	0.5	0.2	19.7	16.6
Mortandad	12	7	42.0	28.3	10.9	5.1	52.9	33.4
Pajarito	17	11	8.4	1.8	0.8	0.8	9.2	2.6
Pueblo	1	1	0.0	0.0	1.0	1.0	1.0	1.0
Sandia	11	8	4.4	15.4	103.5	127.9	107.9	143.3
Water	21	10	29.5	14.1	0.0	0.0	29.5	14.1
Totals	87	55	103.6	76.0	129.6	142.0	233.2	218.1

MGY = millions of gallons per year

[a] NPDES Information Sources: Index information was provided by the Surface Water Data Team Reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Outfall flow projections for the alternatives were based on the outfalls remaining as of November 1997. Additional outfalls may be eliminated in the future (as discussed in the *Environmental Assessment for Effluent Reduction* [DOE 1996e]) as well as several other outfalls that may be closed as part of LANL's ongoing outfall reduction program.

5.4.3.3 *Perched Groundwater*

Groundwater flow and contaminant pathways to the intermediate perched groundwater bodies are not well characterized nor understood. It is possible that NPDES discharges to Los Alamos and Sandia Canyons under the Reduced Operations Alternative, could contribute to recharge of the intermediate perched groundwater and contaminant transport beneath Los Alamos and Sandia Canyons. However, unlike the No Action and the other alternatives, NPDES discharges to Los Alamos Canyon under the Reduced Operations Alternative will be slightly less than the index.

5.4.3.4 *Main Aquifer*

Recharge mechanisms to the main aquifer are uncertain. However, for the same reasons as discussed under the No Action Alternative, impacts resulting from decreased NPDES outfall flows under the Reduced Alternative should be negligible. A conservative projection of LANL water use under the Reduced Operations Alternative is 602 million gallons (2,279 million liters) per year. Los Alamos County and the NPS did not provide projections, but in 1994 the County used about 958 million gallons (3,626 million liters) from this water right and the NPS used about 5 million gallons (19 million liters). Based on this information, it is expected that the water requirements of this community can be met within the existing water rights from the main aquifer.

For the purposes of modeling drawdown of the main aquifer, annual water use projections were made. The total water usage from DOE water rights was projected to average 1,451 million gallons (5,492 million liters) per year under the Reduced Operations Alternative, with a maximum annual use of 1,470 million gallons

(5,564 million liters) and a minimum annual use of 1,444 million gallons (5,466 million liters).

The model results reflect water level changes at the top of the main aquifer across the alternatives, given continued draw from the aquifer by DOE, Española, and Santa Fe. Table 5.4.3.4–1 shows predicted water level changes at the surface of the main aquifer during the period from 1997 through 2006 for the Reduced Operations Alternative; as noted in section 5.2.3.1, these changes are not all due to LANL operations. Although the water use modeled includes water use in Española and Santa Fe, the differences between the alternatives are due only to LANL operations. The impacts to the volume of water in the main aquifer under this alternative are very similar to those described for the No Action Alternative; the drawdowns in the DOE well fields are minimal relative to the total thickness of the main aquifer, and the volume of water to be used over the period from 1997 through 2006 is negligible relative to the volume of water in storage. Details of the conceptual model, assumptions, uncertainties and limitations, and input parameters for the groundwater model are described in volume III, appendix A.

TABLE 5.4.3.4–1.—*Maximum Water Level Changes at the Top of the Main Aquifer Under the Reduced Operations Alternative (1997 Through 2006)*

WATER LEVEL CHANGE IN FEET[a,b]	
AREA OF CONCERN ON SITE	
Pajarito Well Field	-10.7
Otowi Well Field (Well 0-4)	-10.3
AREA OF CONCERN OFF SITE	
DOE - Guaje Well Field	-8.1
Santa Fe Water Supply	
Buckman Well Field	+21.7
Santa Fe Well Field	-20.6
San Juan Chama Diversion	0.0
Springs	
White Rock Canyon Springs, Maximum Drop	0.0
White Rock Canyon Springs, Maximum Rise	+1.0
Other Springs (Sacred, Indian)	+3.8
San Ildefonso Pueblo Supply Wells	
West of Rio Grande	
Household, Community Wells	+0.6
Los Alamos Well Field	+3.8
East of Rio Grande	
Household, Community Wells	0.0

[a] Negative value (-) indicates water level drop; positive value (+) indicates water level rise.

[b] Also, the water level changes projected by the regional MODFLOW model represent average changes over a whole grid- cell (i.e., a square that is a mile on a side). They are, for the most part, not predictive of the water level changes at any single point within the cell (for example, a supply well). Pumping wells have characteristic "cones of depression" where the water surface reflects an inverted cone, and water levels at the well may be quite different from levels even a few ten's of feet away. Whether any individual well would exhibit water level changes consistent with the predicted grid-cell average change is a function of, for example, its location within the grid-cell; proximity to other pumped wells; and the individual well operation, construction, and hydraulics. Hence, the water level changes predicted by the model can only be considered qualitatively and can not be considered as finite changes.

5.4.4 Air Quality

5.4.4.1 *Nonradiological Air Quality Impacts*

Criteria Pollutants

Criteria pollutant emissions under the Reduced Operations Alternative are less than those under the Expanded Operations Alternative. Because the bounding analysis of criteria pollutant emissions for all alternatives (based on the emissions under the Expanded Operations Alternative) results in estimated concentrations of each pollutant below the standards established to protect human health with an ample margin of safety, criteria pollutant

emissions under the Reduced Operations Alternative would also be below these levels.

Toxic Air Pollutants

As discussed in section 5.1.4, the only toxic air emissions with the potential to impact human health and the environment under any alternatives are those associated with high explosives test site operations and the additive emissions from all the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center. Under the Reduced Operations Alternative, such emissions are projected to be similar to those addressed in the No Action Alternative (section 5.1.4). Therefore, pollutants released from LANL operations under the Reduced Operations Alternative are not expected to cause air quality impacts that would affect human health and the environment.

5.4.4.2 *Radiological Air Quality Impacts*

This section addresses the radiation dose to the FS MEI, LANL MEI and the population dose from LANL radionuclide air emissions under the Reduced Operations Alternative.

Facility-Specific Maximally Exposed Individual

Table 5.4.4.2–1 shows the FS MEI doses under the Reduced Operations Alternative. The highest MEI dose was 1.88 millirem per year, which is 18.8 percent of the regulatory limit for the air pathway. This table shows the EPA regulatory limit would not be exceeded from emissions of these facilities under the Reduced Operations Alternative.

LANL Maximally Exposed Individual

The location of the highest dose from all facility emissions was 2,625 feet (approximately 800 meters) north-northeast of TA–53. LANL MEI dose was calculated to be 1.88 mrem per year under the Reduced Operations Alternative.

TABLE 5.4.4.2–1.—*Facility-Specific Information Reduced Operations Alternative*

KEY FACILITY	DOSE[a] (mrem/yr)
TA–3-29 (CMR)	0.36
TA–3-66 (Sigma)	0.36
TA–3-102 (Shops)	0.29
TA–11 (HE Testing)	0.31
TA–15/36 (Firing Sites)[c]	1.76
TA–16 (Tritium Facility)	0.22
TA–18 (Pajarito Site)	1.51
TA–21 (Tritium Facility)	1.22
TA–48 (Radiochemistry Laboratory)	1.08
TA–55 (Plutonium Facility)	1.08
TA–53 (LANSCE)[b]	1.88
TA–54 (Boundary)[c]	0.68
TA–54 (White Rock)	0.39

[a] For each FS MEI, the total dose was calculated by adding the contributions from each modeled facility. An MEI does not leave or take protective measures.
[b] This is also the LANL MEI. Five specific sources were modeled from TA–53. These include the TA–53 ES–2, ES–3, IPF, LEDA, and combined diffuse emissions.
[c] Two FS MEI locations were considered for TA–54 because Area G is bordering San Ildefonso Pueblo land. The first is a MEI location at the LANL boundary, 1,197 feet (365 meters) northeast of Area G. No person from the Pueblo currently is known to live along this boundary. The second is an actual MEI location in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

Population Dose

The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated to be 10.83 person-rem per year under the Reduced Operations Alternative. TA–15/36 accounted for 65.3 percent of this dose (collective diffuse emissions, including those from these TAs, accounted for 66.3 percent of this dose).

The values reported for population doses for this alternative, as well as the other alternatives, is

higher than has been reported in the recent annual environmental reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. The material throughput at the different facilities under the various alternatives is presented in chapter 3, section 3.6.

Isodose Maps

The isodose maps for the 50-mile (80-kilometer) region are shown on Figures 5.4.4.2–1 and 5.4.4.2–2.

5.4.5 Ecological Resources, Biodiversity, and Ecological Risk

Impacts to ecological resources and biodiversity resulting from reducing the scale of operations would not vary appreciably from those of the No Action Alternative. An overall reduction in outfall discharges could cause a commensurate decrease in the extent of affected wetlands. There would not be any incremental changes from the No Action level of ecological risk.

5.4.6 Human Health

The consequences of implementing the Reduced Operations Alternative on public health and worker health are presented below. As discussed in section 5.1.6, "risk," as used in the SWEIS human health analysis, refers to the probability of toxic or cancer mortality consequences under the specific exposure scenarios analyzed.

5.4.6.1 *Public Health*

The consequences of continued operations of LANL on public health under the Reduced Operations Alternative are presented below for the same topics discussed in section 5.2.6.1.

Regional Consequences of Airborne Radioactivity Inhalation and Immersion

The LANL MEI was estimated to be 2,625 feet (800 meters) north-northeast of LANSCE (TA–53). This location is within the LANL reservation, and the dose at this location is estimated to be 1.88 millirem per year (section 5.4.4.2), corresponding to a 72-year lifetime dose of 0.14 rem. This location borders the Los Alamos townsite and is a conservative estimate for an MEI from LANL emissions. The background (TEDE) dose in the Los Alamos area is estimated to be 360 millirem per year; thus, the dose to the MEI is 0.5 percent of the background dose.

Table 5.4.6.1–1 summarizes the LANL MEI dose and presents the corresponding risk of excess LCF to the MEI. The risk of development of nonfatal cancer is also presented. These risks are presented on a lifetime basis, assuming that the hypothetical LANL MEI received the estimated dose of 1.88 millirem each year for a 72-year life. The excess LCF risk was estimated to be 0.000068 over a lifetime.

TABLE 5.4.6.1–1.—*Estimated Public Health Consequences for LANL MEI and the Population Within a 50-Mile (80-Kilometer) Radius of LANL for the Reduced Operations Alternative*

PARAMETER	LANL MEI	50-MILE (80-KILOMETER) RADIUS POPULATION
Dose	1.88 millirem/year	10.83 person-rem/year
Excess LCF	0.000068/lifetime (72 year)	0.0054/year of operations

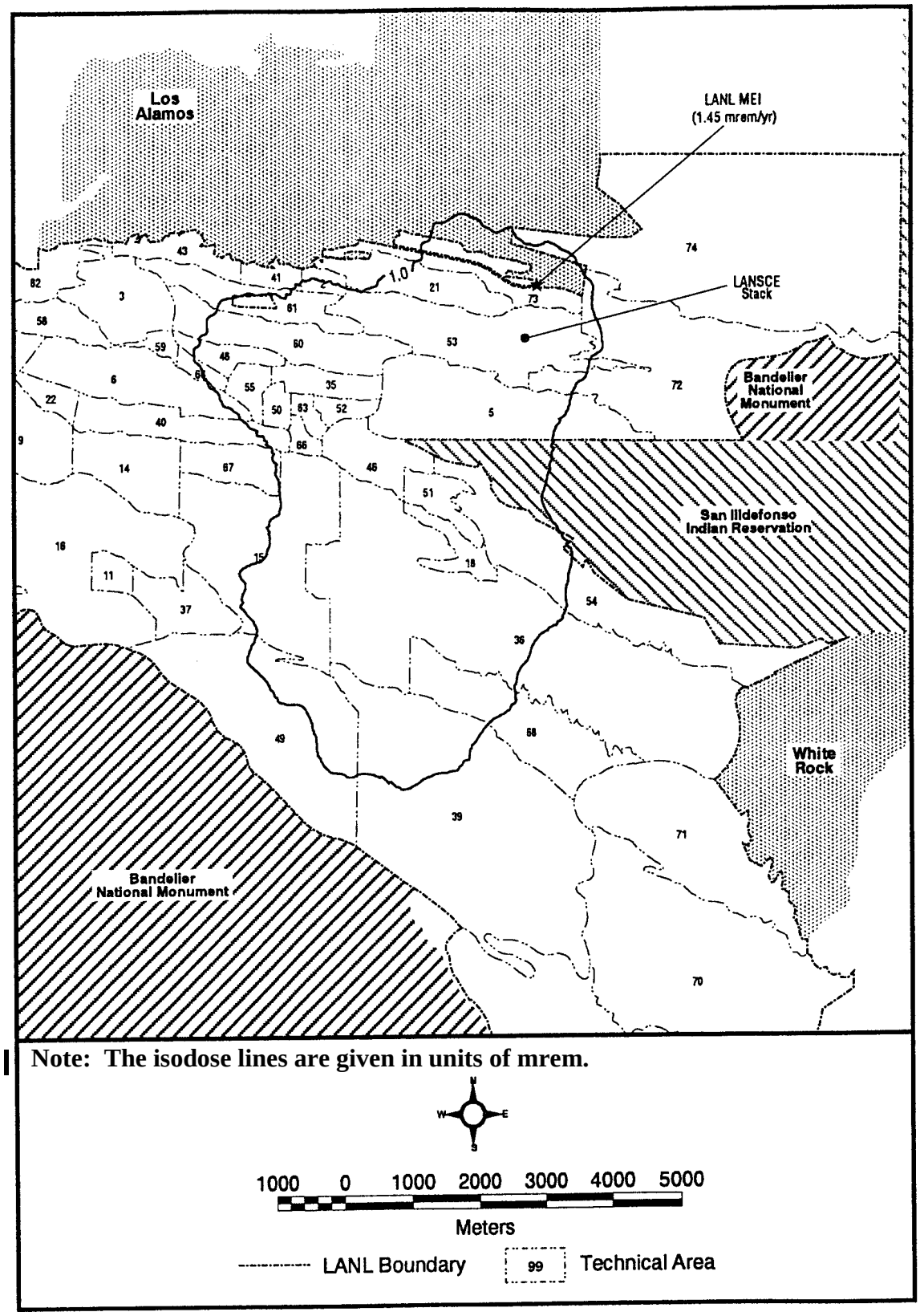

FIGURE 5.4.4.2–1.—*Isodose Map Showing Doses Greater Than 1 Millirem per Year for the Reduced Operations Alternative.*

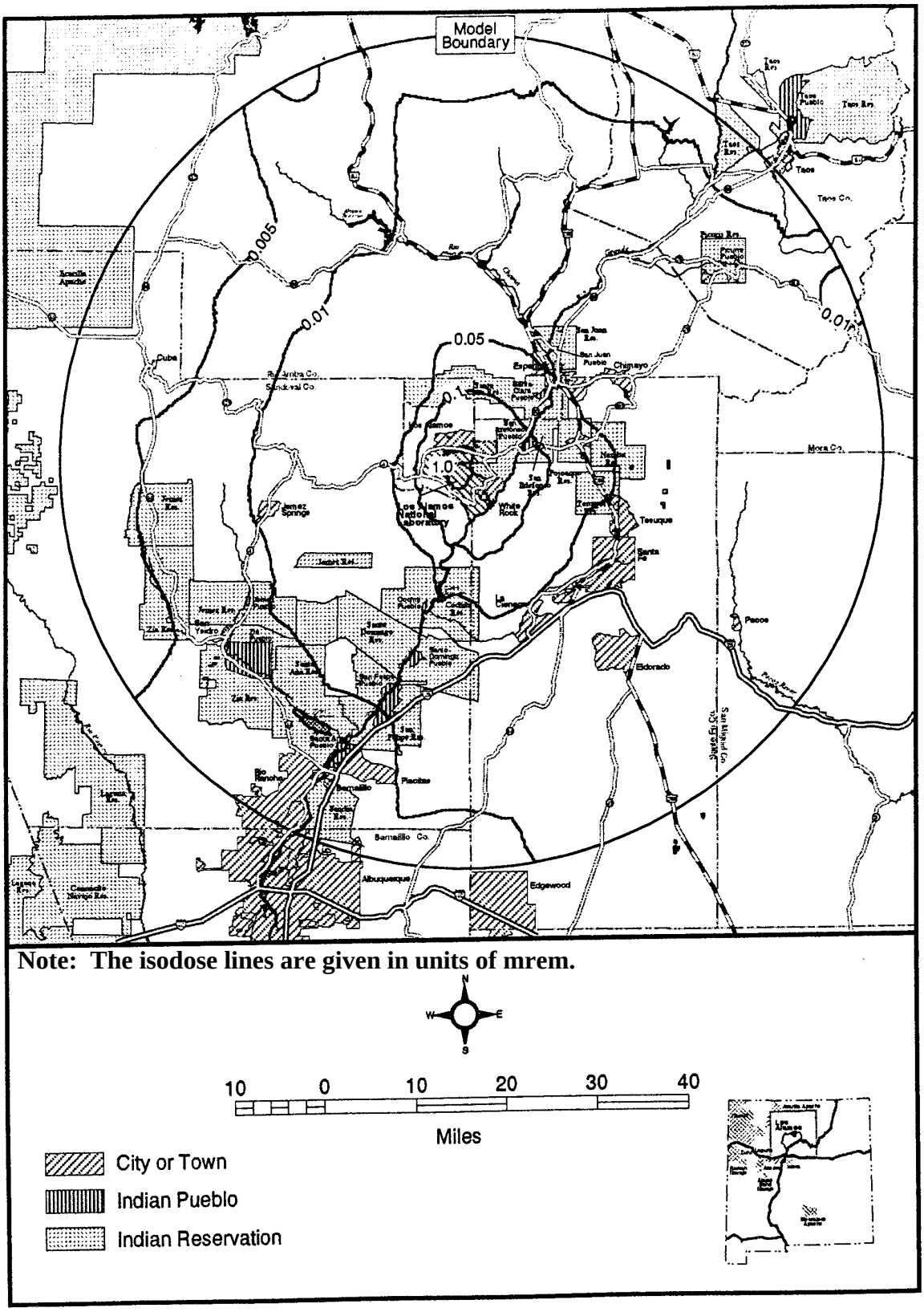

FIGURE 5.4.4.2–2.—*Isodose Map Showing Doses Less Than 1 Millirem per Year for the Reduced Operations Alternative.*

The isodose maps showing both the estimated dose near LANL and within a 50-mile (80-kilometer) radius of LANL are given in Figures 5.4.4.2–1 and 5.4.4.2–2. The population dose within the 50-mile (80-kilometer) radius is also given in Table 5.4.6.1–1, estimated to be 10.8 person-rem per year. As reflected in the table, the annual operations excess LCF risk was estimated to be 0.0054.

In the Reduced Operations Alternative, there are six facilities with FS MEIs receiving a dose that would exceed 1 millirem per year (volume III, appendix B):

- LANSCE, 1.88 millirem per year to the facility MEI
- HE Testing Sites (TA–15 and TA–36), 1.76 millirem
- Pajarito Site (TA–18), 1.51 millirem
- TSTA and TSFF (TA–21), 1.22 millirem
- Radiochemistry Laboratory (TA–48), 1.08 millirem
- Plutonium Facility (TA–55), 1.08 millirem

External Radiation: Two Special Cases

As discussed in section 5.2.6.1, one contribution to public dose results from jogging or hiking for 96 hours on the access road north of TA–21 and is attributable to cesium-137 known to be on the ground within the TA. The MEI dose is not expected to change under the Reduced Operations Alternative from that estimated under the No Action Alternative (an EDE of 2.9 millirem per year and an excess LCF risk of about 1.4×10^{-6} per year).

The other contribution to public dose, as discussed in section 5.2.6.1, would result from TA–18 "road-open" operations. At the 95 percent confidence level, four exposures per year would be expected for the MEI out of the 100 operations per year at TA–18 under the Reduced Operations Alternative (the same as for the No Action Alternative). This would result in an annual projected MEI EDE dose of 19 millirem per year. The lifetime excess LCF risk for this dose is about 9.5×10^{-6} per year of operation.

Nonionizing Radiation

The only uncontained nonionizing radiation source in use or planned for LANL is the microwave transmitter in TA–49. The consequence of a public exposure to this source under the Reduced Operations Alternative is the same as for the No Action Alternative; as discussed in section 5.2.6.1, this consequence is negligible.

Consequences of Airborne Chemical Emissions

For the Reduced Operations Alternative, these consequences are the same as those under the No Action Alternative; the worst-case HI for lead did not exceed one in a million (10^{-6}); for depleted uranium, the worst-case HI did not exceed 1 in 100,000 (0.00010); and the excess LCF for beryllium (evaluated as a carcinogen) under the Reduced Operations Alternative was estimated to be less than 3.6×10^{-7} per year. These analyses are presented in detail in volume III, appendix D.

Carcinogenic Risk from Air Emissions

The screening process described in appendix B identified no individual carcinogenic chemical air emission that required analysis for public health consequences. For carcinogens, an estimate also was made of the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs (appendix B, attachment 6).

This combined cancer risk is less than 1 in 1 million for the Reduced Operations Alternative because projected emissions for this alternative are less than those analyzed for the Expanded Operations Alternative (which was just slightly above the screening guideline value of 1×10^{-6}).

It is believed that negligible increase in incremental combined cancer risk will result from the Reduced Operations Alternative.

Consequences of Ingestion to Residents, Recreational Users, and Special Pathways Receptors

The risk to the public from ingestion under the Reduced Operations Alternative does not differ from that associated with the No Action Alternative; this is because most of the risk is attributable to the existing levels of contamination in water and soils in the area. This is discussed further in section 5.2.6.1. Table 5.2.6.1–2 summarizes the ingestion radiological annual dose and excess LCF per year to the MEIs. Tables 5.2.6.1–2 and 5.2.6.1–3 summarize the total radiological annual ingestion dose and excess LCF to members of the public. Per Table 5.2.6.1–3, the total worst-case ingestion doses for the off-site resident of Los Alamos County and non-Los Alamos County resident are 0.011 and 0.017 rem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose ranges up to 0.001 rem per year, according to the amount of time spent in the canyons (see footnote b in Table 5.2.6.1–3). If the individual has traditional Native American or Hispanic lifestyles, the values found in the final columns of the table should be used in place of the values in the first columns for off-site residents. Per the values in the final columns, these "special pathways receptors" can have worst-case 3.1 millirem per year additional dose. The associated excess LCF risks for the off-site residents are 8.6×10^{-6} per year of exposure and 9.1×10^{-7} per year of exposure for the individual who is also an avid recreational user. These worst-case doses are for a 95th percentile intake of the 95th percentile contamination level, referred to as the UCL. Ingestion pathway calculations included all radionuclides detected in the media. This includes natural background, weapons testing fallout, and previous releases. The actual contribution from continued operations at LANL is only a small fraction of this value. These values apply to the baseline and to all four alternatives. The data and analyses for these calculations are in volume III, appendix D, section D.3.3. Table 5.2.6.1–3 summarizes the risk associated with metals ingestion to MEIs in the LANL region.

Consequences to the Public Along Transportation Routes

Section 5.4.10 details the analysis of transportation consequences under this alternative. Public health consequences include the dose and excess LCF risk associated with routine, accident-free transportation. Table 5.4.10–2 shows the population dose and excess LCF for normal (accident-free) off-site shipments. The population dose and excess LCFs associated with exposures occurring during stops for transportation segments near LANL are provided in Table 5.4.6.1–2. Doses associated with living along route and sharing routes with these shipments are detailed in Table 5.4.10–2, and are less than those associated with stops. Risks associated with accidents during transportation also are discussed in section 5.4.10.

5.4.6.2 *Worker Health*

Worker risks associated with continued operations of LANL include radiological

TABLE 5.4.6.1–2.—*Radiation Doses and Excess LCF Risks Estimated to the Public at Stops During Transportation of Materials and Wastes from LANL*

ROUTE SEGMENT	PERSON-REM PER YEAR (AT STOPS)	EXCESS LCF RISK PER YEAR
LANL to U.S. 84/285	3.4	0.0017
U.S. 84/285	3.6	0.0018

(ionizing and nonionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the Reduced Operations Alternative are given below and detailed in appendix D, section D.2.2.

Radiological Consequences

Ionizing Radiation Consequences. Table 5.4.6.2–1 summarizes the projected doses and associated excess LCF risks from implementation of the Reduced Operations Alternative.

The collective worker dose under the Reduced Operations Alternative is conservatively projected to be 18 percent less than that measured in 1993 to 1995. In terms of the average non-zero dose, the Reduced Operations Alternative is expected to result in less than that experienced in recent years (0.08 rem per year for Reduced Operations compared with 0.097 rem per year, 1993 to 1995). The estimated lifetime excess LCF risk is 0.000033 per year of operation.

Nonionizing Radiation. It is expected that there will continue to be negligible effects to LANL worker health from nonionizing radiation sources including ultraviolet sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves (including the large station at TA–49). (Also see appendix D, section D.2.2.2 for evaluation used to estimate nonionizing radiation from LANL operations to humans and wildlife, and for the estimated results.)

Chemical Exposure Consequences

It is anticipated that there will continue to be a few exposures annually, particularly exposures to:

- Airborne asbestos
- Lead paint particulates
- Crystalline silica
- Fuming perchloric acid, hydrofluoric acid
- Skin contact with acids or alkalis

Under the Reduced Operations Alternative, it is expected that there will be a worker population of approximately 9,300 individuals, approximately equal to the index period employment levels. For the purposes of the SWEIS, it is assumed that there is negligible additional benefit of the chemical hygiene program at LANL over the period analyzed, and that the rate of chemical exposures continues at the index period rates. Therefore, it is expected that reportable chemical exposures would not change from the index period, approximately one to three reportable chemical exposures per year.

Beryllium Processing Consequences. It is anticipated that beryllium operations in the Reduced Operations Alternative would be the same as in the No Action Alternative. It is not anticipated that consequences to workers would be measurable; that is, no sensitization to beryllium would be detected using the LANL industrial hygiene monitoring program.

TABLE 5.4.6.2–1.—*Annual Worker Doses and Associated Lifetime Excess LCF Risks Under the Reduced Operations Alternative*

LANL Collective Worker Dose (person-rem/yr)	170
Estimated Excess LCF Risk (across the worker population) per year of operation	0.07
Average Non-Zero Worker Dose (rem/yr)	0.08
Estimated Excess LCF Risk (average worker > 0 dose)	0.000033

Physical Safety Hazards

Table 5.4.6.2–2 compares the projected reportable accidents and injuries estimated for normal operations occurring under the Reduced Operations Alternative and that experienced during the index period. The Reduced Operations Alternative is expected to result in no change in reportable accidents or injuries due to increases in worker population. These accidents and injuries are considered as consequences of normal operations because of their frequency. These results assume that the aggressive Health and Safety Program underway at LANL does not achieve any additional reduction in reportable cases.

The consequences of these accidents and injuries are expected to be similar to those experienced in the past, and typically are those associated with health response and recovery from acute trauma. Therefore, the consequences include physical pain and therapy/treatment for recovery such as those associated with bone setting, shoulder dislocation reset, and subsequent physical therapy. Some injuries may also result in continuing consequences to the worker that could affect productivity or lifestyle, such as motor skill loss due to nerve damage or cardiovascular debilitation resulting from electrical shock or electrocution.

TABLE 5.4.6.2–2.—*Projected Annual Reportable Accidents and Injuries for the Reduced Operations Alternative Compared with the Index Period*

PARAMETER ESTIMATED	PARAMETER VALUE AND UNITS
Projected Worker Population	Approximately 9,300
Projected Reportable Accidents and Injuries	417/year
Change from Index (1993 to 1996)	Negligible Change

5.4.7 Environmental Justice

As indicated in sections 5.4.1 and 5.4.2, no substantive adverse impacts to land resources or geology and soils are anticipated for the continued operation of LANL under the Reduced Operations Alternative. Thus, no disproportionately high and adverse impacts to minority or low-income communities are anticipated for these impact areas. The potential impacts to surface and groundwater and ecological resources associated with the Reduced Operations Alternative would affect all communities in the area equally (see sections 5.4.3 and 5.4.5 for additional information on the potential for impacts to these resources). Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated to be associated with these resource areas.

Figure 5.4.7–1 reflects the dose from radiological air emissions within 50 miles (80 kilometers) of LANL under the Expanded Operations Alternative. As discussed in section 5.2.7, impacts due to air emissions are equal to lower in the sectors with substantial minority and/or low-income populations than they are in sectors 1–3 and 6–16, and such impacts are not disproportionately high or adverse with respect to the minority or low-income populations (see section 5.4.4 regarding the impacts anticipated for air emissions under the Reduced Operations Alternative).

The air pathway is one example of the analysis of potential human health impacts. As presented in section 5.4.6, there is minimal potential for LANL operations to adversely affect human health for off-site residents or recreational users in the area around LANL under the Reduced Operations Alternative. Similarly, the special pathways have little potential to impact human health under this alternative. Thus, the Reduced Operations Alternative would not present disproportionately high or adverse impacts to

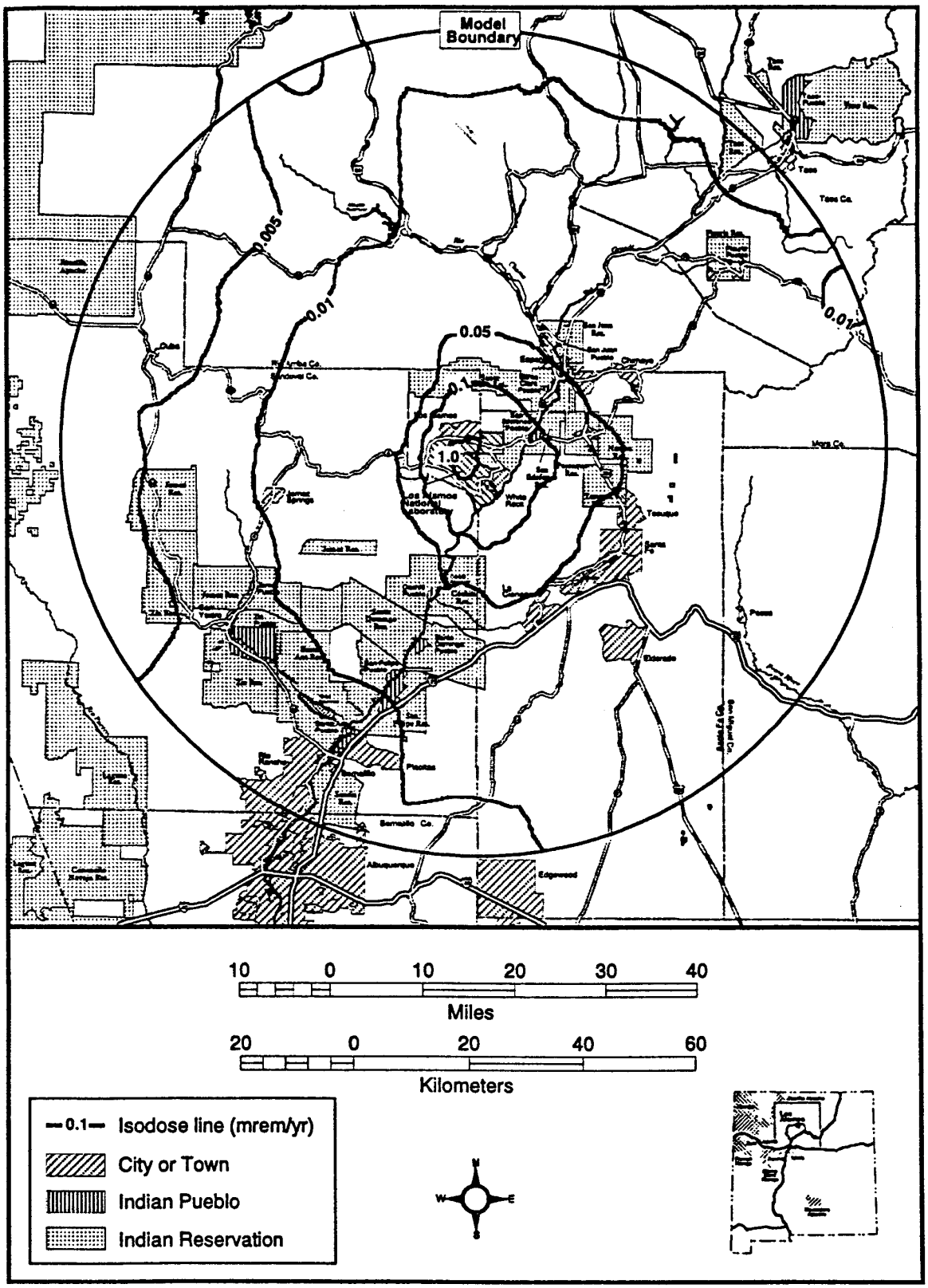

FIGURE 5.4.7–1.—***Isodose Lines from Airborne Releases for the Reduced Operations Alternative Within 50 Miles (80 Kilometers) of LANL.***

human health in minority or low-income communities (section 5.4.6.1).

As shown in section 5.4.10, impacts from on-site transportation and from LANL to U.S. 84/285 are estimated to be 0.0017 excess LCFs per year from incident-free transportation and 0.042 deaths and injuries per year from transportation accidents. Impacts from transportation on route segments that pass through minority or low-income communities (particularly the segment from U.S. 84/285 to I–25) are estimated to be 0.0018 excess LCFs per year from incident-free transportation and 0.095 deaths or injuries per year from transportation accidents. Therefore, no high and adverse impact is expected to either a member of the general public or to a member of a minority or low-income population due to transportation in the vicinity of LANL transportation routes.

5.4.8 Cultural Resources

Construction activities and explosive test activities under this alternative are essentially the same as those under the No Action Alternative. Because these are the activities with the most potential for impacts to cultural resources, impacts to prehistoric resources, historic resources, and TCPs under the Reduced Operations Alternative would be similar to those stated for the No Action Alternative in subsection 5.2.8, including the associated table. DOE would continue to manage and protect the 1,295 inventoried archaeological resources in compliance with the *Archaeological Resources Protection Act* (16 U.S.C. §470aa), Sections 3, 4, 6, and 7, and related legislation (see chapter 4). Management and protection of historic structures would be similar to that of the No Action Alternative (section 5.2.8).

Spiritual Entities

As with the No Action Alternative, no assessment of impacts to “unseen” or “spiritual” entities was attempted.

5.4.9 Socioeconomics, Infrastructure, and Waste Management

This section describes the social, economic, and infrastructure impacts of activities at LANL under the Reduced Operations Alternative.

5.4.9.1 *Socioeconomic Impacts*

Employment, Salaries, and Population

The primary (direct) impacts of this type are presented in Table 5.4.9.1–1 for the LANL workforce only. The secondary (indirect) impacts and the total population changes projected are presented in Table 5.4.9.1–2 for the Tri-County area. These changes are assumed to occur within a year of the ROD for the SWEIS.

Housing

The population changes anticipated in the Tri-County area, based on the total employment changes described above, are projected to result in a reduction in demand of 27 housing units. The distribution of this reduction in the three counties is: a reduction of 6 units in Los Alamos County; a reduction of 10 units in Rio Arriba County; and a reduction of 11 units in Santa Fe County.

A reduction in housing demand at these levels is not expected to exert any significant pressure on rents and house prices, and is not expected to effect apartment vacancies or turnover periods for house sales in any of these three counties.

Construction

Table 5.4.9.1–3 contains the results of the analysis of construction spending, labor salaries, and labor employment for the period fiscal year 1997 through fiscal year 2006. Construction activities associated with this alternative are expected to draw workers already present in the Tri-County area who

TABLE 5.4.9.1–1.—*Summary of Primary LANL Employment, Salaries[a], and Procurement Under the Reduced Operations Alternative[b]*

	LOS ALAMOS COUNTY	RIO ARRIBA COUNTY	SANTA FE COUNTY	TRI-COUNTY TOTAL	OTHER NEW MEXICO COUNTIES	NEW MEXICO TOTAL	OUTSIDE NEW MEXICO	TOTAL
Employees	4,821	1,913	1,832	8,566	607	9,173	174	9,347
Difference[c]	(14)	(6)	(5)	(25)	(1)	(26)	(2)	(28) (-< 1%)
Salaries ($M)	252.4	44.6	73.7	370.7	16.3	387	8.5	395.4
Difference[c]	(2.9)	(0.4)	(0.6)	(3.2)	0	(3.3)	(0.2)	(3.5) (- 1%)
Procurement ($M)	215.4	1.7	20.6	237.7	121.8	359.5	228.8	588.4
Difference[c]	(0.3)	0.0	(0.1)	(0.3)	(0.6)	(1.0)	(2.8)	(3.7) (- 1%)

( ) indicates a decrease as compared to baseline.
[a] Salaries are for UC employees only; subcontractor salaries (Johnson Controls, Inc.; Protection Technology of Los Alamos, etc.) are included in the procurement dollars.
[b] Reflects projected locations of employee residences and LANL procurement activities.
[c] Difference is as compared to fiscal year 1996. Percentage difference is shown in parentheses in the far right (TOTAL) column.

TABLE 5.4.9.1–2.—*Summary of Total Tri-County Employment, Salaries, Business Activity, and Population Changes Under the Reduced Operations Alternative*

	PRIMARY CHANGE	SECONDARY CHANGE	TOTAL TRI-COUNTY CHANGE	TRI-COUNTY PRIMARY WORKER CHANGE[a]	TRI-COUNTY SECONDARY WORKER CHANGE[b]	TOTAL TRI-COUNTY WORKER CHANGE	TOTAL TRI-COUNTY POPULATION CHANGE[c]
Employment/ Population	(25)	(43)	(68)	(20)	(13)	(33)	(64) (-< 1%)
Personal Incomes	($3 million)	($3 million)	($6 million) (-< 1%)				
Annual Business Activity	($0.3 million)	($0.7 million)	($1 million) (-< 1%)				

( ) indicates a decrease as compared to baseline. Percentages in parentheses are the percentage change that the number represents. These are provided for total population change, total person income change, and total annual business activity change.
[a] This is the number of direct workers moving to the Tri-County area, assuming that 80 percent of new LANL employees are from outside this area.
[b] This is the number of secondary workers moving to the Tri-County area, assuming that 30 percent of secondary employment is from outside this area.
[c] This is the total population increase in the Tri-County area, assuming that, on average, each worker moving to the area increases the population by 1.935 (and each worker leaving the area decreases the population by 1.935).

TABLE 5.4.9.1–3.—*Construction Spending, Labor Salaries, and Labor Employment Numbers Under the Reduced Operations Alternative (Fiscal Year 1997 Through 2006)*

YEAR	CONTRACT $M	LABOR $M	EMPLOYEES
1997	63	15	432
1998	187	45	1,282
1999	208	50	1,426
2000	219	53	1,502
2001	210	50	1,440
2002	120	29	823
2003	91	22	624
2004	90	22	617
2005	109	26	747
2006	108	26	741

$M = dollars given in millions
Sources: DOC 1996, PC 1997a, and PC 1997b

historically have worked from job to job in the region. Thus, this employment is not expected to influence socioeconomic factors.

Local Government Finance

Under this alternative, the Tri-County gross receipts tax yields would not be expected to change substantially (about a $100,000 decrease from the baseline yield).

Services

Annual school enrollment in the Tri-County area would decrease by 11 students. This enrollment change would have no discernible effect on classroom capacity. Annual funding assistance from the State of New Mexico could be reduced by about $44,000 because of these enrollment decreases.

The demand for police, fire, and other municipal services would not be expected to change substantially.

5.4.9.2 *Infrastructure Impacts*

Annual electricity use projected under the Reduced Operations Alternative is a total of 508 gigawatt-hours, 163 gigawatt-hours for LANSCE, and 345 gigawatt-hours for the rest of LANL. The peak electrical demand is projected to be 88 megawatts, 38 megawatts for LANSCE, and 50 megawatts for the rest of LANL[1]. The existing supply of electricity to the Los Alamos area is not sufficient year-round to meet the projected electrical peak demand for LANL operations under this alternative; thus, periods of brownouts are anticipated unless measures are taken to increase the supply of electricity to the area. (Sections 1.6.3.1 and 4.9.2 discuss ongoing efforts to increase electrical power supply to this area.) This situation is exacerbated by the additional electrical demand for BNM and the communities of Los Alamos and White Rock. (While these organizations did not provide use projections, their historical usage is reflected in section 4.9.2 of chapter 4.)

Natural gas use is projected to be 1,840,000 decatherms annually, the same as projected under the No Action Alternative. Demand should continue to be dominated by heating requirements.

Water use projected under the Reduced Operations Alternative is a total of 602 million gallons (2,279 million liters) per year, 108 million gallons (409 million liters) per year for LANSCE, and 494 million gallons (1,870 million liters) per year for the rest of LANL. This is well within DOE water rights, about 1,806 million gallons (6,836 million liters) per year; however, this water right also provides for water used by Los Alamos County and BNM. Based on existing information regarding non-LANL water use, the water

1. These values include the proposed SCC Project annual electricity and peak electrical demand for a 50-TeraOp operation and are reflected in all the alternatives. The SCC project was as an interim action to the SWEIS.

demands of this community can be met within the existing water rights (water demand is also discussed in section 5.4.3). The peak water requirements are the same as identified under the No Action Alternative.

5.4.9.3 *Waste Management*

The annual and 10-year total generation projections for radioactive and hazardous waste are reflected in Table 5.4.9.3–1. Radioactive liquid waste is not projected by facility because measurements of individual contributions are not made for all facilities. The total amount of radioactive liquid waste projected for receipt at TA–50 is 53 million gallons (200 million liters) over 10 years (or an average of 5.3 million gallons [20 million liters] per year) for this alternative. These projections include waste from key facilities, all other LANL facilities, waste management facilities, the ER Project, and construction activities.

Due to the reduced level of operations under this alternative, this alternative generates less waste than is generated under the No Action Alternative. As with the No Action Alternative, much of LANL's LLW, TRU, and chemical waste would be treated and packaged to meet waste acceptance criteria and shipped off the site for disposal; nondefense TRU waste from other sites would be stored at LANL pending the development of disposal options. Off-site disposal capabilities are much greater than the waste volumes generated at LANL.

5.4.9.4 *Contaminated Space*

The activities reflected in the Reduced Operations Alternative are projected to increase the total contaminated space at LANL by 63,000 square feet (5,853 square meters) over the next 10 years (the same as the No Action Alternative), as compared to the baseline established for this SWEIS as of May 1996 (chapter 4, section 4.9). The majority of this increase is due to implementation of actions that have already been reviewed under NEPA, but which had not been implemented at the time the baseline was established (the same ones discussed in the No Action Alternative).

5.4.10 Transportation

The transportation impacts projected for the Reduced Operations Alternative are summarized in this section. More detailed information regarding these impacts is included in volume III, appendix F. Although the number of many types of operational shipments associated with the Reduced Operations Alternative are lower than in the other alternatives, the number of LLW shipments for off-site disposal increases substantially as compared to the number of LLW shipments under the No Action Alternative (because the Reduced Operations Alternative reflects off-site disposal of most LLW). Due to the larger number of LLW shipments under this alternative, the total number of shipments of radioactive materials under the Reduced Operations Alternative is actually larger than the number of such shipments under the No Action Alternative (although this is still fewer shipments than are associated with the Expanded Operations or Greener Alternatives). For this reason, the transportation impacts associated with off-site radioactive shipments under the Reduced Operations Alternative are actually greater than the impacts associated with such shipments under the No Action Alternative (this is not true for off-site radioactive materials accidents because LLW transportation accidents are not among the bounding accidents).

5.4.10.1 *Vehicle-Related Risks*

Truck Emissions in Urban Areas

For the Reduced Operations Alternative, the projected risk is 0.034 excess LCF per year. Use of the Santa Fe Relief Route would have a very small effect on this risk (it would change to

TABLE 5.4.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Reduced Operations Alternative*[a]

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR
Plutonium Facility Complex	TA–55	5,250	52,500	688	6,880	12	120	81	810	27	270
Tritium Facilities[c]	TA–16 & 21	1,000	10,000	440	4,400	2	20	NA	NA	NA	NA
CMR Building[d]	TA–3	5,890	58,900	1,280	12,800	16.2	162	15.8	158	7.0	70
Pajarito Site	TA–18	4,000	40,000	145	1,450	1.5	15	NA	NA	NA	NA
Sigma Complex	TA–3	5,500	55,000	420	4,200	2	20	NA	NA	NA	NA
Materials Science Laboratory	TA–3	600	6,000	0	0	0	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	3,800	38,000	10	100	0.4	4	NA	NA	NA	NA
Machine Shops	TA–3	142,000	1.42×10^6	280	2,800	0	0	NA	NA	NA	NA
HE Processing Facilities	TA–8, 9, 11, 16, 28 & 37	7,000	70,000	8	80	0.2	2	NA	NA	NA	NA
HE Testing Facilities	TA–14, 15, 36, 39, 40	25,200	252,000	300	3,000	0.3	3	0.2	2	NA	NA
Los Alamos Neutron Science Center[e]	TA–53	16,600	166,600	156	1,560	1	10	NA	NA	NA	NA
Health Research Laboratory[f]	TA–43	5,050	50,500	14	140	2.5	25	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	1,600	16,000	120	1,200	1.3	13	NA	NA	NA	NA
Radioactive Liquid Waste Treatment Facility[g]	TA–50 & 21	2,200	22,000	150	1,500	0	0	21	210	0	0
Waste Treatment, Storage, and Disposal Facilities[g]	TA–54	920	9,200	174	1,740	4.0	40	27	270	0	0
Non-Key Facilities		651,000	6.51×10^6	520	5,200	30	300	0	0	0	0
ER Project[h]		2×10^6	2×10^7	4,257	42,570	548	5,480	11	110	0	0
Grand Total[i]		2.878×10^6	2.878×10^7	8,960	89,600	621	6,210	156	1,560	34	340

TABLE 5.4.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Reduced Operations Alternative*[a]-Continued

NA indicates that this facility does not routinely generate these types of waste.

[a] Radioactive liquid waste generation is not projected by facility (section 5.4.9.3).

[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under *Toxic Substances Control Act*. This waste category also includes biomedical waste.

[c] These projections include 141,000 cubic feet (4,000 cubic meters) of LLW due to backlogged waste.

[d] These LLW projections include 141,000 cubic feet (4,000 cubic meters) of LLW generation anticipated due to the CMR Building Upgrades, Phase II.

[e] These projections reflect reduced operational waste generation during construction activities that are included in this alternative.

[f] These projections include 22,000 pounds (10,000 kilograms) of chemical waste, 550 pounds (250 kilograms) of biomedical waste (a special form of chemical waste), 1,560 cubic feet (44 cubic meters) of LLW, and 850 cubic feet (24 cubic meters) of LLMW associated with ongoing efforts to remove obsolete and contaminated equipment.

[g] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities.

[h] The ER Project is projected to generate 390 cubic feet (11 cubic meters) per year of TRU and mixed TRU waste together. All of this waste is presented under the TRU waste columns.

[i] Grand totals have been rounded.

0.033 excess LCF per year). The only difference is that the Santa Fe Relief Route would have 1.2 miles (1.9 kilometers) less of urban highway mileage. Approximately 65 percent of the excess LCFs are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. All shipments are conservatively assumed to result in an empty truck making the return trip. This is appropriate for WIPP and LLW shipments and for many SST shipments; however, most shipments are in general commerce and would not include the return of an empty truck.

Truck Accident Injuries and Fatalities

The impacts projected for the Reduced Operations Alternative are presented in Table 5.4.10.1–1. (Additional information is provided in volume III, appendix F, section F.6.3.) Use of the Santa Fe Relief Route would reduce the risks of accidents, injuries, and fatalities by almost one-half of those indicated for the segment from U.S. 84/285 to I–25 due to the assumption that the accident rate on the Santa Fe Relief Route would be much lower than for the route through Santa Fe. Approximately 65 percent of the impacts are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. Again, all shipments are assumed to result in a return by an empty truck.

5.4.10.2 *Cargo-Related Risks*

Incident-free Radiation Exposure

The incident-free radiation exposure impacts projected for the off-site shipments under the Reduced Operations Alternative are presented in Table 5.4.10.2–1; as noted in section 5.2.10.2, the total is the dose throughout the U.S. and is dominated by the segments outside of New Mexico. The aircraft segment is for overnight carrier service; the truck segment to and from the airport is included in the truck results. In general, use of the Santa Fe Relief Route would result in only small changes in this type of impact. Truck crew doses and nonoccupational doses for people at rest stops would increase due to the increased length of the Santa Fe Relief Route for north-bound shipments carrying the radioactive material. Nonoccupational doses for people sharing the road would decrease due to the lower traffic density projected for the relief route.

MEI dose occurs between LANL and I–25 and is 0.00032 rem.

Driver Doses from On-Site Shipments of Radioactive Materials

The projected collective radiation dose for LANL drivers under the Reduced Operations Alternative is 4.262 person-rem. This collective dose would be expected to result in 0.0017 excess LCFs among these drivers.

The average individual driver dose is projected to be 0.178 rem per year, which is well below the DOE radiation protection limit of 5 rem per year.

Transportation Accidents

The following discussion addresses the potential impacts of accidents leading to the release of either radioactive or hazardous material being transported in support of LANL operations under the Reduced Operations Alternative. Results are given for both off-site and on-site shipments.

Off-Site Radioactive Materials Shipments

MEI doses calculated with RADTRAN do not vary by alternative and are given in Table 5.2.10.2–2. The population dose and corresponding excess LCF per year for these shipments are presented in Table 5.4.10.2–2 for these accidents. ADROIT results that are separated into frequency and consequence components are not readily available. The product, MEI dose risk, can be presented in

TABLE 5.4.10.1–1.—*Truck Accident Injuries and Fatalities Projected for LANL Shipments Under the Reduced Operations Alternative*

ROUTE SEGMENT	NUMBER OF ACCIDENTS PER YEAR	NUMBER OF INJURIES PER YEAR	NUMBER OF FATALITIES PER YEAR
On-Site	0.014	0.0029	0.00014
LANL to U.S. 84/285	0.18	0.037	0.0018
U.S. 84/285 to I–25	0.43	0.091	0.0043
Remainder of New Mexico	0.70	0.68	0.075
Outside New Mexico	3.6	3.3	0.33
Total	4.9	4.1	0.41

TABLE 5.4.10.2–1.—*Incident-Free Population Dose and Lifetime Excess LCFs for Off-Site Shipments per Year of Operation Under the Reduced Operations Alternative*

ROUTE SEGMENT	TRUCK DRIVER OR AIRCREW		NONOCCUPATIONAL					
			ALONG ROUTE		SHARING ROUTE		STOPS	
	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	6.4	0.0026	0.034	0.000017	0.56	0.00028	3.4	0.0017
U.S. 84/285 to I–25	8.7	0.0035	0.42	0.00021	3.4	0.0017	3.6	0.0018
Remainder of New Mexico	50	0.02	0.12	0.00006	1.9	0.00095	27	0.014
Outside New Mexico	440	0.18	2.9	0.0014	0.25	0.012	200	0.1
Aircraft	2.4	0.0012	NA	NA	NA	NA	NA	NA
Total	510	0.21	3.5	0.0017	31	0.015	230	0.12

NA = Not applicable, rem = roentgen equivalent man

TABLE 5.4.10.2–2.—*Bounding Radioactive Materials Off-Site Accident Population Risk for the Reduced Operations Alternative*

ROUTE SEGMENT	ANNUAL POPULATION DOSE RISK AND EXCESS LCF RISK						
	SHIPMENT TYPE						
	AMERICIUM -241	CH-TRU	RH-TRU	PLUTONIUM -238	PITS	TOTAL	
	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	0.015	0.0014	2.9×10^{-6}	4×10^{-7}	2×10^{-6}	0.016	8.0×10^{-6}
U.S. 84/285 to I–25	0.24	0.019	0.00004	1×10^{-6}	8×10^{-6}	0.26	0.00013
Remainder of New Mexico	0.031	0.012	0.000025	4×10^{-7}	4×10^{-6}	0.043	0.000022
Rest of U.S.	2.5	NA	NA	4×10^{-6}	0.00001	2.5	0.0012

NA = Not applicable

terms of excess LCF per year; for the Reduced Operations Alternative, MEI dose risk due to plutonium-238 oxide and due to pit shipments were each less than 1×10^{-10} excess LCF per year.

The use of the Santa Fe Relief Route would reduce the projected population dose (and therefore the excess LCFs per year) to about one-third for the U.S. 84/285 to I–25 segment, as compared to use of the route through Santa Fe. This difference is primarily due to the difference in population density along these routes. (The lower traffic density along the relief route is also a factor.) The use of the Santa Fe Relief Route would increase the projected population dose (and therefore excess LCFs per year) for the remainder of New Mexico segment to about double that identified if the route through Santa Fe is used. This difference is due to the increase (6 miles [9.6 kilometers] more) in the distance traveled on I–25 for north-bound shipments.

On-Site Radioactive Materials Shipments

The MEI doses, frequencies, and MEI risks due to the bounding on-site shipments involving radioactive materials are given in Table 5.4.10.2–3. As noted in section 5.2.10.2, the frequency of the bounding DARHT and PHERMEX shipments has been added to the frequency of irradiated target shipments.

TABLE 5.4.10.2–3.—*MEI Doses and Frequencies for Bounding On-Site Radioactive Materials Accidents Under the Reduced Operations Alternative*

SHIPMENT TYPE	EVENT FREQUENCY PER YEAR	MEI DOSE	MEI RISK
Plutonium-238 Solution	8.8×10^{-8}	8.7 rem	7.7×10^{-7} rem/year (3.1×10^{-10} excess LCF/year)
Irradiated Targets	2.9×10^{-6}	acute fatality	2.9×10^{-6} fatalities/ year

Hazardous Materials Shipments

The bounding hazardous materials shipments for accident analyses are major chlorine shipments (toxic), major propane shipments (flammable), and major explosive shipments. The consequences of an accident involving a major explosive shipment is bounded by the consequences of an accident involving a major propane shipment, so the frequency of explosives shipments was added to the frequency of propane shipments (rather than analyzing them separately).

Accidental Chlorine Release

The projected frequencies, consequences, and risks associated with major chlorine accidents under the Reduced Operations Alternative are presented in Table 5.4.10.2–4.

The use of the Santa Fe Relief Route would result in about one-tenth the risk of fatalities and injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight increase in the risk of fatalities and injuries on the remainder of New Mexico segment because of the extra 6 miles (9.6 kilometers) traveled on I–25 for northbound traffic (chlorine shipments are all assumed to travel north on I–25).

Accidental Propane Release

The projected frequencies, consequences, and risks associated with major propane accidents under the Reduced Operations Alternative are presented in Table 5.4.10.2–5.

The use of the Santa Fe Relief Route would result in about one-third the risk of fatalities and one-fourth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight decrease in the risk of injuries and fatalities on the Remainder of New Mexico segment because of the 6-mile (9.6-kilometer) reduction in distance traveled on I–25 for southbound traffic (propane shipments are all assumed to travel south on I–25).

5.4.11 Accident Analysis

Transportation accidents for the Reduced Operations Alternative are addressed in section 5.4.10. High-frequency (greater than 1 in 100) occupational accidents for the Reduced Operations Alternative are addressed in section 5.4.6.

5.4.11.1 *Multiple Source Release of Hazardous Material from Site-Wide Earthquake and Wildfire*

The risks from these accidents are driven primarily by the frequency and magnitude of the earthquakes and wildfires in the area. Because the same types of operations will be conducted in the same facilities and the inventories of MAR will be about the same, there are no substantial changes in risk from earthquakes between the No Action and the Reduced Operations Alternatives.

For the wildfire scenario, the frequency will remain the same, but the MAR will be reduced by about 25 percent at TSTA, reducing the consequences by approximately 1 percent (6 person-rem) compared to the No Action Alternative. Table 5.2.11.1–1 and 5.2.11.1–2 can be referenced for the results of the No Action Alternative.

TABLE 5.4.10.2–4.—*Frequencies, Consequences, and Risk for a Major Chlorine Accident Under the Reduced Operations Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000026	0.065	0.24	8.0×10^{-6}	0.00003
	Suburban	4.3×10^{-6}	1.5	5.6		
U.S. 84/285 to I–25	Rural	0.00002	0.053	0.20	0.00027	0.001
	Suburban	0.000044	3.0	11		
	Urban	0.000013	11	40		
Remainder of New Mexico	Rural	0.00015	0.015	0.056	0.000048	0.00018
	Suburban	0.000016	1.5	5.5		
	Urban	2.6×10^{-6}	8.4	32		
Remainder of U.S.	Rural	0.0011	0.028	0.10	0.0012	0.0044
	Suburban	0.00028	1.6	6.1		
	Urban	0.000066	10	39		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

TABLE 5.4.10.2–5.—*Frequencies, Consequences, and Risk for a Major Propane Accident Under the Reduced Operations Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER TRIP	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	9.2×10^{-6}	0.28	1.1	9.2×10^{-6}	0.000037
	Suburban	1.6×10^{-6}	4.2	17		
U.S. 84/285 to I–25	Rural	7.1×10^{-6}	0.23	0.92	0.00014	0.0006
	Suburban	0.000016	8.4	34		
	Urban	4.8×10^{-6}	1.8	7.3		
Remainder of New Mexico	Rural	0.000062	0.15	0.6	0.00011	0.00048
	Suburban	0.00002	5.1	20		
	Urban	2.5×10^{-6}	1.5	6.1		
Remainder of U.S.	Rural	0.000078	0.09	0.36	0.000063	0.00027
	Suburban	9.9×10^{-6}	4.8	19		
	Urban	5.1×10^{-6}	1.9	7.5		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

5.4.11.2 *Plutonium Releases from Manmade and Process Hazards at LANL*

For the Reduced Operations Alternative, the frequencies and consequences of these accidents are the same as under the No Action Alternative. These are presented in Table 5.2.11.2–1.

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between Rocky Flats and TA–55–4 are presented in volume III, appendix G, section G.4.1.2.

Substantial differences exist between the nuclear facility and operations being conducted in TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiencies detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including enhanced seismic resistance and fire containment.

5.4.11.3 *Highly Enriched Uranium Release from Process Hazard Accident*

As discussed in section 5.2.11.3, this accident is the dominant accident for release of HEU. Because there are no planned changes in the number of experiments or the inventories associated with this activity, the frequency and consequences of this scenario under the Reduced Operations Alternative are the same as presented under the No Action Alternative. These are reflected in Table 5.2.11.3–1.

5.4.11.4 *Tritium Release from a Manmade Hazard Accident at LANL*

As presented in section 5.2.11.4, the aircraft crash event is the dominant accident that involves tritium. Because no changes in operations or inventories from the No Action Alternative are made, the consequences and frequencies associated with these scenarios are the same as those presented in Table 5.2.11.4–1.

5.4.11.5 *Chemical Releases from Manmade and Process Hazard Accidents at LANL*

For the chlorine releases, on-site personnel could be exposed to concentrations in excess of ERPG–2. Chlorine has a highly objectionable odor, which prompts sheltering and escape; however, personnel can be quickly overcome when exposed to high concentrations.

The number of accidental releases of chlorine depends upon the number of times the material is handled. The minor changes in activity levels cause the risk to decrease by about 5 to 10 percent. The incremental risk for this alternative over the No Action Alternative is essentially zero. These changes do not alter the overall risk profile for the site or substantially alter the relative ranking of each of these accidents. These results are provided in Tables 5.4.11.5–1 and 5.4.11.5–2.

5.4.11.6 *Worker Accidents*

Because there are no changes in the types of activities, frequencies, or inventories from the No Action Alternative, an individual worker is subject to the same risk, as presented in Table 5.2.11.6–1.

TABLE 5.4.11.5–1.—*Summary of Chlorine Exposure Scenarios at LANL—Reduced Operations Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
PROCESS HAZARD ACCIDENTS			
CHEM–01 Chlorine release (150 pounds [68 kilograms]) from potable water treatment station, due to human error during cylinder changeout or maintenance, or due to random hardware failures.	Approximately 0.0011 per year (i.e., one such event in approximately 900 years)	For the risk-dominant large leak scenario, an average of approximately 43 persons exposed above ERPG–2 levels, and approximately 12 persons exposed above ERPG–3 levels, to distances of up to a few tenths of a mile.	0.047 The Reduced Operations Alternative is 5% less likely than the No Action due to the handling of one less chlorine cylinder; no change in severity.
CHEM–02 Multiple cylinder (1,500 pounds [680 kilograms]) from toxic gas storage shed at Gas Plant, due to fire or aircraft crash.	Approximately 0.00012 per year (i.e., one in approximately 8,500 years)	Average of 292 people within LANL (ranging from none to 1,000 depending upon wind direction) exposed at or above ERPG–2 or –3 levels; town protected by canyon from highest concentrations.	0.035 Frequency increases by 8% from the No Action Alternative; no change in severity.
CHEM–03 Chlorine release (150 pounds [68 kilograms]) from toxic gas storage shed at Gas Plant, due to random failure or human errors during cylinder handling.	Approximately 0.00012 per year (i.e., one in approximately 8,000 years)	An average of approximately 263 exposed above ERPG–2 levels; or 239 above ERPG–3 levels, at distances to a fraction of a mile, all within LANL; town protected by canyon from highest concentrations.	0.032 No change in likelihood or severity over the No Action Alternative.
CHEM–06 Chlorine gas release outside Plutonium Facility.	Approximately 0.063 per year (i.e., one event in approximately 16 years)	Average number exposed at or above ERPG–2 doses is approximately 102, and above ERPG–3, approximately 7 at ranges to a fraction of a mile.	6.426 No change in likelihood or severity over the No Action Alternative.

[a] Accident likelihood estimates are conservative, given the information available. However, for the particularly unlikely accidents, it is possible that there are causal mechanisms that were missed, so the possibility of a more probable scenario cannot be rigorously ruled out.

[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.

[c] Accident consequences are generally conservative (pessimistic), but do not bound the effects of accidents occurring under unusually unfavorable weather conditions. The results quoted are weather averaged.

TABLE 5.4.11.5–2.—*Summary of Chemical Exposure Scenarios—Reduced Operations Alternative*

SCENARIO	DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
CHEM–04	Bounding single container release of toxic gas (selenium hexafluoride) from waste cylinder storage.	Approximately 0.004 per year (i.e., one in about 250 years)	Average number of off-site persons exposed above ERPG–2 level is zero; toxic effects generally limited to the source's TA (TA–54).	0 No changes in frequency or severity from the No Action Alternative.
CHEM–05	Bounding multiple cylinder release of toxic gas (sulfur dioxide) from waste cylinder storage.	Approximately 0.00014 per year (i.e., one event in approximately 7,000 years)	Under conservative daytime conditions, no one outside the source area (TA–54) would see levels above ERPG–2. Under least favorable conditions, 13 persons could be exposed above ERPG–3 levels.	0 No changes in frequency or severity from the No Action Alternative.

[a] Accident likelihood estimates are conservative, given the information available. However, for the particularly unlikely accidents, it is possible that there are causal mechanisms that were missed, so the possibility of a more probable scenario cannot be rigorously ruled out.

[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.

[c] Accident consequences are generally conservative (pessimistic), but do not bound the effects of accidents occurring under unusually unfavorable weather conditions. The results quoted are weather averaged.

5.5 IMPACTS OF THE GREENER ALTERNATIVE

5.5.1 Land Resources

5.5.1.1 *Land Use*

Changes to land use under the Greener Alternative would be the same as for the No Action Alternative.

5.5.1.2 *Visual Resources*

Changes to visual resources under the Greener Alternative would be the same as for the No Action Alternative.

5.5.1.3 *Noise*

Changes to noise levels and air blasts associated with high explosives testing under the Greener Alternative would be the same as for the No Action Alternative. The overall LANL on-site activities (due to the increased operational levels in activities not related to weapons) would increase under implementation of the Greener Alternative resulting in an overall greater total number of noise producing events for workers. This could be a slight negative impact to the worker noise environment, as compared to the No Action Alternative.

5.5.2 Geology and Soils

Potential impacts for the Greener Alternative on geology and soils would be the same as those for the No Action Alternative.

5.5.3 Water Resources

5.5.3.1 *Surface Water*

Table 5.5.3.1–1 shows the total flow from the NPDES outfalls for each of the major watersheds under the Greener Alternative. In volume III, appendix A, Table A.1–1 presents more detailed information on the NPDES outfalls for all four alternatives by facility (key and non-key), watershed, and location. The estimated total gallons discharged into all watersheds totals 275 million gallons (1,041 million liters) under the Greener Alternative. This is an increase from the index effluent volume of 233 million gallons (882 million liters).

NPDES outfall effluent quality during the period of the SWEIS (1997 through 2006) is expected to be the same under this alternative as described for the No Action Alternative, including the radionuclide concentrations in effluent from TA–50, as presented in Table 5.2.3–2. The canyons with increased NPDES outfall flows (Los Alamos and Sandia) are the same as the No Action and the Expanded Operations Alternatives. The increased flow volumes in these two canyons are the same as the Expanded Operations Alternative, and the potential impacts should be minimal for the same reasons as discussed in the No Action and the Expanded Operations Alternatives. For the Greener Alternative, there are no new activities that will result in changes to stormwater runoff.

5.5.3.2 *Alluvial Groundwater*

The NPDES outfall discharges are similar to those under Expanded Operations and are expected to result in similar alluvial groundwater volumes.

The projected discharge from the RLWTF into Mortandad Canyon under the Greener Alternative is 6.6 million gallons (25 million liters) per year, as compared to the RLWTF index volume of 5.5 millions gallons (21 million liters) per year.

The new HELWTF will result in improved water quality to Canyon de Valle as discussed under the No Action Alternative.

TABLE 5.5.3.1–1.—*NPDES Discharges by Watershed Under the Greener Alternative*[a]

WATERSHED	#OUTFALLS		DISCHARGES (MGY)					
			KEY FACILITIES		NON-KEY		TOTALS	
	INDEX	GREENER	INDEX	GREENER	INDEX	GREENER	INDEX	GREENER
Ancho	2	0	0.1	0.0	0.0	0.0	0.1	0.0
Cañada del Buey	3	3	0.0	0.0	6.4	6.4	6.4	6.4
Chaquehui	1	0	0.0	0.0	5.8	0.0	5.8	0.0
Guaje	7	7	0.0	0.0	0.7	0.7	0.7	0.7
Los Alamos	12	8	19.2	44.5	0.5	0.2	19.7	44.7
Mortandad	12	7	42.0	29.6	10.9	5.1	52.9	34.7
Pajarito	17	11	8.4	1.8	0.8	0.8	9.2	2.6
Pueblo	1	1	0.0	0.0	1.0	1.0	1.0	1.0
Sandia	11	8	4.4	42.8	103.5	127.9	107.9	170.7
Water	21	10	29.5	14.1	0.0	0.0	29.5	14.1
Totals	87	55	103.6	132.3	129.6	142.0	233.2	274.9

MGY: millions of gallons per year

[a] NPDES Information Sources: Index information was provided by the Surface Water Data Team Reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Outfall flow projections for the alternatives were based on the outfalls remaining as of November 1997. Additional outfalls may be eliminated in the future, as discussed in the *Environmental Assessment for Effluent Reduction* (DOE 1996e), as well as several other outfalls that may be closed as part of LANL's ongoing outfall reduction program.

5.5.3.3 *Perched Groundwater*

Groundwater flow and contaminant pathways to the intermediate perched groundwater bodies are not well characterized nor understood. It is possible that the increased NPDES discharges to Los Alamos and Sandia Canyons under this alternative could increase recharge of the intermediate perched groundwater and contaminant transport beneath these canyons.

5.5.3.4 *Main Aquifer*

Recharge mechanisms to the main aquifer are uncertain. However, for the same reasons as discussed under the No Action Alternative, impacts resulting from increased NPDES outfall flows under the Greener Alternative should be negligible.

A conservative projection of LANL water use under the Greener Alternative is 759 million gallons (2,873 million liters) per year. Los Alamos County and the NPS did not provide projections, but in 1994 the County used about 958 million gallons (3,626 million liters) from this water right and the NPS used about 5 million gallons (19 million liters). Based on this information, it is expected that the water requirements of this community can be met within the existing water rights from the main aquifer; however, projected use may approach 100 percent of the existing water rights to the main aquifer under this alternative.

For the purposes of modeling drawdown of the main aquifer, annual water use projections were made. The total water usage from DOE water rights was projected to average 1,670 million gallons (6,321 million liters) per year under the Greener Alternative, with a maximum annual use of 1,697 million gallons (6,423 million liters) and a minimum annual use of 1,611 million gallons (6,098 million liters).

The model results reflect water level changes at the top of the main aquifer across the alternatives, given continued draw from the aquifer by DOE, Española, and Santa Fe. Table 5.5.3.4–1 shows predicted water level changes at the surface of the main aquifer during the period from 1997 through 2006 for the Greener Alternative; as noted in section 5.2.3.1, these changes are not all due to LANL operations. Although the water use modeled includes water use in Española and Santa Fe, the differences between the alternatives are due only to LANL operations. The impacts to the volume of water in the main aquifer under this alternative are very similar to those described for the No Action Alternative; the drawdowns in DOE well fields are minimal relative to the total thickness of the main aquifer, and the volume of water to be used over the period from 1997 through 2006 is negligible relative to the volume of water in storage. Details of the conceptual model, assumptions, uncertainties and limitations, and input parameters for the groundwater model are described in volume III, appendix A.

TABLE 5.5.3.4–1.—*Maximum Water Level Changes at the Top of the Main Aquifer Under the Greener Alternative (1997 Through 2006)*

WATER LEVEL CHANGE IN FEET[a,b]	
AREA OF CONCERN ON SITE	
Pajarito Well Field	-14.5
Otowi Well Field (Well 0-4)	-14.2
AREA OF CONCERN OFF SITE	
DOE - Guaje Well Field	-9.0
Santa Fe Water Supply	
Buckman Well Field	+21.6
Santa Fe Well Field	-20.6
San Juan Chama Diversion	0.0
Springs	
White Rock Canyon Springs, Maximum Drop	0.0
White Rock Canyon Springs, Maximum Rise	+1.0
Other Springs (Sacred, Indian)	+3.8
San Ildefonso Pueblo Supply Wells	
West of Rio Grande	
Household, Community Wells	+0.6
Los Alamos Well Field	+3.8
East of Rio Grande	
Household, Community Wells	0.0

[a] Negative value (-) indicates water level drop; positive value (+) indicates water level rise.

[b] Also, the water level changes projected by the regional MODFLOW model represent average changes over a whole grid-cell (i.e., a square that is a mile on a side). They are, for the most part, not predictive of the water level changes at any single point within the cell (for example, a supply well). Pumping wells have characteristic "cones of depression" where the water surface reflects an inverted cone, and water levels at the well may be quite different from levels even a few ten's of feet away. Whether any individual well would exhibit water level changes consistent with the predicted grid-cell average change is a function of, for example, its location within the grid-cell; proximity to other pumped wells; and the individual well operation, construction, and hydraulics. Hence, the water level changes predicted by the model can only be considered qualitatively and cannot be considered as finite changes.

5.5.4 Air Quality

5.5.4.1 *Nonradiological Air Quality Impacts*

Criteria pollutant emissions under the Greener Alternative are less than those under the Expanded Operations Alternative. Because the bounding analysis of criteria pollutant emissions for all alternatives (based on the emissions under the Expanded Operations Alternative) results in estimated concentrations of each pollutant below the standards established to protect human health with an ample margin of safety, criteria pollutant emissions under the Greener Alternative would also be below these levels.

As discussed in section 5.1.4, the only toxic air emissions with the potential to impact human

health and the environment under any alternatives are those associated with HEFS operations and the additive emissions from all the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center. Under the Greener Alternative, such emissions are projected to be similar to those addressed in the No Action Alternative (section 5.1.4). Therefore, pollutants released from LANL operations under the Greener Alternative are not expected to cause air quality impacts that would affect human health and the environment.

5.5.4.2 *Radiological Air Quality Impacts*

This section addresses the radiation dose to the FS MEI, LANL MEI, and the population dose from LANL radionuclide air emissions under the Greener Alternative.

Facility-Specific Maximally Exposed Individual

Table 5.5.4.2–1 shows the FS MEI for each facility analyzed under the Greener Alternative. The highest MEI dose was 4.52 millirems per year, which is 45.2 percent of the regulatory limit for the air pathway. The EPA regulatory limit would not be exceeded from emissions of these facilities under the Greener Alternative.

TABLE 5.5.4.2–1.—*Facility-Specific Information—Greener Alternative*

FACILITY	DOSE[a] (MREM/YR)
TA–3–29 (CMR)	0.35
TA–3–66 (Sigma)	0.35
TA–3–102 (Shops)	0.28
TA–11 (High Explosive Testing)	0.31
TA–15/36 (Firing Sites)	2.17
TA–16 (Tritium Facility)	0.31
TA–18 (Pajarito Site)	1.93
TA–21 (Tritium Facility)	1.54
TA–48 (Radiochemistry Laboratory)	1.64
TA–55 (Plutonium Facility)	1.64
TA–53 (LANSCE)[b]	4.52
TA–54 (Boundary)[c]	0.79
TA–54 (White Rock)	0.45

[a] For each FS MEI, the total dose was calculated by adding the contributions from each modeled facility. An MEI does not leave or take protective measures.
[b] This is also the LANL MEI. Five specific sources were modeled from TA–53. These include the TA–53 ES–2, ES–3, IPF, LEDA and combined diffuse emissions.
[c] Two FS MEI locations were considered for TA–54 because Area G is bordering San Ildefonso Pueblo land. The first is a MEI location at the LANL boundary, 1,197 feet (365 meters) northeast of Area G. No person from the Pueblo currently is known to live along this boundary. The second is an actual MEI location in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

LANL Maximally Exposed Individual

The location of the LANL MEI (2,625 feet [approximately 800 meters] north-northeast of TA–53) was shown to be identical to the FS MEI with the highest dose under this alternative. The LANL MEI dose was calculated to be 4.52 millirems per year under the Greener Alternative.

Population Dose

The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated for emissions from all key facilities and found to be 13.79 person-rem per year. TA–15/36 account for 51.3 percent of this dose, and collectively, collective diffuse emissions, including those from these TAs, account for 52.1 percent of this dose. The values reported for population doses for this alternative, as well as the other alternatives, is higher than has been reported in the recent annual environmental reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. The material throughput at the different facilities under the various alternatives is presented in chapter 3, section 3.6.

Isodose Maps

The isodose maps for the 50-mile (80-kilometer) region are shown on the isodose maps in Figures 5.5.4.2–1 and 5.5.4.2–2.

5.5.5 Ecological Resources, Biodiversity, and Ecological Risk

Impacts to ecological resources and biodiversity resulting from the Greener Alternative would not vary appreciably from those of the No Action alternative. There would not be any incremental changes from the No Action level of ecological risk.

5.5.6 Human Health

The consequences of implementing the Greener Alternative on public health and worker health are presented below. As discussed in section 5.1.6, "risk," as used in the SWEIS human health analysis, refers to the probability of toxic or cancer mortality under the specific exposure scenarios analyzed.

5.5.6.1 *Public Health*

The consequences of continued operations of LANL on public health under the Greener Alternative are presented below for the same topics discussed in section 5.2.6.1.

Regional Consequences of Airborne Radioactivity Inhalation and Immersion

The LANL MEI was estimated to be 2,625 feet (approximately 800 meters) north-northeast of LANSCE (TA–53). This location is within the LANL reservation, and the dose at this location is estimated to be 4.5 millirem per year (section 5.5.4.2), corresponding to a 72-year lifetime dose of 320 millirem. This location borders the Los Alamos townsite and is a conservative estimate for an MEI from LANL emissions. The background (TEDE) dose in the Los Alamos area is estimated to be 360 millirem per year; thus, the dose is 1.3 percent of the background dose.

Table 5.5.6.1–1 summarizes the LANL MEI dose and presents the corresponding excess risk of excess LCF to the MEI. These risks are presented on a lifetime basis, assuming that the hypothetical LANL MEI received the estimated dose of 4.5 millirem each year for a 72-year life. The excess LCF risk was estimated to be 0.0002 over a lifetime.

The isodose maps showing both the estimated dose near LANL and within a 50-mile (80-kilometer) radius of LANL are given in Figures 5.5.4.2–1 and 5.5.4.2–2. The population dose within the 50-mile (80-kilometer) radius is also given in Table 5.5.6.1–1, estimated to be 13.8 person-rem per year. As reflected in the table, the annual operations excess LCF risk was estimated to be 0.0069.

In the Greener Alternative, there are six facilities with FS MEIs receiving a dose that would exceed 1 millirem per year (volume III, appendix B):

- LANSCE, 4.52 millirem per year to the facility MEI
- HE Testing Sites (TA–15 and TA–36), 2.17 millirem
- Pajarito Site (TA–18), 1.93 millirem
- Radiochemistry Laboratory (TA–48), 1.64 millirem
- Plutonium Facility, 1.64 millirem
- TSTA and TSFF (TA–21), 1.54 millirem

External Radiation: Two Special Cases

As discussed in section 5.2.6.1, one contribution to public dose results from jogging or hiking the access road north of TA–21 and is attributable to cesium-137 known to be on the ground within the TA. The MEI dose is not expected to change

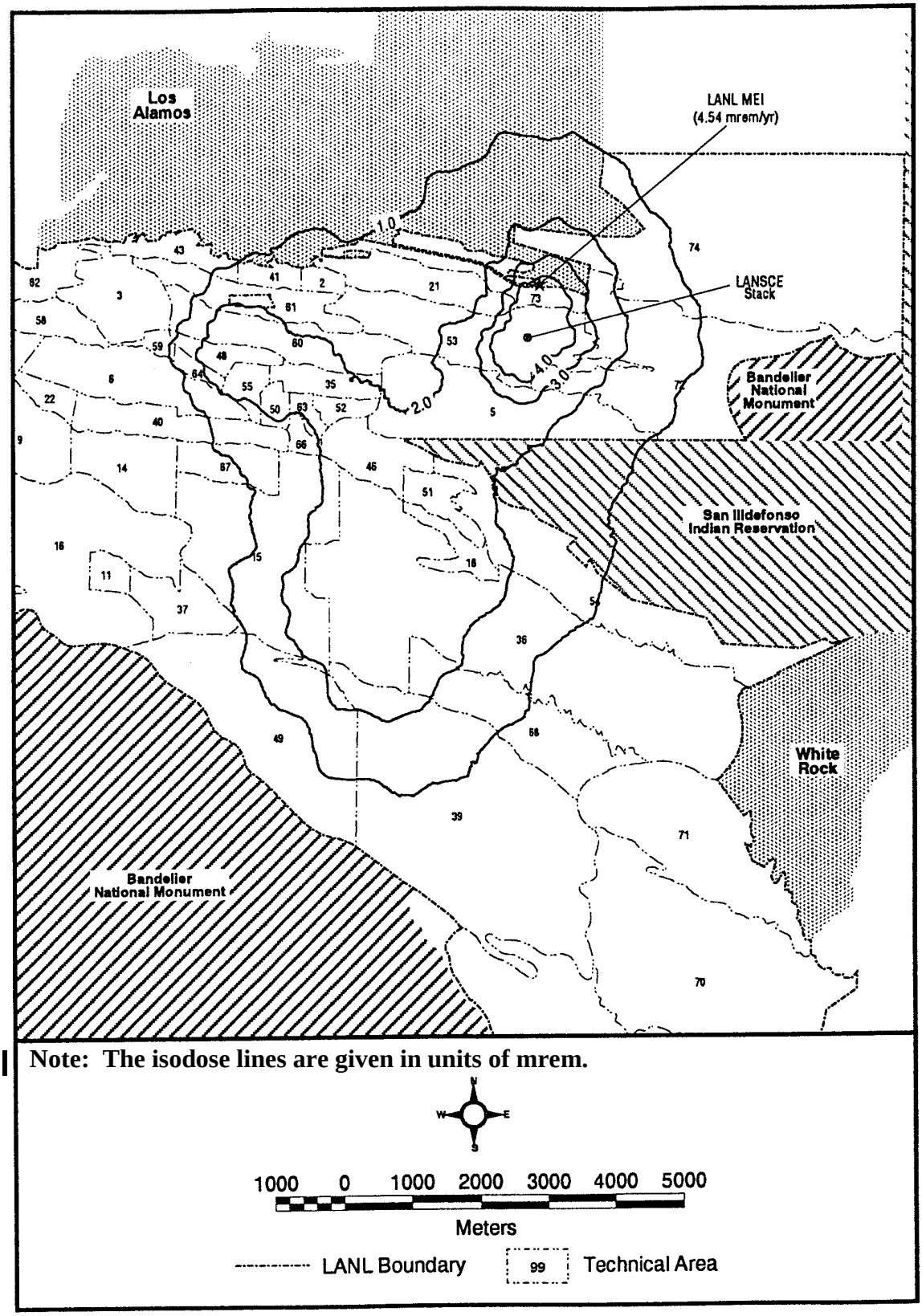

FIGURE 5.5.4.2–1.—*Isodose Map Showing Doses Greater Than 1 Millirem per Year for the Greener Alternative.*

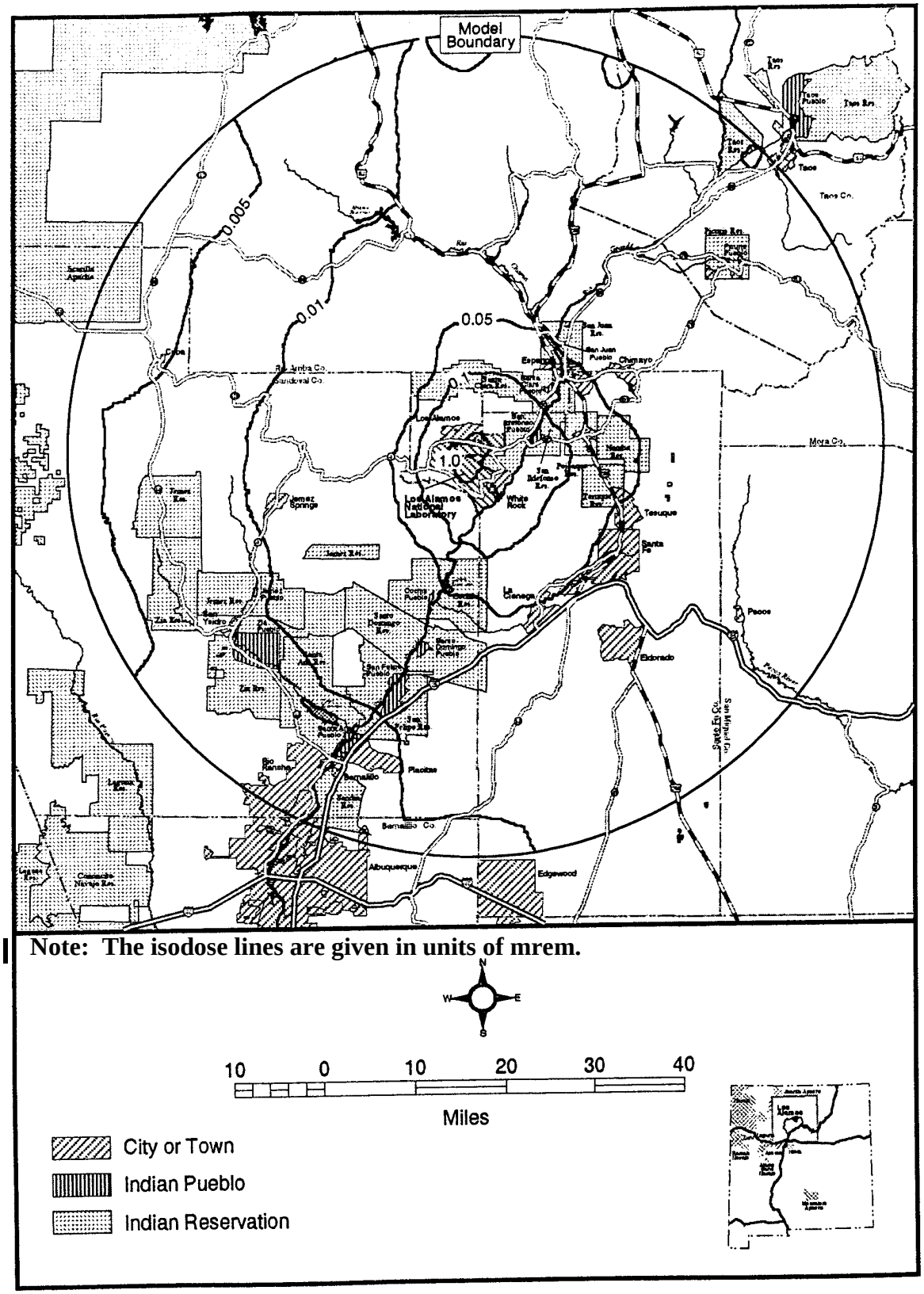

FIGURE 5.5.4.2–2.—*Isodose Map Showing Doses Less Than 1 Millirem per Year for the Greener Alternative.*

TABLE 5.5.6.1–1.—*Estimated Public Health Consequences for LANL MEI and the Population Within 50-Mile (80-Kilometer) Radius of LANL for the Greener Alternative*

PARAMETER	LANL HYPOTHETICAL MEI	50-MILE (80-KILOMETER) RADIUS POPULATION
Dose (Committed Effective Dose Equivalent)	4.52 millirem/year	13.79 person-rem/year
Excess LCF	0.0002/lifetime (72 year)	0.0069/year of operations

under the Greener Alternative from that estimated under the No Action Alternative (an EDE of 2.9 millirem per year and a lifetime excess LCF risk of about 1 x 10^{-6} per year of operation).

The other contribution to public dose, as discussed in section 5.2.6.1, would result from TA–18 "road-open" operations. At the 95 percent confidence level, four exposures per year would be expected for the MEI out of the 100 operations per year at TA–18 under the Greener Alternative (the same as for the No Action Alternative). This would result in an annual projected MEI EDE dose of 19 millirem per year. The lifetime excess LCF risk for this dose is about 9.5 x 10^{-6} per year of operation.

Nonionizing Radiation

The only uncontained nonionizing radiation source in use or planned for LANL is the microwave transmitter in TA–49. The consequence of a public exposure to this source under the Greener Alternative is the same as for the No Action Alternative; as discussed in section 5.2.6.1, this consequence is negligible.

Consequences of Airborne Chemical Emissions

For the Greener Alternative, these consequences are the same as those under the No Action Alternative; the worst case HI for lead did not exceed one in a million (10^{-6}); for DU, the worst case HI did not exceed 1 in 100,000 (0.00010); and the excess LCF for beryllium (evaluated as a carcinogen) under the Greener Alternative was estimated to be less than 3.6 x 10^{-7} per year. These analyses are presented in detail in volume III, appendix D.

Consequences of Ingestion and Dermal Exposures to Residents, Recreational Users, and Special Pathways Receptors

The risk to the public from ingestion under the Greener Alternative does not differ from that associated with the No Action Alternative; this is because most of the risk is attributable to the existing levels of contamination in water and soils in the area. This is discussed further in section 5.2.6.1. Table 5.2.6.1–2 summarizes the ingestion radiological annual dose and excess LCF per year to the MEIs. Tables 5.2.6.1–2 and 5.2.6.1–3 summarize the total radiological annual ingestion dose and excess LCF to members of the public. Per Table 5.2.6.1–3, the total worst-case ingestion doses for the off-site resident of Los Alamos County and non-Los Alamos County resident are 0.011 and 0.017 rem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose ranges up to 0.001 rem per year, according to the amount of time spent in the canyons (see footnote b in Table 5.2.6.1–3). If the individual has traditional Native American or Hispanic lifestyles, the values found in the final columns of the table should be used in place of the values in the first columns for off-site residents. Per the values in the final columns, these "special pathways receptors" can have worst-case 3.1 millirem per year additional dose. The associated excess LCF risks for the off-site

residents are 8.6 x 10^{-6} per year of exposure and 9.1 x 10^{-7} per year of exposure for the individual who is also an avid recreational user. These worst-case doses are for a 95th percentile intake of the 95th percentile contamination level, referred to as the UCL. Ingestion pathway calculations included all radionuclides detected in the media. This includes natural background, weapons testing fallout, and previous releases. The actual contribution from continued operations at LANL is only a small fraction of this value. These values apply to the baseline and to all four alternatives. The data and analyses for these calculations are in appendix D, section 3.3. Table 5.2.6.1–3 summarizes the risk associated with metals ingestion to MEIs in the LANL region.

Consequences to the Public along Transportation Routes

Section 5.5.10 details the analysis of transportation consequences. Public health consequences include the dose and excess LCF risk associated with routine, accident-free, transportation. Table 5.5.10–2 shows the population dose and excess LCF for normal (accident-free) off-site shipments. The population dose and excess LCF that are associated with exposures occurring during stops for transportation segments near LANL are provided in Table 5.5.6.1–2. Doses associated with living along route and sharing routes with these shipments are detailed in Table 5.5.10–2, and are less than those associated with stops. Risks associated with accidents during transportation also are discussed in section 5.5.10.

TABLE 5.5.6.1–2.—*Radiation Doses and Excess LCF Risks Estimated to the Public at Stops During Transportation of Materials and Wastes from LANL*

ROUTE SEGMENT	PERSON-REM PER YEAR (AT STOPS)	EXCESS LCF RISK PER YEAR
LANL to U.S. 84/285	3.6	0.0018
U.S. 84/285	3.8	0.0019

5.5.6.2 *Worker Health*

Worker risks associated with continued operations of LANL include radiological (ionizing and nonionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the Greener Alternative are given below and detailed in volume III, appendix D, section D.2.2.

Radiological Consequences

Ionizing Radiation Consequences. Table 5.5.6.2–1 summarizes the projected doses and associated excess LCF risks from implementation of the Greener Alternative.

The collective worker dose under the Greener Alternative is conservatively projected to be approximately 2.3 times that measured in 1993 to 1995. In terms of the average non-zero dose, the Greener Alternative is expected to result in

TABLE 5.5.6.2–1.—*Annual Worker Doses and Associated Lifetime Excess LCF Risks Under the Greener Alternative*

LANL Collective Worker Dose (person-rem/year)	472
Estimated Excess LCF Risk (across the worker population) per year of operation	0.19
Average Non-Zero Worker Dose (rem/year)	0.14
Estimated Excess LCF Risk (average worker > 0 dose)	0.000056

0.14 rem per year for Greener, compared with 0.097 rem per year, 1993 to 1995. The estimated lifetime excess LCF risk is 0.000056 per year of operation.

Nonionizing Radiation. It is expected that there will continue to be negligible effects to LANL worker health from nonionizing radiation sources including ultraviolet sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves (including the large station at TA–49). (Also see volume III, appendix D, section D.2.2.2 for evaluation used to estimate nonionizing radiation from LANL operations to humans and wildlife and for the estimated results.)

Carcinogenic Risk from Air Emissions

The screening process described in appendix B identified no individual carcinogenic chemical air emission that required analysis for public health consequences. For carcinogens, an estimate also was made of the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs (appendix B, attachment 6).

This incremental combined cancer risk is less than 1 in 1 million for the Greener Alternative because the projected emissions for this alternative are less than for the Expanded Operations Alternative (which was slightly above the screening guideline value of 1×10^{-6}). It is believed that negligible increase in incremental combined cancer risk will result from the Greener Alternative.

Chemical Exposure Consequences

It is anticipated that there will continue to be a few chemical exposures annually, particularly exposures to:

- Airborne asbestos
- Lead paint particulates
- Crystalline silica
- Fuming perchloric acid, hydrofluoric acid
- Skin contact with acids or alkalis

Under the Greener Alternative, it is expected that there will be a worker population of approximately 10,000 individuals, approximately 10 percent higher than the index period employment levels. For the purposes of the SWEIS, it is assumed that there is negligible additional benefit of the Chemical Hygiene Program at LANL over the period analyzed, and that the rate of chemical exposures continues at the index period rates. Therefore, it is expected that reportable chemical exposures would not change appreciably from the index period, approximately one to three reportable chemical exposures per year.

Beryllium Processing Consequences. It is anticipated that beryllium operations in the Reduced Operations Alternative would be the same as in the No Action Alternative. It is not anticipated that consequences to workers would be measurable; that is, no sensitization to beryllium would be detected using the LANL IH monitoring program.

Physical Safety Hazards

Table 5.5.6.2–2 compares the projected reportable cases of accidents and injuries estimated for normal operations occurring under the Greener Alternative and that experienced during the index period. The Greener Alternative is expected to result in a slight increase in reportable cases due to increases in worker population. These accidents and injuries are considered as consequences of normal operations because of their frequency. These results assume that the aggressive Health and Safety Program underway at LANL does not achieve any additional reduction in reportable cases.

The consequences of these accidents and injuries are expected to be similar to those experienced in the past, and typically are those

TABLE 5.5.6.2–2.—*Projected Reportable Annual Accidents and Injuries for the Greener Alternative Compared with the Index Period*

PARAMETER ESTIMATED	PARAMETER VALUE AND UNITS
Projected Worker Population	Approximately 10,000
Projected Reportable Accidents and Injuries	460/year
Change from Index (1993 to 1996)	+ 10%

associated with health response and recovery from acute trauma. Therefore, the consequences include physical pain and therapy/treatment for recovery such as those associated with bone setting, shoulder dislocation reset and subsequent physical therapy. Some injuries also may result in continuing consequences to the worker that could affect productivity or lifestyle, such as motor skill loss due to nerve damage or cardiovascular debilitation resulting from electrical shock or electrocution.

5.5.7 Environmental Justice

As indicated in sections 5.5.1 and 5.5.2, no substantive adverse impacts to land resources or geology and soils are anticipated for the continued operation of LANL under the Greener Alternative. Thus, no disproportionately high and adverse impacts to minority or low-income communities are anticipated for these impact areas. The potential impacts to surface and groundwater and ecological resources associated with the Greener Alternative would affect all communities in the area equally (see sections 5.5.3 and 5.5.5 for additional information on the potential for impacts to these resources). Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated to be associated with these resource areas.

Figure 5.5.7–1 reflects the dose from radiological air emissions within 50 miles (80 kilometers) of LANL under the Greener Alternative. As discussed in section 5.2.7, impacts due to air emissions are equal to or lower in the sectors with substantial minority and/or low-income populations than they are in sectors 1–3 and 6–16, and such impacts are not disproportionately high or adverse with respect to the minority or low-income populations (see section 5.5.4 regarding the impacts anticipated for air emissions under the Expanded Operations Alternative).

The air pathway is one example of the analysis of potential human health impacts. As presented in section 5.5.6, there is minimal potential for LANL operations to adversely affect human health for off-site residents or recreational users in the area around LANL under the Greener Alternative. Similarly, the special pathways have little potential to impact human health under this Alternative. Thus, the Greener Alternative would not present disproportionately high or adverse impacts to human health in minority or low-income communities (section 5.4.6.1).

As shown in section 5.5.10, impacts from on-site transportation and from LANL to U.S. 84/285 are estimated to be 0.0018 excess LCFs per year from incident-free transportation and 0.040 deaths or injuries per year from transportation accidents. Impacts from transportation on route segments that pass through minority or low-income communities (particularly the segment from U.S. 84/285 to I–25) are estimated to be 0.0019 excess LCFs per year from incident-free transportation and 0.091 deaths or injuries per year from transportation accidents. Therefore, no high and adverse impact is expected to either a member of the general public or to a member of a minority or low-income population due to

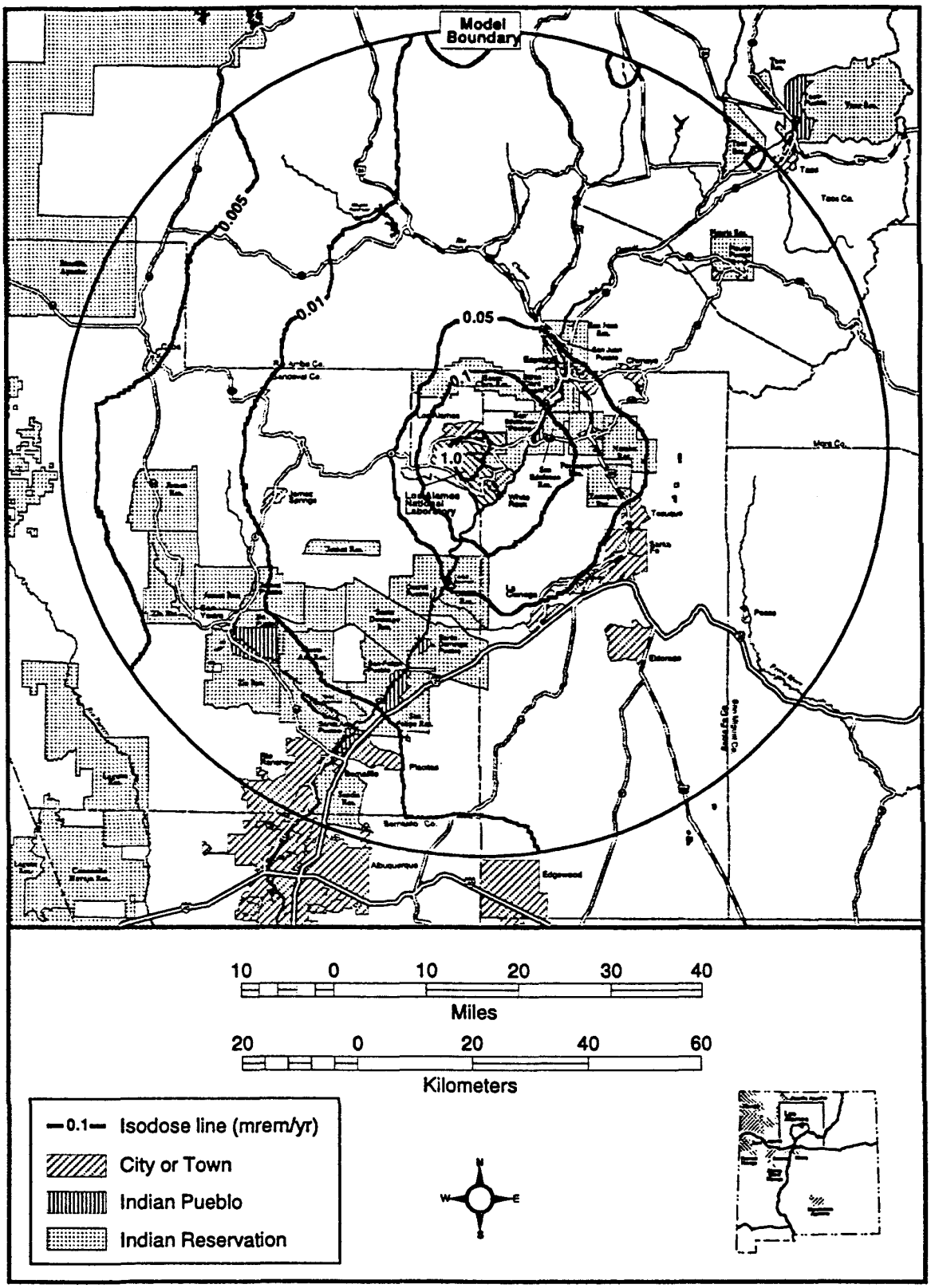

FIGURE 5.5.7–1.—***Isodose Lines from Airborne Releases for the Greener Alternative Within 50 Miles (80 Kilometers) of LANL.***

transportation in the vicinity of LANL transportation routes.

5.5.8 Cultural Resources

Construction activities and explosive test activities under this alternative are essentially the same as those under the No Action alternative. Because these are the activities with the most potential for impacts to cultural resources, impacts to prehistoric resources, historic resources, and TCPs under the Greener Alternative would be similar to those stated for the No Action Alternative in section 5.2.8. Management and protection of prehistoric and historic resources also would be similar to that of the No Action Alternative.

Spiritual Entities

As with the No Action Alternative, no assessment of impacts to "unseen" or "spiritual" entities was attempted.

5.5.9 Socioeconomics, Infrastructure, and Waste Management

This section describes the social, economic, and infrastructure impacts of activities at LANL under the Greener Alternative.

5.5.9.1 *Socioeconomic Impacts*

Employment, Salaries, and Population

The primary (direct) impacts of this type are presented in Table 5.5.9.1–1 for the LANL workforce only. The secondary (indirect) impacts and the total population changes projected are presented in Table 5.5.9.1–2 for the Tri-County area. These changes are assumed to occur within a year of the ROD for the SWEIS.

Housing

The population changes anticipated in the Tri-County area, based on the total employment changes described above, are projected to result in 551 additional (new) demand for housing units. The distribution of this demand in the three counties is projected to be: 130 additional units in Los Alamos County, 197 additional units in Rio Arriba County, and 224 additional units in Santa Fe County.

In Los Alamos County, the projected housing demand can be accommodated from absorption of apartment vacancies and the inventory of houses for sale and new construction. Beyond 130 units, no new housing units can be anticipated because of the absence of buildable land in private ownership. This constraint upon supply would be expected to exert an upward pressure on rents and house prices.

The projected housing demand in Rio Arriba and Santa Fe counties can be accommodated without significant pressure on rents and house sales prices. Both counties possess a sufficient inventory of finished lots and parcels, have access to adequate mortgage capital, and have sufficient entrepreneurial developer talent to absorb the demand.

Construction

Table 5.5.9.1–3 contains the results of the analysis of construction spending, labor salaries, and labor employment for the period fiscal year 1997 through fiscal year 2006. Construction activities associated with this alternative are expected to draw workers already present in the Tri-County area who historically have worked from job to job in the region. Thus, this employment is not expected to influence socioeconomic factors such as local government finance.

Under this alternative, the Tri-County annual gross receipts tax yields would be expected to increase by $1.1 million. This increase would

TABLE 5.5.9.1–1.—*Summary of Primary LANL Employment, Salaries[a], and Procurement Under the Greener Alternative[b]*

	LOS ALAMOS COUNTY	RIO ARRIBA COUNTY	SANTA FE COUNTY	TRI-COUNTY TOTAL	OTHER NEW MEXICO COUNTIES	NEW MEXICO TOTAL	OUTSIDE NEW MEXICO	TOTAL
Employees	4,995	2,082	2,032	9,109	661	9,770	198	9,968
Difference[c]	160	163	195	518	53	571	22	593 (+6%)
Salaries ($M)	264.4	51.5	85.5	401.4	19	420.4	10.3	430.7
Difference[c]	9.8	6.5	11.2	27.5	2.7	30.1	1.6	31.8 (+8%)
Procurement ($M)	217.3	1.8	21	240.1	124.2	364.3	237.5	601.8
Difference[c]	1.6	0.1	0.3	2.1	1.8	3.8	5.9	9.7 (+2%)

[a] Salaries are for UC employees only; subcontractor salaries (Johnson Controls, Inc.; Protection Technology of Los Alamos, etc.) are included in the procurement dollars.
[b] Reflects projected locations of employee residences and LANL procurement activities.
[c] Difference is as compared to baseline (fiscal year 1996). Percent difference is shown in parentheses in the far right (TOTAL) column.

TABLE 5.5.9.1–2.—*Summary of Total Tri-County Employment, Salaries, Business Activity, and Population Changes Under the Greener Alternative*

	PRIMARY CHANGE	SECONDARY CHANGE	TOTAL TRI-COUNTY CHANGE	TRI-COUNTY PRIMARY WORKER CHANGE[a]	TRI-COUNTY SECONDARY WORKER CHANGE[b]	TOTAL TRI-COUNTY WORKER CHANGE	TOTAL TRI-COUNTY POPULATION CHANGE[c]
Employment/ Population	518	886	1,404	414	266	680	1,316 (+1%)
Personal Incomes	$28 million	$27 million	$55 million (+ < 1%)				
Annual Business Activity	$2 million	$4 million	$6 million (+ < 1%)				

Note: Percentages in parentheses are the percentage change that the number represents. These are provided for total population change, total personal income change, and total business activity change.
[a] This is the number of direct workers moving to the Tri-County area, assuming that 80 percent of new LANL employees are from outside this area.
[b] This is the number of secondary workers moving to the Tri-County area, assuming that 30 percent of secondary employment is from outside this area.
[c] This is the total population increase in the Tri-County area, assuming that, on average, each worker moving to the area increases the population by 1.935.

TABLE 5.5.9.1–3.—*Construction Spending, Labor Salaries, and Labor Employment Numbers Under the Greener Alternative (Fiscal Year 1997 Through 2006)*

YEAR	CONTRACT ($M)	LABOR ($M)	EMPLOYEES
1997	63	15	432
1998	187	45	1,282
1999	208	50	1,426
2000	219	53	1,502
2001	210	50	1,440
2002	120	29	823
2003	91	22	624
2004	90	22	617
2005	109	26	747
2006	108	26	741

$M = dollars given in millions
Source: (DOC 1996, PC 1997a, and PC 1997b)

be matched by increases in service levels adequate to meet public demand.

Services

Annual school enrollment in the Tri-County area would increase by 224 students. Additional annual funding assistance of about $898,000 from the State of New Mexico would be required for school operations because of these enrollment increases.

In Los Alamos, the school district can absorb the anticipated new enrollment levels. This school district has excess capacity because of its discretionary policy of accepting out-of-district students who are the children of LANL employees and subcontractors. In Rio Arriba County and the cities of Española and Santa Fe, adequate classroom capacity exists because of recent school construction projects.

The demands for police, fire, and other municipal services would be expected to increase in proportion to the increase in gross receipts tax yields, as discussed above. However, any changes in local government services tend to be inelastic in the short term and typically are responsive only after the completion of at least one full budget cycle.

5.5.9.2 *Infrastructure Impacts*

Annual electricity use projected under the Greener Alternative is a total of 782 gigawatt-hours, 437 gigawatt-hours for LANSCE, and 345 gigawatt-hours for the rest of LANL. The peak electrical demand is projected to be 113 megawatts, 63 megawatts for LANSCE and 50 megawatts for the rest of LANL[1]. The existing supply of electricity to the Los Alamos area is not sufficient year-round to meet the projected electrical peak demand for LANL operations under this alternative; thus, periods of brown-outs are anticipated unless measures are taken to increase the supply of electricity to the area. (In chapter 1, sections 1.6.3.1 and 4.9.2 discuss ongoing efforts to increase electrical power supply to this area.) This situation is exacerbated by the additional electrical demand for BNM, and the communities of Los Alamos and White Rock. (While these organizations did not provide use projections, their historical usage is reflected in chapter 4, section 4.9.2.)

Natural gas use is projected to be 1.84 x 10^6 decatherms annually, the same as projected under the No Action Alternative. Although electrical demand may increase natural gas demand for the generation of electricity at TA–3, demand should continue to be dominated by heating requirements and is not expected to exceed this projection.

Water use projected under the Greener Alternative is a total of 759 million gallons

1. These values include the proposed SCC Project annual electricity and peak electrical demand for a 50-TeraOp operation and are reflected in all the alternatives. The SCC project was as an interim action to the SWEIS.

(2,873 million liters) per year, 265 million gallons (1,003 million liters) per year for LANSCE and 494 million gallons (1,869 million liters) per year for the rest of LANL. This is well within DOE water rights, about 1,806 million gallons (6,836 million liters) per year; however, this water right also provides for water used by Los Alamos County and BNM. Based on existing information regarding non-LANL water use, the water demands of this community can be met within the existing water rights (water demand is also discussed in section 5.5.3). The peak water requirements are the same as identified under the No Action Alternative.

5.5.9.3 *Waste Management*

The annual and 10-year total generation projections for radioactive and hazardous waste are reflected in Table 5.5.9.3–1. Radioactive liquid is not projected by facility because measurements of individual contributions are not made for all facilities. The total amount of radioactive liquid waste projected for receipt at TA–50 is 66 million gallons (250 million liters) over 10 years (or an average of 6.6 million gallons [25 million liters] per year) for this alternative. These projections include waste from key facilities, all other LANL facilities, waste management facilities, the ER Project, and construction activities.

The waste volumes generated under this alternative are very similar to those under the No Action Alternative; TRU and mixed TRU wastes under this alternative are lower (due to the reduced weapon-related activities), while the other categories are slightly higher (due to the increased nonweapons work). As with the No Action Alternative, much of LANL's LLW, TRU, and chemical waste would be treated and packaged to meet WAC and shipped off the site for disposal; nondefense TRU waste from other sites would be stored at LANL pending the development of disposal options. Off-site disposal capabilities are much greater than the waste volumes generated at LANL.

5.5.9.4 *Contaminated Space*

The activities reflected in the Greener Alternative are projected to increase the total contaminated space at LANL by 63,000 square feet (5,853 square meters) over the next 10 years (the same as for the No Action Alternative), as compared to the baseline established for the SWEIS as of May 1996 (chapter 4, section 4.9). The majority of this increase is due to implementation of actions that have already been reviewed under NEPA, but which had not been implemented at the time the baseline was established (the same ones discussed in the No Action Alternative).

5.5.10 Transportation

5.5.10.1 *Vehicle-Related Risks*

The transportation impacts projected for the Greener Alternative are summarized in this section. As with the Reduced Operations Alternative, most of the LLW generated is shipped off the site for disposal under the Greener Alternative. While most other shipments are similar to those under the No Action Alternative, these LLW shipments increase the total number of shipments and total shipment miles enough that the transportation impacts under the Greener Alternative approach (but are less than) those of Expanded Operations for off-site radioactive material shipments. More detailed information regarding these impacts is included in volume III, appendix F.

Truck Emissions in Urban Areas

For the Greener Alternative, the projected risk is 0.036 excess LCF per year. Use of the Santa Fe Relief Route would have a very small effect on this risk (it would change to 0.035 excess LCF per year). The only difference is that the Santa Fe Relief Route would have 1.2 miles (1.93 kilometers) less of urban highway mileage. Approximately 65 percent of the excess LCFs are due to radioactive material

TABLE 5.5.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Greener Alternative*[a]

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR
Plutonium Facility Complex	TA–55	5,250	52,500	688	6,880	12	120	127	1,270	35	350
Tritium Facilities[c]	TA–16 & TA–21	1,300	13,000	450	4,500	2	20	NA	NA	NA	NA
CMR Building[d]	TA–3	8,270	82,700	1,410	14,100	16.5	165	19.5	195	8.7	87
Pajarito Site	TA–18	4,000	40,000	145	1,450	1.5	15	NA	NA	NA	NA
Sigma Complex	TA–3	5,500	55,000	420	4,200	2	20	NA	NA	NA	NA
Materials Science Laboratory	TA–3	600	6,000	0	0	0	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	3,800	38,000	10	100	0.4	4	NA	NA	NA	NA
Machine Shops	TA–3	142,000	1.42×10^6	280	2,800	0	0	NA	NA	NA	NA
HE Processing Facilities	TA–8, 9, 11, 16, 28 & 37	7,000	70,000	8	80	0.2	2	NA	NA	NA	NA
HE Testing Facilities	TA–14, 15, 36, 39, 40	25,200	252,000	300	3,000	0.3	3	0.2	2	NA	NA
Los Alamos Neutron Science Center[e]	TA–53	16,600	166,600	1,085	10,850	1	10	NA	NA	NA	NA
Health Research Laboratory[f]	TA–43	13,280	132,800	34	340	3.4	34	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	2,900	29,000	240	2,400	3.4	34	NA	NA	NA	NA
Radioactive Liquid Waste Treatment Facility[g]	TA–50 & TA–21	2,200	22,000	150	1,500	0	0	21	210	0	0
Waste Treatment, Storage, and Disposal Facilities[g]	TA–54	920	9,200	174	1,740	4.0	40	27	270	0	0
Non-Key Facilities		651,000	6.51×10^6	520	5,200	30	300	0	0	0	0
Environmental Restoration Project[h]		2×10^6	2×10^7	4,257	42,570	548	5,480	11	110	0	0
Grand Total[i]		2.89×10^6	2.89×10^7	10,200	102,000	625	6,250	206	2,060	44	440

TABLE 5.5.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Greener Alternative*[a]-Continued

NA indicates that this facility does not routinely generate these types of waste.

[a] Radioactive liquid waste generation is not projected by facility (see text in section 5.5.9.3, Radioactive and Hazardous Waste Generation).

[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under *Toxic Substance Control Act*. This category also includes biomedical waste.

[c] These projections include 141,000 cubic feet (4,000 cubic meters) of LLW due to backlogged waste.

[d] These LLW projections include 141,000 cubic feet (4,000 cubic meters) of LLW generation anticipated due to the CMR Building Upgrades, Phase II.

[e] These projections include 228,000 cubic feet (6,450 cubic meters) of LLW due to the construction of the new Long-Pulse Spallation Source Facility and 86,000 cubic feet (2,450 cubic meters) of LLW due to upgrades to Areas A5 and A6, as well as reduced operational waste generation during these construction activities.

[f] These projections include 22,000 pounds (10,000 kilograms) of chemical waste, 550 pounds (250 kilograms) of biomedical waste (a special form of chemical waste), 1,560 cubic feet (44 cubic meters) of LLW, and 850 cubic feet (24 cubic meters) of LLMW associated with ongoing efforts to remove obsolete and contaminated equipment.

[g] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities.

[h] The ER Project is projected to generate 390 cubic feet (11 cubic meters) per year of TRU and mixed TRU waste together. All of this waste is presented under the TRU waste columns.

[i] Grand totals have been rounded.

shipments and 35 percent are due to hazardous chemical shipments. All shipments are conservatively assumed to result in an empty truck making the return trip. This is appropriate for WIPP and LLW shipments and for many SST shipments; however, most shipments are in general commerce and would not include the return of an empty truck.

Truck Accident Injuries and Fatalities

The impacts projected for the Greener Alternative are presented in Table 5.5.10.1–1 (additional information is provided in volume III, appendix F, section F.6.3). Use of the Santa Fe Relief Route would reduce the risks of accidents, injuries, and fatalities by almost one-half of those indicated for the segment from U.S. 84/285 to I–25 due to the assumption that the accident rate on the Santa Fe Relief Route would be much lower than for the route through Santa Fe. Use of the Santa Fe Relief Route would not substantially change the risks of accidents, injuries, and fatalities on the remainder of New Mexico segment, as compared to the risks reflected for this segment in Table 5.5.10.1–1. Approximately 65 percent of the impacts are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. Again, all shipments are assumed to result in a return by an empty truck.

5.5.10.2 *Cargo-Related Risks*

Incident-Free Radiation Exposure

The incident-free radiation exposure impacts projected for the off-site shipments under the Greener Alternative are presented in Table 5.5.10.2–1; as noted in section 5.2.10.2, the total is the dose throughout the U.S. and is dominated by the segments outside of New Mexico. The aircraft segment is for overnight carrier service; the truck segment to and from the airport is included in the truck results. In general, use of the Santa Fe Relief Route would result in only small changes in this type of impact. Truck crew doses and nonoccupational doses for people at rest stops would increase due to the increased length of the Santa Fe Relief Route for north-bound shipments carrying the radioactive material. Nonoccupational doses for people sharing the road would decrease due to the lower traffic density projected for the relief route. The MEI dose occurs between LANL and I–25 and is 0.00034 rem.

Driver Doses from On-Site Shipments of Radioactive Materials

The projected collective radiation dose for on-site shipments of radioactive materials is 4.5 person-rem. This collective dose would be expected to result in 0.00181 excess LCFs among these drivers.

The average individual driver dose is projected to be 0.189 rem, which is well below the DOE radiation protection limit of 5 rem per year.

Transportation Accidents

The following discussion addresses the potential impacts of accidents leading to the release of either radioactive or hazardous material being transported in support of LANL operations under the Greener Alternative. Results are given for both off-site and on-site shipments.

Off-Site Radioactive Materials Shipments. The MEI doses calculated with RADTRAN do not vary by alternative and are given in Table 5.2.10.2–2. The population dose and corresponding excess LCF per year for these shipments are presented in Table 5.5.10.2–2 for these accidents. ADROIT results that are separated into frequency and consequence components are not readily available. The product, MEI dose risk, can be presented in terms of excess LCF per year; for the Greener Alternative, the MEI dose risk due to plutonium-238 oxide and due to pit shipments were each less than 1×10^{-10} excess LCF per year.

TABLE 5.5.10.1–1.—*Truck Accident Injuries and Fatalities Projected for LANL Shipments Under the Greener Alternative*

ROUTE SEGMENT	NUMBER OF ACCIDENTS PER YEAR	NUMBER OF INJURIES PER YEAR	NUMBER OF FATALITIES PER YEAR
On-Site	0.015	0.0031	0.00015
LANL to U.S. 84/285	0.17	0.035	0.0019
U.S. 84/285 to I–25	0.41	0.086	0.0046
Remainder of New Mexico	0.67	0.64	0.08
Outside New Mexico	3.2	3.0	0.35
Total	4.5	3.8	0.44

TABLE 5.5.10.2–1.—*Incident-Free Population Dose and Lifetime Excess LCFs for Off-Site Shipments per Year of Operation Under the Greener Alternative*

ROUTE SEGMENT	TRUCK OR AIR CREW		NONOCCUPATIONAL					
			ALONG ROUTE		SHARING ROUTE		STOPS	
	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year
LANL to U.S. 84/285	6.8	0.0027	0.036	0.000018	0.59	0.0003	3.6	0.0018
U.S. 84/285 to I–25	9.2	0.0037	0.44	0.00022	4.2	0.0021	3.8	0.0019
Remainder of New Mexico	52	0.021	0.13	0.000065	2.0	0.001	28	0.014
Outside New Mexico	460	0.18	3.0	0.0015	26	0.013	210	0.1
Aircraft	2.4	0.0012	NA	NA	NA	NA	NA	NA
TOTAL	530	0.21	3.6	0.0018	33	0.015	250	0.12

NA = Not applicable

TABLE 5.5.10.2–2.—*Bounding Radioactive Materials Off-Site Accident Population Risk for the Greener Alternative*

ROUTE SEGMENT	ANNUAL POPULATION DOSE RISK AND EXCESS LCF RISK						
	SHIPMENT TYPE						
	AMERICIUM-241	CH TRU	RH TRU	PLUTONIUM-238	PITS	TOTAL	
	person-rem/ year	person-rem/year	person-rem/year	person-rem/ year	person-rem/year	person-rem/year	excess LCF/ year
LANL to U.S. 84/285	0.016	0.0015	3.2×10^{-6}	4×10^{-7}	2×10^{-6}	0.018	9.0×10^{-6}
U.S. 84/285 to I–25	0.25	0.02	0.000044	1×10^{-6}	8×10^{-6}	0.27	0.00014
Remainder of New Mexico	0.033	0.013	0.000027	4×10^{-7}	4×10^{-6}	0.046	0.000023
Rest of U.S.	2.7	NA	NA	4×10^{-6}	0.00001	2.7	0.0014

NA = Not available; CH TRU = contact-handled TRU waste; RH TRU = remote-handled TRU waste

The use of the Santa Fe Relief Route would reduce the projected population dose (and therefore, the excess LCFs per year) by about one-third for the U.S. 84/285 to I–25 segment, as compared to use of the route through Santa Fe. This difference is primarily due to the difference in population density along these routes. (The lower traffic density along the relief route is also a factor.) The use of the Santa Fe Relief Route would increase the projected population dose (and therefore the excess LCFs per year) for the remainder of New Mexico segment to about double that identified if the route through Santa Fe is used. This difference is due to the increase (6 miles [9.65 kilometers] more) in the distance traveled on I–25 for north-bound shipments.

On-Site Radioactive Materials Shipments. The MEI doses, frequencies, and MEI risks due to the bounding on-site shipments involving radioactive materials are given in Table 5.5.10.2–3. As noted in section 5.2.10.2, the frequency of the bounding DARHT and PHERMEX shipments has been added to the frequency of irradiated target shipments.

Hazardous Materials Shipments. The bounding hazardous materials shipments for accident analyses are major chlorine shipments (toxic), major propane shipments (flammable), and major explosive shipments. The consequences of an accident involving a major explosive shipment is bounded by the consequences of an accident involving a major propane shipment, so the frequency of

TABLE 5.5.10.2–3.—*MEI Doses and Frequencies for Bounding On-Site Radioactive Materials Accidents Under the Greener Alternative*

SHIPMENT TYPE	EVENT FREQUENCY PER YEAR	MEI DOSE	MEI RISK
Plutonium-238 Solution	8.8×10^{-8}	8.7 rem	7.7×10^{-7} rem/year (3.1×10^{-10} excess LCF/ year)
Irradiated Targets	3.2×10^{-6}	acute fatality	3.2×10^{-6} fatalities/year

explosives shipments was added to the frequency of propane shipments (rather than analyzing them separately).

Accidental Chlorine Release. The projected frequencies, consequences, and risks associated with major chlorine accidents under the Greener Alternative are presented in Table 5.5.10.2–4.

The use of the Santa Fe Relief Route would result in about one-sixth the risk of fatalities and one-tenth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight increase in injuries and fatalities on the remainder of New Mexico segment because of the extra 6 miles (9.65 kilometers) traveled on I–25 for northbound traffic (chlorine shipments are all assumed to travel north on I–25).

Accidental Propane Release. The projected frequencies, consequences, and risks associated with major propane accidents under the Greener Alternative are presented in Table 5.5.10.2–5.

The use of the Santa Fe Relief Route would result in about one-third the risk of fatalities and one-fourth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight decrease in injuries and fatalities on the remainder of New Mexico segment because of the 6 miles (9.5 kilometers) reduction in distance traveled on I–25 for southbound traffic (propane shipments are all assumed to travel south on I–25).

5.5.11 Accident Analysis

Transportation accidents for the Greener Alternative are addressed in section 5.5.10. High-frequency (greater than 1 in 100) occupational accidents for the Greener Alternative are addressed in section 5.5.6.

5.5.11.1 *Multiple Source Release of Hazardous Material from Site-Wide Earthquake and Wildfire*

The risks from these accidents are driven primarily by the frequency and magnitude of an earthquake and wildfire in the area. Because the same types of operations will be conducted in the same facilities and the inventories of MAR will be about the same, there are no substantial changes between the No Action and the Greener Alternatives. Tables 5.2.11.1–1 and 5.2.11.1–2 show these results.

5.5.11.2 *Plutonium Releases from Manmade and Process Hazards at LANL*

For the Greener Alternative, the activities and conditions that determine the material release and accident progressions do not change. Therefore, the frequencies and consequences of these scenarios under the Greener Alternative are the same as those presented for the No Action Alternative in Table 5.2.11.2–1.

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between the Rocky Flats Plant and TA–55–4 are presented in volume III, appendix G, section G.4.1.2.

Substantial differences exist between the nuclear facility and operations being conducted at TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiencies detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including

TABLE 5.5.10.2–4.—*Frequencies, Consequences, and Risk for a Major Chlorine Accident Under the Greener Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000028	0.065	0.24	8.6×10^{-6}	0.000032
	Suburban	4.6×10^{-6}	1.5	5.6		
U.S. 84/285 to I–25	Rural	0.000022	0.053	0.2	0.00029	0.0011
	Suburban	0.000047	3.0	11		
	Urban	0.000014	11	40		
Remainder of New Mexico	Rural	0.00016	0.015	0.056	0.000052	0.00019
	Suburban	0.000017	1.5	5.5		
	Urban	2.8×10^{-6}	8.4	32		
Remainder of U.S.	Rural	0.0012	0.028	0.1	0.0012	0.0047
	Suburban	0.0003	1.6	6.1		
	Urban	0.00007	10	39		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

TABLE 5.5.10.2–5.—*Frequencies, Consequences, and Risk for a Major Propane Accident Under the Greener Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	9.6×10^{-6}	0.28	1.1	9.7×10^{-6}	0.000039
	Suburban	1.6×10^{-6}	4.2	17		
U.S. 84/285 to I–25	Rural	7.4×10^{-6}	0.23	0.92	0.00015	0.0006
	Suburban	0.000016	8.4	34		
	Urban	5.0×10^{-6}	1.8	7.3		
Remainder of New Mexico	Rural	0.000064	0.15	0.6	0.00012	0.00048
	Suburban	0.000021	5.1	20		
	Urban	2.6×10^{-6}	1.5	6.1		
Remainder of U.S.	Rural	0.000081	0.09	0.36	0.000067	0.00027
	Suburban	0.00001	4.8	19		
	Urban	5.3×10^{-6}	1.9	7.5		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

enhanced seismic resistance and fire containment.

5.5.11.3 *Highly Enriched Uranium Release from Process Hazard Accident at LANL*

As discussed in section 5.2.11.3, this accident is the dominant accident for the release of HEU. Because there are no planned changes in the number of experiments or the inventories associated with this activity, the frequency and consequences of this scenario under the Greener Alternative are the same as presented under the No Action Alternative in Table 5.2.11.3–1.

5.5.11.4 *Tritium Release from a Manmade Hazard*

As presented in section 5.2.11.4, the aircraft crash event is the dominant accident that involves tritium. Because no changes in operations or inventories from the No Action Alternative are made, the consequences and frequencies associated with these scenarios are the same as those presented for the No Action Alternative in Table 5.2.11.4–1.

5.5.11.5 *Chemical Releases from Manmade and Process Hazard Accidents at LANL*

For the chlorine releases, on-site personnel could be exposed to concentrations in excess of ERPG–2. Chlorine has a highly objectionable odor, which prompts sheltering and escape; however, personnel can be quickly overcome when exposed to high concentrations.

Because no changes in operations or inventories from the No Action Alternative are made, the frequencies and consequences of these scenarios are the same as those under the No Action Alternative, as presented in Tables 5.2.11.5–1 and 5.2.11.5–2.

5.5.11.6 *Worker Accidents at LANL*

Although there are some planned decreases under this alternative in the handling of high explosives, the accident frequencies remain within same range of values as for the No Action Alternative. Therefore, the frequencies and consequences of these scenarios under the Greener Alternative are the same as those presented for the No Action Alternative in Table 5.2.11.6–1.

5.6 CUMULATIVE AND UNAVOIDABLE IMPACTS

5.6.1 Cumulative Impacts

Cumulative impact is defined by the CEQ NEPA regulations as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (federal or not federal) or person undertakes such other actions." This discussion of cumulative impacts deals with the effect of LANL operations when added to similar effects from the actions of other entities within the same region of influence. Effects are discussed by impact or resource area, and as can be seen from the discussions of each environmental impact area of analysis in chapter 5, the region of influence can vary. Some effects of LANL operations are not detectable beyond the facility or site boundary, while others involve effects with the potential to extend beyond site boundaries, interact with other sources of the same impact, and so may be managed under a regional regulatory authority (such as for criteria pollutants under the *Clean Air Act)*. Other effects, such as fire control or the movement of grazing animals, are best viewed within a common habitat or natural resource area.

This site-wide analysis in large measure is, by its scope, an analysis of cumulative impacts. To analyze the effects of LANL operations, regions of influence were selected to identify the maximum extent of impacts while still providing a discussion of effects that can be evaluated meaningfully. These impacts represent the effects from all operations at the site, and some effects do not have contributors from sources other than LANL. The following discussion represents all operational alternatives. The nature of the impacts from LANL operations and those of the surrounding area are such that the analyses presented in the previous sections of chapter 5 are, in fact, most of the relevant materials on this subject. The discussion that follows is not greatly influenced by the variation in impacts from the alternatives because most of these impacts are not significant and/or there is little contribution to impacts from other sources that are in the same region of influence as LANL. Information was gathered from city, county, state, tribal, and other federal organizations concerning future plans for development and to get information on any regional planning efforts. Following is a summary of the effects from LANL operations presented in this regional context and in a cumulative sense where such additional information was not already used in the previous section of the impact analysis.

5.6.1.1 *Land Use*

Much of the area around LANL is undeveloped USFS and NPS land, and is projected to remain undeveloped. Future land use patterns are projected to remain the same within the LANL site, and trends in population growth for the region immediately surrounding Los Alamos are likely to continue to increase the urban nature of development. Sections on land use in chapters 4 and 5 of this document provide more detail on these subjects and the cumulative impacts for this aspect of the analysis.

There is a potential for a change in these projections in land use for some parcels on the LANL site that have been identified for possible conveyance and transfer as part of PL 105-119 (also see chapter 4, section 4.1.1.4). The DOE has submitted the first required deliverable to Congress that gives a preliminary identification of 10 parcels that could be considered for transfer, comprising a total of approximately 4,600 acres (1,860 hectares). Those parcels are being evaluated further in the LANL Conveyance and Transfer (CT) EIS (DOE 1998a) (see chapter 1, section 1.5.10) for possible restrictions that may limit their use because of cultural and ecological resource impacts. These parcels also will be evaluated by

the ER Project to determine whether any needed remedial actions to allow unrestricted use are practical and could be completed in a 10-year time frame. Transferred lands are available for historic, cultural, or environmental preservation purposes; economic diversification purposes; or community self-sufficiency purposes, as stated in the law. A maximum of 1,158 acres (468 hectares) of the total acreage proposed to be transferred and conveyed would be developed or the land use otherwise changed (DOE 1998a).

5.6.1.2 *Water Resources*

Direct wastewater discharges to the canyons were evaluated in previous sections of this chapter, and no impacts were identified from the quality of current discharges. Soil contaminants from past operations can be affected by surface water flows within the canyons and potentially be carried further down the canyons and into the perched water zones or the underlying deep aquifer. The potential for this type of transport from stormwater runoff as well as transport caused by potential variation in future industrial discharges are discussed in this document. These also are factors in mitigative actions and specific risk analyses for each of the units to be evaluated under the ER Project. No other major water discharge to upper and middle reaches of these canyons occurs from human activity other than from LANL operations and the sanitary wastewater treatment that is performed for these operations as well as for the county, and no other planned discharges were evident. The Los Alamos County sewage treatment plant that discharges into the lower portions of Cañada del Buey is not likely to be a factor of concern for contaminant transport because no contamination above regional background reference levels is found in sediments in that portion of Cañada del Buey or in the lower portion of Mortandad Canyon, which receives the waters from Cañada del Buey. LANL operations are therefore the only activities of interest from the standpoint of cumulative impacts. The Los Alamos County sewage treatment plant in Bayo Canyon does discharge into an area of measurable radioactive contamination from past operations. Levels of contaminants have remained relatively constant in recent years and are slightly above background levels in the vicinity of the plan. While stormwater events are the primary force for movement of sediments, there is the potential for this discharge to contribute to the movement of sediments contaminated with radionuclides in the lower portions of Pueblo Canyon and Los Alamos Canyon. More details on these subjects may be found in the water resource sections of this document.

New development under the CT EIS (DOE 1998a) proposed action could degrade the surface water quality, increasing the pollutant loads and surface runoff volumes from construction activity and the increase in impermeable areas. Increases in discharges to wastewater treatment plants could be 132 million gallons (500 million liters) per year for the Bayo plant and 41 million gallons (155 million liters) per year for the White Rock plant.

5.6.1.3 *Air Quality*

No sources of air pollutants, other than those from LANL operations, were identified that would be of relevance for an evaluation of cumulative impacts; therefore, to give perspective on this situation, a brief description is provided below of the region that could be influenced by LANL operations. Except for Bernalillo County (greater Albuquerque area), the State of New Mexico manages the entire state as one air quality district. This district includes several wilderness areas, national parks, and national monuments and must consider the special status of these areas under the regulations for the prevention of significant deterioration (PSD). The proximity of BNM's wilderness area to LANL is of special note. The largest sources in the state for criteria pollutants

are in the Four Corners area, about 200 miles (320 kilometers) to the northwest, and the Bernalillo County area about 50 miles (80 kilometers) to the southwest; but neither areas exhibit major influence in the proximity of the LANL site. Sources in the immediate area are relatively small and separated from one another. Past ambient air quality monitoring by LANL and the State of New Mexico in the vicinity of BNM showed values well below standards developed to protect human health with an ample margin of safety, and monitoring was discontinued in 1994. No future development at LANL is proposed that would require evaluation under PSD regulations. Industrial development in the general area puts little pressure on ambient air quality concerns, and complex permitting or monitoring strategies are not necessary in this area to prevent degradation of air quality.

Only very minor effects from LANL operations could be identified from emissions of toxic air pollutants. No other sources of pollutants having the same potential effect at these receptors of concern for LANL operations were identified. Although some of the impact analyses considered receptors within a 50-mile (80-kilometer) radius of the site, impacts are primarily associated with areas close to the site.

There would be increases in criteria pollutants from mobile sources and homes using natural gas or propane from implementing the CT EIS proposed action. Slight increases in emissions of hazardous air pollutants would be expected from the development of new industrial facilities.

Implementation of the draft Surplus Plutonium Disposition (SPD) EIS Lead Assembly Alternative (DOE 1998b) at LANL would increase the radiological emissions to the MEI by no more than 0.01 millirem per year. Overall, LANL would be expected to remain within the 10 millirem per year NESHAP limit.

5.6.1.4 *Ecological Resources*

The analysis of direct effects on ecological resources from LANL operations in previous sections of this chapter shows that these effects do not, in most cases, extend beyond the perimeter of the site. Where contaminants from LANL are found off the site, contributions from sources other than worldwide fallout were not identified. Analysis of these effects are found in previous sections of this chapter. Additionally, potential effects on biota and ecosystems discussed in those sections are presented within the context of the larger regional ecosystem in which the LANL site is immersed. Potential effects from existing soil contaminants were identified, some dominated by naturally occurring metals, some dominated by legacy contamination from LANL operations. No current or planned additions of contaminants of concern by LANL or any other entity were identified.

The LANL site is relatively large and undeveloped, and serves as a reservation for a wide diversity of plants and animals. Although the impacts to biota and ecosystems are beneficial in this aspect, the site is affected by land uses predating LANL and influenced by fragmented management strategies. Resolution of problems such as risk of catastrophic wildfire, erosion, elk overpopulation, and habitat loss and fragmentation, will benefit from permanent interagency coordination and the development of a joint planning and management program with the other land management agencies. The continuation of and implementation of ongoing site programs and planning actions such as the ER Project, the Threatened and Endangered Species Habitat Management Plan, and the Natural Resources Management Plan will place site managers in a position to contribute in a meaningful way to regionalized strategies as they develop. Discussions in previous sections of this chapter

present this regional context in the evaluation of impacts.

Implementation of the CT EIS proposed action would cause approximately 1,230 acres (498 hectares) of ponderosa pine forest and pinyon-juniper woodland habitat to be heavily modified or lost. Also, approximately 3.8 percent of American peregrine falcon and Mexican spotted owl preferred habitat available at DOE/LANL would be affected.

5.6.1.5 *Cultural Resources*

The presence of federal lands adjacent to LANL and the highly restricted nature of the LANL site tends to prevent impacts to these resources from activities other than those directly attributable to LANL operations, and therefore, the discussion of impacts in previous sections of the chapter represents the analysis of cumulative impacts for this aspect of the analysis. Impacts from LANL operations extending beyond the site boundaries were not noted. The analysis in previous sections noted the potential for on-site impacts to TCPs from explosives, residual contamination, and restriction of access; but insufficient information on locations of these sites limits this area of analysis. More information may be found in chapter 4, (section 4.8), chapter 5, and appendix E.

The proposed action under the CT EIS would cause the development of approximately 1,020 acres (413 hectares) and use of tracts for recreation that could result in physical destruction, damage, or alteration of cultural resources on the subject tracts and in adjacent areas.

5.6.1.6 *Socioeconomics*

Government operations (federal, state, local, tribal) and service-sector businesses dominate the economics of the region influenced by LANL by a very large margin. Activities at LANL itself are estimated to directly and indirectly account for more than a third of employment, wage and salary, and business activity in the Tri-County region. The service sector aspect of the economy has experienced little growth in recent years, although projections of population growth, particularly in Santa Fe County, can reasonably be expected to result in the continued major influence of this economic sector. No major fluctuation in other aspects of the economy or introductions of significant new activities were identified. The discussion of impacts in previous sections of this chapter evaluates impacts in the area influenced by LANL (the Tri-County region) and in the context of identified growth patterns. Those sections may therefore be referred to for details on cumulative impacts for this aspect of the analysis.

Short-term economic gains would be expected from employment due to construction activities for new development under the CT EIS proposed action. The long-term gains would be dependent on the intensity and success of the development.

5.6.1.7 *Infrastructure*

LANL is a significant user of electric power in the region, but is not the dominant user in northern New Mexico. Within the electric power pool that serves LANL, direct use by LANL is about 80 percent of the total. The system serving LANL is near capacity, and future projections on electric power use from LANL under all alternatives, except Reduced Operations, indicate that demand will exceed capacity. Consideration of options to increase system capacity is complicated by the fact that the systems for other major power users in the region (the cities in northern New Mexico) are also nearing capacity, and demand from these users is also projected to exceed capacity. While the regional system capacity problem will exist regardless of the alternative selected

for LANL operations, selection of an option to deal with LANL alone is strongly influenced by these regional considerations. No specific proposals have been fully developed to remedy this situation (although, as noted in chapter 1, section 1.6.3.1, some specific solutions are being evaluated), and further analysis of environmental impacts will be necessary as future options are developed sufficiently to analyze them. Previous sections of this chapter discuss these electric power issues in the context of regional problems and may therefore be referred to for details on cumulative impacts for this aspect of the analysis.

Natural gas use is projected to remain within the capacity of the current system to provide it. Even if electricity demand increases natural gas demand for the generation of electricity at the LANL main power plant, demand for natural gas should continue to be dominated by heating requirements, and increase in demand sufficient to exceed capacity is not expected. Currently, there are no projections from other consumers in the region using the same natural gas supply lines that show demand potentially exceeding capacity. The evaluation of impacts in this resource area in previous sections of this chapter discuss natural gas use in this regional user context, and may therefore be referred to for details on this aspect of the cumulative impact analysis.

Potable water use was analyzed in previous sections of this chapter in the context of multiple users of a common aquifer and projected future use patterns of these users. The potential drawdown associated with LANL activities as well as services provided to other entities under the DOE water rights were modeled along with the other users in the region. All the users of the aquifer in the Española Basin are assumed to influence one another, but the exact relationships are unknown. Effects such as reduction in the height of the water table at a particular location are primarily influenced by major pumping operations in the immediate area. As pumping by DOE or by the City of Santa Fe shifts from one well field to another, water table height increases in the abandoned area and reduces in the new area. Therefore, even though Santa Fe may be the major water user in the area, total water use in the region still comprises a small fraction of the total volume within the main aquifer, and overall effects, while measurable, are not pronounced. Water use is projected to remain within existing water rights (which cumulatively constitute less than 1 percent of the estimated volume of the aquifer, as discussed in volume III, appendix A, section A.5), and no reduction in the discharge volume from springs in the area is foreseen.

The only aspects of solid waste management that have considerations of cumulative impact are those associated with the multiple users of the Los Alamos County landfill, and the potential for use of the LANL LLW disposal area by other DOE generators. Sufficient capacity in the county solid waste landfill will remain for the foreseeable future, and a decision on expansion of the LLW disposal area is likely to be driven by needs at LANL and not elsewhere. Sections of this document dealing with waste management activities contain more information on this aspect of cumulative impacts.

The total increases in utility usage for the CT EIS proposed action would be as follows:

- Electric use, 31 gigawatt-hours
- Peak power, 5 megawatts
- Natural Gas, 459 million cubic feet
- Water, 382 million gallons per year
- Solid Waste, 2,385 tons per year

Land development under the proposed CT EIS could result in an increased use of 382 million gallons (1,450 million liters) per year of groundwater, a significant increase over the water rights allocation of 1,805 million gallons (6,830 million liters) per year. Under the Expanded Operations and Preferred

Alternatives, the estimated water rights use would be 1,724 million gallons (6,525 million liters) per year. Implementation of the CT EIS proposed action would exceed the water rights allocation. Implementation of the Special Neutron Source (SNS) EIS proposed action of the 1-megawatt beam would use 42 million gallons (160 million liters) per year of groundwater, which could not be met with the current water infrastructure and water rights.

The Spallation Neutron Source (SNS) EIS proposed 1-megawatt beam would use 62 megawatts of peak power. LANL's existing electrical infrastructure is not adequate to support the additional power demand. The increase in peak power demand would exacerbate the power supply-demand problems in the Los Alamos region.

The additional impacts from implementing the draft SPD EIS, Lead Assembly Alternative at LANL would include a total of 4,840 cubic feet (137 cubic meters) of TRU waste, 24,900 cubic feet (705 cubic meters) of LLW, and relatively small quantities of other hazardous and nonhazardous wastes. These impacts are not a significant contributor to the waste management activities at LANL. The annual electricity requirements would increase by 0.72 gigawatt-hours, with an increase peak power demand of 0.3 megawatts. The annual process water usage would increase by 20,000 gallons (76,000 liters) per year. Both the electrical power and water usages are minor in the context of LANL's overall requirements and, thus, are not significant contributors to the power and water concerns at LANL.

5.6.1.8 *Transportation*

The future population of Los Alamos is not projected to increase significantly, although future land transfers may increase local traffic. As discussed in other sections, no other major cause for growth in the region has been identified, although some communities are expected to increase in size just as other areas of the state. Impacts associated with traffic congestion and vehicle emissions discussed in previous sections of this chapter consider the effects attributable to LANL operations in the context of effects that may be present from other sources, as well as the effect of future growth in the area. More detail on cumulative impacts may be found in those sections. Hazardous chemical and radioactive materials shipments comprise about 1 percent of the off-site truck shipments for LANL. The number of these type of shipments may increase above the No Action levels for the Expanded Operations, Reduced Operations (driven by waste shipments) and Greener Alternatives, but the percentage is likely to remain about the same. For perspective on the regional context for these types of shipments, the percentage of truck shipments that carry hazardous chemicals or radioactive materials in the State of New Mexico has been estimated by state transportation officials to be about 10 percent, although some segments of highway, such as I–40, may be much higher.

Under the CT EIS proposed action, the peak traffic entering or exiting all 10 tracts could increase by a range of approximately 751 to 3,775 trips per day. Many of the current roads and intersections would have to be upgraded to accommodate the new traffic levels.

The draft SPD EIS (DOE 1998b), Lead Assembly Alternative, documents the additional transportation impacts should LANL, be selected for this activity. Plutonium dioxide would already be at LANL, so no shipping would be required for this material. LANL would receive uranium dioxide and other material needed to assemble mixed oxide (MOX) fuel bundles from a nuclear fuel fabricator and would ship MOX fuel assemblies to a reactor site. Approximately 20 shipments of radiative materials would be carried out by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be about 34,000 miles (55,000 kilometers). The dose to transportation

workers from all transportation activities under this lead assembly alternative has been estimated at 1.5 person-rem; the dose to the public has been estimated at 10.3 person-rem. Accordingly, the incident-free transportation of radioactive material would result in 5.9×10^{-4} excess LCFs; among transportation workers and 5.1×10^{-3} excess LCFs in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions would be 1.5×10^{-4}. Estimates of the total ground transportation accident risks indicate a radiological dose to the population of 6.2 person-rem, resulting in a total population risk of 3.1×10^{-3} excess LCFs and traffic accidents resulting in 6.7×10^{-4} traffic fatality.

5.6.1.9 Human Health

The development of the CT EIS proposed action could bring as many as 900 new residents into closer proximity to LANL facilities at the DOE Los Alamos Area Office and DP Road Tracts, and another 2,200 residents and lodgers at the White Rock Tract. Commercial development could bring as many as 6,000 private-sector employees into existing radiation buffer zones at the DP Road, TA–21, and Airport Tracts. These developments would mean increased public exposures to radiological and chemical emissions from LANL, from normal operations and hypothetical accidents. A substantial increase in the public collective radiation dose would result.

Implementation of the Lead Assembly Alternative, analyzed in the draft SPD EIS (DOE 1998b), at LANL would contribute the following impacts. The expected number of excess LCFs as a result of the radiation released from these activities in the general population residing within 50 miles (80 kilometers) of LANL would be 1.2×10^{-5}. The expected number of excess LCFs to involved workers would be 0.011. The expected annual dose to the MEI is 9.0×10^{-3} millirem per year, which corresponds to an associated excess LCF risk of 4.5×10^{-9}. Transportation related to these activities would not be expected to result in any excess LCFs either. Thus, implementation of the lead assembly fabrication activities at LANL would pose no significant health risks to the public.

5.6.2 Unavoidable Adverse Impacts

Operating LANL under any alternative involves the release of small quantities of radioactive and hazardous materials via routinely monitored air and water effluent discharges. Analysis has shown these discharges to be of minimal consequence; nonetheless, they represent an impact that is unavoidable. Control measures commensurate with potential risk are in place, and in an evolutionary manner, seek to reduce these discharges to the lowest practical levels. Solid radioactive and hazardous waste, and sanitary wastes also result from routine operations, and must be treated and disposed. The active recycle, waste minimization, and waste avoidance programs at LANL continuously work to reduce the volume and types of these wastes. Potential disturbance of biological and cultural resources can result from operations, and restricted access to some traditional cultural properties might be viewed as adverse.

5.6.3 Irreversible and Irretrievable Commitments of Resources

Operations at LANL under the various alternatives require the consumption of a number of resources. Table 3.6.2–1 in chapter 3 shows the projected usage of water, natural gas, and electricity across the SWEIS alternatives. (These resources are also discussed by alternative in sections 5.2.9.2, 5.3.9.2, 5.4.9.2, and 5.5.9.2.) While deficiencies in some of the local distribution systems for gas and electricity were discussed in this analysis, no shortages in total regional supplies were noted. There also

are many materials requirements for maintenance of facilities, and operations require the consumption of the entire range of expected products and materials, such as chemicals. There is an active recycling program at LANL; most products are expended or disposed. Approximately 43 square miles (111 square kilometers) are reserved for laboratory operations. A large amount of that area remains undisturbed, and development has been, and will continue to be, concentrated in areas of like operations. While it is theoretically possible to consider that the entire facility could be decommissioned and removed, operations, including waste disposal, are expected to continue into the foreseeable future. These lands are therefore removed from use for other purposes. An active environmental restoration program seeks to reduce the risk from past discharges of radioactive and hazardous materials; but, not all areas are expected to be restored to their original condition. LLW disposal at LANL places strict limitations on alternative or future uses of the disposal areas. The disposal sites would require monitoring and various forms of protective actions, including administrative access control, for an extended period of time.

5.6.4 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

A decision to operate LANL under any alternative requires the commitment of resources that cannot be recovered, the acceptance of impacts from normal operations that release pollutants and cause disturbances. The national resource embodied in LANL, which is continually tapped by different entities throughout the U.S. as well as abroad, is used to work on problems involving national security, energy resources, environmental quality, and in science.

A large portion of the knowledge and capability necessary to support the nuclear weapons program resides at LANL. The program implemented by DOE, and as discussed in the SSM PEIS (DOE 1996d), has been reduced in size, refocused, and operations consolidated to a fewer number of sites.

REFERENCES

BH&A 1995 — *Needs Assessment for Fire Department Services and Resources, Los Alamos National Laboratory, Los Alamos, New Mexico*. Beatty, Harvey & Associates. New York, New York. November 15, 1995.

Bradford 1996 — W. Bradford, ESH-EIS. Memorandum to Doris Garvey, ESH/M889, on *NPDES Outfalls and Annual Volume Discharges for Other than Key Facilities.* August 28, 1996.

CEQ 1993 — *Incorporating Bidodiversity Considerations into Environmental Impact Analysis Under the National Environmental Policy Act.* Council on Environmental Quality. Washington, D.C. 1993.

Dennis et al. 1978 — *Severities of Transportation Accidents Involving Large Packages*. SAND-77-0001. A. W. Dennis et al. Sandia National Laboratories. Albuquerque, New Mexico. 1978.

DOC 1992 — *1990 Census of Population, General Population Characteristics, New Mexico*. 1990 CP-1-33. U.S. Department of Commerce, Bureau of the Census. Washington, D.C. 1992.

DOC 1993a — *1990 Census of Population, Social and Economic Characteristics, New Mexico*. 1990 CP-2-33. U.S. Department of Commerce, Bureau of the Census. Washington, D.C. 1993.

DOC 1993b — *1990 Census of Housing, Detailed Housing Characteristics, New Mexico*. 1990 CH-2-33. U.S. Department of Commerce, Bureau of the Census. Washington, D.C. 1993.

DOC 1996 — *Personal Income by Major Source and Earnings by Industry, New Mexico and Los Alamos, Rio Arriba, and Santa Fe Counties, 1989 through 1994*. U.S. Department of Commerce, Bureau of Economic Analysis, Economic Information System. Washington, D.C. June 1996.

DOE 1993 — *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements.* U.S. Department of Energy, Office of NEPA Oversight. May 1993.

DOE 1994 — *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities.* DOE Handbook 3010-94, Vols. I & II. U.S. Department of Energy. December 1994.

DOE 1995a *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement.* DOE/EIS-0228. U.S. Department of Energy, Albuquerque Operations Office and Los Alamos Area Office, Albuquerque, New Mexico. August 1995.

DOE 1995b *Environmental Assessment, High Explosive Wastewater Treatment Facility.* DOE/EA-1100. Los Alamos National Laboratory, Los Alamos, New Mexico. August 1995.

DOE 1996b *Accident Analysis for Aircraft Crash Into Hazardous Facilities.* DOE Standard 3014-96. U.S. Department of Energy. October 1996.

DOE 1996c *Interim Format and Content Guide and Standard Review Plan for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments.* U.S. Department of Energy. Washington, D.C. October 1996.

DOE 1996d *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*. DOE/EIS-0236. U.S. Department of Energy, Office of Defense Programs, Washington, D.C. 1996.

DOE 1996e *Environmental Assessment for Effluent Reduction.* DOE/EA-1156. U.S. Department of Energy, Los Alamos Area Office. Los Alamos, New Mexico. September 11, 1996.

DOE 1997 *Approaches for Upgrading Electrical Power System Reliability and Import Capability*. LA-UR-96-3882. Prepared by Lundberg, Marshall & Associates, Ltd., for the U.S. Department of Energy, Albuquerque Operations Office, under Contract Number DE-ACOA-93AL82990. Albuquerque, New Mexico. August 28, 1997.

DOE 1998a *Draft Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico*. (Predecisional Draft). U.S. Department of Energy, Los Alamos Area Office. Los Alamos, New Mexico. December 14, 1998.

DOE 1998b *Surplus Plutonium Disposition Environmental Impact Statement.* U.S. Department of Energy, Office of Fissile Materials Disposition. DOE/Draft EIS-0283. Washington, D.C. July 1998.

DOT 1992 *FAA Statistical Handbook of Aviation: Calendar Year 1992.* FAA APO-94-5. U.S. Department of Transportation, Federal Aviation Administration. Washington, D.C. 1992.

EPA 1987 — *Radiation Protection Guidance to the Federal Agencies for Occupational Exposure*. *Federal Register*, Vol. 52, No. 17 (52 FR 2822-2834). January 27, 1987.

EPA 1992 — *Framework for Ecological Risk Assessment.* U.S. Environmental Protection Agency. Report No. EPA/630/R-92/001. Washington, D.C. 1992.

Frenzel 1995 — *Geohydrology and Simulation of Groundwater Flow near Los Alamos, North-Central New Mexico.* P. Frenzel. USGS Water Resources Investigations Report 95-4091. 1995.

Garvey 1997 — D. Garvey, ESH-EIS. Memorandum to Corey Cruz, DOE Albuquerque Operations, regarding NPDES outfalls. December 19, 1997.

Geffen et al. 1980 — *An Assessment of the Risk of Transporting Propane by Truck and Train*. C. A. Geffen et al. PNL-3308. Pacific Northwest Laboratory, Richland, Washington. 1980.

Glickman and Raj 1992 — *A Comparison of Theoretical and Actual Consequences in Two Fatal Ammonia Accidents*. T. A. Glickman and P. K. Raj. *Transportation of Dangerous Goods: Assessing the Risks.* F. Frank Saccomanno and Keith Cassidy, eds. Institute for Risk Research, University of Waterloo. Ontario, Canada. 1992.

Havens and Spicer 1985 — *Development of an Atmospheric Dispersion Model for Heavier-than-Air Gas Mixtures*. CG-D-22-85. J. A. Havens and T. O. Spicer. U.S. Coast Guard. Washington, D.C. 1985.

Holt 1998 — Memorandum from James Holt, Program Director, Institutional Facilities and Construction, Los Alamos National Laboratory, to Herman LeDoux, U.S. Department of Energy. October 22, 1998.

ICRP 1977 — *Recommendations of the International Commission on Radiological Protection*. International Commission on Radiological Protection. ICRP Publication No. 26, Annals of the ICRP 1, (3). Pergamon Press. New York. 1977.

ICRP 1991 — *Recommendations of the International Commission on Radiological Protection*. International Commission on Radiological Protection. ICRP Publication No. 60. Pergamon Press. New York. 1991.

Johnson et al. 1993 — HIGHWAY 3.1 + An Enhanced Highway Routing Model: Program Description, Methodology, and Revised User's Manual. ORNL/TM-12124. P. E. Johnson, D. S. Joy, D. B. Clarke, and J. M. Jacobi. Oak Ridge National Laboratory. Oak Ridge, Tennessee. March 1993.

Kumar 1997 — J. Kumar, Lundberg, Marshall & Associates, Ltd., Letter to D. Agar, U.S. Department of Energy, regarding the capacity gas line that supplies the Los Alamos area. Prepared under Contract Number DE-ACOA-93AL82990. August 27, 1997.

LANL 1992 — *Environmental Surveillance at Los Alamos During 1990.* Los Alamos National Laboratory. LA-12271-M8. UC-1990. Los Alamos, New Mexico. March 1992.

LANL 1993 — *Environmental Surveillance at Los Alamos During 1991.* Los Alamos National Laboratory. LA-12572-ENV. UC-902. Los Alamos, New Mexico. August 1993.

LANL 1994 — *Environmental Surveillance at Los Alamos During 1992.* Los Alamos National Laboratory. LA-12764-MS. UC-902. Los Alamos, New Mexico. July 1994.

LANL 1995b — Information on historical LANL procurement received from the LANL Business Operations Division. Los Alamos National Laboratory. Los Alamos, New Mexico. November 13, 1995; October 17, 1996; and January 3, 1997.

LANL 1995c — *Environmental Surveillance at Los Alamos During 1993.* Los Alamos National Laboratory. LA-12973-ENV. UC-902. Los Alamos, New Mexico. October 1995.

LANL 1995d — *Materials Expended Report for PHERMEX*. Los Alamos National Laboratory. DX-11-95-109. Los Alamos, New Mexico. March 16, 1995.

LANL 1996a — Information on LANL salaries received from the University of California Payroll Department. Los Alamos National Laboratory. Los Alamos, New Mexico. November 21, 1996, and December 12, 1996.

LANL 1996b — *Environmental Surveillance at Los Alamos During 1994.* Los Alamos National Laboratory. LA-13047-ENV. UC-902. Los Alamos, New Mexico. July 1996.

LANL 1996c — *Environmental Surveillance at Los Alamos During 1995.* Los Alamos National Laboratory. LA-13210-ENV, UC-902. Los Alamos, New Mexico. October 1996.

LANL 1996d — *Evaluation of Aircraft Crash Hazard at Los Alamos National Laboratory Facilities.* Los Alamos National Laboratory. LA-13105. Los Alamos, New Mexico. July 1996.

LANL 1997a — SH-EIS:97-159: Kenneth Rea to Corey Cruz, subject: socioeconomic data corrections. June 18, 1997.

LANL 1997b — Field Observations of Eight Cultural Resource Sites in the Vicinity of LANL Firing Sites. Report transmitted from T. Ladino, Los Alamos National Laboratory, ESH-20/Ecol-98-0084. Los Alamos, New Mexico. October 29, 1997.

LANL 1997c — *Capital Asset Management Process, Fiscal Year 1997.* Los Alamos National Laboratory. LA-UR-95-1187. Los Alamos, New Mexico. 1997.

LANL 1997d — *Environmental Surveillance and Compliance at Los Alamos during 1996.* Los Alamos National Laboratory, Environmental Assessments and Resource Evaluations Group. LA-13343-ENV. Los Alamos, New Mexico. 1997.

LANL 1998a — *Waste Management Strategies for LANL*. Los Alamos National Laboratory. LA-UR-97-4764. Los Alamos, New Mexico. April 1998.

LANL 1998b — *Description of Technical Areas and Facilities at LANL.* Los Alamos National Laboratory. LA-UR-97-4275. Los Alamos, New Mexico. March 1998.

LANL 1998c — *Performance Assessment and Composite Analysis for the Los Alamos National Laboratory Low-Level Waste Material Disposal Area G*. Los Alamos National Laboratory. LA-UR-97-85. Los Alamos, New Mexico. Submitted to the U.S. Department of Energy March 1997. Approved October 1998.

LANL 1998d — *Los Alamos National Laboratory Hydrogeologic Workplan*. Los Alamos National Laboratory. Los Alamos, New Mexico. May 1998.

Lansford et al. 1996 — *The Economic Impact of Los Alamos National Laboratory on North-Central New Mexico and the State of New Mexico, Fiscal Year 1995*. R. R. Lansford, L. D. Adcock, L. M. Gentry, and S. Ben-David. U.S. Department of Energy, Albuquerque Operations Office, in cooperation with the University of New Mexico, Albuquerque, New Mexico, and New Mexico State University, Las Cruces, New Mexico. August 1996.

Lundberg 1997 — Information provided by J. Lundberg, Lundberg, Marshall & Associates, Ltd., to D. Agar, U.S. Department of Energy, regarding the peak water demand and the capacity of the water delivery system that supplies the Los Alamos area. Prepared under Contract Number DE-ACOA-93AL82990. August 28, 1997.

NCRP 1993 — *A Practical Guide to the Determination of Human Exposure to Radiofrequency Fields.* National Council on Radiation Protection. NCRP Report No. 119. Bethesda, Maryland. December 31, 1993.

Newell 1998 — *Application of the TA–54, Area G Radiological Performance Assessment to Alternatives Considered in the LANL SWEIS for Low-Level Waste Disposal*. D. Newell. Los Alamos National Laboratory. Los Alamos, New Mexico. January 7, 1998.

NM 1996 — *New Mexico Dispersion Modeling Guidelines* (Revised). January 1996.

NMDE 1995 — *New Mexico Public Schools Financial Statistics, Fiscal Years 1993-1994, Actual: 1994–1995, Estimated*. New Mexico State Department of Education. Santa Fe, New Mexico. 1995.

NMDFA 1996 — *Financial and Property Tax Data by County and Municipality, Fiscal Year 1995*. New Mexico Department of Finance and Administration, Local Government Division. Santa Fe, New Mexico. 1996.

NMDL 1996 — "Table C. Civilian Labor Force, Employment, and Unemployment, 1990–1995." New Mexico Department of Labor, Economic Research and Analysis Unit. Santa Fe, New Mexico. April 1966.

NMTR 1995 — Information on local government finance, as reported in *Economic Review*, 1994. New Mexico Taxation and Revenue Department. Sunwest Bank. Albuquerque, New Mexico. 1995.

NMTR 1996 — Information on local government finance, as reported in *Economic Review*, 1995. New Mexico Taxation and Revenue Department. Sunwest Bank. Albuquerque, New Mexico. 1996.

NSC 1995 — *ALOHA™ + Areal Locations of Hazardous Atmospheres, User's Manual*. National Safety Council. Itasca, Illinois. 1995.

PC 1996a — C. Ball, GRAM Team, Personal communications with Kevin Fenner, Los Alamos County Community Development Director; John Valentine, President, Sunwest Bank of Rio Arriba County; and Ivan Guillan, City Planner, City of Española; regarding community services and housing. October 2, 1996.

PC 1996b — C. Ball, GRAM Team, Personal communication with Fred Brueggmann, Assistant Los Alamos County Administrator for Intergovernmental Relations, regarding community services, local government finance, and DOE local government assistance payments. October 2, 1996.

PC 1997a — C. Ball, GRAM Team, Personal communication with Radon Tolman, LANL SWEIS Project Office, Los Alamos, New Mexico, regarding construction algorithms. February 20, 1997.

PC 1997b — C. Ball, GRAM Team, Personal communication with Robert Turner, Vice President, Bradbury and Stamm Construction Company, Albuquerque, New Mexico, regarding construction algorithms. February 20, 1997.

PC 1997c — C. Ball, GRAM Team, Personal communications with Kevin Fenner, Los Alamos County Community Development Director; John Valentine, President, Sunwest Bank of Rio Arriba County; and Ivan Guillan, City Planner, City of Española; regarding community services and housing. January 16, 1997.

PC 1997d — C. Pazera and C. Ball, GRAM Team, Personal communications with personnel from the Los Alamos Police Department. Los Alamos, New Mexico. January 23, 1997, and January 27, 1997.

Phillips et al. 1994 — *Determination of Influence Factors and Accident Rates for the Armored Tractor/Safe Secure Trailer*. J. S. Phillips, D. B. Clauss, and D. F. Blower. SAND93-0111. Sandia National Laboratories. Albuquerque, New Mexico. 1994.

Purtymun 1995 — *Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs and Surface Water Stations in the Los Alamos Area*. W. D. Purtymun. Los Alamos National Laboratory. LA-12883-MS. Los Alamos, New Mexico. 1995.

Rao et al. 1982 — *Non-Radiological Impacts of Transporting Radioactive Material*. R. K. Rao, E. L. Wilmot, and R. E. Luna. DE8-2012844. Sandia National Laboratories. Albuquerque, New Mexico. February 1982.

Rhyne 1994a — *Hazardous Materials Transportation Risk Analysis: Quantitative Approaches for Truck and Train*. W. R. Rhyne. Van Nostrand Reinhold. New York, New York. 1994.

Rhyne 1994b — *Risk Management of the Transport of Irradiated Targets from LAMPF to TA-48.* W. R. Rhyne. SM-BUS-6-TQC-53.0. H&R Technical Associates. Oak Ridge, Tennessee. July 1994.

UNM 1994 — *Population Projections for the State of New Mexico by Age and Sex, 1990–2020.* University of New Mexico, Bureau of Economic Research. Albuquerque, New Mexico. May 1994.

Vance et al. 1996 — "An Evaluation of Options for Implementing New Radioactive Liquid Waste Treatment Processes at Los Alamos National Laboratory." Jane Vance et al. Vance and Associates, Inc. July 1996.

Wong et al. 1995 — *Seismic Hazards Evaluation of the Los Alamos National Laboratory*, Final Report. Volume III. I. Wong, et al. Woodward-Clyde Federal Services. Oakland, California. 1995.

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