DOE/EA 1147

FINAL

ENVIRONMENTAL ASSESSMENT

for the

LOW ENERGY DEMONSTRATION ACCELERATOR

TECHNICAL AREA 53

LOS ALAMOS NATIONAL LABORATORY

LOS ALAMOS, NEW MEXICO

Date Prepared: April 1, 1996
Prepared for: Office of Defense Programs
US Department of Energy Los Alamos Area Office

DISCLAIMER

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EXECUTIVE SUMMARY

As part of the Department of Energy's (DOE) need to maintain the capability of producing tritium in support of its historic and near-term stewardship of the nation's nuclear weapons stockpile, the agency has recently completed a Programmatic Environmental Impact Statement for Tritium Supply and Recycling. The resulting Record of Decision (ROD) determined that over the next three years the DOE would follow a dual-track acquisition strategy that assures tritium production for the nuclear weapon stockpile in a rapid, cost effective, and safe manner. Under this strategy the DOE will further investigate and compare two options for producing tritium: (1) purchase of an existing commercial light-water reactor or irradiation services with an option to purchase the reactor for conversion to a defense facility; and (2) design, build, and test critical components of a system for accelerator production of tritium (APT). The final decision to select the primary production option will be made by the Secretary of Energy in the October 1998 time frame. The alternative not chosen as the primary production method, if feasible, would be developed as a back-up tritium supply source.

This Environmental Assessment (EA) analyzes the potential environmental effects that would be expected to occur if the DOE were to design, build, and test critical prototypical components of the accelerator system for tritium production, specifically the front-end low-energy section of the accelerator, at Los Alamos National Laboratory (LANL), Los Alamos, New Mexico. The Low Energy Demonstration Accelerator (LEDA) would be incrementally developed and tested in five separate stages over the next seven years. LEDA would be located at an existing building at Technical Area 53 (TA-53); the LEDA components would be tested in order to verify equipment and prototype design and resolve related performance and production issues for future full-scale operation at Savannah River Site (SRS) in the event the APT plant is built. Production operations would not occur at LANL under the proposed action.

Alternatives to the proposed action considered, but eliminated from further analysis in this EA, include (1) conducting the LEDA project at an alternative location at LANL, (2) conducting the LEDA project at another DOE facility, and (3) developing an alternative accelerator technology. Conducting the LEDA project at another LANL or DOE site was eliminated due to the schedule and cost constraints inherent in demonstrating the feasibility of the accelerator production of tritium by October of 1998. Developing an alternative accelerator technology was eliminated from further analysis in this EA either due to lack of technical feasibility or a direct conflict with the October 1998 implementation schedule. The no action alternative, which is to not conduct the LEDA project, does not meet the DOE's purpose and need; however, it is analyzed in this EA to provide a baseline comparison with the proposed action.

The following issues were evaluated for the proposed action: utility demands, air, human health, environmental restoration, waste management, transportation, water, threatened and endangered species, wetlands, cultural resources, and environmental justice.

Utility demands: The LEDA project would use additional electricity, natural gas, and water which would be provided by proposed and existing on-site support facilities.

Air: There would be a slight increase in non-radioactive air emissions as a result of normal LEDA project operations and increased support facility activities, but they would not exceed ambient air quality standards. Radioactive air emissions from accelerator operations at TA-53 are expected to remain relatively constant; however, if it is determined that planned engineering controls are unable to limit radioactive emissions to current levels or below, appropriate permits would be sought.

Human Health: The proposed LEDA project would slightly increase the worker, co-located worker, and public dose from activated air products released from the LEDA building exhaust stack. However, no additional cancer fatalities in the population within 80 km (50 mi) of LANL would be expected to result from the LEDA project.

Environmental Restoration: LANL's Environmental Restoration (ER) Project has identified the presence of lead shot immediately downgradient of the National Pollutant Discharge Elimination System (NPDES) permitted outfall that would be used for the LEDA project, and has recommended remediation to prevent the spread of potential contamination. This remediation would be undertaken before the LEDA project began any release of cooling tower effluent. Other Potential Release Sites (PRSs) related primarily to historical site use are located in Sandia Canyon. The ER Project manages two PRSs within Sandia Canyon where contaminants of concern are known to exist at levels above screening action levels. These PRSs are being investigated by the ER Project with oversight from several offices of the State of New Mexico Environment Department, and will undergo remediation by removal within the next two years as Voluntary Corrective Actions (VCAs). A third site is a small arms firing range used by LANL's Security Force, and is recommended for deferred corrective action until after the site is decommissioned. Due to the nature of the PRSs' remedial actions and their timing relative to the LEDA project development, no spread of potential contaminants downstream is expected from effluent release as a result of the proposed LEDA project.

Waste Management: The LEDA project would generate construction and demolition debris, and other solid waste, non-radioactive treated cooling water, asbestos waste, hazardous waste, and solid and liquid low-level radioactive waste. Construction and demolition debris would be disposed of in the Los Alamos County Landfill. Treated cooling water would be discharged through a permitted outfall. Asbestos and hazardous wastes would be managed on-site for off-site disposal. Low-level radioactive waste would be managed on-site by LANL's waste management system.

Transportation: No transportation accidents are likely.

Water: Discharged cooling water could produce surface flow in Sandia Canyon during the third through seventh years of the LEDA project. Sandia Canyon sediments within the existing stream channel have no known radionuclides, heavy metals, or organics above screening action levels or method detection limits (also known as limits of quantification) that would move downstream.

Threatened and Endangered Species: No effects on threatened and endangered species or their critical habitat have been identified.

Wetlands: The increased discharge could produce saturated substrate conditions in Sandia Canyon. However, other characteristics necessary to create a wetland are not expected to develop during the LEDA project.

Cultural Resources: No effects on cultural resources have been identified.

Environmental Justice: The proposed action would not result in any changes to current conditions.

The accident scenario with the worst potential consequence to the worker would involve a high power electrocution resulting in serious injury or death. This accident has the likelihood of occurring once in ten thousand to one million years. The accident scenario with the worst potential consequence to the co-located worker, the public, and the environment would involve a beam spill, which would be largely confined within the shielded beam tunnel. This accident would result in a negligible (acute) dose from neutron and gamma radiation and no adverse health or environmental effects. This accident has the likelihood of occurring once in ten thousand to one million years.

The no action alternative would not change existing conditions.

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1. PURPOSE AND NEED

1.1 BACKGROUND

Tritium, a radioactive gas, is crucial to the continuing operation of the United States' nuclear weapons stockpile. The radiological half-life of tritium is a relatively short 12.3 years. For that reason, weapons components using tritium must be periodically replenished. The federal government has not produced tritium since 1988, and has had no production source since the shutdown of the K-reactor at the US Department of Energy's (DOE[1] or Agency) Savannah River Site (SRS) in South Carolina. In support of its historic mission and near-term stewardship of the nuclear weapons stockpile, the DOE needs a capability to produce tritium to meet the requirements set forth in the 1994 Nuclear Weapons Stockpile plan, the latest official guidance. The DOE is currently meeting tritium requirements for the stockpile by utilizing tritium recycled from dismantled weapons. Ratification of the Strategic Arms Reduction Talks (START) II Protocol would mean that a new source of tritium must be available by the year 2009, and new tritium must be available for stockpile use by 2011.

The Programmatic Environmental Impact Statement (PEIS) for Tritium Supply and Recycling (TS&R) (DOE/EIS 0161), issued in October 1995 examined alternatives for producing tritium; these included use of an advanced light-water reactor, a modular high-temperature gas-cooled reactor, a heavy water reactor, and accelerator production of tritium (APT) using a proton linear accelerator (DOE 1995a). The use of an existing commercial light water reactor that would be used for irradiation services or purchased and converted for tritium production was also considered as an alternative.

In the Record of Decision (ROD) issued December 5, 1995, for that PEIS, the DOE determined that over the next three years it would follow a dual-track acquisition strategy that assures tritium production for the nuclear weapon stockpile in a rapid, cost-effective, and safe manner. Under this strategy, the DOE will further investigate and compare two options for producing tritium: (1) purchase of an existing commercial light-water reactor or irradiation services with an option to purchase the reactor for conversion to a defense facility; and (2) design, build, and test critical components of an accelerator system for tritium production. The final decision to select the primary production option is scheduled to be made by the Secretary of Energy in the October 1998 time frame. The alternative not chosen as the primary production method, if feasible, would be developed as a back-up tritium supply source.

Both of the proposed options under consideration present advantages and disadvantages for their use. The APT alternative has the highest probability to meet earlier production requirements because of less regulatory uncertainty. It also has the least environmental impact because it does not use fissile material, generates no high-level wastes, and although the risk from a severe accident is very small for all of the alternatives, the risk for the accelerator production of tritium is the smallest. While both options are known technologies, tritium production by accelerator at the scale required in the time frame needed and with system functional reliability has not yet been successfully demonstrated. Although the individual

[1] Technical terms and acronyms are defined in Chapter 7 (Glossary)

components of the accelerator have been proven, the critical components need to be integrated and operated as a complete system.

1.2 PURPOSE AND NEED FOR AGENCY ACTION

The Agency must produce tritium for its nuclear weapons stockpile. The final TS&R PEIS ROD issued December 5, 1995, established the strategy to pursue two options for tritium production. One of these options is to design, build, and test critical components of an accelerator system for tritium production using a proton linear accelerator. Design confirmation and reliability of operations need to be successfully demonstrated to adequately meet the production requirements. The major uncertainty for achieving the reliable and successful operation of an APT plant resides in the function of one of the key components of a proton linear accelerator, the low-energy, front-end portion of the accelerator. Therefore, DOE now needs to design, build, and test critical components of the APT system, specifically a full-sized prototype of the low-energy, front-end section of the accelerator, in order to verify equipment design and resolve related performance and production issues for full-scale operation while minimizing beam-loss mechanisms. These tests must be accomplished within the next three years in order to facilitate the Secretary's scheduled 1998 decision to select the primary option for tritium production in support of the nation's stockpile stewardship and management program. Failure to meet this deadline would mean that the 1998 decision either would have to be postponed until research and development of the critical accelerator components has been completed, which could negatively impact the nation's ability to meet weapons stockpile requirements, or the Secretary would be called upon to make a decision based on incomplete or limited information.

1.3 ENVIRONMENTAL ASSESSMENT METHODOLOGY

The National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 et seq.), requires DOE to consider the environmental consequences of proposed actions before decisions are made. In complying with NEPA, DOE follows the Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1508) and DOE's own NEPA implementing regulations (10 CFR 1021). The purpose of this EA is to provide the DOE with sufficient information to determine whether a Finding of No Significant Impact (FONSI) is supported for the proposed action or whether an Environmental Impact Statement (EIS) must be prepared to more adequately analyze any potential impacts. This assessment of potential effects is based on conservative assumptions that overestimate the environmental effects.

2. DESCRIPTION OF ALTERNATIVES

2.1 PROPOSED ACTION

2.1.1 Description of Action

To meet the purpose and need for Agency action, DOE proposes to design, build, test, and verify the performance of a low-energy demonstration accelerator (LEDA) at Los Alamos National Laboratory (LANL), Los Alamos, New Mexico (Figure 1). LEDA is a prototype of the low-energy, front-end of the linear accelerator (linac) to be used in an APT plant. LEDA must be capable of producing a beam of protons of 20 to 40 million electron volts (MeV) energy and a current level of 100 to 200 milli-Amperes (mA) and must be capable of sustained continuous operation. LEDA would consist of a proton injector, a radio-frequency quadrupole (RFQ) accelerator, two sections of coupled-cavity drift-tube linac (CCDTL), a diagnostic beam line, and beamstops. Beam diagnostics and a computer control system would also be included as part of the LEDA facility. LEDA would be assembled and tested in five stages. Each successive stage would have a different configuration of test apparatus, with beam power increasing from stage to stage. The five stages are described in Section 2.1.2. The APT plant accelerator, to be located at SRS, would require a proton beam of up to 1,800 MeV, which represents a 45-to 90-fold increase over the LEDA beam energy. Thus, LEDA would not be a prototype for the complete, full-scale APT plant.

LEDA would be located in an existing building, Building MPF-365, at Technical Area 53 (TA-53) (Figures 2 and 3). Some construction would be required in Building MPF-365. Additionally some minor infrastructure additions would be made.

2.1.2 LEDA Project

The stages of the LEDA project are illustrated in Figure 4 and listed in Table 2-1 together with their proposed schedules for installation and testing. Stages I through IV would operate in continuous mode during their operating periods. Stage I would consist of installing and testing a 75- kilo electron volts (keV), 110-mA proton injector. In Stage II, a 350-megahertz (MHz) RFQ accelerator would be added to accelerate a 100 mA proton beam to 7 MeV. In Stage III, a 700-MHz CCDTL would be added to further accelerate the 100-mA proton beam to 20 MeV. In Stage IV, additional CCDTL modules would be added to raise the final energy of the 100-mA proton beam to 40 MeV. Optional Stage V would consist of adding a second parallel apparatus similar to that of Stage III and a beam combiner called a "funnel." The funnel would combine the two 350-MHz, 100-mA, 20-MeV proton beams into a single 700-MHz, 200-mA, 20-MeV proton beam. This beam would then be accelerated with CCDTL modules to an energy as high as 30 MeV in continuous mode or to an energy as high as 40-MeV in pulsed mode. The LEDA project is scheduled to last about seven years. The near-term LEDA project objective is to complete Stage II and a substantial portion of Stage III prior to the Secretary's decision, scheduled for October 1998. Enough information sould be available by October 1988 to determine if accelerator production of tritium is genuinely feasible at the production level needed

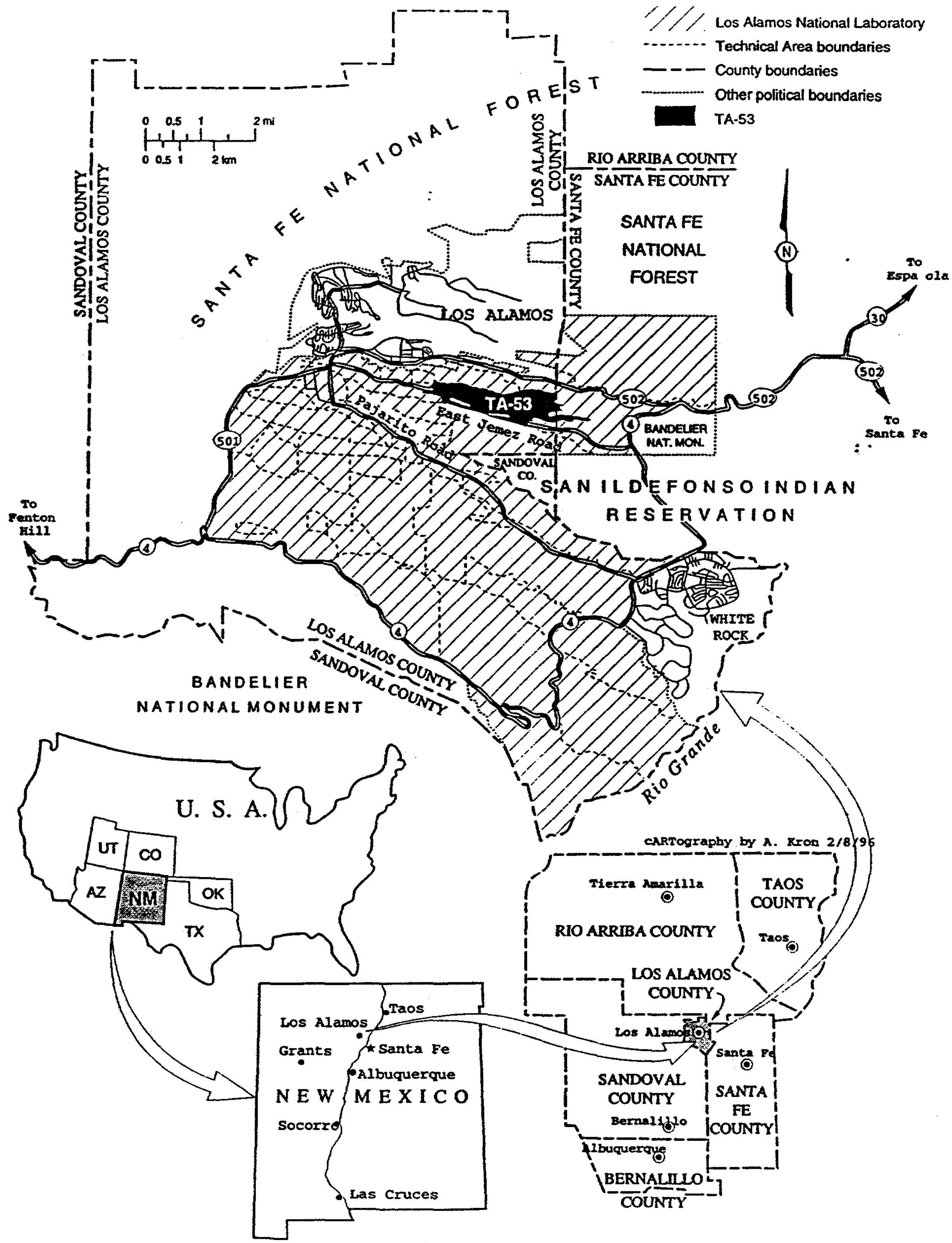


Figure 1. Location of Los Alamos National Laboratory.

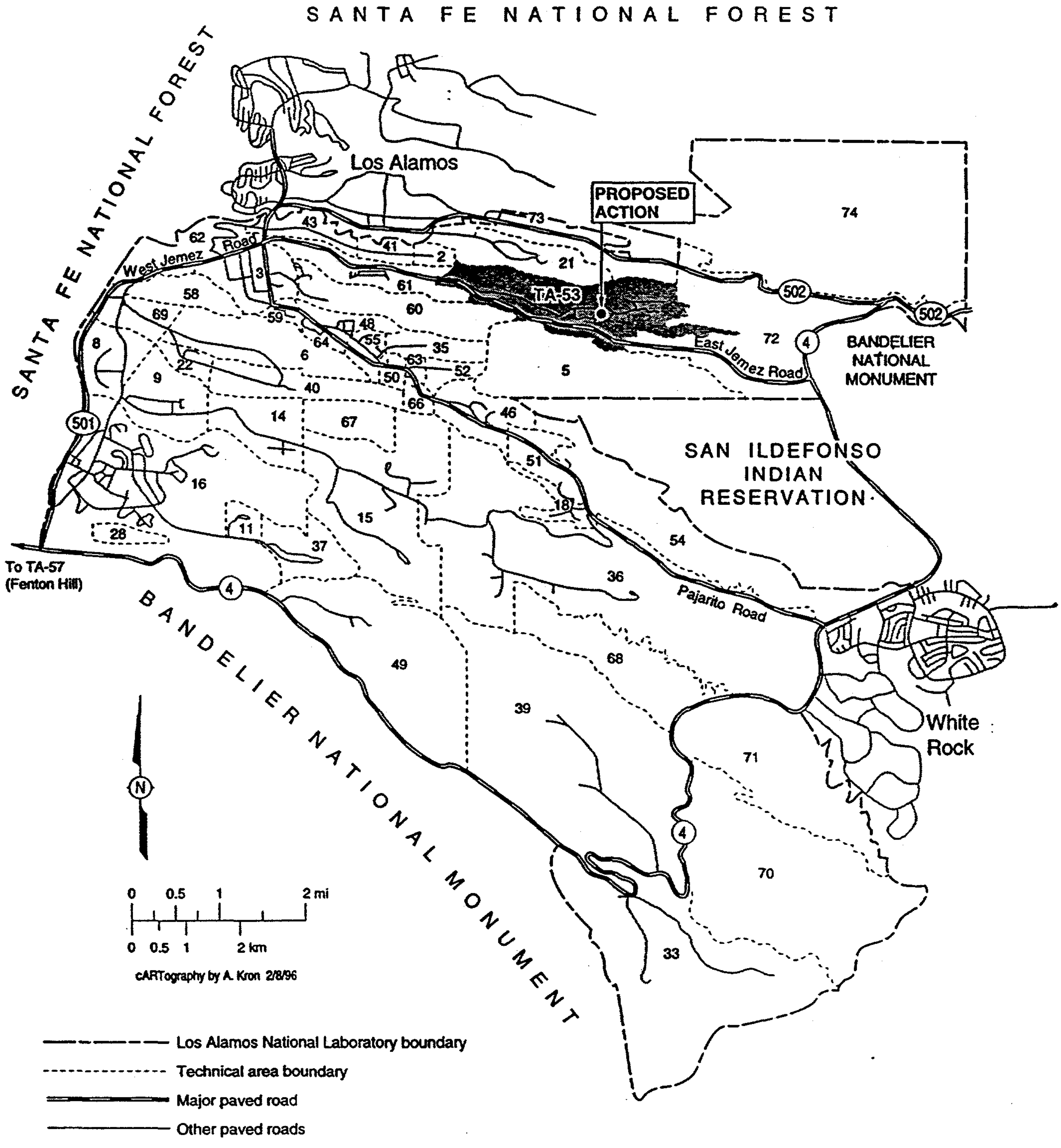


Figure 2. Location of TA-53 and Proposed Action.

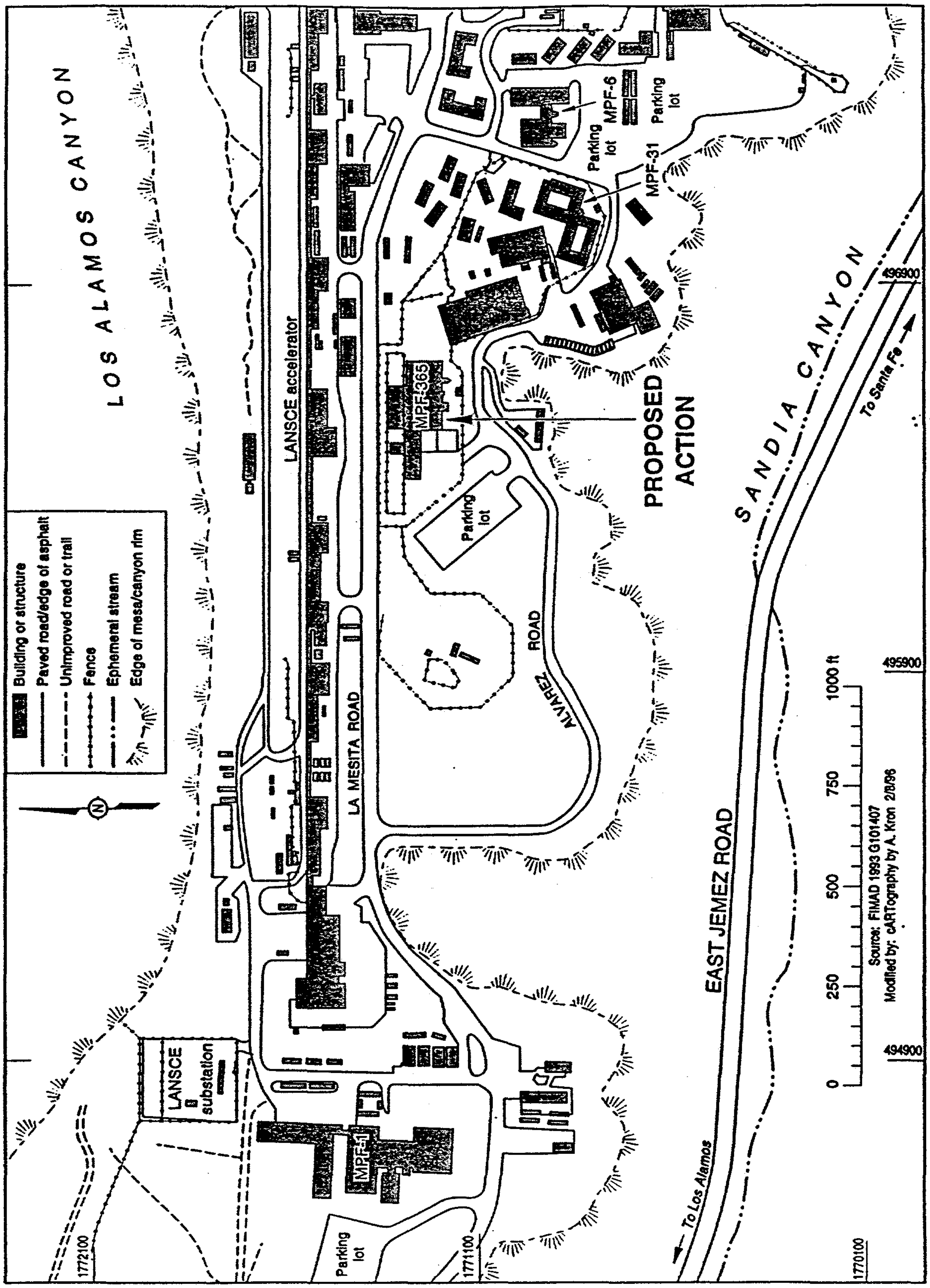


Figure 3. Site of the Proposed Action at TA-53

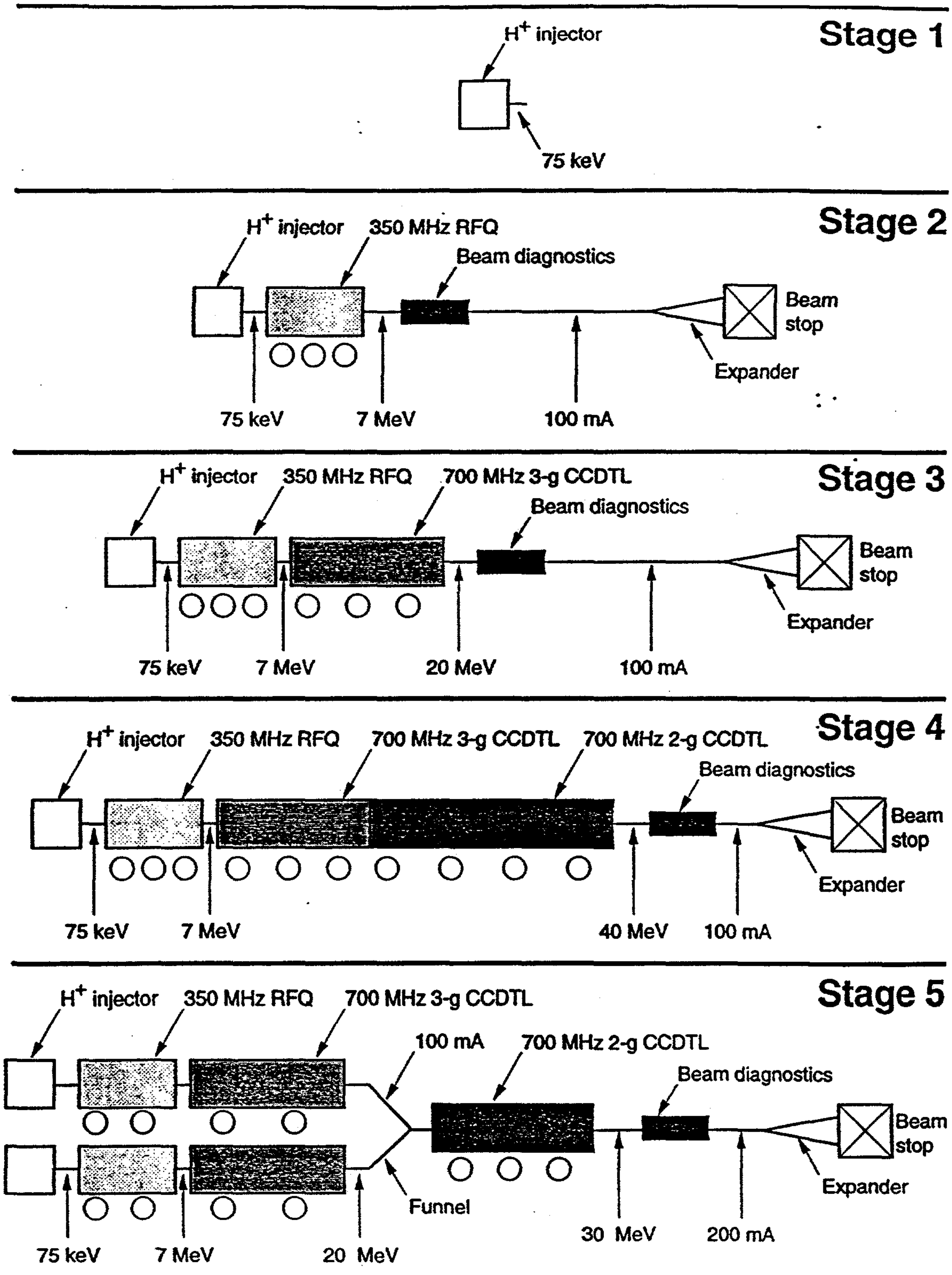


Figure 4. Schematic of LEDA stages.

and in the time-frame required. Stage III would be completed and Stages IV and V would be conducted over the remaining five years of the project. The additional research and development provided by Stages IV and V would be needed to "fine tune" the equipment and its operation before incorporation into the actual production plant. This is why a seven-year project is proposed even though a decision regarding the preferred method will be made two to three years into the life of the project. The alternative not chosen by the Secretary as the preferred alternative will be developed as a backup system to the preferred method. If accelerator production of tritium is not chosen as the preferred method of tritium production over reactor-based tritium production, it will still be developed as a backup system so that the nation does not have to rely solely on a single production system.

Table 2-1: Projected LEDA Stages and Schedule

Stage	Configuration	Proton Beam Energy (MeV)	Proton Beam Current (mA)	Installation Begins*	Experiments Begin*	Expected Duration
Initial Preparation						12 months
I	Injector only	0.075	110	October 1996	April 1997	7 months
II	Injector + RFQ	7	100	April 1997	November 1997	8 months
III	Injector + RFQ + one 20 MeV CCDTL	20	100	March 1998	July 1998	15 months
IV	Injector + RFQ + one 40 MeV CCDTL	40	100	December 1998	October 1999	11 months
V	2 Injectors + 2 RFQs + two 20 MeV CCDTLs + Funnel + another CCDTL	30-40	200	December 1999	September 2000	31 months

*These dates reflect the earliest possible dates.

2.1.2.1 Component Fabrication and Assembly

The new LEDA components would be fabricated in machine shops either at LANL or elsewhere. Some equipment would be recycled from other projects at LANL. Most of the auxiliary equipment needed for the LEDA project (e.g., the computer equipment) would be purchased from commercial firms. The LEDA components would be made from conventional materials (e.g., copper and steel). No nuclear materials (e.g., uranium or plutonium) would be used for the LEDA project.

2.1.2.2 Experiments

Staging the LEDA project would allow development of the apparatus section by section. Beam performance would be established at each stage and computer simulations used in the system designs would be verified. Enough beam diagnostics (e.g., beam-current, beam-profile, and beam-emittance measuring devices) would be installed on the LEDA apparatus to measure and characterize the beam performance. The reliability of the various components would be evaluated by operating the LEDA apparatus for long periods of time (up to nine months of continuous operation). Because of the high power in the beam, it is crucial to limit beam-particle loss as the beam is accelerated. The staged construction of the LEDA apparatus would allow beam loss to be assessed and beam control methods to be developed for each LEDA stage.

In addition, the LEDA project would include development of the radio frequency (rf) power technology necessary for LEDA operation. Development of the 350-MHz and 700-MHz rf power systems would continue at two test stands during all stages of the LEDA project. The two rf test stands would be located in Building MPF-365.

2.1.2.3 Operations

LEDA would be expected to operate up to 6,600 hours per year for the duration of the project (7 years). The accelerator would be turned on and off on a regular basis, perhaps several times per week. Maintenance of the equipment would be done when LEDA is not in use. Maintenance would include periodic routine calibration and diagnostic activities for both safety-related and accelerator-related equipment. Within the LEDA project, reconfiguration of equipment and modifications to the proton source, changes to focusing elements, use of different RFQs and CCDTLs, changes to the funnel and beamstops, and improvements to diagnostics would occur periodically.

<u>Personnel</u>

At any given time, a maximum of 150 individuals would be present in the LEDA facility (Building MPF-365) during operations. Of these 150 individuals, about 100 would be in the facility full-time; the remaining 50 would be in the facility less than full-time. Some LEDA project workers may have offices in nearby office buildings (MPF-6 and MPF-31) (Figure 3). The LEDA project workers would represent less than 25 percent of the current[2] 700-plus work force at TA-53. The development and testing of LEDA would mostly involve staff members and technicians already employed at LANL. Few new personnel would be needed.

Workers would be protected from exposure to radiation by the personnel safety system. Administrative and standard operating procedures would be followed during operations. A hardware interlock system would prevent premature operation of the accelerator. Radiation shielding and the building ventilation system would be used to protect personnel from radiological hazards.

[2] as of January, 1996

2.1.3 Waste Generation

Waste minimization for the LEDA project would be implemented to the extent consistent with good and safe experimental practices. Over the seven-year life of the project, the main hazardous waste stream from operations would involve less than 70 m^3 (2,450 ft^3) of solvents (methanol, acetone, and ethanol) used to clean experimental apparatus. Solvent waste would be collected, staged at a newly designated satellite storage area (SSA), and disposed of through LANL's waste management system.

Heat generated by the LEDA experiments would be dissipated by using cooling water loops and evaporative cooling towers. Cooling water discharged from the final cooling loop to the cooling towers would be "non-contact" treated cooling water. It would not pick up radioactive material nor be activated. The effluent from the cooling towers would contain minerals normal in drinking water plus commercially-available anti-corrosion and scale inhibitor additives. The effluent water would be discharged to the environment, at a temperature of less than 90^0 Fahrenheit (32^0 Celsius), through National Pollutant Discharge Elimination System (NPDES) Outfall 03A-113, which discharges into Sandia Canyon. The peak discharge would be 148 million liters (39 million gal) per year in Stages IV and V. In Stages I through III, peak discharges may range from 13 million liters (3.4 million gal) to 97 million liters (26 million gal) over a one-year period. The total amount of water released through Outfall 03A-113 over the life of the LEDA project would be approximately 708 million liters (187 million gal). The drainage channel of Outfall 03A-113 would be monitored and appropriate erosion controls would be implemented if needed.

The only potentially radioactive liquid from the LEDA project would be activated cooling water from primary cooling loops. This water may contain small amounts of tritium or other activation products. Building MPF-365 would have the capability to contain potentially radioactive liquid. It would be pumped into a tank for holding during monitoring and analysis. Subsequently it would be disposed of properly through the LANL waste management system. Approximately 107,030 liters (28,280 gal) of radioactive liquid would be generated over the life of the project.

Solid low-level radioactive waste (LLW) generated during operation of the LEDA project would be less than 67 m^3 (2,370 ft^3), including the beamstop used for Stage II. Upon completion of the LEDA project, shielding materials, beamstop materials, and various equipment may either be reused in other projects, or used in the full-scale APT plant, or be disposed of as LLW at LANL's TA-54 waste management area at Area G or an appropriate on-site or off-site facility. If disposed of as waste, the LEDA components would constitute about 230 m^3 (8,100 ft^3) of LLW and about 225 m^3 (8,000 ft^3) of other solid waste. Beamstops, shielding, and accelerator structures, however, would be reused if at all possible. Reuse of materials and equipment in projects other than LEDA would be subject to a separate NEPA review.

Construction and demolition debris that would result from building and utility modifications would constitute a volume of about 88 m^3 (3,120 ft^3). The LEDA project would also generate about 196 m^3 (6,920 ft^3) of other solid waste, such as paper and packing materials. An existing water cooling tower that would be removed may contain some asbestos. Asbestos waste (approximately 4.6 m^3 [162 ft^3]) would be removed by trained personnel and staged at TA-54, Area J for shipment to an off-site permitted disposal facility. All other construction debris would be disposed of in the Los Alamos County Landfill.

Decommissioning

The ultimate decontamination and/or decommissioning of the LEDA building would be considered, and a separate NEPA analysis would be prepared when the facility is no longer needed.

2.1.4 Facility (Description, Construction, Modification)

The LEDA project would be located in an existing metal building, Building MPF-365 (Figure 3). Building MPF-365 was originally constructed around 1989 to house the Ground Test Accelerator (GTA) experiment. The GTA program has been canceled, leaving Building MPF-365 available for use. Because it was constructed for similar accelerator research, this building could easily be modified for the LEDA project. A few interior modifications would be required, additional cooling towers would be constructed adjacent to the building, and additional utilities would be run to the building. No major construction would be necessary.

2.1.4.1 Site and Building Description

TA-53 is accessible only to DOE and LANL badge holders and their guests. Operational areas at TA-53 also regulate personnel access for safety reasons. This restricted access would protect members of the public from potential hazards resulting from accelerator operations (e.g., radiation produced while the accelerator is on).

Building MPF-365 is located near other accelerator and support buildings. The land immediately around Building MPF-365 has been cleared and bladed. There are paved parking areas next to Building MPF-365 and southeast of Building MPF-31 (Figure 3) sufficient to accommodate LEDA project personnel.

Building MPF-365 consists of two major parts: a shielded, underground beam tunnel of about 1,500 m^2 (16,200 ft^2) in area, and a conventional four-story, steel-framed building of about 5,000 m^2 (53,800 ft^2) in area. Figure 5A shows the floor plan of Building MPF-365 with Stage IV of the LEDA apparatus in the beam tunnel. Figure 5B shows the building in cross-section, including the existing shielding around the beam tunnel. The building has a shielded control room and is equipped with experimental-equipment wiring. The building heating, ventilation, and air conditioning (HVAC) system allows short-lived radioisotopes to decay in the beam tunnel before the tunnel air is released to the environment through a 25-m (82.5-ft) high-exhaust stack. In addition, Building MPF-365 has limited office space and sufficient laboratory space for support personnel and functions that would be required for the LEDA project.

2.1.4.2 Construction

The existing building electrical power and cooling water utilities at Building MPF-365 are adequate for only Stage I of the LEDA project. Stages II to V would require upgrades of the electrical power capacities (up to 30 mega watts [MW]) and of the building cooling water systems' heat exchange capacity (up to 25 MW), as shown in Table 2-2. Electrical and cooling upgrades would require some construction outside Building MPF-365. All external construction would take place in previously disturbed areas of TA-53. These activities would involve minimal removal of existing vegetation. Trenches for electrical, gas, and cooling water lines

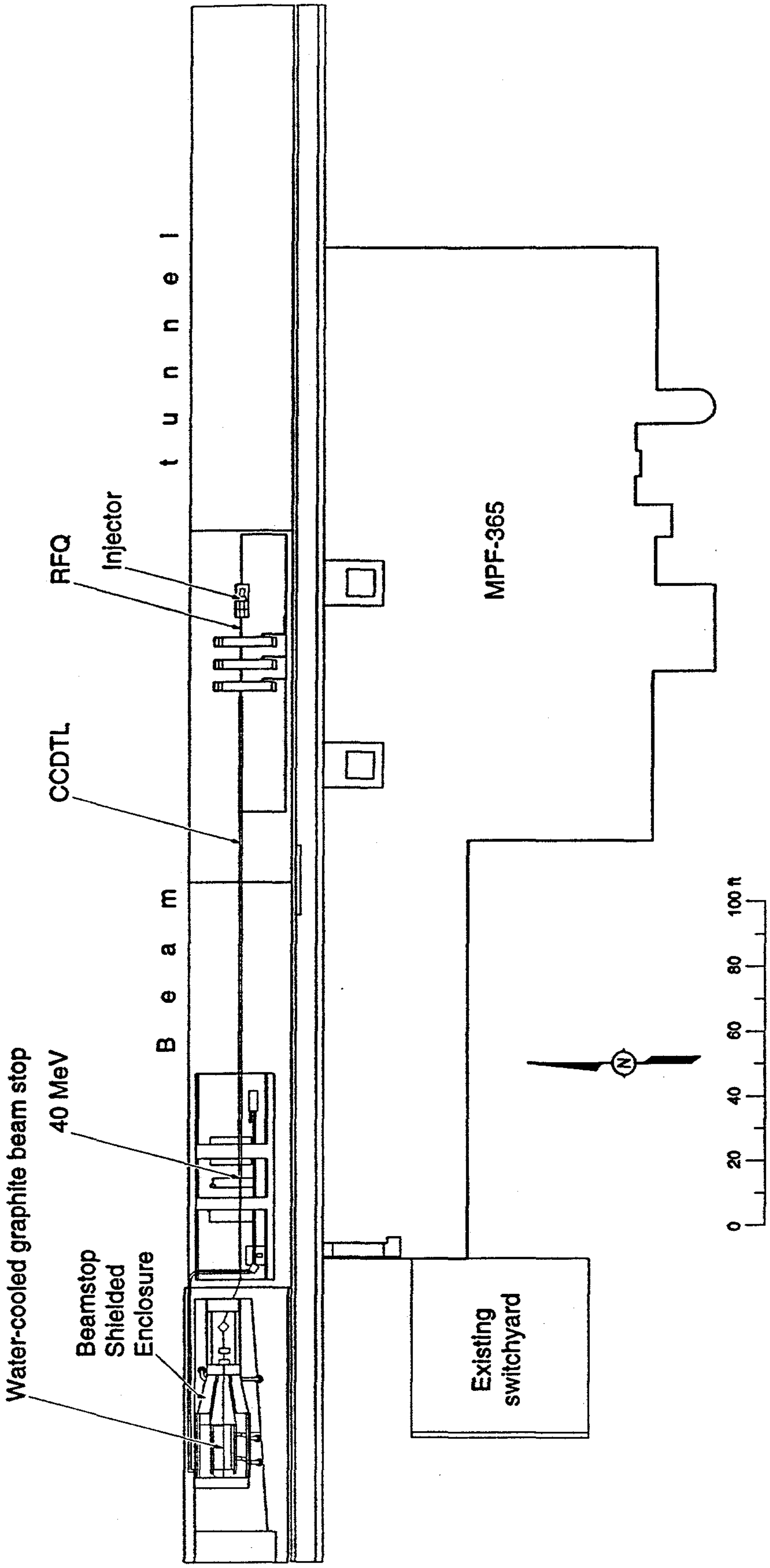


Figure 5A. Outline of Building MPF-365 with Stage IV of LEDA in place.

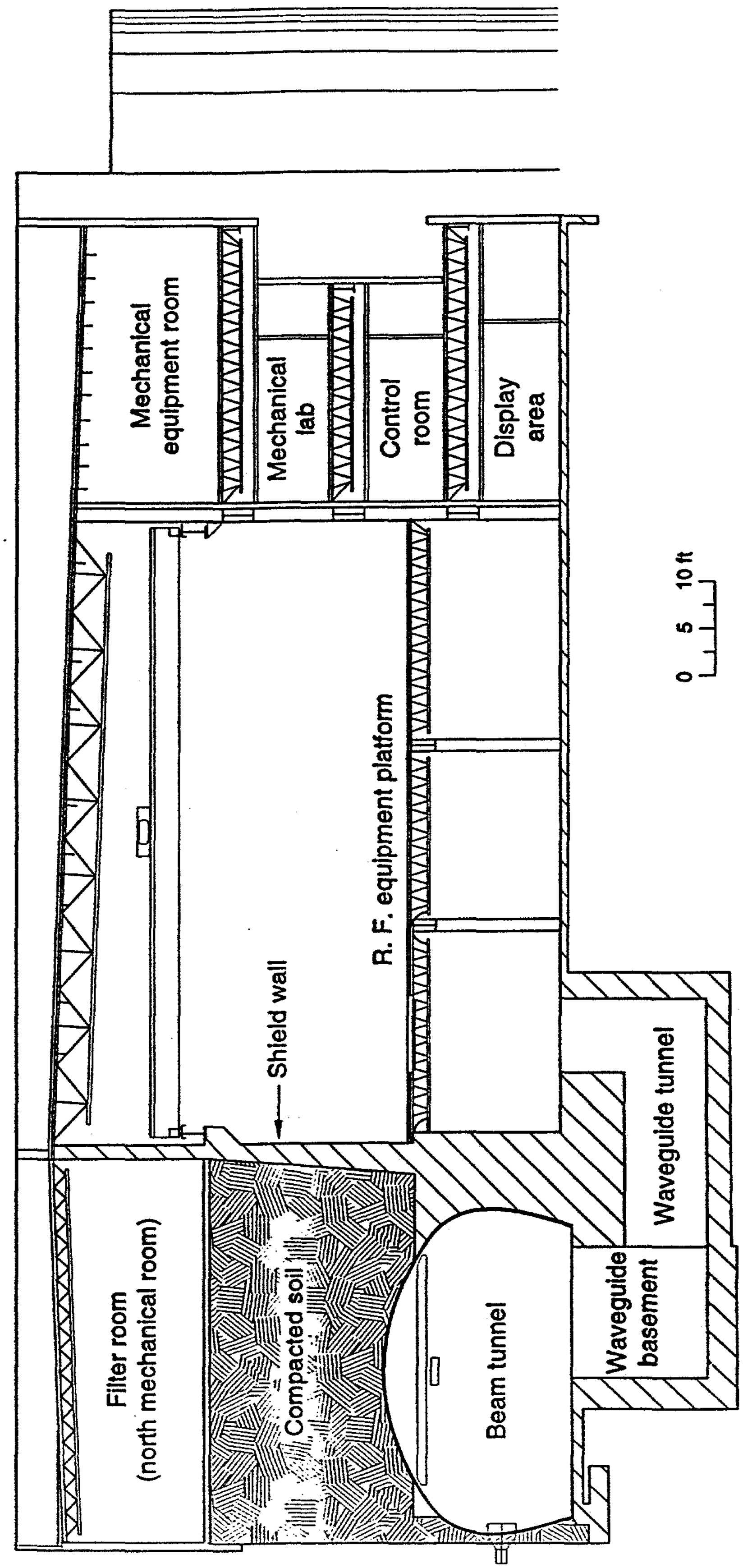


Figure 5B. Cross section of Building MPF-365.

would vary in length but would be about 1.5 m (5 ft) wide and 1.8 m (6 ft) deep for the 13.2-kV ductbanks (arrays of conduits or ducts for electrical wiring) and about 0.9 m (3 ft) wide and 1.2 m (4 ft) deep for low voltage ductbanks, electrical lines, gas lines, and water lines. Erecting sheds to house cooling tower equipment, chiller units, and other equipment may require minor leveling, removal of existing equipment or utilities, pouring concrete foundations, and similar small-scale construction activities. If final designs for the LEDA project indicate that there would be more than 5 acres of ground disturbance, a Stormwater Construction Permit and a Pollution Prevention Plan under NPDES would be required. Exterior walls in Building MPF-365 may be partially removed or penetrated to attach sheds to the main building. Minimal construction inside Building MPF-365 would also be needed to support the LEDA project. Small amounts of demolition and construction debris (88 m^3 [3,120 ft^3]) may be generated during internal and external construction activities. Standard dust suppression measures might be needed occasionally during construction.

Table 2-2: Current Building MPF-365 electrical and water-cooling capacities, and the building electrical and cooling capacities required for Stages I - V of the LEDA project[1].

Capacity (MW)[2]	Current	Stage I	Stage II	Stage III	Stage IV	Stage V
Electrical	6	2.6	9.5	16.7	28.5	28.5
Heat Absorption of Cooling Tower Water	2.9	2.6	8.2	14.0	24.3	24.3

[1] Calculations of required capacity would be refined as design and experiments proceed. Water cooling equipment and electrical power would be installed as needed and would allow for slightly more capacity than current calculations.

[2] Water requirements are specified in terms of the amount of heat (in MW) that needs to be dissipated, rather than in flow (gal/min) or total volume, in order to facilitate comparisons of the electrical power requirements and the amount of heat that needs to be removed by water cooling.

Electrical Upgrades

The LEDA project would require electrical power for operating the accelerator apparatus and for pumping the required cooling water. The transmission lines to TA-53 would not need to be upgraded to support the LEDA project. Currently Building MPF-365 is supplied with electrical power from a feeder line that runs from the existing Los Alamos Neutron Scattering Center (LANSCE) accelerator 13.2-kV ductbank located north of the LANSCE accelerator building (Figure 6A). Portions of this line between the LANSCE ductbank and Building MPF-365 run aboveground; other portions are buried. This feeder line runs through another existing ductbank along the north side of Building MPF-365, then over Building MPF-365 to the existing 13.2-kV switchyard. The present building electrical feeder line is inadequate to supply the power needed for Stages III to V of the LEDA project.

Increasing the Building MPF-365 electrical power supply from 6 MW to as much as 30 MW may require installation of new power lines and one or two higher capacity substations. Three options for providing additional electrical power have been identified. Each of the three options would involve enlarging the existing 13.2-kV switchyard by 185 m^2 (2,000 ft^2) to accommodate equipment to supply the electrical requirements of Stages IV and V and constructing a new 13.2-kV substation along the northwest side of Building MPF-365. Construction of the new 13.2-kV substation would disturb an area less than 1,860 m^2 (20,000 ft^2). All three options would also involve excavating trenches to install new electrical distribution lines. In addition, both Options 1 and 2 would involve enlarging the existing LANSCE 115-kV substation by about 750 m^2 (8,000 ft^2) to accommodate additional step-down transformers for Stages IV and V.

Option 1 (Figure 6A) would make use of the existing LANSCE ductbank located north of the LANSCE accelerator building from which Building MPF-365 currently draws its electrical power. An additional line would be run through an empty conduit in the existing LANSCE ductbank. After exiting the LANSCE ductbank, the new feeder line would parallel the existing one. Like the existing feeder, the new one would have both aboveground and buried portions between the existing LANSCE accelerator ductbank and Building MPF-365. A small amount of trenching (about 100 m, [330 ft]) in disturbed ground would be needed for the underground portions of this line. The new feeder would then be run through a vacant conduit in the existing ductbank along the north side of Building MPF-365 to an existing manhole. From this point, trenches (270 m [900 ft] total) would be excavated to bury electrical cables between the manhole and the new 13.2-kV substation.

Option 2 (Figure 6B) would allow additional 13.2-kV lines to be added as the electrical requirements of the LEDA project increased. It would involve installing a new underground ductbank with a capacity of six electrical conduits within the existing utility corridor that runs along La Mesita and Alvarez roads from the existing LANSCE substation. A more direct route along La Mesita Road could be selected instead of the route shown in Figure 6B. The new ductbank would be installed in the disturbed ground parallel to or underneath the roadbeds. The trench for the ductbank would be approximately 1,000 m (3,300 ft) long. Short trenches (about 120 m long [400 ft]) would be excavated to connect the new ductbank with the LANSCE substation and with the new 13.2-kV substation.

Option 3 (Figure 6C) would provide full capacity for the LEDA project's electrical requirements through Stage V. Under Option 3, new 115-kV overhead electrical lines would be run from the existing LANSCE substation to a new 115-kV substation that would be constructed west of Building MPF-365. Approximately 490 m (1,600 ft) of 115-kV line would be run from the LANSCE substation, north of the LANSCE accelerator, then over the LANSCE-accelerator building and La Mesita Road to the new 115-kV substation. Depending on the specific design of the line, as many as 10 stanchions would be required to support the line between the existing LANSCE substation and the new 115-kV substation. Each stanchion would occupy an area of about 60 m2 (650 ft2); a surface area of approximately 0.06 hectares (ha) (0.15 acres) for all 10 stanchions would be leveled and cleared. The power line corridor would be approximately 31 m (100 ft) wide. A maximum of about 1.5 ha (3.7 acres) of moderately to highly disturbed ground would be modified for the power line installation. The new 115-kV substation would be located within 0.2 ha (0.5 acres) of previously disturbed ground west of Building MPF-365. The

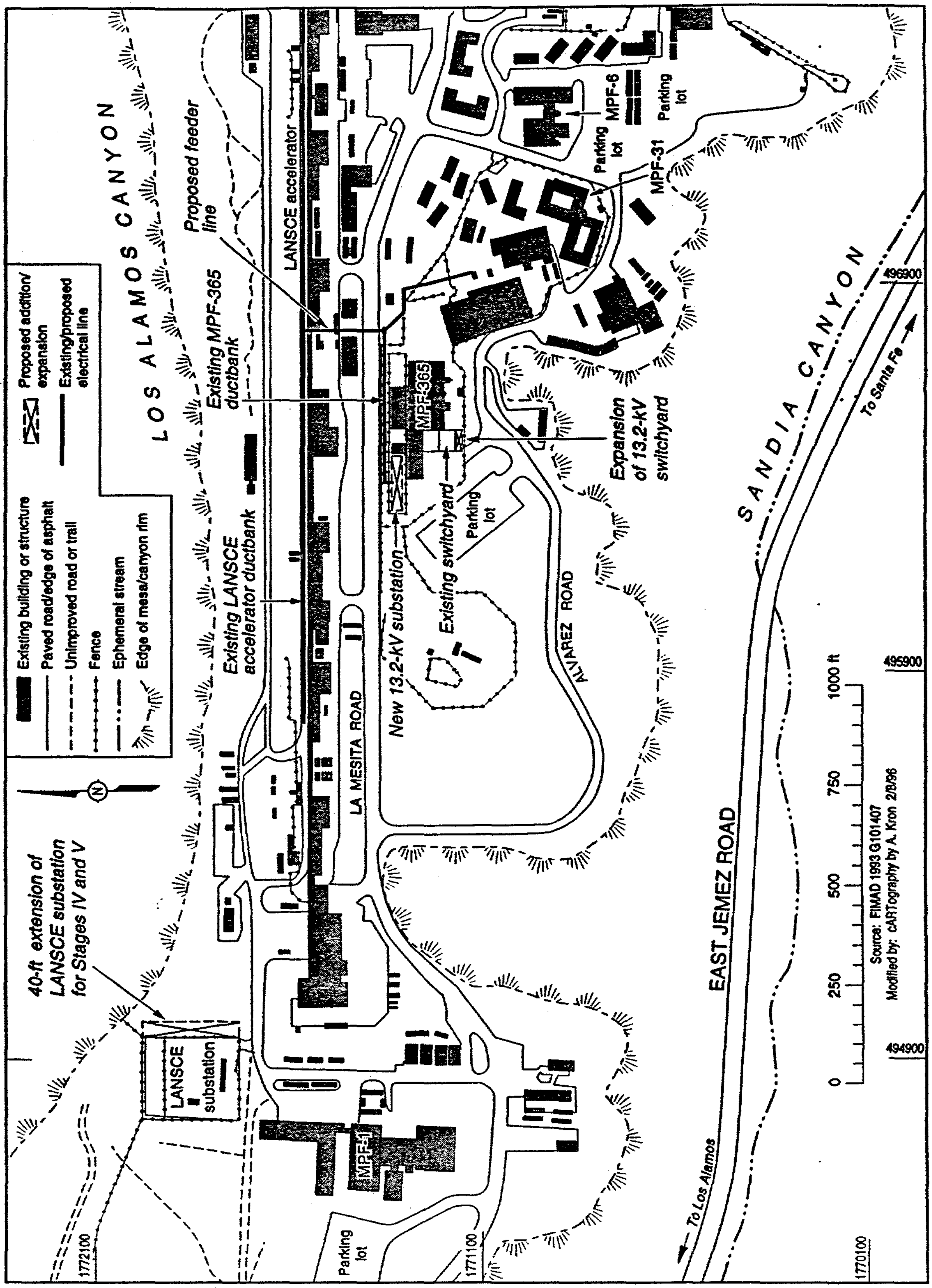


Figure 6A. Additions to electrical distribution system required for LEDA, Option 1.

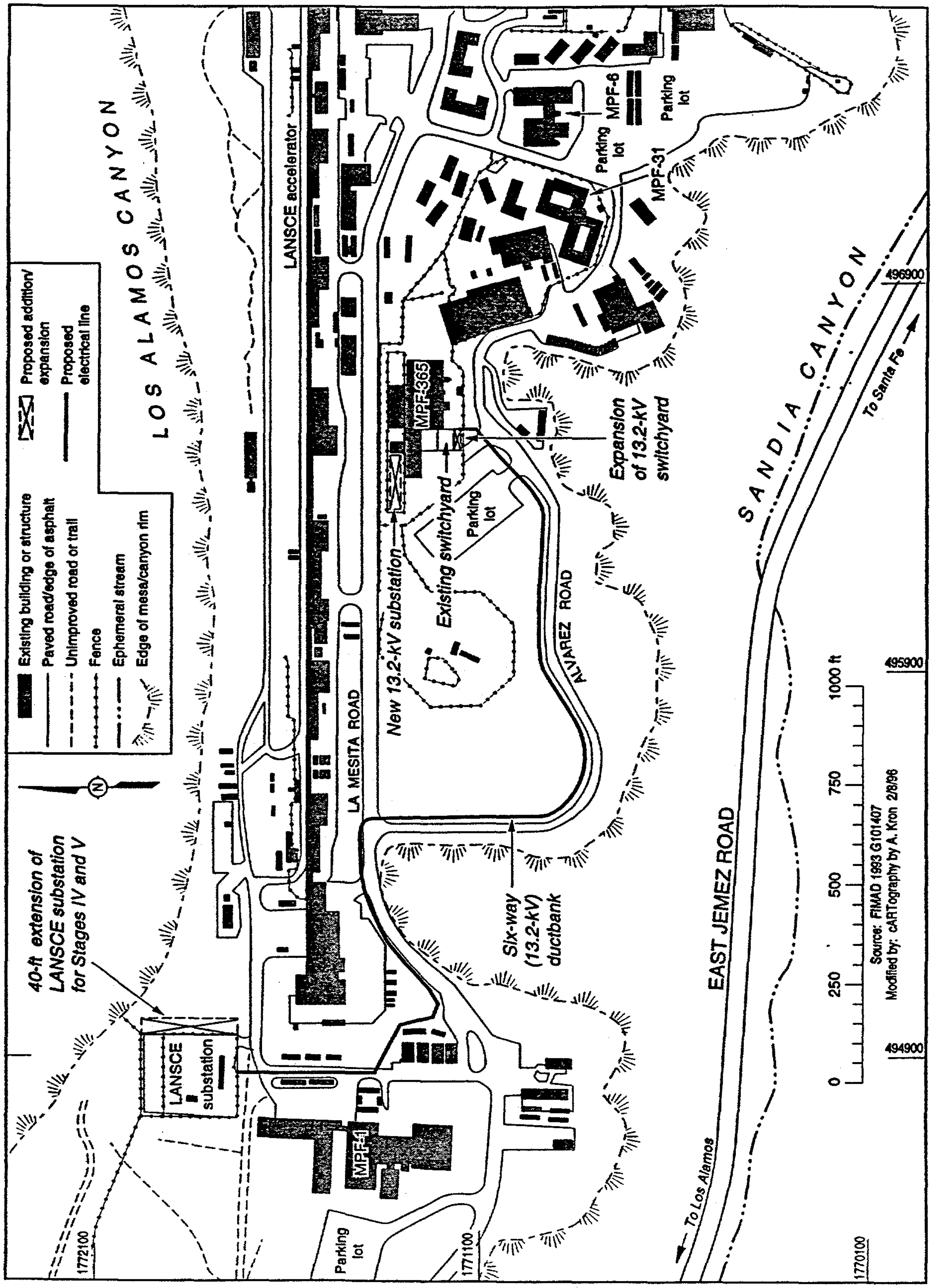


Figure 6B. Additions to electrical distribution system required for LEDA, Option 2.

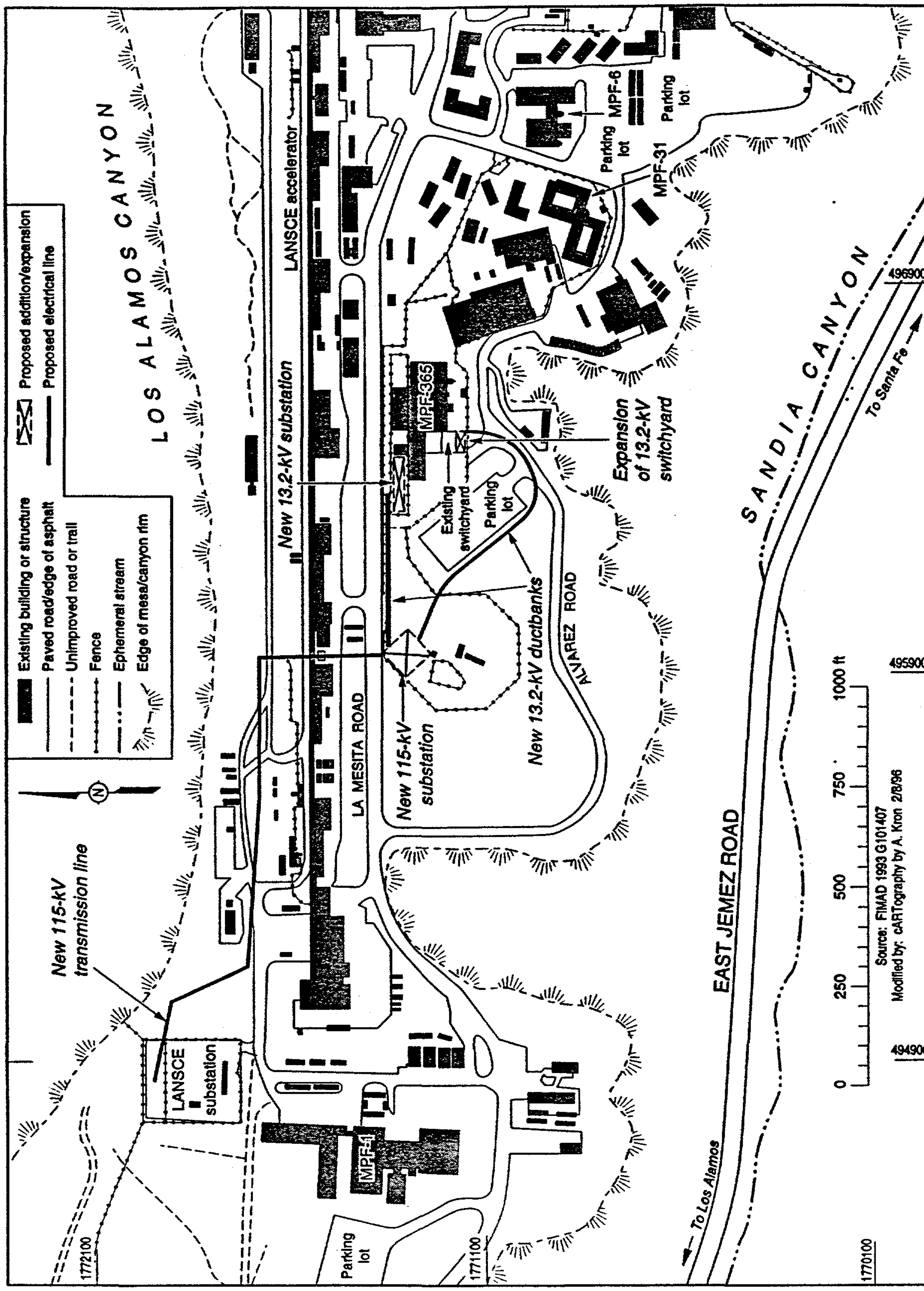


Figure 6C. Additions to electrical distribution system required for LEDA, Option 3.

electrical voltage would be stepped down to 13.2 kV at that substation and then 13.2-kV power lines would be run through two new underground ductbanks, one to the expanded, existing 13.2-kV switchyard and one to the new 13.2-kV substation. Trenches totaling about 365 m (1,200 ft) in length would be needed to accommodate these new 13.2-kV ductbanks.

Under Option 1, Stages II and III could be run without modification to the existing ductbanks. Even with these modifications, Option 1 may not be sufficient for Stages IV and V. If the LEDA project proceeds to Stage IV, Option 2 or 3 may need to be implemented.

Approximately 20 persons working full-time for four months would be required for electrical upgrade installation under any option.

Cooling Water Upgrades

The LEDA and beamstops would be equipped with a closed-loop water cooling system. The beamstop primary cooling loop water could become activated. Heat produced in the beamstop would be transferred to the primary cooling loop. Heat would then be transferred in a heat exchanger to the intermediate cooling loop. The intermediate cooling loop would transfer heat to a third and final cooling loop which would then release heat to the atmosphere through evaporative cooling towers. Because each cooling loop is self-contained, or closed, water would not move between the different loops as heat was transferred from one to the other. Heat exchangers are required for transferring heat from the primary cooling loop to the intermediate cooling loop and from the intermediate cooling loop to the final cooling loop. The existing Building MPF-365 equipment room would need to be expanded by approximately 110 m^2 (1,200 ft^2) to accommodate these heat exchangers and their associated equipment. This building extension would require such activities as putting in a foundation and enclosing the space.

The existing cooling tower has sufficient cooling capacity (2.9 MW) for Stage I of the LEDA project. Stages IV and V would require approximately 25 MW of cooling capacity. Increasing the Building MPF-365 water cooling capacity from the existing capacity of 2.9 MW to 25 MW would require running new water lines from the existing TA-53 water main and erecting five new 5-MW modular cooling towers adjacent to Building MPF-365 as shown in Figure 7.

During the progression of the project, one or two cooling tower modules would be installed east of Building MPF-365 (replacing the existing 2.9-MW cooling tower), followed by three or four more cooling tower modules west of Building MPF-365. An existing 2.9-MW cooling tower would be removed. Two small sheds (one about 95 m^2 [1,000 ft^2], one about 170 m^2 [1,800 ft^2]) would be constructed to house the cooling-tower equipment. These sheds would house natural gas-fired boilers to prevent water in the new cooling towers from freezing up. Trenches about 90 m (300 ft) long for natural gas lines would be excavated. Initially the cooling tower sites would be cleared of any obstructions and the trenches excavated and the piping installed at one time. A 60 m (200 ft) trench would be excavated between the TA-53 water main and the western cooling towers to install a new water distribution line. A 200 m (650 ft) trench for the waterlines would also be excavated between the western cooling towers and Building MPF-365. The eastern cooling towers would make use of existing water lines, but a new line for additional supply water may also be needed. This new supply line would require

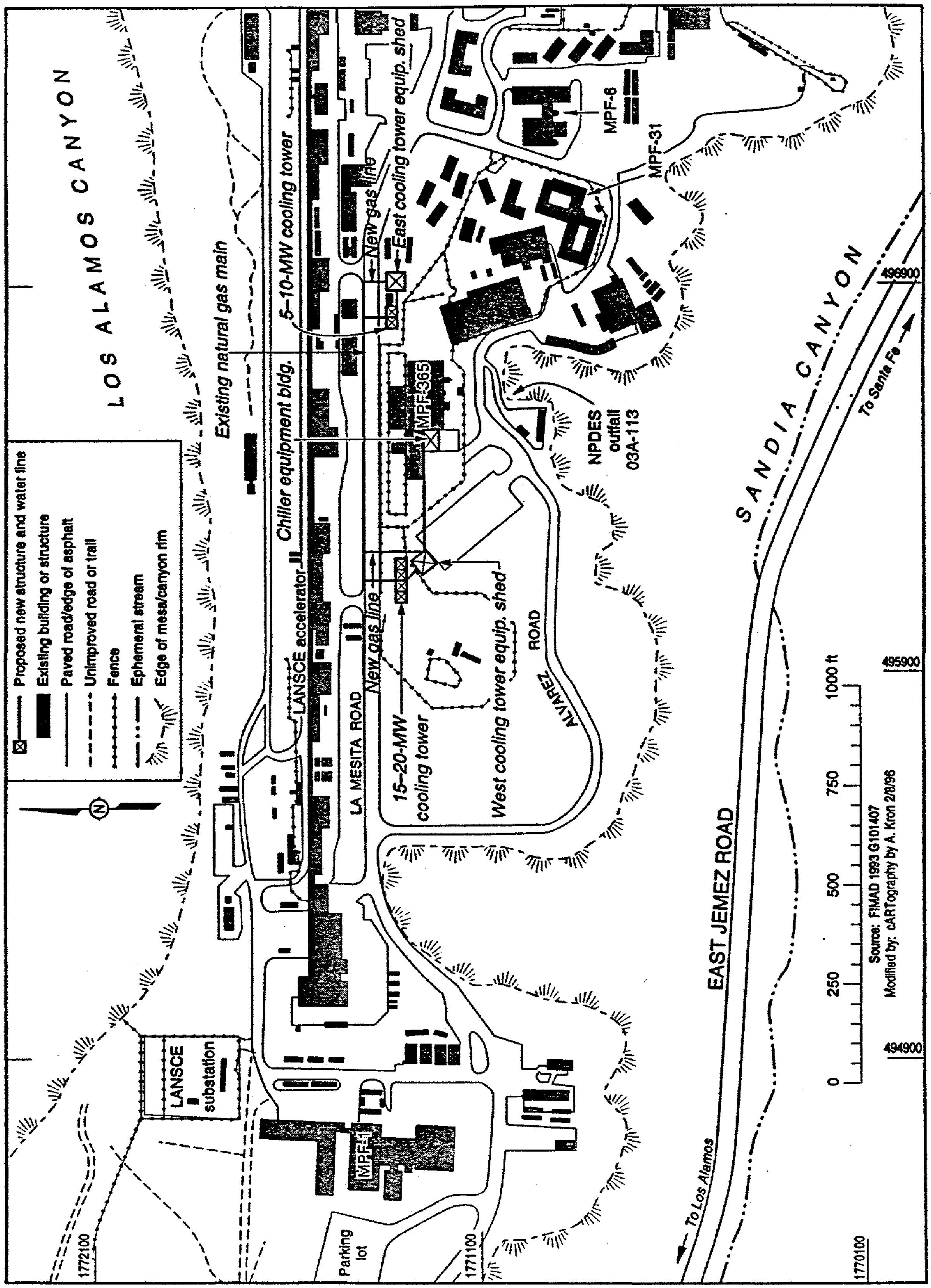


Figure 7. Additions to water distribution system required for LEDA.

trenching along the existing supply waterline to install about 30 m (100 ft) of new water pipe. Construction of the western cooling towers would be contained in an area of about 0.2 ha (0.5 acres); the eastern cooling towers would replace the existing cooling tower and would occupy an area of about 0.1 ha (0.25 acres).

The cooling loops and cooling towers would be used to cool the LEDA beamstops and some of the LEDA equipment. In addition, the LEDA facility also would require some chilled water units for the accelerator structures themselves. A small shed (about 140 m^2 [1,500 ft^2] in area) would be erected against the south side of Building MPF-365 to house the chillers.

Cooling water upgrades would require approximately 20 construction personnel and would be completed within 12 months.

Interior Modifications

Minimal construction would be needed inside Building MPF-365 to provide for the LEDA project. The proposed LEDA project would require interior structural reinforcements to the mezzanine floor in Building MPF-365 to support rf-power equipment.

The LEDA beamstops would be selected to absorb energy and to minimize incidental radioactivity. The beamstop required for Stage II would be located in a shielded vault in the tunnel 3 to 20 m (10 to 64 ft) from the LEDA apparatus. The beamstop needed for Stages III–V would be located in a shielded vault at the west end of the beam tunnel (see Figure 5A). These shielded vaults would be constructed with magnetite-loaded concrete shielding blocks and would be about 12 m (39 ft) long by 5.2 m (17 ft) wide by 5.2 m (17 ft) high. Diagnostic stations would be installed at various points along the accelerator. These stations may be shielded by concrete-block walls to protect equipment or to improve signal-to-noise ratios.

Approximately 30 construction workers would complete the jobs within 9 months. A maximum of 28 m^3 (1,000 ft^3) of construction debris could be generated by interior construction activities.

Transportation of Materials

The building materials and equipment would be brought to TA-53 by truck. About 50 trips would be required to bring construction materials to the site and remove demolition debris. These shipments would include cooling tower equipment, water pumps, heaters, chemical treatment equipment, electrical switchgear, accelerator system components and other project equipment that would be shipped under Department of Transportation (DOT) regulations.

An injector that would be used in the first stage of the LEDA project is presently in an adjacent building and would be moved to Building MPF-365 at the beginning of the LEDA project.

2.1.5 Foreseeable Related and Future Actions

The LANL Site-Wide Environmental Impact Statement (SWEIS), currently being prepared, will address cumulative effects for all LANL operations including those that could result from a decision made regarding the subject of this EA. A ROD for the LANL SWEIS is expected in the spring of 1997. Delaying the proposed project until the LANL SWEIS is completed could result in unacceptable program risks; DOE has therefore determined that the NEPA analysis of the proposed action should continue in parallel with the LANL SWEIS process. It would neither influence nor be influenced by the LANL SWEIS.

The DOE had earlier identified a need to advance the technology of the low-energy end of a linear accelerator system. An EA (DOE/EA 0969) was published in April 1995, analyzing the environmental effects of constructing a building and performing that research at LANL (DOE 1995b). A FONSI was signed on April 17, 1995. The Low-Energy Accelerator Laboratory (LEAL) was planned for construction about 150 m (450 ft) southwest of Building MPF-365 (the proposed location for the LEDA project). The LEAL prototype accelerator would not have the same characteristics as LEDA. At present, LEAL construction has not been funded and the project is currently on hold.

LANSCE (previously called the Los Alamos Meson Physics Facility [LAMPF] or the Clinton P. Anderson Meson Facility), which is the main accelerator facility at LANL, is also located at TA-53, north of the proposed project location (Figure 3). This facility will continue to be operated. Upgrades and some reconfigurations are being considered for LANSCE, but are still in the early planning stages and are not yet ready for decision. Upgrades or reconfigurations of LANSCE, if DOE decided to proceed, would not affect, or be affected by, the proposed action.

2.2 NO ACTION ALTERNATIVE

The No Action Alternative is not to modify Building MPF-365 and not to conduct the LEDA project at LANL. If the full-scale APT accelerator is constructed at SRS, the technology demonstrations and risk reduction programs would not be available. At LANL, Building MPF-365 would be underutilized, as it is now, since the GTA program was terminated.

The feasibility of a prototypic low-energy, front-end of the APT accelerator must be demonstrated within the next three years in order to facilitate the Secretary's scheduled 1998 decision to select the primary production option for tritium production. Failure to meet this schedule would mean that the Secretary of Energy could not make an informed decision about the tritium production options in 1998. Therefore, this alternative does not meet DOE's purpose and need for action. It is analyzed in this EA to provide a baseline for comparison with the proposed action.

2.3 ALTERNATIVES CONSIDERED BUT NOT ANALYZED

2.3.1 Conduct the LEDA Project At An Alternative Location at LANL

DOE considered locating the LEDA project in another location at LANL. However, no other facility of the required size and configuration was identified that was unoccupied and uncommitted to other mission functions.

A new facility could be constructed at LANL. However, the environmental impacts of developing an undisturbed site, the delay in schedule, and the cost of constructing a new building all exceed those of the proposed action. New construction, as opposed to modifying an existing building, would not conform to the Secretary of Energy's Land and Facility Use policy, issued in 1994, directing DOE to manage land and facilities as valuable national resources. New construction would generate fugitive dust from construction and truck exhaust fumes from transporting building materials and would consume raw construction materials. Under this alternative, Building MFP-365 would continue to be underutilized, as it is now, and additional land area would be built upon. This alternative was not considered to be a reasonable alternative to meet the DOE's purpose and need and was not considered further in this EA.

2.3.2 Conduct the LEDA Project At Another DOE Facility

Locating an accelerator technology development project equivalent to LEDA at another DOE site would not offer any advantage to performing the work at LANL. DOE considered locating the LEDA project at SRS or at Nevada Test Site (NTS) in Nevada. These sites were considered because potential environmental impacts of the full-scale APT plant analyzed in the final TS&R PEIS appeared to be least at these sites. Neither SRS nor NTS have a readily available building of the appropriate size and configuration with the necessary utilities to support the LEDA project.

The conclusions of a DOE siting study conducted by Fluor Daniel, Inc. comparing NTS and SRS concluded that locating LEDA at either of these sites would be technically feasible (FDI 1995). Both of these facilities have buildings that could be modified to accommodate LEDA and much of the necessary infrastructure including utilities exists at both sites. However, the time estimated to modify buildings at these sites would take 1 to 2 years more than at LANL's proposed site at TA-53, and the estimated costs of the modifications (several tens of millions of dollars) were much higher than LANL's costs (about 15 million dollars). The LEDA research and development program would not be started as scheduled, and DOE's schedule for determining the primary option for tritium production (October 1998) would be compromised.

This alternative was considered unreasonable to meet DOE's purpose and need for action and was not developed further in this EA.

2.3.3 Alternative Technology

Two alternative accelerator technologies (cyclotrons and induction linacs) have been evaluated for producing the Stage IV (40-MeV, 100-mA average current) or Stage V (30-MeV, 200-mA average current) proton beams that are needed to meet DOE's purpose and need.

A cyclotron capable of producing a maximum average beam current of 10 mA may be developed within the next 10 years (current maximum levels are less than 2 mA). However, the maximum average beam current required for APT development is at least 100 mA. Induction linacs are pulsed power accelerators inherently unsuited to the high-average-power requirements of APT development. Some proton induction linacs may be capable of producing peak beam currents and energy similar to what is required for APT development, but they are not able to sustain the high-average current required. In addition, if used in an APT plant, the energetic pulses from an induction linac could damage or destroy the target.

Therefore, both cyclotron and induction linac technology have been eliminated as reasonable alternatives for meeting DOE's purpose and need for agency action. They are not considered further in this EA.

3. AFFECTED ENVIRONMENT

3.1 GENERAL SETTING

The general location of LANL within Los Alamos County and New Mexico is shown in Figure 1. The TA-53 site is within a developed area with many similar activities grouped within the same ecological environment.

LANL is a DOE facility located on 111 square kilometers (km^2) (43 square miles [mi^2]) of land in Los Alamos County in north-central New Mexico, approximately 100 km (60 mi) north of Albuquerque. LANL is on the Pajarito Plateau, a series of mesas and canyons, at an elevation of about 2,200 m (7,200 ft) above sea level. Los Alamos has a semiarid, temperate mountain climate with about 45 centimeters (18 inches) of annual precipitation. Detailed descriptions of LANL environs, its climatology, meteorology, hydrology, cultural resources, floodplains, wetlands, and threatened and endangered species are presented in the 1979 Final EIS for Los Alamos Scientific Laboratory Site (DOE/EIS 0018) (DOE 1979) and in the annual environmental surveillance report (see LANL 1995). LANL supports an ongoing environmental surveillance program, as required by DOE orders (DOE 1981, 1988). This program includes routine monitoring programs for radiation, radioactive emissions and effluents, and hazardous materials management at LANL. Relevant site information is summarized beginning in Section 3.2.1.

In 1995, Los Alamos County had an estimated population of approximately 18,180 (based on the 1990 US census adjusted to July 1, 1995). Two residential and related commercial areas exist in the county. The Los Alamos townsite has an estimated population of 11,400. The White Rock area, including the residential areas of White Rock and Pajarito Acres, has about 6,800 residents. About one-third of the 7,550 people employed by the University of California at LANL commute from other counties. The 1990 census conducted by the US Census Bureau indicates that approximately 215,000 people live in Los Alamos County and the adjoining counties of Rio Arriba, Santa Fe, and Sandoval.

The principal population centers within an 80-km (50-mi) radius of LANL are Santa Fe, Española, and the Pojaque Valley. About 12, 250 people (LANL 1995) are employed at LANL and live within 80 km (50 mi) of LANL.

Fourteen pueblos and Native American reservations are located within an 80 km (50 mi) radius of LANL. The populations of the four closest pueblos are as follows: San Idelfonso Pueblo has a population of 1,499; the Santa Clara Pueblo has a population of about 3,000; the Cochiti Pueblo has 1,342 people; and the Jemez Pueblo has 1,750 people (Commerce 1991).

3.2 POTENTIAL ISSUES

Table 3-1 lists potential issues and whether they are analyzed in this EA.

Table 3-1: Potential Environmental Issues

Potential Issue	Applicability	Described in Section
Utility Demands		3.2.1
Air		3.2.2
Human Health		3.2.3
Environmental Restoration		3.2.4
Waste Management		3.2.5
Transportation		3.2.6
Water		3.2.7
Threatened and Endangered Species		3.2.8
Wetlands		3.2.9
Cultural resources		3.2.10
Environmental Justice		3.2.11
Socioeconomics	NA - minimal or no change in regional socioeconomic conditions	
Floodplains	NA - none of the alternatives would take place in a floodplain	
Wild horses and burros	NA - none present at LANL	
Wildlife	NA - within existing building; activities outside building occur in already disturbed areas	
Noise	N/A - within industrial developed area /inside existing building	
Aesthetics	NA - *in existing facilities or in/or* adjacent to developed areas	
Coral reefs and tundra	NA - none present at LANL	
Prime farmland	NA - none present at LANL	
Wild and scenic rivers	NA - none present at LANL or bordering LANL	
Geology/Seismology/Soils	NA - within existing building or in /or adjacent to disturbed or developed areas	
Parks, forests, conservation areas, areas of recreational, ecological, or aesthetic importance	NA - within existing building or in /or adjacent to disturbed or developed areas	
Land Use	NA - no change from current industrial use	

3.2.1 Utility Demands

Electrical Usage

DOE draws electrical power for LANL's operations from the Los Alamos Area Electric Distribution System and also generates additional electrical power at TA-3 from natural gas-fired steam turbines at LANL's Steam Power Plant. LANL's annual electrical usage (including TA-53) between 1990 and 1995 has been between about 352,000 and 393,000 MW-hours/yr and averages 373,088 MW-hr/yr. During the same period, TA-53's usage varied between 80,000 and 103,000 MW-hr, or approximately 23 to 27 percent of LANL's total usage (Hinrichs 1995).

Natural Gas

DOE supplies natural gas for LANL's usage and for Los Alamos County. LANL uses natural gas to run the TA-3 Steam Power Plant, other steam and boiler facilities, water pumps, and similar support operations. The TA-3 Steam Power Plant operates 24 hours/day (hr/dy) to produce steam for heating and industrial uses and is the single largest contributor to LANL's natural gas usage. Daily steam production at the TA-3 Steam Power Plant consumes a relatively constant amount of natural gas. When the Steam Power Plant is also generating electricity, gas consumption increases in proportion to the electrical demand. Gas consumption for electrical power production varies widely from year to year. Between 1993 and 1995, LANL used approximately 43 to 53 million m^3 (1,513 to 1,862 million ft^3) of natural gas annually, most of it for steam production.

On average, LANL has used 47.9 million m^3 (1,692 million ft^3) of natural gas annually. The TA-3 Steam Power Plant used approximately 11.5 million m^3 (406 million ft^3) in 1993, 6.9 million m^3 (245 million ft^3) in 1994, and 1.6 million m^3 (57 million ft^3) in 1995 for electrical power generation.

Water

DOE has rights to withdraw 6.8 billion liters (1.8 billion gal, 5,540 acre-feet) of water from the main aquifer annually. From this allotment, DOE supplies all water requirements of LANL and Los Alamos County. The county consumes about two-thirds of the water used in any given year. During calendar year 1994, the DOE drew 5.5 billion liters (1.46 billion gal) from these wells. This amounts to about 81 percent of the DOE's annual allotment. LANL's use has been nearly constant at about 1.9 billion liters (500 million gal) annually. TA-53 (LANSCE) annually uses about 292 million liters/yr (77 million gal/yr), about 15 percent of LANL's yearly usage or about 5 percent of DOE's annual usage.

3.2.2 Air

Non-radioactive Air Emissions

Information on non-radioactive air emissions from LANL is summarized in the annual surveillance report (LANL 1995) and in LANL's 1990 Non-Radioactive Air Emission Inventory. Currently LANL operations emit approximately 589 kg (1,298 lbs) of methanol and 2,214 kg (4,881 lbs) of acetone annually. Ethanol emissions are not reported separately.

LANL's current emissions of criteria air pollutants—nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), and volatile organic compounds (VOCs)—are based on estimates for the Laboratory's major sources of these emissions. LANL's major sources include the TA-3 Steam Power Plant, the TA-16 Steam Plant, the TA-21 Steam Plant, the TA-3 Asphalt Plant, and a natural gas-fired water pump at Pajarito Well No. 4 (PM-4). These sources account for approximately 34 million m^3 (1,200 million ft^3) of natural gas consumption, 71% of LANL's total annual natural gas consumption averaged over the last 5 years (47.9 million m^3 [1,692 million ft^3]). There are other sources of criteria pollutant emissions from natural gas combustion at LANL, but these sources cannot be readily quantified and their emissions are considered negligible in comparison. Therefore, their emissions are not included in the emissions total for LANL. The total annual emissions of criteria air pollutants from the major sources in tons/yr are listed in Table 3-2. These emission estimates are based on average annual fuel consumption and production data for LANL's major sources over the last 5 years. These emissions do not exceed applicable ambient air quality standards.

Radioactive Air Emissions

Routine operations at LANL produce radioactive air emissions. Information on these LANL emissions is summarized in the Laboratory's annual surveillance report (LANL 1995). In 1994 LANL operations emitted 5.15×10^4 Curies (Ci) of radionuclides into the air (LANL 1995). Facilities located at TA-3, 16, 21, 33, 41, and 53 contributed the majority of these radioactive air emissions. The effective dose equivalent (EDE) to LANL's nearest public receptor from 1994 point source and non-point sources was 7.62 millirem (mrem). The public dose for 1994 was below the EPA's annual radioactive air emission limit of 10 mrem. LANL operations are expected to continue to emit approximately the same quantity of radioactive air emissions as in 1994. LANL closely monitors the routine emissions of TA-53 and the other major radioactive air emitting facilities to ensure that Environmental Protection Agency (EPA) air standards are not exceeded.

3.2.3 Human Health

Background radiation is ionizing radiation originating from sources other than routine LANL activities. This background may include cosmic radiation; external radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; and internal radiation from naturally occurring radioactive elements in the human body.

Table 3-2: Total Annual Criteria Pollutant Emissions from Natural Gas Combustion at LANL

Year	Emissions (ton/yr)				
	NOx	CO	SO_2	PM	VOC
1991	82.8	22.4	0.26	2.3	0.93
1992	123.8	32.1	0.41	3.8	1.3
1993	139.5	36.2	0.47	4.0	1.4
1994	117.1	30.5	0.39	3.3	1.2
1995	87.8	23.4	0.30	4.2	1.3
Annual Average	110.2	28.9	0.37	3.5	1.2

EDEs from natural background sources are estimated in order to provide a comparison with doses resulting from LANL operations. The total effective dose equivalent from natural sources is 342 mrem/yr and 327 mrem/yr at Los Alamos and White Rock, respectively. The average dose to residents in Los Alamos townsite attributable to LANL operations in 1993 was 0.15 mrem. The corresponding dose to White Rock residents was 0.03 mrem (LANL 1995).

All LANL worker exposures to radiation under normal operations is controlled under established procedures that require doses to be kept as low as reasonably achievable (ALARA), and that limit any individual's dose to less than 5 rem/yr (5,000 mrem/yr) (DOE 1994). LANL's goal is to keep any individual's dose to less than 2 rem/yr.

The nearest place to TA-53 that is continuously inhabited by a member of the public is a single trailer located across a deep canyon to the northeast at the LANL boundary approximately 1,524 m (5,000 ft) from TA-53. This site is referred to as the East Gate location. The nearest public access road, East Jemez Road, is in the bottom of a canyon to the south approximately 305 m (1,000 ft) away (Figure 2). The community of Los Alamos lies to the northwest, and the community of White Rock lies to the southeast, neither of which would be in the prevailing downwind path from TA-53 (LANL 1995).

3.2.4 Environmental Restoration

The Environmental Restoration (ER) Project at LANL has conducted preliminary RCRA investigations throughout Sandia Canyon and TA-53. Twelve Potential Release Sites (PRSs), primarily related to past site use, have been identified in the canyon area downgradient of NPDES Outfall 03A-113 (LANL 1994). These PRSs are being investigated by the ER Project with oversight from several offices of the State of New Mexico Environment Department and will undergo remediation by removal within the next two years as Voluntary Corrècitve Actions (VCAs). Two of these PRSs contain concentrations of contaminants above EPA Screening Action Limits (SALs) (LANL 1996), and are slated for remediation by soil removal within the next two years. A third PRS is a small arms firing range used by LANL's Security Force; it contains lead shot contamination and is recommended for deferred corrective action until after the site is decommissioned. LANL is developing a storm water control plan for this small arms firing range to ensure that no lead shot migration occurs from the PRS to the stream channel nearby. Of the remaining nine PRSs, eight have been recommended for No Further Action because the sites have been characterized and no chemicals of potential concern are present above SALs. The last remaining PRS is still undergoing characterization.

The ER Project has also identified an area of lead shot located within part of the drainage channel below NPDES Outfall 03A-113. The lead shot, approximately 1.5 to 4 mm (0.06 to 0.16 in.) in diameter, is scattered on the soil surface in several locations. The ER Project recommends that this PRS be remediated to prevent further spread of the lead and the potential for spread of lead contamination.

Solid Waste Management Unit (SWMU) 3-056C is located near the head of Sandia Canyon; it contains polychlorinated biphenyls (PCBs) and has been partially remediated by soil removals. EPA's "Guidance on Remedial Action for Superfund Sites with PCB Contamination" (August 1990) recommends for PCBs in soil, preliminary remediation goals (PRGs) of 1 parts per million (ppm) (1mg/kg) for residential sites and 10-25 ppm for industrial remote sites. The ER Project is developing a plan to remediate this TA-3 SWMU down to EPA's PRG (1 ppm) for PCBs. Analysis of samples obtained from the TA-53 outfall area have demonstrated that PCB contamination has not migrated downstream at levels above the analytical method detection limits (also known as limits of quantification; for this analysis, the limit is 33 parts per billion (ppb) (1µg/kg) of analyte) (Appendix A).

3.2.5 Waste Management

LANL has established procedures to be in compliance with all applicable laws and regulations for collecting, storing, processing, and disposing of routinely generated solid wastes at established permitted facilities. Currently LANL's solid waste is disposed of at the Los Alamos County Landfill. Resource Conservation and Recovery Act (RCRA)-regulated hazardous wastes are temporarily staged in satellite storage areas (SSA) at LANL. Hazardous wastes are segregated as flammable solvents, halogenated solvents, and, if necessary, into other chemical categories, according to regulatory guidance. Full, or nearly full, waste containers are removed from SSAs and taken to the TA-54, Area L waste management area in US Department of Transportation (DOT) specified containers for transport; there the waste is managed and stored pending ultimate disposal either on site or off-site at a permitted commercial or DOE treatment/storage facility.

Sanitary sewage lines from TA-53 are connected to the TA-46 Sanitary Wastewater System Consolidation (SWSC) facility. This sanitary waste is delivered to TA-46 for treatment, and then released to the environment through a permitted outfall into Two Mile Canyon.

Radioactive liquid waste at TA-53 is either contained in a holding tank to allow short-lived radioisotopes to decay, or piped to the TA-53 evaporation lagoons, or trucked to LANL's Radioactive Liquid Waste Treatment Facility at TA-50. Solid[3] LLW is brought to TA-54, Area G for disposal, or it may be shipped to a commercial permitted disposal facility.

Asbestos waste is removed by trained personnel and staged at TA-54 for shipment to a permitted off-site disposal site. LANL's annual volumes of wastes are shown in Table 3-3.

[3] "Solid" refers to the physical state of the waste and not its regulatory definition.

3.2.6 Transportation

Equipment and material to be used at TA-53 are shipped from LANL's central shipping and receiving facility at TA-3. LANL LLW is transported over public-use roads from the point of generation to the disposal site at TA-54. Wastes are contained in DOT-approved shipping containers, when required. All waste shipments would be made in accordance with LANL transportation procedures. Roads may be closed during transport to prevent exposures to members of the public.

LANL routinely maintains and repairs roads within the LANL boundary as needed. The accident rate in Los Alamos County is 1.83 accidents per million miles driven.

Table 3-3: LANL Annual Waste Volumes

Type	Volume	Disposal
solid waste (construction and demolition debris and other solid waste)	23,910 m^3 (844,370 ft^3)	Los Alamos County Landfill
low-level radioactive solid waste	2,730 m^3 (96,400 ft^3)[1]	TA-54, Area G
low-level radioactive liquid waste	1,014,000 liters (268,000 gal)[2]	TA-53 evaporation lagoons
RCRA-regulated hazardous waste	153 m^3 (5400 ft^3)	TA-54, Area L for some treatment and storage; disposal at permitted off-site facility
Asbestos waste	271 m^3 (9,585 ft^3)	TA-54, Area J for staging prior to disposal at permitted off-site facility
Cooling tower discharge (Outfall 03A-113)	10.2 million liters (2.7 million gal)[3]	Outfall 03A-113

[1] 1992-1995 average
[2] Radioactive liquid disposed of at the TA-53 evaporation lagoons; LANL produces other radioactive-liquid wastes that are treated at the Radioactive Liquid Waste Treatment Facility at TA-50 that are not included in this table
[3] Maximum expected flow; actual discharges have been much lower

3.2.7 Water

The Rio Grande flows through White Rock Canyon 10.4 km (6.4 mi) to the southeast of TA-53. Most surface-flows within LANL originate from storm water runoff, NPDES permitted outfalls from LANL facilities, or naturally occurring springs. Water from intermittent stream flow and stormwater runoff infiltrates the alluvium of the canyon bottoms on LANL until its downward movement is impeded by less permeable tuff and volcanic sediment. This results in shallow alluvial groundwater zones.

The main potable water supply aquifer is much deeper than the shallow alluvial groundwater zones. The top of the main water supply aquifer ranges from 180 to 360 m (590 to 1,180 ft) below the ground surface. This main aquifer is separated from alluvial and perched waters by 110 to 190 m (360 to 620 ft) of dry tuff and volcanic sediments. Water withdrawn from the main aquifer meets all current federal and state drinking water standards.

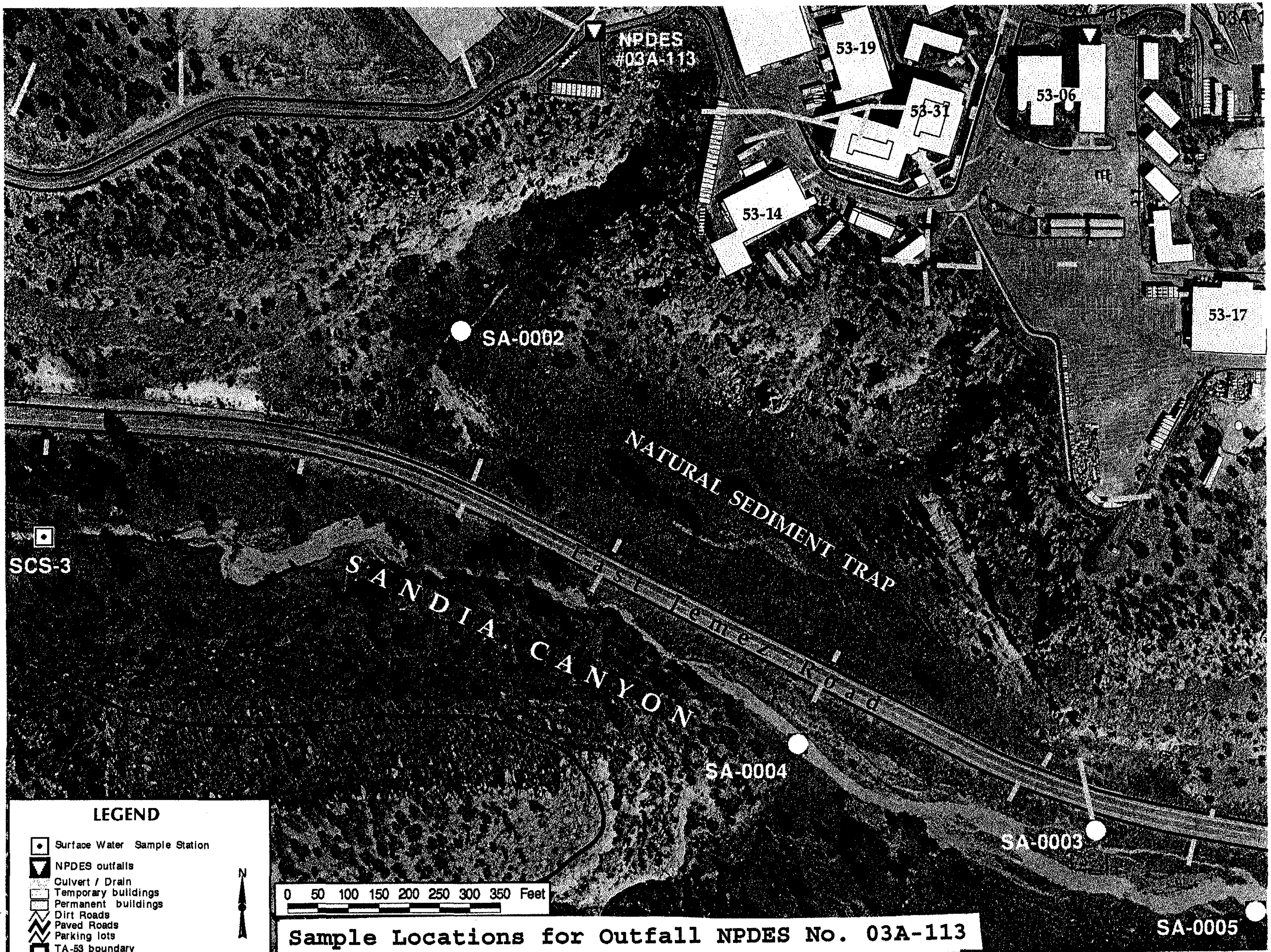
Natural surface drainage from the TA-53 area is either northward into Los Alamos Canyon or southward into Sandia Canyon. Existing NPDES outfalls several miles upstream from TA-53 discharge into Sandia Canyon and have created perennial flow below these outfalls for several miles. In the vicinity of TA-53, Sandia Canyon has only ephemeral flow. There may be surface flow in Sandia Canyon to State Road 4, located about one mile (1.6 km) downstream from TA-53, on about 6 to 25 separate days in an average year. Radiochemical analyses of stormwater samples taken at State Road 4 show concentrations comparable to regional background levels which are far lower than EPA Primary Drinking Water Standards and DOE derived concentration guide levels (LANL 1995). Analyses of sediment samples from this same location also show concentrations comparable to regional background levels that are far lower than SALs. For the most part, these surface discharges evaporate on-site or are contained within the alluvial fill in the canyon. The alluvium in this section of Sandia Canyon has a water holding capacity of about 125 million liters (33 million gal) (McLin 1996a).

No liquid effluents, except water from the landscape-irrigation system and "non-contact," treated cooling water tower effluent, is released routinely to the surface drainages. Equipment in many facilities is cooled with water, which is then sent through evaporative cooling towers to release heat. About 132 million liters/yr (35 million gal/yr) of water from these cooling towers is discharged to the ground surface at TA-53. Cooling towers at Building MPF-365 discharge permitted effluents to Outfall 03A-113, which historically was expected to discharge 10.2 million liters/yr (2.7 million gal/yr). Recent discharges have been much less than the expected amount. All such discharge points are covered by, and in compliance with, NPDES permits for industrial discharges. In addition, TA-53 discharges have met state standards for livestock and wildlife watering. During 1995, LANL's NPDES Permit required annual sampling of all outfalls for compliance with New Mexico Water Quality Control Commission's Standards for Interstate and Intrastate Streams, Section 2111. Outfall 03A-113 met Section 2111 requirements for livestock watering and wildlife habitats.

3.2.8 Threatened and Endangered Species

LANL contains habitat that is highly suitable for several state and federally protected threatened and endangered species (LANL 1995). However, none of these species have been found at TA-53.

LANL staff biologists have generated a database derived from the United States Fish and Wildlife Service (USFWS) and the State of New Mexico of information on threatened and endangered species that might occur in Los Alamos County. The database includes expected habitat. This information together with field surveys was used by the LANL staff biologists to evaluate any potential impact to threatened or endangered species that could result from operations at TA-53. Based on their evaluation, the DOE has concluded that there would be no potential for adverse effects to threatened and endangered species or their critical habitat from operations at TA-53 (Bennett 1993).



Sample Locations for Outfall NPDES No. 03A-113

3.2.9 Wetlands

There are no existing wetlands at, or near, NPDES Outfall 03A-113 at TA-53.

3.2.10 Cultural Resources

Slightly more than half of the DOE land in Los Alamos County has been surveyed for prehistoric and historic cultural resources and close to 1,000 sites have been recorded (LANL 1995).

The area around TA-53 was surveyed for cultural resources in 1985 (Snow 1985, McGehee 1985), before Alvarez Road was constructed (Figure 3), and again in 1991 (Larson 1994). A small archeological site west of Building MPF-365 has been fenced to prevent intrusion by TA-53 activities; no other cultural resources are present.

3.2.11 Environmental Justice

On February 11, 1994, Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," was published in the Federal Register (59 FR 7629). This Executive Order requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income communities. DOE is in the process of finalizing procedures for implementing the Executive Order. The manner in which environmental justice issues should be addressed in an environmental assessment is expected to be addressed in the procedures. The analysis of environmental justice in this EA is not intended to establish the direction of DOE's future procedures implementing the Executive Order.

Los Alamos County is approximately 14 percent minority (the percentage of non-whites, including Hispanics, defined by the US Census) and has a median family income of $60,798 (1990 US Census, in 1989 dollars). Los Alamos County, which would be most directly affected by the proposed action, has a higher median family income and a much lower percentage of minority residents than the four surrounding counties.

4. ENVIRONMENTAL CONSEQUENCES

The following chapter considers the potential environmental consequences of impacts associated with the proposed action. Where appropriate, this chapter considers both direct and indirect impacts associated with the construction and operation of the proposed LEDA project. A section on potential accidents is also included. Table 4-1 summarizes the potential environmental effects of the proposed action and the no action alternative.

Table 4-1: Summary of Environmental Effects

Issue	Proposed Action	No Action Alternative
Utility Demands	Increase in LANL's use of electricity (up to 51%), natural gas (up to 55%), water (up to 17%)	no change
Air	Minor additional radioactive air emissions - doses within EPA limits; increased non-radioactive emissions of criteria air pollutants - emissions do not exceed ambient air quality standards	no change
Human Health	Radiological doses from normal operations would be very unlikely to produce any additional cancer fatalities in the population within 80 km (50 mi) of LANL	no change
Environmental Restoration	Potential Release Site containing lead shot would be remediated prior to discharge of LEDA cooling tower water	no change
Waste Management	Construction and demolition debris, solid LLW, liquid LLW, asbestos waste, and RCRA-regulated hazardous waste produced; within capacities for LANL waste management system	no change
Transportation	Miles driven during life of project too low to be likely to result in a traffic accident	no change
Water	Wastewater releases would contain chemicals and minerals within permitted limits; increased wastewater discharge may result in continuous surface flow in Sandia Canyon to the Rio Grande about 25 to 50 days each year	no change
Threatened and Endangered Species	No effect on T&E species or critical habitat	no change
Wetlands	Increased wastewater discharge could saturate substrate but wetland would not be likely to form during the life of the LEDA project	no change
Cultural resources	None present in area affected by LEDA project	no change
Environmental Justice	No change in current conditions	no change

4.1.1 Utility Demands

Electrical Power

The proposed LEDA project would require nearly 30 MW of electrical energy in Stages IV and V. LEDA electrical power needs would increase from stage to stage as shown in Table 2-2. If the electrical power available through the Los Alamos Area Electrical Distribution System should be insufficient due to external demands, LANL has the capability to generate additional power on-site at LANL's TA-3 Power Plant. Under worst case scenarios, the TA-3 Steam Power Plant would supply approximately 0.02 to 0.03 percent of the total electrical power requirements of the LEDA project. Table 4-2 shows the LEDA projects estimated usage in MW-hr/yr and the percent increase over LANL's current electrical usage. At the conclusion of the LEDA project, electrical power demand would decrease to pre-LEDA levels (assuming the electrical needs of other LANL activities remain constant).

Table 4-2: LEDA Project Estimated Electrical Usage

Fiscal Year	Estimated Electrical Usage(MW-hr/yr)	Estimated Increase in LANL Electrical Usage (%)
1996	2,196	0.6
1997	16,778	4.4
1998	94,010	24.4
1999	146,293	38.0
2000	197,904	51.3
2001	197,220	51.2
2002	196,220	51.2
2003	124,448	32.3

Natural Gas

The LEDA project may require additional electrical power to be generated from the TA-3 Steam Power Plant. The amount of additional natural gas that would be consumed by the TA-3 Steam Power Plant to support LEDA electrical requirements is shown in Table 4-3. The worst case scenario reflects unexpectedly high consumer use of electrical power during seasons of peak demand, which would reduce the electrical power available to the local Los Alamos Electrical Distribution System. The average case scenario reflects expected demand under normal weather conditions even in seasons of peak demand. All calculations assume that LEDA would be operating continuously for a nine-month period during each stage. In fact, actual operating time would be expected to be less than nine months in any single year.

Table 4-3: Additional Natural Gas Consumption by the TA-3 Steam Power Plant

LEDA Stage	Average Case Scenario		Worst Case Scenario	
	Natural Gas Use (in million cubic feet)	Increase in LANL's Usage (%)	Natural Gas Use (in million cubic feet)	Increase in LANL's Usage (%)
Stage I	0	0	0	0
Stage II	0	0	0	0
Stage III	0	0	463	27.4
Stage IV	463	27.4	926	54.7
Stage V	463	27.4	926	54.7

In addition to natural gas use at the TA-3 Steam Power Plant, both the boilers that keep the cooling towers' water from freezing and the water pump at PM-4 operate on natural gas. Each 5-MW cooling tower module would require a boiler that would use 0.021 million m^3 (0.75 million ft^3) of natural gas annually. At Stages IV and V, when all five cooling tower modules would be in operation, the boilers would consume 0.11 million m^3 (3.75 million ft^3) annually. Gas consumption figures for the PM-4 water pump are not available. Natural gas consumption would be expected to return to pre-LEDA levels at the conclusion of the LEDA project, assuming that the natural gas requirements of other LANL activities remain constant.

Water

The proposed LEDA project would require increasing amounts of water for each stage of the project. Table 4-4 shows the expected water consumption for each stage of the LEDA project. Approximately 1,552 million liters (410 million gal) of cooling water would be required over the life of the LEDA project to provide up to 25-MW of cooling capacity. The LEDA project would increase LANL's water usage by about 1.5 percent (Stage I) and 17.3 percent (Stages IV and V). DOE's total water use would increase about 0.5 percent in Stage I and about 6 percent in Stages IV and V, an increase from 81 percent to 87 percent of the total DOE annual water allotment. At the conclusion of the project, LANL's water use would return to pre-LEDA project levels (assuming that other operations do not have increased water requirements).

4.1.2 Air

Non-radioactive Air Emissions:

Direct Effects

The LEDA project would use about 1,504 kg (3,312 lb) of methanol, ethanol, and acetone annually as solvents to clean LEDA components. Methanol and ethanol are regulated as VOCs with no federal or state de minimus permitting or ambient air quality standards. Some vapors from these solvents would be expected to be released to the environment from the stack at Building MPF-365.

Tale 4-4: Water Use for LEDA Stages

Stage	Expected Water Use		Increase over Current LANL Use	Increase over Current DOE Use
	million liters/yr	million gal/yr	%	%
I	30	7.6	1.5	0.5
II	136	36.4	7.3	2.5
III	216	57.1	11.4	3.9
IV	327	86.5	17.3	5.9
V	327	86.5	17.3	5.9

Construction activities would be expected to produce dust and some diesel emissions from construction vehicles. Since construction would take place within already developed areas of TA-53, minimal dust generation would be expected. Standard dust suppression methods would be used to control dust emissions when necessary. Diesel fumes from construction vehicles would be produced during the few months when construction would be underway. Local winds would be expected to disperse the fumes quickly.

Indirect Effects

As identified in Chapter 2.0, the proposed LEDA project would rely on other LANL facilities for electrical power and water needs. Emissions from these facilities are considered indirect effects because they would not originate from the TA-53 project area or the LEDA project. LANL facilities supporting the LEDA project—the LEDA cooling tower boilers, the PM-4 water pump, and the TA-3 Steam Power Plant—would generate increased emissions of NO_x, CO, SO_2, PM, and VOCs. Table 4-5 summarizes the increase in criteria pollutants (tons/yr) that these facilities would produce supporting the LEDA project, based on worst-case assumptions. In the worst case, consumer demand elsewhere would reduce the power available off the local electrical distribution system. The TA-3 Steam Power Plant would provide the additional electricity required for the LEDA project. For a whole worst-case year, the TA-3 Steam Power Plant would consume 12 million m^3 (463 million ft^3) of natural gas in Stage III and 24 million m^3 (926 million ft^3) of natural gas in Stages IV and V. Table 4-5 gives the resulting criteria air pollutant levels for this worst-case year. Emissions of criteria pollutants for each LEDA stage are shown. Because the three sources of pollutants are located in different parts of LANL, their emissions are reported separately and their air quality effects are evaluated separately.

Table 4-5: Worst-Case Increases in Criteria Air Emissions from LEDA Support Facilities

Stage	Source	Emissions (ton/year)				
		NO_x	CO	SO_2	PM	VOC
I	LEDA Cooling Tower Boilers	0	0	0	0	0
	TA-3 Steam Power Plant	0	0	0	0	0
	PM-4 Water Pump	0.097	0.031	0	0	0.002
	Total	0.097	0.031	0	0	0.002
II	LEDA Cooling Tower Boilers	0.075	0.016	0.0005	0.009	0.004
	TA-3 Steam Power Plant	0	0	0	0	0
	PM-4 Water Pump	0.54	0.17	0	0	0.011
	Total	0.62	0.19	0.0005	0.009	0.015
III	LEDA Cooling Tower Boilers	0.15	0.032	0.0009	0.018	0.008
	TA-3 Steam Power Plant	37.7	9.3	0.14	1.0	0.32
	PM-4 Water Pump	0.84	0.27	0	0.0005	0.017
	Total	38.7	9.6	0.14	1.02	0.35
IV and V	LEDA Cooling Tower Boilers	0.23	0.047	0.001	0.027	0.012
	TA-3 Steam Power Plant	75.5	18.5	0.28	2.3	0.65
	PM-4 Water Pump	1.28	0.41	0	0.0008	0.026
	Total	77.0	19.0	0.28	2.3	0.69

As shown in Table 4-5, emissions generated from the TA-3 Steam Power Plant account for the majority of the overall LEDA support facility emissions in Stages III, IV, and V. Table 4-6 shows the expected percent increase in LANL's criteria pollutant emissions above average annual emissions due to the LEDA support activity emissions under normal operating conditions. During a normal operating year, the increased emissions generated by the TA-3 Steam Power Plant are actually expected to be zero in Stage III and half of the worst-case estimates (shown in Table 4-5) for Stages IV and V.

Table 4-6: Percent Increase in LANL's Average Annual Criteria Air Pollutant Emissions from LEDA Support Activities under Normal Operating Conditions

Stage	Percent (%) Increase in Emissions by Stage				
	NO_x	CO	SO_2	PM	VOC
I	0.1	0.1	0	0	0.2
II	0.6	0.6	0.1	0.3	1
III	0.9	1	0.2	0.5	2
IV/V	36	34	38	34	30

Table 4-7 lists the NMED Ambient Air Quality Standard (20 NMAC 2.3) for each criteria pollutant of interest and the maximum concentrations of these pollutants produced by the LEDA cooling tower boilers during each stage of the LEDA project (calculated using SCREEN3, an EPA-approved air dispersion modeling program). Table 4-8 and Table 4-9 give similar information for the TA-3 Steam Power Plant and the PM-4 Water Pump, respectively. VOCs are not included on these tables because there are no federal or state ambient air quality standards for VOCs. These tables show the total, cumulative effect of all LEDA stages that are "additive" (such as the total number of cooling tower boilers, all of which would be in use in Stage IV) and the effects of current operations. Estimates of air quality impacts in these tables assume that the TA-3 Steam Power Plant would be operating at worst-case levels and the boilers and water pump would operate at their maximum capacity, all under the worst-case meteorological conditions. As shown in these tables, the LEDA project, as a whole or by component or stage, would not exceed the ambient air quality standards.

Radioactive Air Emissions

Radioactive air emissions from the LEDA project would be released to the environment from the Building MPF-365 exhaust stack. The radioactive emissions would consist of radionuclides (in gaseous form) produced primarily when the energetic proton beam strikes the beamstop. The air volume surrounding the accelerator and the beamstop would be confined inside the beam tunnel. In addition, a (nearly-sealed) shielded enclosure would be placed around the beamstop (Figure 5A), thereby providing double confinement of the activated air produced near the beamstop. The dominant air radionuclides that would be produced by LEDA have half lives between 7 sec and 2 hr. The longer these radionuclides would spend inside Building MPF-365, the lower the activity that would be released through the exhaust stack. The Building MPF-365 ventilation system delays the transport of the activated air produced at the west end of the beam tunnel to the exhaust stack exit (by about 28 min on average). The beamstop shielding enclosure would further delay the release of activated air from inside that enclosure into the beam tunnel. This additional delay would allow the short-lived radionuclides even more time to undergo radioactive decay before being released to the environment.

Table 4-7. Ambient Air Impacts from the LEDA Cooling Tower Boilers

Pollutant	Ambient Air Quality Standard			Maximum Impact by Stage[a]					
	Averaging time	New Mexico	Federal	Current	I	II	III	IV	V
CO	8 hours	8.7 ppm	9 ppm	NA	no impact	0.003 ppm	0.007 ppm	0.008 ppm	0.008 ppm
	1 hour	13.1 ppm	35 ppm	NA	no impact	0.005 ppm	0.010 ppm	0.012 ppm	0.012 ppm
NO_x	24 hours	0.10 ppm	no standard	NA	no impact	0.003 ppm	0.007 ppm	0.010 ppm	0.010 ppm
	annual arithmetic average	0.05 ppm	0.053 ppm	NA	no impact	2E-4 ppm[c]	5E-4 ppm	8E-4 ppm	8E-4 ppm
SO_2	3 hours	no standard	0.50 ppm	NA	no impact	5E-5 ppm	1E-4 ppm	2E-4 ppm	2E-4 ppm
	24 hours	0.10 ppm	0.14 ppm	NA	no impact	1E-5 ppm	3E-5 ppm	6E-6 ppm	6E-6 ppm
	annual arithmetic average	0.02 ppm	0.03 ppm	NA	no impact	9E-7 ppm	3E-6 ppm	3E-6 ppm	3E-6 ppm
PM	24 hours[b]	150 $\mu g/m^3$	150 $\mu g/m^3$	NA	no impact	0.59 $\mu g/m^3$	1.2 $\mu g/m^3$	1.8 $\mu g/m^3$	1.8 $\mu g/m^3$
	7 days	110 $\mu g/m^3$	no standard	NA	no impact	not calc.	not calc.	not calc.	not calc.
	30 days	90 $\mu g/m^3$	no standard	NA	no impact	not calc.	not calc.	not calc.	not calc.
	annual geometric mean[b]	60 $\mu g/m^3$	50 $\mu g/m^3$	NA	no impact	0.05 $\mu g/m^3$	0.11 $\mu g/m^3$	0.18 $\mu g/m^3$	0.18 $\mu g/m^3$

[a] Maximum impacts occur at a radius of 73 meters from the emission source.

[b] The New Mexico standards are for total suspended solids; the National standard is for PM-10 (average particle diameter ≤ 10 microns).

[c] Scientific notation: E represents 10, for example 2E-4 and 2×10^{-4} are the same, 0.0002

Table 4-8. Ambient Air Impacts for Increased Electricity Generation at the TA-3 Steam Power Plant

Pollutant	Ambient Air Quality Standard			Maximum Effects by Stage[a]					
	Averaging time	New Mexico	Federal	Current	I	II	III	IV	V
CO	8 hours	8.7 ppm	9 ppm	0.010 ppm	0.010 ppm	0.010 ppm	0.010 ppm	0.010 ppm	0.010 ppm
	1 hour	13.1 ppm	35 ppm	0.014 ppm	0.014 ppm	0.014 ppm	0.014 ppm	0.014 ppm	0.014 ppm
NO_x	24 hours	0.10 ppm	no standard	0.019 ppm	0.019 ppm	0.019 ppm	0.019 ppm	0.019 ppm	0.019 ppm
	annual arithmetic average	0.05 ppm	0.053 ppm	6E-4 ppm[c]	6E-4 ppm	6E-4 ppm	8E-4 ppm	0.001 ppm	0.001 ppm
SO_2	3 hours	no standard	0.50 ppm	1E-4 ppm	1E-4 ppm	1E-4 ppm	1E-4 ppm	1E-4 ppm	1E-4 ppm
	24 hours	0.10 ppm	0.14 ppm	5E-5 ppm	5E-5 ppm	5E-5 ppm	5E-5 ppm	5E-5 ppm	5E-5 ppm
	annual arithmetic average	0.02 ppm	0.03 ppm	1E-6 ppm	1E-6 ppm	1E-6 ppm	2E-6 ppm	3E-6 ppm	3E-6 ppm
PM	24 hours[b]	150 $\mu g/m^3$	150 $\mu g/m^3$	0.86 $\mu g/m^3$	0.86 $\mu g/m^3$	0.86 $\mu g/m^3$	0.86 $\mu g/m^3$	0.86 $\mu g/m^3$	0.86 $\mu g/m^3$
	7 days	110 $\mu g/m^3$	no standard	not calc.	not calc.	not calc.	not calc.	not calc.	not calc.
	30 days	90 $\mu g/m^3$	no standard	not calc.	not calc.	not calc.	not calc.	not calc.	not calc.
	annual geometric mean[b]	60 $\mu g/m^3$	50 $\mu g/m^3$	0.03 $\mu g/m^3$	0.03 $\mu g/m^3$	0.03 $\mu g/m^3$	0.04 $\mu g/m^3$	0.05 $\mu g/m^3$	0.05 $\mu g/m^3$

(a) Maximum impacts occur at a radius of 676 meters from the emission source.
(b) The New Mexico standards are for total suspended solids; the National standard is for PM-10 (average particle diameter ≤ 10 microns).
(c) Scientific notation: E represents 10, for example 6E-4 and 6×10^{-4} are the same, 0.0006

Table 4-9: Ambient Air Impacts from using the PM-4 Water Pump

Pollutant	Ambient Air Quality Standard			Maximum Impact by Stage[a]					
	Averaging time	New Mexico	Federal	Current	I	II	III	IV	V
CO	8 hours	8.7 ppm	9 ppm	0.038 ppm	0.038 ppm	0.038 ppm	0.038 ppm	0.038 ppm	0.038 ppm
	1 hour	13.1 ppm	35 ppm	0.057 ppm	0.057 ppm	0.057 ppm	0.057 ppm	0.057 ppm	0.057 ppm
NO_x	24 hours	0.10 ppm	no standard	0.028 ppm	0.028 ppm	0.028 ppm	0.028 ppm	0.028 ppm	0.028 ppm
	annual arithmetic average	0.05 ppm	0.053 ppm	0.004 ppm	0.004 ppm	0.004 ppm	0.004 ppm	0.004 ppm	0.004 ppm
SO_2	3 hours	no standard	0.50 ppm	NA	NA	NA	NA	NA	NA
	24 hours	0.10 ppm	0.14 ppm	NA	NA	NA	NA	NA	NA
	annual arithmetic average	0.02 ppm	0.03 ppm	NA	NA	NA	NA	NA	NA
PM	24 hours[b]	150 $\mu g/m^3$	150 $\mu g/m^3$	0.026 $\mu g/m^3$	0.026 $\mu g/m^3$	0.026 $\mu g/m^3$	0.026 $\mu g/m^3$	0.026 $\mu g/m^3$	0.026 $\mu g/m^3$
	7 days	110 $\mu g/m^3$	no standard	not calc.	not calc.	not calc.	not calc.	not calc.	not calc.
	30 days	90 $\mu g/m^3$	no standard	not calc.	not calc.	not calc.	not calc.	not calc.	not calc.
	annual geometric mean[b]	60 $\mu g/m^3$	50 $\mu g/m^3$	0.004 $\mu g/m^3$	0.004 $\mu g/m^3$	0.004 $\mu g/m^3$	0.004 $\mu g/m^3$	0.004 $\mu g/m^3$	0.004 $\mu g/m^3$

(a) Maximum impacts occur at a radius of 94 meters from the emission source.
(b) The New Mexico standards are for total suspended solids; the National standard is for PM-10 (average particle diameter ≤ 10 microns).

Source term calculations have been performed for Stage IV of the LEDA project assuming the worst case scenario, i.e., that there is no confinement of activated air products and that all activated air products would be released into the environment. Stage IV would produce the most radionuclides of any of the LEDA stages. Table 4-10 lists the major air-activated radionuclides that would contribute a dose to the public and worker, the half-lives of the radionuclides, and the amount of radioactive material discharged (expressed in Curies [Ci]) in Stage IV. The total amount of radioactive material released by the LEDA stack in Stage IV with no air confinement would be about 1,603 Ci/yr. With maximum air confinement, a situation that closely approximates normal operating conditions, the total amount of radioactive material that would be released would be about 2.5 Ci. Calculations assume that Stage IV would run continuously for nine months and that Stage IV emissions, the highest of any LEDA project stage, would be typical of all the other LEDA stages. This is a conservative assumption.

The LEDA facility, however, is designed to allow short-lived radionuclides to decay before being released to the environment. Under normal operating conditions, the radioactive air emissions released into the environment would be much lower (Table 4-10) than those expected with no air confinement. Radiation doses to the maximum exposed individual (MEI), the on-site non-involved (non-LEDA) workers, the involved (LEDA) workers, and the total population within 80 km (50 mi) of LANL have been calculated. Doses were calculated using estimated radioactive stack emissions and the EPA-approved atmospheric dispersion code (or mathematical model) CAP88. The methodology for calculating the dose to the MEI is described in Appendix B. A four year average of meteorological data collected by the TA-53 meteorological tower was used to provide wind direction and velocity. Table 4-11 shows the effective dose equivalent for the worst case scenario where all LEDA air-activated radionuclides would be released to the environment, and from the more realistic scenario, where air activation products are confined and allowed to decay. As discussed in Section 4.1.3, No human health effects would be expected under either scenario.

4.1.3 Human Health

Based on doses from radioactive air emissions (see Section 4.1.2), DOE expects the maximum dose (assuming no air confinement) from normal operations under the Proposed Action to be 0.5 mrem per year for Stages IV-V to the MEI at the East Gate area on the LANL boundary. The dose to the MEI would be lower for Stages I-III (0 for Stage I). Calculations and assumptions are given in Appendix B. The expected period of exposure would be seven years. The estimated population dose for the population living within 80 km (50 mi) would be 1 person-rem/yr. The risk of additional cancer fatalities is assumed to be 4.4×10^{-4} per rem[4] (LANL 1995). Based on this risk factor, there would be no additional cancer deaths predicted in the population within 80 km (50 mi) of LANL. In addition, the incremental cancer risk to the MEI is calculated to be 2.5×10^{-7}, which is equivalent to a risk of 1 excess total cancer fatalities in a population of 4 million people per year of LEDA operation.

[4] LANL's risk factors are derived from source material provided by the National Academy of Sciences (1990).

Table 4-10: LEDA Radioactive Air Emissions for Stage IV

Radionuclide	Half-life	No Air Confinement		Maximum Air Confinement
		Amount Discharged (Ci/yr)	Contribution to Total Dose MEI (%)	Amount Discharged (Ci/yr)
^{13}Nitrogen	10 min	1004	54.1	0.163
^{16}Nitrogen	7 sec	176	≈0	0.0285
^{15}Oxygen	2 min	8	≈0	0.00177
^{19}Oxygen	27 sec	2	≈0	0.00216
^{37}Sulfur	5 min	10	0.9	0.00181
^{39}Chlorine	55 min	2	0.2	0.00047
^{40}Chlorine	83 sec	13	≈0	0.00219
^{41}Argon	2 hr	387	44.4	2.29
^{83m}Krypton	2 hr	1	≈0	0.00221
All Others		<1	0.2	0.00111
Total		≈1603		≈2.5

Table 4-11: Effective Dose Equivalents

Receptor	Location	Effective Dose Equivalent		DOE Radiation Dose Limit
		No Air Confinement	Maximum Air Confinement	
MEI	LANL boundary	0.5 mrem/yr	0.0006 mrem	10 mrem/yr
Non-involved Worker	At 200 m from Building MPF-365	2 mrem/yr	0.0006 mrem	5000 mrem/yr
Involved Worker[1]	Building MPF-365	10 mrem/yr	0.002 mrem	5000 mrem/yr
Population	Within 80 km (50 mi) of LANL	1 person-rem/yr	0.0007 person-rem/yr	none[2]

[1] The dose to workers considers only activated air effluents

[2] Although there is no established collective population dose limit, a limit can be derived using EPA's proposed general public dose limit of 100 mrem/yr per person. This would be equivalent to about 20,000 person-rem/yr.

Doses to workers would be less than 2 rem/yr and would be maintained by administrative controls and engineering features, such as shielding and interlocks. For the radioactive air emissions, the number of additional cancer fatalities in non-involved workers, based on a dose of 2 mrem/yr at a point 200 m (670 ft) from Building MPF-365 and a risk factor of 4×10^{-4} per rem, would be 8×10^{-7}, which is equivalent to one excess total cancer fatality in a population of 1,250,000 per year of LEDA operation. For involved workers, the expected number of excess cancer fatalities, based on a dose of 10 mrem/yr and a risk factor of 4×10^{-4} per rem, would be 4×10^{-6}, which is equivalent to one excess cancer fatality in a population of 250,000 per year of LEDA operation. The actual number of excess cancer fatalities would be expected to be far less due to the reduced stack emissions that would be expected under normal operating conditions.

4.1.4 Environmental Restoration

As described in Chapter 2.0 (Section 2.1.3), the LEDA project would discharge a total of 187 million gal of "non-contact" treated cooling water to NPDES Outfall 03A-113 over a 7-year period. LANL's ER Project has identified a lead shot area within the drainage channel immediately below Outfall 03A-113. The lead shot could be transported into Sandia Canyon via the outfall discharges during the LEDA project. The spread of lead shot over time could result in an increased risk to the environment from leachable lead contamination. This area would be fully remediated prior to initiating the LEDA project. Due to the nature of the remedial action on this lead shot area and its timing relative to the LEDA project development, no spread of lead shot downstream is expected.

Other PRSs located downgradient of Outfall 03A-113 are not expected to either affect or be affected by the increased volumes of effluent generated by the LEDA project. Based on sample analysis, contaminants within these areas are below SALs or method detection limits , or the PRSs are being managed or remediated by the LANL ER Project so that no contaminants are expected to migrate into the stream channel.

4.1.5 Waste Management

Wastes generated over the seven year life of the LEDA project would include the following: construction and demolition debris and other solid wastes (such as paper and packing material), solid LLW, liquid LLW, RCRA-regulated hazardous wastes, asbestos wastes, and industrial wastewater ("non-contact" treated cooling water). Table 4-12 shows the expected volumes of these wastes and the increase over current LANL waste volumes that they represent. Table 4-12 also includes disposal of all LEDA equipment, materials, and beamstops at the conclusion of the project. This would generate an additional 225 m^3 (8,000 ft^3) of solid waste and 230 m^3 (8,100 ft^3) of solid LLW. Since these items would be reused if possible, these figures represent maximum waste volumes. LANL waste management systems would be able to manage these waste volumes without expanding existing facilities.

4.1.6 Transportation

Transportation of materials, equipment, and operational waste across LANL would entail about 150 trips to transport materials and equipment and to dispose of waste, each of which would be less than 48 km (30 mi) round-trip, for a total of 7,200 km (4,500 mi) driven during the life of the project. At the current accident rate in Los Alamos County (1.83 accidents/million miles), it is very unlikely that there would be an accident involving transportation. In addition, the DOE would close publicly accessible roads for any transportation of wastes that could not be shipped in DOT approved containers or which otherwise could pose a risk to the public.

Table 4-12: Waste Volumes Per Year Averaged Over Life of the LEDA Project

Type of Waste	LEDA Volume	Increase in LANL's Annual Waste Volume (%)
Construction and demolition debris and other solid wastes	72.7 m^3 (2,570 ft^3)	0.3
Solid LLW	42.4 m^3 (1,500 ft^3)	1.6
Liquid LLW[1]	15,290 liters (4,040 gal)	1.5
RCRA-regulated hazardous wastes	10 m^3 (350 ft^3)	6.5
Asbestos wastes[2]	4.6 m^3 (162 ft^3)	1.7
Industrial wastewater (treated cooling water at Outfall 03A-113)	101 million liters (27 million gal)	1,000

[1] TA-53 disposal only
[2] One-time disposal

4.1.7 Water

Outfall 03A-113 would release wastewater containing commercial chemical additives that reduce corrosion and inhibit scale formation in the cooling towers and minerals normally found in drinking water. The cooling water would contain no more than 250 mg/liter of a commercial chemical additive. Concentrations of chemical constituents within this additive (such as 2-phosphono-1, 2, 4-butane-tricarboxylic acid, sodium molybdate, and benzotriazole) would not exceed regulatory thresholds under the Clean Water Act. Wastewater effluent would also contain small amounts of bromine and chlorine. The wastewater would be monitored and would meet the requirements of LANL's NPDES permit.

LANL's NPDES permit had previously identified Outfall 03A-113 as having an expected flow of 10.1 million liters/yr (2.7 million gal/yr). The LEDA project would, on average, in Stages IV and V release about 148 million liters/yr (39.1 million gal/yr). The drainage channel of Outfall 03A-113 would be monitored over the life of the project as water discharge increases, and appropriate erosion controls would be implemented if needed. These controls might consist of spill pads with velocity breakers or other similar standard control methods.

In Stages III to V, the wastewater may infiltrate the coarse sandy soil on the floor of Sandia Canyon, saturate it, and create surface flow to the Rio Grande about 25 to 50 days in each year of the last four to five years of the LEDA project (McLin 1996b). During Phases III to V of this project, flows reaching the Rio Grande will be required to meet New Mexico Water Quality Control Commission's Standards for Interstate and Intrastate Streams, Section 2111. These designated uses include livestock watering and wildlife habitat. These flows would commingle with other surface flows due to other factors, such as stormwater runoff and upstream outfalls. During prolonged discharge periods during the second or third year of the LEDA project, Sandia Canyon may become perennial along the first channel mile below Outfall 03A-113. By the fifth year of the LEDA project, Sandia Canyon may be perennial for its entire course within LANL's boundary. Surface flow may extend onto Pueblo of San Ildefonso lands. During summer months, combined effluent discharges and natural stormwater runoff may reach the Rio Grande on a regular basis, about 25 to 50 days between April and November. Increased surface flows in Sandia Canyon attributed to LEDA may mobilize sediments and contaminants present within the area of the stream channel. However, there are no known historical radionuclides, heavy metals, or organics in Sandia Canyon stream sediments present at contaminant concentration levels greater than SALs or method detection limits (i.e., trace quantities only).

If the final designs for the LEDA project indicate that there would be more than 5 acres of ground disturbance, a Stormwater Construction Permit and a Pollution Prevention Plan under NPDES would be required. Current estimates indicate that up to 5.1 acres could be disturbed.

4.1.8 Threatened and Endangered Species

LANL biologists conducted a biological survey of the proposed LEDA project site in 1995 and DOE concluded that there would be no potential for adverse effect to either threatened and endangered species or their critical habitat as a result of the LEDA experiments or the modifications to utilities in the vicinity of Building MPF-365. DOE has initiated informal consultation with the USFSW under Section 7 of the Endangered Species Act. Consultation would be completed prior to beginning construction activities.

4.1.9 Wetlands

LANL biologists and hydrologists have evaluated the potential effect of increasing the effluent discharge from NPDES Outfall 03A-113 into the canyon below. During Stages III through V, wastewater released by the outfall may saturate the sandy substrate on the floor of Sandia Canyon and may create saturated soil conditions conducive to forming a wetland. These conditions may persist until the end of the LEDA project, a period of about four to five years. The sandy substrate, however, is not conducive to establishment of hydrophytic (wetland-type) vegetation. Furthermore, large amounts of organic matter necessary for hydric soil formation would not be expected to accumulate. Periodic drying would further inhibit hydric soil formation. Thus, two of the three diagnostic characteristics of wetlands (vegetation, soil, and hydrology) would not be expected to occur. In the unlikely event that a wetland would form by the end of the LEDA project, further biological evaluation would be performed. Appropriate NEPA analysis and wetland regulatory compliance evaluation would be conducted before flow to the outfall was eliminated.

4.1.10 Cultural Resources

As identified in Section 3.2.10, a small archaeological site was previously identified west of Building MPF-365 and subsequently fenced for protection. The proposed action would not disturb this site and the action would not constitute an effect on cultural resources. DOE has determined that consultation under the National Historic Preservation Act of 1966, Section 106, with the State Historic Preservation Office (SHPO) is not required since there would be no effect.

4.1.11 Environmental Justice

Although environmental justice populations are present within 80 km (50 mi) of LANL, the LEDA project would not disproportionately adversely affect low-income, minority, or Native American populations. The LEDA project would not have adverse consequences on air quality, water quality, availability of natural resources, or human health. Therefore, no adverse effects to environmental justice populations would be expected under the Proposed Action.

4.1.12 Accidents

This section summarizes accidents that could be associated with the construction and operation of the LEDA project. The selected accidents are based on a screening of a Preliminary Hazards Analysis (PHA) and analyzed in terms of potential effects to site workers, co-located workers, the public, and the environment.

Accidents with the highest consequence to workers would have the likelihood of occurring between, once in ten thousand to one million years. Accidents with the highest consequence to co-located workers, the public, and the environment would have the likelihood of occurring between once in ten thousand to one million years.

A full spectrum of potential accidents scenarios are contained within the PHA (Appendix C). Accidents analyzed in this EA are summarized in Table 4-13.

<u>Site Workers</u>

Accidents with the highest likelihood of resulting in serious injury or death of a site worker include scenarios involving high voltage electrocution during normal operations or heavy equipment operation during construction.

<u>Co-located Worker</u>

The accident with the highest likelihood of resulting in an effect to co-located workers would be a beam spill. A beam spill, a scattering of the accelerator beam within the beam tunnel, that would go undetected for one hour would result in production of neutron and gamma radiation. The beam tunnel would be designed to include appropriate shielding such that neutron and gamma radiation would be largely contained within the beam tunnel. Therefore, co-located workers would be exposed to a negligible (acute) dose from a beam spill. No permanent health effects would be expected.

Public

The only accident with the potential to affect a member of the public would be a beam spill. Since access to TA-53 is restricted, members of the public are not likely to be in the area of the LEDA project if a beam spill were to occur. If an individual were in the area, the effect would be the same as for a co-located worker. Other members of the public would not be expected to receive a dose and no health effects would be expected.

Table 4-13: Accidents Analyzed

Accidents	Likelihood of occurrence	Worst Consequence
Site Worker High-energy power source electrocution	1 in 10,000 to 1,000,000 years	serious worker injury or death
Co-located Worker Beam spill	1 in 10,000 to 1,000,000 years	potential for negligible increase in dose from single event; no permanent health effects
Public Beam spill	1 in 10,000 to 1,000,000 years	potential for negligible increase in dose from single event; no permanent health effects
Environment Beam spill	1 in 10,000 to 1,000,000 years	negligible release of neutron and gamma radiation from single event; no environmental consequence

Environment

Although a beam spill would result in a minimal release of neutrons and gamma radiation, a single event would have no effect on the environment.

4.2 NO ACTION ALTERNATIVE

Under the no action alternative the proposed LEDA project would not be implemented. No effect on, or change in, the affected LANL environment would be expected.

5. PERMITS

Radioactive Air Emissions

Because radioactive airborne emissions are involved in LEDA, a preconstruction approval from EPA following 40 CFR 61, Subparts A and H, may be required (Buhl 1991). LANL group ESH-17 (Air Quality) has already determined that this approval is not required for Stage I. A National Emission Standards for Hazardous Air Pollutants (NESHAP) permit may be required for Stage II through V based on final engineering designs and controls.

Non-radioactive Air Emissions

Emissions of ethanol and methanol are regulated as volatile organic compounds (VOCs) with no federal or state de minimus permitting levels or ambient air quality standards. Solvent fumes generated from the use of ethanol and methanol in the LEDA cleaning operations are not expected to increase the facilities current potential VOC emissions. Therefore, a construction permit for the LEDA project would not be required under 20 NMAC.

The LEDA cooling tower boilers would emit less than one ton/year of any regulated air pollutant and therefore are exempt from permitting under 20 NMAC 2.70 (Operating Permits). The PM-4 water pump, operating at its maximum capacity, is already included in LANL's operating permit application and therefore LANL's operating permit limits would require no adjustment to account for the potential increased pumping to support the LEDA project. LANL's operating permit application also specifies an annual natural gas consumption of 1,500 million ft^3 for the TA-3 Steam Power Plant. As discussed in Section 3.2 natural gas consumption varies considerably from year to year. In a worst-case year, gas consumption at the TA-3 Steam Power Plant for electrical power and steam generation would be expected to be less than 1,100 million ft^3/yr. Since the LEDA project would, under normal conditions, require use of about an additional 463 million ft^3/yr of gas for electrical power generation in Stages IV and V, it may approach LANL's operational limit for the TA-3 Steam Power Plant. An increase in fuel consumption above 1,500 million ft^3 would be considered a modification to the facility and would require a construction permit under 20 NMAC 2.72.

Clean Water Act

LANL has submitted a Notice of Change Conditions to the EPA. This notice indicates the expected increase in discharge volume from Outfall 03A-113.

If the final designs for the LEDA project indicate that there would be more than 5 acres of ground disturbance, a Stormwater Construction Permit and a Pollution Prevention Plan under NPDES would be required. Current, worst-case estimates indicate that 5.1 acres would be disturbed.

6. AGENCIES AND PERSONS CONTACTED

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7. GLOSSARY AND LIST OF TERMS, ABBREVIATIONS, AND ACRONYMS

alluvium	a deposit of sand, silt, or mud left by flowing water
amperes	unit of electric current; current net transfer of electric charge per unit time
acre-feet	the volume of water that will cover one acre to a depth of one foot (43,560 ft^3)
Agency	United States Department of Energy
ALARA	as low as reasonably achievable
Area G	waste disposal site at TA-54
beam spill	a scattering of the accelerator beam within the team tunnel
CAP88	computer software that calculates dispersion of contaminants in air, EPA approved method.
CEQ	Council on Environmental Quality
chiller equipment	a unit that produces chilled water used to adjust accelerator temperature
CO	carbon monoxide
cooling loop	system for removing heat build-up from an accelerator; the primary cooling loop water may become radioactive depending on its location; water in intermediate and final cooling loops does not become radioactive
cooling tower	water in the final cooling loop pass through these structures, which then release heat to the atmosphere
criteria air pollutants	six pollutants known to be hazardous to human health and for which pollutants EPA set National Ambient Air Quality Standards under the Clean Air Act
cyclotron	a circular accelerator in which charged particles travel an approximately spiral path
DOT	Department of Transportation
ductbank	an enclosure for electrical cables
EA	Environmental Assessment
EDE	effective dose equivalent; see below also

effective dose equivalent	hypothetical whole-body dose that would give the same risk of cancer, equivalent mortality, and serious genetic disorder as a given exposure that is limited to a few organs
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
Ephemeral stream	a stream or reach of a stream that flows briefly only in direct response to precipitation or snowmelt in the immediate locality; its channel bed is always above the water table of the region adjoining the stream
ft^2	square foot, a unit of area
ft^3	cubic foot, a unit of volume
funnel	equipment that combines two beams in an accelerator beam line
gal	gallon, a unit of volume
heat exchanger	device that transfers heat from one fluid to another or to the environment
induction LINAC	a type of linear accelerator which accelerate charged particles by means of a changing magnetic field
injector	initial portion of an accelerator that generates the charged particles
intermittent stream	a stream or reach of a stream that flows only at certain times of the year, such as when it receives flow from springs, melting snow, or localized precipitation
kg	kilogram, a unit of measure
km	kilometer, a unit of length
livestock watering and wildlife habitat standards	standards under 20 NMAC 6.1 for water supplies used by livestock and wildlife
LLW	low-level radioactive waste
low-level radioactive waste	radioactive waste with an activity of less than 100 nanocuries per gram
MEI	maximally exposed individual; a hypothetical person located at the LANL site boundary to receive the maximum possible dose by a given exposure scenario

MeV	million electron volts - a unit of energy commonly used in nuclear and particle physics, equal to the energy acquired by an electron in falling through a potential of 10^6 volts; also known as mega electron volt
μg	micogram, unit of measure
mg	millogram, unit of measure
NMAC	New Mexico Administrative Code
NO_X	oxides of nitrogen, primarily nitrogen oxide (NO) and nitrogen dioxide (NO_2)
NMED	State of New Mexico Environment Department
outfall	a place where water effluent is discharged
perennial stream	a stream or reach of a stream that flows continuously throughout the year in all years; its upper surface is generally lower than the water table of the region adjoining the stream
PHA	Preliminary Hazard Analysis
PM	particulate matter
ppb	parts per billion
ppm	parts per million
power	energy per unit of time
PRS	Potential Release Site; a term used by the ER Project to denote a contaminated location
RCRA	Resource Conservation and Recovery Act
SAL	Screening Action Limits; refers to EPA threshold values for clean up activities
SO_2	sulfur dioxide
solid waste	solid waste refers to construction/demolition materials and other non-radioactive/non-hazardous wastes
SRS	Savannah River Site
SSA	satellite storage area

START	Strategic Arms Reduction Talks
switchyard	electric power substation whose equipment includes connections and transformers
SWMU	Solid Waste Management Unit; a term used by the ER Project to identify a historically contaminated site
TAP	toxic air pollutant
transformers	device used to transfer energy from one circuit to another, often changing the voltage
tritium	isotope of hydrogen whose nucleus contains one proton and two neutrons
tuff	rock formed from compacted volcanic ash fragments
VCA	Voluntary Corrective Action; a category of remediation conducted by the ER Project
voltage	electrical quantity measured in volts; analogous to pressure in a liquid system
VOCs	volatile organic compounds
USFWS	United State Fish and Wildlife Service

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9. APPENDIX A - PRELIMINARY RESULTS OF PCB ANALYSIS FOR SANDIA CANYON SEDIMENT SAMPLES

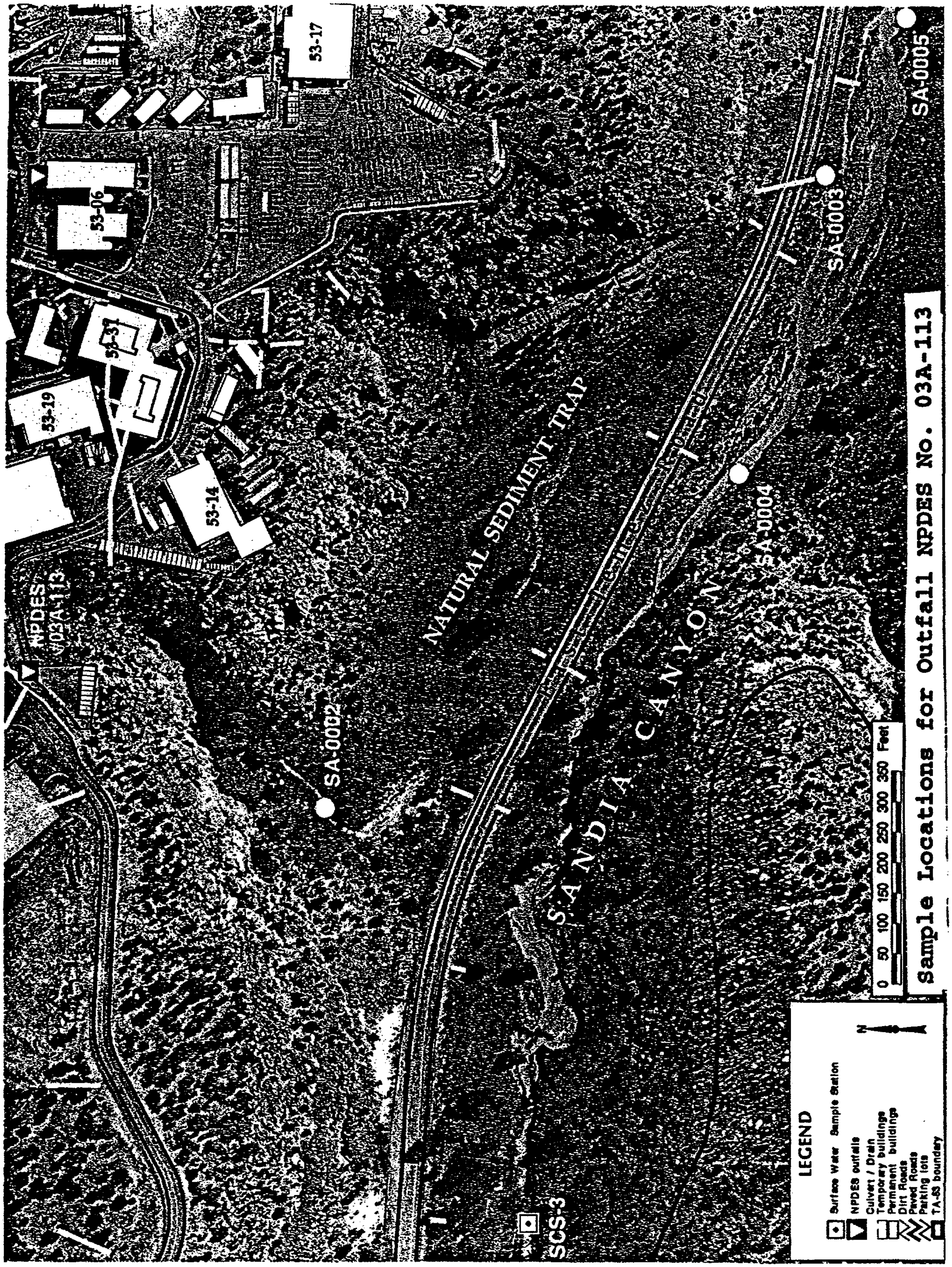
FU 4 Sample ID	Sample No. (Aggregate, Loc. ID, Depth ID)	Depth	Arocior 1260 (µg/kg)	Qualifier Flag	EQL[a] (µg/kg)
04SA-96-0001	DSA-0002-A1	0-6 in	ND[b]	-	33
04SA-96-0002	DSA-0002-A2	6-12 in	ND	-	33
04SA-96-0003	DSA-0003-A1	0-6 in	27	J[c]	33
04SA-96-0004	DSA-0003-A2	6-12 in	ND	-	33
04SA-96-0005	DSA-0004-A1	0-6 in	13	J	33
04SA-96-0006	DSA-0004-A2	6-12 in	12	J	33
04SA-96-0007(reg)	DSA-0005-A1	0-6 in	21	J	33
04SA-96-0008	DSA-0005-A2	6-12 in	16	J	33
04SA-96-0009(dup)	DSA-0005-A3	0-6 in Duplicate	18	J	33

This Sample No. is made up of Aggregate (ex: D), Location ID (ex: SA-0002), and Depth ID (ex: A1). The Location ID's are indicated on the map.

a. EQL = Estimated quantitation limit

b. ND = Not detected

c. "J" flag means the analyte was positively identified, and the associated numerical value is the approximate concentration of the analyte in the sample.


Sample Locations for Outfall NPDES No. 03A-113
53-17
53-06
53-31
53-19
53-14
NPDES
03A-113
NATURAL SEDIMENT TRAP
SANDIA CANYON
SA-0002
SA-0003
SA-0004
SA-0005
SCS-3
0 50 100 150 200 250 300 350 Feet
LEGEND
Surface Water Sample Station
NPDES outfalls
Culvert / Drain
Temporary buildings
Permanent buildings
Dirt Roads
Paved Roads
Parking lots
TA-53 boundary
N

10. APPENDIX B - DOSE AND HUMAN HEALTH RISK CALCULATION METHODOLOGY

The annual Effective Dose Equivalent (EDE or dose) to the maximally exposed individual (MEI) was calculated using the EPA approved CAP88 dose assessment program. Atmospheric dispersion of radionuclide releases from the LEDA project were modeled by the CAP88 program using actual meteorological conditions measured at TA-53 averaged over a four year period. Based on the predicted transport of radioactivity to the MEI location, the CAP88 program then calculates the total dose from all possible paths of exposure (air immersion, ground deposition, inhalation, and ingestion) to obtain the annual EDE.

Risk Calculation Methodology

"Human health effect" is used as a synonym for "risk" in this discussion and is directly proportional to the total effective dose equivalent. Human health effect and risk mean the chance of exposed individual(s) developing additional fatal cancers as a result of the exposure to radioactive materials. The linear dose response and relative risk models discussed in "The 1990 Report of the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR-V)" are used to establish the risk factors (BEIR 1990). These models extrapolate fatal tumor risks to future periods and assume the risk to be proportional to the natural cancer incidence, which generally increases with age. Use of these risk factors is required by DOE in their EA preparation recommendations (DOE 1993).

BEIR-V relates excess fatal cancer cases to dose, giving a lifetime risk factor of a radiation-induced cancer fatality of about 4×10^{-4} fatal cancers per rem for workers and 5×10^{-4}. fatal cancers per rem for members of the general population. The higher value for the public takes into account the higher sensitivity and longer period of exposure for the younger ages present in the general population (NRC 1991). Where the dose to an entire population group is estimated and stated in person-rem, the risk factor is expressed as 5×10^{-4} fatal cancers per person-rem. The risk is in terms of added chances of cancer mortality over the entire population rather than an individual but is used in EA risk calculations to estimate the probability of an exposed individual's developing fatal cancer.

An occupational risk factor of 4×10^{-4} excess cancer fatalities per rem is equivalent to an individual risk for cancer mortality of one chance in 2,500 for a dose of one rem. The risk factor for the public of 5×10^{-4} excess cancer fatalities per person-rem is equivalent to an individual risk for cancer mortality of one chance in 2,000 for a dose of one rem. The human health effect is thus expressed as the number of chances of an individual developing a fatal cancer as a result of the EDE in rem. For a worker population group, the risk factor of 4×10^{-4} excess cancer fatalities per rem is equivalent to a group risk of one chance in 2,500 for a dose of one rem to cause a single additional individual within that group to die of cancer. For a population group the risk factor of 5×10^{-4} excess cancer fatalities per person-rem is equivalent to a group risk of one chance in 2,000 for an exposure of one rem to cause a single additional individual within that group to die of cancer.

References

BEIR 1990: National Research Council, "Health Effects of Exposure to Low Levels of Ionizing Radiation-BEIR V," Committee on the Biological Effects of Ionizing Radiations, Board on Radiation Effects Research, Commission on Life Sciences, 1990.

DOE 1993: US Department of Energy, "Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements," Office of NEPA Oversight, May 1993.

NRC 1991: "Preamble to Standards for Protection Against Radiation," US Nuclear Regulatory Commission, 56 Federal Register 23363, May 21, 1991.

11. APPENDIX C - PRELIMINARY HAZARD ANALYSIS

An overview of the methodology used is presented in Section 1. The process of a Preliminary Hazard Analysis (PHA) is presented in Section 2, and a review of the LEDA PHA is presented in Section 3.

1.0 Overview

A PHA is a systematic approach for identifying the hazards associated with a process and assessing the risk of those hazards qualitatively. The methodology is recognized by various Federal agencies, the chemical and nuclear industry, and professional organizations. An PHA is performed to answer three questions.

- What can happen?
- How likely is it?
- What is the damage?

A PHA can be conducted during a number of phases: research and development, conceptual design, initial operations, detailed engineering, or modification of a process. It is preferable to perform a PHA during the early stages of the conceptual design or research and development phase because risk reduction measures can be implemented cost-effectively at that stage.

A PHA is a formal, systematic, and in-depth method for assessing the entire set of possible accident scenarios for a given facility. Frequency estimates of occurrence for all scenarios are assessed along with estimates of the damage level. Credit is taken for any existing protective features for reducing the likelihood of occurrence of each accident scenario. Each accident scenario is assigned a "risk rank" based on the estimates of the frequency of occurrence and the damage level. The entire set of accident scenarios then can be sorted by the severity of the risk rank.

Those accident scenarios identified by the PHA to be of relatively high risk can be studied in more detail or be subjected to a quantitative analysis. The results of the PHA can be used to develop or modify guidelines and policies for the process operations.

Reasons for performing a PHA include the following:

- identifying hazards associated with facility operation,
- providing a qualitative ranking of hazardous situations for identifying potential process upgrades, and
- providing input for the facility Environmental Assessment (EA) or Safety Analysis Report (SAR).

Many questions that arise during the PHA process can be resolved by gathering information related to the topic of the PHA. This includes a process description, hazard studies on similar processes, and incident histories and other empirical information. This is supplemented by expert judgment throughout the PHA.

A thorough understanding of basic process information is necessary, and the materials involved in any step of the process must be identified. In addition, data are required for appropriate process parameters, such as pressure, temperature, and chemical reactions, given the state of the process. Major equipment, safety-related equipment, and component interfaces must be noted. Knowledge of the operating environments (e.g., earthquakes, winds, flooding, and transportation systems) provides insight into potential hazards and guidance on how to reduce the risk. Existing or draft procedures relating to operation, maintenance, inspection, and emergencies also are required. A facility layout places the process in the context of other processes and the external surroundings.

2.0 The PHA Process

There are four principal steps to be followed in performing a PHA.

1. Identify Processes/Equipment to be Analyzed The facilities, processes, and equipment analyzed in a PHA are identified based on (1) a review of written descriptions of the facilities, (2) review of design documents, and (3) a review of process flow diagrams of the facility. The facility is then organized into systems or processes in order to facilitate the hazard analysis process.

2. Examine Each Process for Possible Hazards and Assess Effects A PHA focuses on identifying accident scenarios by asking the fundamental question "What can go wrong?" For each process, a predefined set of possible hazards is reviewed for applicability, a sample of which is shown in Table 1. For example, the question "What if there is a spill?" is considered for each process where applicable. If it is determined that the spill does create a problem, then the problem is assessed in terms of its consequences, causes, and expected frequency of occurrence. The frequency is estimated using several databases for equipment and human failure or, in some instances, expert judgment. The consequences are estimated from representative calculations performed for postulated accident scenarios.

3. Assign Hazard Severity Category, Frequency, and Risk Ranking (R-F-C) For those accident scenarios deemed by the PHA analyst to pose a potential problem in terms of consequences, causes, and/or expected frequency of occurrence, a qualitative assessment of risk is performed based on best judgment and predefined criteria. Tables 2 and 3 present a summary of the criteria used to select frequency rankings and consequence-severity for those hazard scenarios considered to have a significant consequence or frequency. The risk-ranking matrix used to assign a qualitative risk measure to each significant accident scenario is based on these severity and frequency rankings and is shown in Table 4 .

The key attributes of a scenario are the following:

- System or Process Description
- Hazard Type
- Cause/Initiating Event (the cause of the hazard scenario)
- Consequences (the specific consequences of the given scenario, including the severity of the consequences for the public, co-located worker, facility worker, and environment)
- Protective Features (mitigation currently available)
- Action/Resolution (recommendations to reduce the risk of the scenario)
- R (the risk rank of the scenario as determined using Table 4)
- C (the consequence of the scenario for each receptor as determined using Table 3)
- F (the frequency of the scenario as determined using Table 2)

Table 1: Potential Hazard Sources

Hazard Sources	Examples
Electric Sources	High-Voltage and Current Sources Transformers Batteries Static Electricity
Motion Sources	Shears, Sharp Edges, Pinch Points, Machinery Vehicles/Forklifts and Trucks Mass in Motion
Gravity-Mass Sources	Falling Falling Objects Lifting Tripping, Slipping Earthquakes
Pressure Sources	Chemical Reactions Noise Confined Gases Extreme Wind
Chemical Sources	Corrosive Materials Flammable Materials Toxic Materials Reactive Materials Carcinogenic Materials Oxygen Deficiency
Heat Sources	Electrical Plasma Torch Natural Gas Friction
Cold Sources	Cryogenic Materials Ice, Snow Wind, Rain
Radiant Sources	Radioactive Materials Ionizing Radiation RF Fields Infrared Sources Ultraviolet Plasma Beam Chemical Reactions

4. Review Risk Rankings and Recommend Possible Mitigation Actions The final risk rankings determine which further actions, if any, should be taken to mitigate or eliminate selected scenarios. The accident scenarios with a risk ranking of 1 or 2 are reviewed using the Risk Decision Criteria in Table 5 to identify if immediate or near-term mitigation actions are warranted. Accident scenarios with lower risk rankings also are reviewed, and recommendations are made for possible risk reduction wherever appropriate. As part of the PHA, estimates of the

consequence severity, likelihood, and risk can be assigned given that the recommended actions are implemented.

After all of the accident scenarios are identified, the results are organized into a summary table (Table 6). Each ranking parameter provides a unique perspective on how hazards affect the process being studied. These results are the basis for determining if a more detailed, quantitative risk assessment of one or more accident scenarios is required to better assess the risk of possible on-site or off-site consequences associated with selected hazard scenarios.

3.0 LEDA Hazard Analysis

Preparation

Documentation referenced in preparation for the LEDA PHA included the GTA Final Safety Analysis Report (1994), Calculation of APT-LEDA Beamstop Cooling Water Activation, and Calculation of Air Activation Released from the GTA Tunnel with APT-LEDA Operation at 40 MeV Protons.

The activities selected to be reviewed encompass those activities that would be performed in the APT-LEDA Project that pose a risk to the public, workers, and environment because of accidents involving facility hazards. The following processes/operations were reviewed during the course of the PHA preparation:

- Injector
- Radio-Frequency Quadruple (RFQ) Accelerator
- Coupled-Cavity Drift-Tube Linac (CCDTL)
- Diagnostic Beam Line
- Beamstop and
- Construction Activities

Table 2: Consequence Likelihood Categories

I (1 to 0.1)	**Normal Operations:** Frequency as often as once in 10 operating years or at least once in 10 similar facilities operated for one year.
II (0.1 to .01)	**Anticipated Events:** Frequency between 1 in 10 years and 1 in 100 years or at least once in 100 similar operating facilities operated for one year.
III (10E-02 to 10E-04)	**Unlikely:** Frequency between 1 in 100 years and 1 in 10,000 years or at least once in 10,000 similar facilities operated for one year.
IV (10E-04 to 10 E-06)	**Very Unlikely:** Frequency between 1 in 10,000 years and once in 1 million years or at least once in a million similar facilities operated for 1 year.
V	**Improbable:** Frequency of less than once in a million years.

Table 3: Consequence Severity Categories - Maximum Possible Consequence

Category	Public	Co-located Worker	Worker	Environment
A	Immediate health effects.	Immediate health effects.	Loss of life.	Substantial off-site contamination
B	Long-term health effects.	Long-term health effects.	Severe injury or disability.	Substantial contamination of originating facility/activity, minor on-site contamination. No off-site contamination.
C	Irritation or discomfort, but no permanent health effects.	Irritation or discomfort, but no permanent health effects.	Lost-time injury but no disability.	Minor or no contamination of originating facility/activity. No off-site contamination.
D	No substantial off-site release.	No substantial off-site release.	Minor or no injury and no disability.	Minor or no contamination of originating facility/activity. No off-site contamination.
E	No effect	No effect	No effect	No effect

Off-site: Public, private, or Indian lands that are not part of Laboratory property.
On-site: Laboratory property but not necessarily the originating technical area.
Facility: Originating technical area of the laboratory.

Table 4: Risk Ranking Matrix

	Risk Ranking Matrix for Public and Co-located Workers				
Severity of Consequence	Likelihood of Consequences				
	I	II	III	IV	V
A	1	1	2	2	3
B	1	2	2	3	4
C	2	2	3	4	4
D	3	4	4	4	NH
E	NH	NH	NH	NH	NH

NH: Not a Hazard

	Risk Ranking Matrix for Workers and Environment				
Severity of Consequence	Likelihood of Consequences				
	I	II	III	IV	V
A	1	1	2	3	3
B	1	2	3	3	4
C	2	3	3	4	4
D	3	4	4	4	NH
E	NH	NH	NH	NH	NH

Table 5 - Mitigation Recommendations for Risk Rank Levels

Risk Rank	Recommendation
1	**Unacceptable:** Should be mitigated to risk rank 3 or lower within a reasonable time period.
2	**Undesirable:** Should be mitigated to risk rank 3 or lower within a reasonable time period.
3	**Acceptable with Controls:** Verify that procedures, controls, and safeguards are in place.
4	**Acceptable as is:** No action is necessary
5	**Not a Hazard**

Table 6: Summary Of LEDA Hazards And Impacts With Risk Ranks

Hazard	Scenario	Impact On Public (Risk Rank)	Impact On Co-Located Worker (Risk Rank)	Impact On Worker (Risk Rank)	Impact On Environment (Risk Rank)	Highest Consequence
Electricity-High Voltage	Access breach of RF or klystron systems	No	No	Yes (3)	No	Potential death/ severe worker injury
Ionizing Radiation	Inadvertent access of personnel to beam stop or accelerator tunnel	No	No	Yes (3)	No	Potential exposure of personnel to ionizing radiation
Radiation (X-rays)	Injector access	No	No	Yes (4)	No	Potential exposure of facility workers
Radiation (X-rays)	Access during high RF power (RFQ and CCDTL)	No	No	Yes (4)	No	Potential exposure of facility workers
Radiation (Neutrons & Gamma)	Beam spill	No	Yes (4)	Yes (3)	No	Potential exposure of facility/co-located workers
Mechanical	Oxygen deficiency in confined space	No	No	Yes (3)	No	Potential worker injury/death from asphyxiation
Mechanical	Failure of crane during LEDA construction	No	No	Yes (2)	No	Potential severe worker injury
Fire	Fire in building MPF-365	No	No	Yes (4)	No	Worker injury from inhalation of fire combustion products

Table 7: Preliminary Hazard Analysis Tables

SYSTEM OR PROCESS DESCRIPTION	HAZARD TYPE	CAUSE/ INITIATING EVENT	CONSEQUENCES (Public, Co-located worker, Worker, Environment)	PROTECTIVE FEATURES	ACTION/ RESOLUTION	R-C-F Public Co-located Worker Worker Environment
Run Permit System	Thermal, Ionizing Radiation	System failure, beam fails to turn off	Potential hardware damage (E,E,E,E)	Periodic testing and maintenance; redundant systems	None	NH (III E) NH (III E) NH (III E) NH (III E)
Personnel Safety System	Ionizing Radiation	System failure, beam fails to turn off, failure to conduct personnel sweep properly	Potential exposure of workers to beam induced radiation (E,E,C,E)	Periodic inspection and maintenance; redundant systems; shielding; access controls; interlock system	None	NH (II E) NH (II E) 3 (II C) NH (II E)
Radiation monitoring instruments	Radiation (x-rays, neutrons, gammas)	Radiation monitor fails	Minor radiological dose to worker (E,E,C,E)	Periodic inspection and maintenance; shielding; access controls; interlock systems	None	NH (IV E) NH (IV E) 4 (IV C) NH (IV E)
Injector - Injector Source System	Radiation (x-rays)	Failure of x-ray detector	Minor radiological dose to worker (E,E,D,E)	Periodic inspection and maintenance; area monitor	None	NH (III E) NH (III E) 4 (III D) NH (III E)
Injector	Electrical - High Voltage	Voltage shorting unit or resistors fails	Potential injury to worker (E,E,C,E)	Periodic testing and maintenance; Indicator lights; SOP; Interlocks	None	NH (II E) NH (II E) 3 II C NH (II E)
Injector - RF Radiation Monitor	RF Radiation	RF leakage detector fails	RF-radiation dose to worker (E,E,C,E)	Periodic inspection and maintenance of RF-leakage detector	None	NH (II E) NH (II E) 3 II C NH (II E)

Table 7: Preliminary Hazard Analysis Tables (Cont.)

SYSTEM OR PROCESS DESCRIPTION	HAZARD TYPE	CAUSE/ INITIATING EVENT	CONSEQUENCES (Public, Co-located worker, Worker, Environment)	PROTECTIVE FEATURES	ACTION/ RESOLUTION	R-C-F Public Co-located Worker Worker Environment
RFQ Accelerator - Klystrons	Ionizing radiation - (x-rays) from high RF power	Inadvertent access to RFQ during high RF power	Potential radiological dose to workers from x-rays (E,E,D,E)	Administrative exclusion of personnel from beam tunnel during RF conditioning; shielding; interlocks	None	NH (III E) NH (III E) 4 III D NH (III E)
RFQ Accelerator - Klystrons - Waveguide Lines	Nonionizing radiation from high RF power	Waveguide left open during operation, RF leakage from waveguide flange	Potential exposure of personnel to nonionizing RF radiation, potential permanent eye damage (E,E,C,E)	RF leakage sensing and RF mismatch sensing; Periodic inspection and testing of waveguides	None	NH (II E) NH (II E) 3 II C NH (II E)
RFQ Accelerator - Klystrons	Electrical - High Voltage	Inadvertent access to high voltage klystron systems	Potential death/severe injury to worker (E,E,A,E)	Redundant hard-wire and software interlock chains; administrative SOPs	None	NH (IV E) NH (IV E) 3 IV A NH (IV E)
RFQ Accelerator - Waveguide Basement	Chemical - oxygen deficiency	Compressed gas or cryogen released in an enclosed space	Potential asphyxiation of worker (E,E,A,E)	Oxygen monitors; alarms in local area & control room; hazard controls	None	NH (IV E) NH (IV E) 3 IV A NH (IV E)
RFQ Accelerator - Vacuum Vessel	Pressure	Vacuum vessel becomes overpressurized	Potential injury to worker from rupture of vacuum vessel (E,E,D,E)	Pressure relief valves; design of systems and subsystems to ASME code	None	NH (IV E) NH (IV E) 4 IV D NH (IV E)
RFQ Accelerator - Vacuum Vessel	Flying debris	Vacuum viewing window breaks	Potential injury to worker from debris (E,E,D,E)	Design of systems and subsystems to ASME code	None	NH (IV E) NH (IV E) 4 IV D NH (IV E)

Table 7: Preliminary Hazard Analysis Tables (Cont.)

SYSTEM OR PROCESS DESCRIPTION	HAZARD TYPE	CAUSE/ INITIATING EVENT	CONSEQUENCES (Public, Co-located worker, Worker, Environment)	PROTECTIVE FEATURES	ACTION/ RESOLUTION	R-C-F Public Co-located Worker Worker Environment
Coupled-Cavity Drift-Tube Linac (CCDTL) Klystrons	Radiation - x-rays	Inadvertent access of personnel during high RF power	Potential radiological exposure of workers to x-rays (E,E,D,E)	Administrative exclusion of personnel from beam tunnel during RF conditioning; shielding; interlocks	None	NH (III E) NH (III E) 4 III D NH (III E)
Coupled-Cavity Drift-Tube Linac (CCDTL) Klystrons and Waveguide Lines	Nonionizing radiation from high RF power	Waveguide left open during operation, RF leakage from waveguide flange	Potential exposure of personnel to nonionizing RF radiation, potential permanent eye damage (E,E,C,E)	RF leakage sensing and RF mismatch sensing; Periodic inspection and testing of waveguides	None	NH (II E) NH (II E) 3 II C NH (II E)
Coupled-Cavity Drift-Tube Linac (CCDTL) Klystrons	Electrical - High Voltage	Inadvertent access to high voltage klystron systems	Potential death/severe injury to worker (E,E,A,E)	Redundant hard-wire and software interlock chains; administrative SOPs	None	NH (IV E) NH (IV E) 3 IV A NH (IV E)
Coupled-Cavity Drift-Tube Linac (CCDTL) Vacuum Vessel	Pressure	Vacuum vessel becomes overpressurized	Potential injury to worker from rupture of vacuum vessel (E,E,D,E)	Pressure relief valves; design of systems and subsystems to ASME code	None	NH (IV E) NH (IV E) 4 IV D NH (IV E)
Coupled-Cavity Drift-Tube Linac (CCDTL) Vacuum Vessel	Flying debris	Vacuum viewing window breaks	Potential injury to worker from debris (E,E,D,E)	Design of systems and subsystems to ASME code	None	NH (IV E) NH (IV E) 4 IV D NH (IV E)

Table 7: Preliminary Hazard Analysis Tables (Cont.)

SYSTEM OR PROCESS DESCRIPTION	HAZARD TYPE	CAUSE/ INITIATING EVENT	CONSEQUENCES (Public, Co-located worker, Worker, Environment)	PROTECTIVE FEATURES	ACTION/ RESOLUTION	R-C-F Public Co-located Worker Worker Environment
Diagnostic Beam Line	Electrical	Open or shorted connections in the DBL or subsystems	Potential lost-time injury to the worker from the short circuit; Loss of diagnostic information or control in the system or subsystems(E,E,C,E)	Control/ Monitoring; redundant systems; and grounding	None	NH (IV E) NH (IV E) 4 IV C NH (IV E)
Diagnostic Beam Line	Electrical	Misdirected signals in the DBL or subsystems	Loss of diagnostic information or control in the system or subsystems (E,E,E,E)	Control/ Monitoring redundant systems	None	NH (IV E) NH (IV E) NH (IV E) NH (IV E)
Diagnostic Beam Line	Electrical	Misinterpreted signals in any of the monitors or diagnostic systems	Loss of diagnostic information or control in the system or subsystems (E,E,E,E)	Control/ Monitoring redundant systems	None	NH (IV E) NH (IV E) NH (IV E) NH (IV E)
Diagnostic Beam Line	Pressure - Vacuum	Fiber Optic Transmitters Fail	Loss of vacuum monitoring capability (E,E,E,E)	Backup/Redundant monitoring	None	NH (V E) NH (V E) NH (V E) NH (V E)
Diagnostic Beam Line	Pressure - Vacuum	Failure of vacuum system	Diagnostic region will not achieve vacuum pressure, diagnostics will fail (E,E,E,E)	Control/ Monitoring systems	None	NH (IV E) NH (IV E) NH (IV E) NH (IV E)
Diagnostic Beam Line	Pressure - Vacuum	Inadequate pump-out of diagnostic region	Diagnostic region will not achieve vacuum pressure, diagnostics will fail (E,E,E,E)	Control/ Monitoring systems	None	NH (IV E) NH (IV E) NH (IV E) NH (IV E)
Diagnostic Beam Line	Pressure - Vacuum	Remote operated vacuum pumps fail	Vacuum pumps can't be closed off, vacuum to diagnostic lines can't be opened (E,E,E,E)	Control/ Monitoring systems	None	NH (III E) NH (III E) NH (III E) NH (III E)

Table 7: Preliminary Hazard Analysis Tables (Cont.)

SYSTEM OR PROCESS DESCRIPTION	HAZARD TYPE	CAUSE/ INITIATING EVENT	CONSEQUENCES (Public, Co-located worker, Worker, Environment)	PROTECTIVE FEATURES	ACTION/ RESOLUTION	R-C-F Public Co-located Worker Worker Environment
Beam Stops and beamline	Radiation (Neutrons & Gamma)	Beam spill	Potential increase in radiological dose to the worker, co-located worker,(E,D,C,E)	Complete shutdown of the LEDA machine; neutron and gamma radiation detectors: 8-ft thick shielding wall	None	NH (III E) 4 III D 3 III C NH (III E)
Facility - Bldg. MPF-365	Fire	Ignition of flammable chemicals or materials	Potential worker injury from inhalation of combustion products; minor contamination of the facility; LEDA downtime (E,E,C,E)	Fire suppression system; automatic LEDA shutoff	None	NH (IV E) NH (IV E) 4 IV C NH (IV E)
Beam Stop	Thermal - molten radioactive metals	Beam spill, possibly penetrates vacuum vessel and melts a small portion of the beam stop	Heating and rupture of the beam tube; loss of vacuum; accelerator shut down for beam stop decontamination and repairs (E,E,D,E)	Fire suppression system; beam stop material (graphite, copper, or tantalum), can't be disbursed; shielding; confinement; remote handling	None	NH (IV E) NH (IV E) 4 IV D NH (IV E)
Beam Stop	Radiation - activated air from beam stop	HVAC or confinement failure	Potential radiological exposure to workers (E,E,D,E)	Activated air released from the MPF-365 stack through HEPA filters; stack fan interlocked to run permit	None	NH (II E) NH (II E) 4 II D NH (II E)
Beam Stop	Radiation - beam stop exclusion area	Inadvertent access to the beam stop exclusion area before radiation-cool-down time	Radiological exposure to workers (E,E,C,E)	Access controlled to beam stop area; interlocked barriers; SOPs; RWPs	None	NH (II E) NH (II E) 3 II C NH (II E)
Beam Stop	Radiation - radioactive water	Radioactive water leak in beam stop cooling system	No injury to workers or damage to environment; accelerator shut down for repairs (D,D,D,D)	Confinement system in building; water level monitored; low activation	None	3 (I D) 3 (I D) 3 (I D) 3 (I D)

Table 7: Preliminary Hazard Analysis Tables (Cont.)

SYSTEM OR PROCESS DESCRIPTION	HAZARD TYPE	CAUSE/ INITIATING EVENT	CONSEQUENCES (Public, Co-located worker, Worker, Environment)	PROTECTIVE FEATURES	ACTION/ RESOLUTION	R-C-F Public Co-located Worker Worker Environment
Construction Activities Cooling Towers	Gravity-mass	Failure of crane during construction of cooling tower	Potential severe worker injury from falling crane or materials (E,E,B,E)	Safety inspections and maintenance of the crane	Crane load test verification prior to use	NH (II E) NH (II E) 2 II B NH (II E)
Construction Activities Electrical Upgrades	Electrical - High Voltage	Accidental contract with high voltage line	Potential serious injury/death of construction worker (E,E,A,E)	Pre-construction survey ; training	None	NH (IV E) NH (IV E) 3 IV A NH (IV E)
Construction Activities Cooling Upgrades	Gravity-mass	Trench collapses during water line installation	Potential severe injury to construction workers(E,E,B,E)	Proper trench shoring; on-site inspections	None	NH (III E) NH (III E) 3 III B NH (III E)
Construction Activities Movement of Accelerator or Support Equipment	Gravity-mass	Failure of overhead crane, overload; dropping of load; or rigging failure	Potential serious worker injury from falling objects (E,E,B,E)	Safety inspections and maintenance of the crane; follow procedures; and rigging inspections	None	NH (III E) NH (III E) 3 III B NH (III E)
Construction Activities Interior upgrades of MPF-365	Electrical; gravity-mass	Electrical accident; fall from scaffolding	Potential injury to construction worker (E,E,C,E)	Properly trained personnel; OSHA inspections	None	NH (II E) NH (II E) 3 II C NH (II E)