DOE/EA-1822

U.S. Department of Energy
Idaho Operations Office

Idaho National Laboratory Stand-Off Experiment (SOX) Range Environmental Assessment

Final

March 2011

Idaho National Laboratory

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Prepared for the
U.S. Department of Energy
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CONTENTS

FIGURES

TABLES

ACRONYMS

AI	Active Interrogation or Active Inspection
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
ASE	Accelerator Safety Envelope
BBS	Breeding Bird Survey
BEA	Battelle Energy Alliance
BLM	Bureau of Land Management
CAA	Clean Air Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CITRC	Critical Infrastructure Test Range Complex
CWA	Clean Water Act
DOE	U.S. Department of Energy
EA	Environmental Assessment
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FWS	U.S. Fish and Wildlife Service
GHG	Greenhouse Gas
HAPs	Hazardous Air Pollutants
HPGe	High Purity Germanium
IDS	Intrusion Detection System
IET	Initial Engine Test
INL	Idaho National Laboratory
ISU	Idaho State University
Linac	Linear accelerator
MEI	Maximally Exposed Individual
MeV	Mega (million) electron volts
MFC	Materials and Fuels Complex
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants

NRHP	National Register of Historic Places
PPA	Pulsed Photonuclear Assessment
PSD	Prevention of Significant Deterioration
RAD	Radiation Absorbed Dose
R&D	Research and Development
RCM	INL's Radiological Control Manual
RRTR	Radiological Response Training Range
RWMC	Radioactive Waste Management Complex
SADs	Safety Assessment Documents
SMC	Specific Manufacturing Capability
SOX	Stand-Off Experiment Range
SF6	Sulfur Hexafluoride
SRPA	Snake River Plain Aquifer
TAN	Test Area North
TSF	Technical Services Facility
U.S.	United States
UAV	Unmanned Aerial Vehicle
VHRA	Very High Radiation Area

GLOSSARY

Active Interrogation (AI): The process of inducing a signature from a material using an interrogating source. A common use of AI is to use radar or lasers to measure the speed of a vehicle. Radar systems use photons and light that travel from a source to an interrogated vehicle and then are reflected back to the source to determine the interrogated vehicle's speed. Similarly, the Idaho National Laboratory (INL) uses high energy x-rays (which are also photons) to interrogate material characteristics.

Attainment Area: An area considered to have air quality as good as or better than the National Ambient Air Quality Standards (NAAQS) as defined in the Federal Clean Air Act (CAA). An area may be an attainment for one pollutant and a nonattainment area for others.

Bremsstrahlung photons: Bremsstrahlung is a German word meaning "braking radiation," and refers to the x-rays produced when high-velocity charged particles, such as electrons, undergo a rapid change in velocity. The bremsstrahlung process creates x-rays when electrons change direction (i.e., are accelerated). For radiotherapy, linac electrons can have maximum energies of about 25 million electron volts (MeV). These electrons are slowed down in a very short distance through the bremsstrahlung process to create the high energy x-rays that are used for radiotherapy treatments. The SOX Range would be allowed to use electron energies with a maximum energy of 60 MeV to produce x-rays.

Cairns: Rock piles constructed historically and prehistorically to mark features on the landscape, such as travel corridors, caves, or campsites.

Clean Air Act (CAA): The Federal Clean Air Act (CAA) is the basis for the national air pollution control effort. Basic elements of the act include standards for major air pollutants, hazardous air pollutants, state attainment plans, motor vehicle emission standards, stationary source emission standards and permits, acid rain control measures, stratospheric ozone protection, and enforcement provisions.

Clean Water Act (CWA): The Federal Clean Water Act (CWA) is the primary federal law in the United States (U.S.) governing water pollution. The act established the goals of eliminating releases to water of high amounts of toxic substances, eliminating additional water pollution by 1985, and ensuring that surface waters meet standards necessary for human sports and recreation by 1983.

Effective Dose Equivalent (EDE): The summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent, or EDE, includes the committed dose from internal deposition of radionuclides and the dose due to penetrating radiation from sources external to the body. The EDE is expressed in units of rem.

Ethnobotany: The scientific study of the relationships that exist between people and plants. In the case of this EA, ethnobotany refers to the study of those plants that Shoshone-Bannock Tribal members use as part of their culture.

High Energy X-rays: Photons, produced from the interaction of energetic electrons with matter, having an energy continuum (i.e., bremsstrahlung distribution) with its maximum energy equal to the maximum electron energy.

Linac: A linac is a machine that operates on electricity. When the linac is turned on, it generates an electric field within a metal waveguide that can accelerate charged particles. These accelerated charged particles, like electrons, interact with materials and produce interactions of interest, such as high energy x-rays. When the linac is turned off, it cannot accelerate the charged particles and therefore the x-rays are no longer produced. Linacs come in many different sizes with waveguides from a few inches long that can be carried by hand, to some that are miles long with small communities built around them. The linacs that would be used at the SOX Range are small and transportable with waveguides less than a few yards in length that could be placed inside a cargo container.

National Ambient Air Quality Standards (NAAQS): Standards established by the U.S. Environmental Protection Agency (EPA) under authority of Federal Clean Air Act (CAA) that apply for outdoor air throughout the country. Primary standards are designed to protect human health with an adequate margin of safety, including sensitive populations (such as children, the elderly, and individuals suffering from respiratory disease). Secondary standards are designed to protect public welfare from any known or anticipated adverse effects of a pollutant.

National Environmental Research Park: The INL Site is categorized as a National Environmental Research Park, or NERP. NERPs are outdoor laboratories that provide opportunities for environmental studies on protected lands that act as buffers around U.S. Department of Energy (DOE) facilities. DOE uses these research parks to evaluate the environmental consequences of energy use and development, as well as strategies to mitigate these effects and demonstrate possible environmental and land-use options. The seven NERPs located in the U.S. are administered through their regional DOE Operations Offices and are coordinated and guided by the U.S. Office of Science.

National Emission Standards for Hazardous Air Pollutants for Radionuclides (Rad NESHAPs): The U.S. Environmental Protection Agency's (EPA) standards found at 40 CFR 61 Subpart H that regulate airborne emissions of hazardous air pollutants (HAPs), including radionuclides, from a specific list of industrial sources called "source categories." Each source category that emits radionuclides in significant quantities must meet technology requirements to control them and is required to meet specific regulatory limits.

Nonattainment Area: The Federal Clean Air Act (CAA) and its "Amendments of 1990" define a "nonattainment area" as a locality where air pollution levels persistently exceed *NAAQS* (see glossary), or that contribute to ambient air quality in a nearby area that fails to meet those standards. The U.S. Environmental Protection Agency (EPA) gives nonattainment areas a classification based on the severity of the violation and the type of air quality standard they exceed. EPA designations of nonattainment areas are only based on violations of national air quality standards for carbon monoxide, lead, ozone (1-hour), particulate matter (PM-10), and sulfur dioxide.

Photonuclear: The process of photons interacting with the nucleus of an atom. Some photons (such as radio waves and light-waves) have wavelengths that are large compared to the nucleus of an atom and therefore interact with the outer electron shells or surfaces of the atoms. Higher energy photons have smaller wavelengths and penetrate the electron clouds that surround the atom and can interact with the nucleus.

Plant species of ethnobotanical interest: Plants traditionally used by indigenous cultures in folklore, and medicine, religion.

Prevention of Significant Deterioration: This term applies to new major air pollution sources or major modifications at sources for pollutants where the area the sources are located is in attainment or unclassifiable with the *NAAQS* (see glossary). The regulation requires the installation of "best available control technology," air quality analysis, additional impacts analysis, and public involvement to control these sources.

Pulsed Photonuclear Assessment: The Pulsed Photonuclear Assessment (PPA) technology uses short pulses of high energy x-rays (sometimes called photons) that can interact with the nucleus of atoms to produce photonuclear reactions. After a short x-ray pulse, the x-rays interact with the nucleus of the inspected material. The return emissions from the material's photonuclear reactions are evaluated to assess the material's characteristics.

Radiological NESHAP: Referring to Federal Regulation 40 CFR 61 Subpart H, which protects the public and the environment from the hazards of radionuclide emissions.

***S**tand-**O**ff e**X**periment (SOX) Range:* The proposed SOX Range is located on the INL Site, north and east of the TAN/TSF area. The range would consists of three primary work areas including: (1) The Down Range Activity Area, (2) the Expanded Range Activity Area, and (3) the Linac Support Building Activity Area. The Down Range and Linac Support Building Activity areas are encompassed within an existing fenced area (an octagonal shaped area of about 2,000 acres) (see Figure 2).

Vadose Zone: The region of aeration above the water table, which extends from the top of the ground surface to the water table.

EXECUTIVE SUMMARY

Various organizations within the United States (U.S.) government have recognized the need to rapidly identify, characterize, and verify container contents without the time-consuming manual inspection methods currently used. Since the terrorist attacks of September 11, 2001, nuclear and explosive material detection have become major focus areas. To aid in the detection of nuclear and explosive materials, Idaho National Laboratory (INL) is developing *nonintrusive active-interrogation (AI) systems* (see glossary) capable of detecting such materials in a variety of field-deployable applications at greater standoff distances.

The objective of this environmental assessment (EA) is to evaluate the potential environmental impacts of creating and operating a high-energy x-ray ***S**tand-**O**ff e**X**periment (SOX) Range* (see glossary) at the INL Site by evaluating two alternatives: (1) the proposed action, and (2) a 'No Action' alternative. The U.S. Department of Energy (DOE) reviewed several possible alternatives and determined that the only reasonable alternative involved locating the project at a previously disturbed location north of Test Area North (TAN)/Technical Support Facility (TSF) to meet the purpose and need and satisfy program requirements; no off-site locations met the site selection criteria.

Alternative 1 would establish a SOX Range with the capability to perform outdoor accelerator testing northeast of the TAN/TSF boundary fence and the TSF parking lot. The SOX Range would be located in a large fenced and previously disturbed area. This EA describes the environmental impacts of the proposed action and a 'No Action' alternative on air, biological, and cultural resources.

The site would be used to research and develop *linear particle accelerators* (*linacs*) (see glossary) with a maximum energy of 60 Mega (million) electron volts (MeV) and a current of 100 microamperes for AI technologies at greater standoff distances than is currently possible at the INL. Typical activities that would occur at the SOX Range include installing, assembling, and operating electron linacs. Typically, four to twelve people and three vehicles would be involved in range operations.

In accordance with Federal Regulations 40 CFR 61 subpart H (*National Emission Standards for Hazardous Air Pollutants for Radionuclides*) (see glossary), the atmospheric transport and radiological dose code, CAP88 PC Version 3,[1] was used to calculate the *Effective Dose Equivalent* (*EDE*) (see glossary) from operating linacs to a Maximally Exposed Individual (MEI) located off the INL Site boundary using the methodology described in the 2009 INL NESHAP Report for Radionuclides.[2] The maximum EDE to the public from the SOX Range location would be controlled to less than 1% of the 10 millirem (mrem)/yr EDE limit (refer to page 13, Section 4.1.1, footnote 'f,' for an explanation of 'rem').

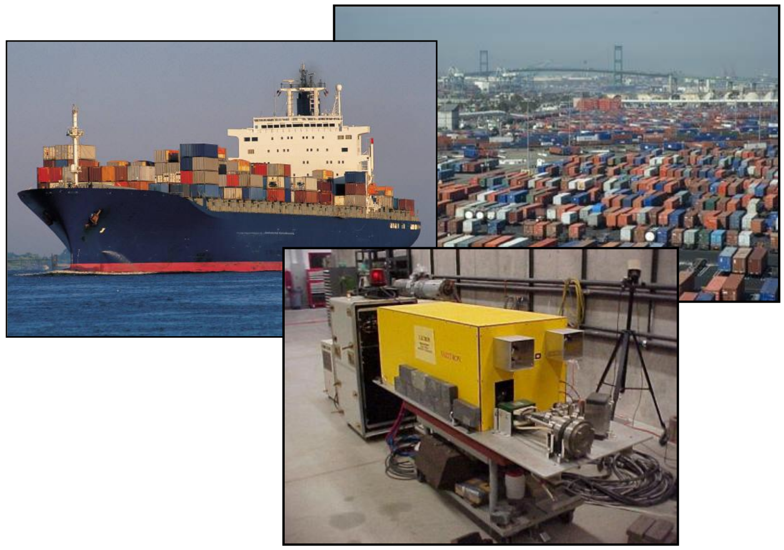
The impact of radioactivity from proposed activities at the SOX Range on nonhuman biota was assessed using *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*[3] and the associated software, RESRAD-Biota.[4] Dose to terrestrial plants would remain 1,000 times below the regulatory limit, except for those near the linac. Due to the mobility of birds and large mammals, and several layers of administrative and physical controls, it would be highly unlikely for those birds or large mammals to receive a dose above regulatory limits.

The majority of activities would occur in previously disturbed areas. The surrounding areas within the project area consist of natural vegetation, wildlife, and cultural resources. The proposed action would remove a small amount of habitat for sage-grouse and pygmy rabbits and slightly increase habitat fragmentation in an area that is already disturbed. Proposed operational controls would minimize potential impacts to sensitive resources, such as sage-grouse, pygmy rabbits, migratory birds, and cultural and archaeological resources.

Idaho National Laboratory Stand-Off Experiment Range Environmental Assessment

1.0 PURPOSE AND NEED

Various organizations within the United States (U.S.) government have recognized the need to rapidly identify, characterize, and verify container contents without the time-consuming manual inspection methods currently used. Since the terrorist attacks of September 11, 2001, nuclear and explosive material detection have become major focus areas. To aid in the detection of nuclear and explosive materials, Idaho National Laboratory (INL) is developing *nonintrusive active-interrogation (AI) systems* (see glossary) capable of detecting such materials in a variety of field-deployable applications at greater standoff distances.[5,6,7,8,9,10,11,12]



INL has a long history of active interrogation research and development (R&D), especially in the area of *high-energy x-ray* (see glossary) related technologies. Early *photonuclear* (see glossary) R&D conducted at INL in the 1970s focused on waste monitoring,[13] while more recent efforts have focused on developing material identification and nuclear arms treaty verification technologies.[14,15,16,17,18] For many years, INL has been working collaboratively with Idaho State University (ISU), other national laboratories, and government agencies to enhance nuclear material detection capabilities. Based on INL's continued R&D success with *Pulsed Photonuclear Assessment* (*PPA*) (see glossary) technology, there is now a need for a larger area to conduct additional R&D. The U.S. Department of Energy (DOE) proposes locating a ***S**tand-**O**ff e**X**periment (SOX) Range* (see glossary) on the INL Site for the continued R&D in support of this critical national and homeland security mission.

This environmental assessment (EA) evaluates constructing and operating a high-energy x-ray SOX Range on the INL Site. The proposed range would be capable of operating *linear particle accelerators* (*linacs*) (see glossary) with maximum electron energies of 60 MeV and beam currents of 100 microampere configurations. Currently, INL is using *linac* (see glossary) AI technologies at the ISU airport facility and INL's Critical Infrastructure Test Range Complex (CITRC) area. To continue this technology development effort, a dedicated SOX Range with a longer beam path than is currently available is required. The development of this dedicated range would allow INL to continue its leading R&D role with AI photonuclear-based technologies at greater standoff distances at the SOX Range. DOE would continue to use the current locations, as described above, for AI R&D activities not requiring the large standoff distances.

The objective of this EA is to evaluate the potential environmental impacts of creating and operating a SOX Range on the INL Site. This document was prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969 (Public Law 91 190), as amended;[19] the Council on Environmental Quality's NEPA Regulations (40 Code of Federal Regulations [CFR] Parts 1500-1508);[20] U.S. Department of Energy (DOE) Order 451.1;[21] and DOE NEPA Implementing Regulations (10 CFR Part 1021).[22]

2.0 ALTERNATIVES

2.1 Background

The INL Site, an 890-square mile reservation in southeastern Idaho (see Figure 1), is managed and operated by Battelle Energy Alliance (BEA). INL continues to build on several decades of R&D efforts in the area of photonuclear AI for material detection and identification. One of the goals of this effort is to detect actively induced signatures from nuclear materials from large standoff distances. The *Pulsed Photonuclear Assessment* (*PPA*) (see glossary) is an AI technique that uses an electron linac to produce *high-energy x-ray* (also called *Bremsstrahlung photons*) (see glossary) and various detector technologies to identify nuclear and non-nuclear materials of interest.

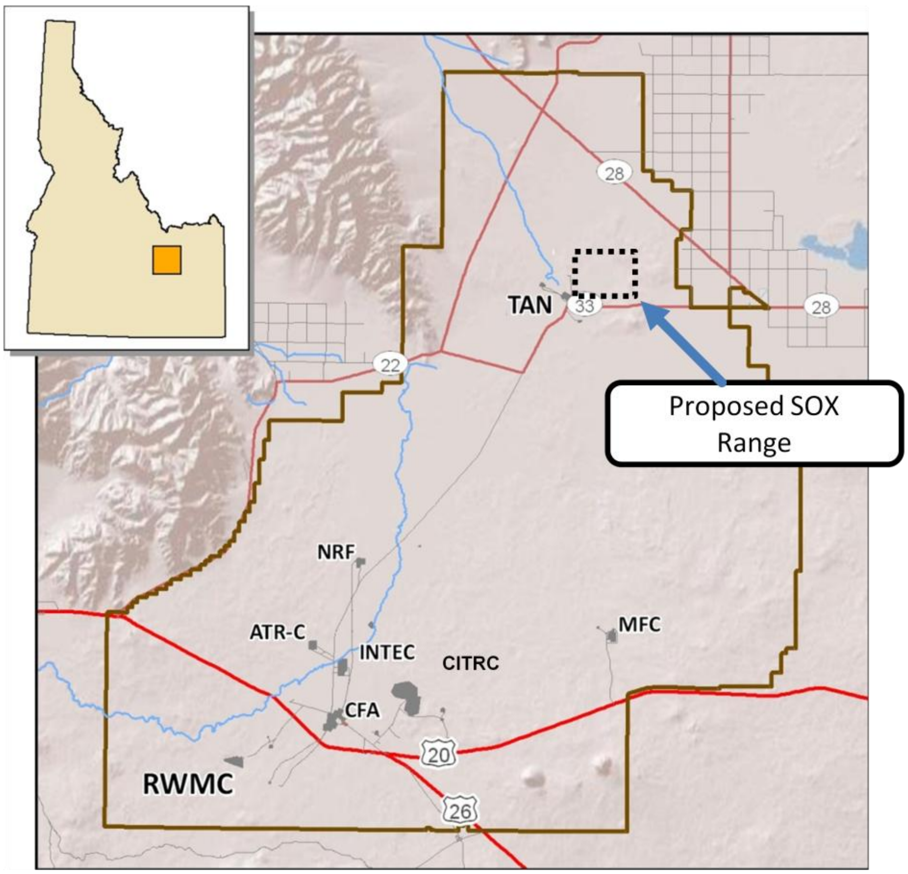


Figure 1. Idaho National Laboratory showing the general location of the proposed SOX Range.

2.2 Range of Reasonable Alternatives and Siting Analysis Criteria

DOE considered several sites within the INL Site boundaries to construct and operate the SOX Range. These sites include the CITRC, the Live Fire Range Complex (near Central Facilities Area [CFA]), the Material and Fuels Complex (MFC) Gun Range, a remote area east of MFC, a location near the Unmanned Aerial Vehicle (UAV) runway, and the Initial Engine Test (IET) site near Test Area North/Technical Support Facility (TAN/TSF). DOE developed the following set of site selection criteria to help identify alternatives to meet the purpose and need and to satisfy program requirements (see inset box on the following page). The site near TAN/TSF has several clear advantages compared to the other locations considered, and it met all the site-selection criteria. The other locations did not meet the site-selection criteria and DOE did not consider those locations for further analyses in this EA. The CITRC site, the Live Fire Range Complex, the UAV runway area, and the MFC Gun Range were removed from further analysis due to obstructed terrain and/or proximity to other work activities. The area east of MFC has acceptable terrain and no other work activities nearby, but is located in an undeveloped area with a lack of nearby power and well-maintained roads. Road upgrades and power installation to this location would be cost-prohibitive and would not take advantage of using a previously disturbed area.

DOE did not consider offsite locations because the purpose and need is directly related to supporting the INL AI R&D Program in accordance with the site selection criteria listed below. Specific criteria that could not be satisfied at a near off-site location included one or more of the following: the availability and ability to regularly use nuclear material in support of testing, the ability to conduct testing at the required distances including the exclusion of public access to the area for radiological protection, and the need for isolation from any co-located activities to support uninterrupted daily R&D. A new range is necessary to allow for the use of higher power accelerators (and at larger standoff distances) that promotes the expansion of INL's AI R&D capability. Based on this criteria, DOE chose to evaluate two alternatives: (1) Alternative 1: The Proposed Action – Constructing and Operating the SOX Range on the INL Site just north of TAN (see Section 2.3), and (2) Alternative 2: 'No Action' (see Section 2.4).

Site Selection Criteria

- Remote location
- Flat, continuous, and unobstructed terrain along the beam paths extending several miles
- Limited public access to provide the needed radiological controls
- No occupied facilities located within 1/2 mile of the back and sides of the linac and within four miles downrange from the linac
- Accessibility to range via well-maintained roads
- Reliable commercial power
- Availability of various nuclear and non-nuclear materials for AI assessments
- Located on the INL site to conduct daily R&D and assessment activities in support of the INL AI Program

2.3 Alternative 1 – Constructing and Operating the Stand-Off Experiment (SOX) Range near Test Area North (TAN)

Note: Refer to **Appendix A** as you read the proposed action to help visualize the SOX footprint and operational activities (see Figures A-1 through A-5).

DOE's proposed action is to establish a SOX Range with the capability to perform outdoor accelerator testing northeast of the TAN/TSF boundary fence and TSF parking lot. The SOX Range would be located in a large fenced and previously disturbed area. Figure 2 shows a bird's eye view of the SOX Range and surrounding area. The SOX Range includes several activity areas: the Down Range Activity Area, the Extended Range Activity Area, and the Linac Support Building Activity Area. The Down Range and Linac Support Building Activity areas are enclosed within an existing fenced area (see octagonal area in Figure 2). The SOX Range also includes a Buffer Area to the north, east, and south of the activity areas (see Figure 2 and Figure A-1). The fenced area was used in the 1950s to support engine development for the aircraft nuclear propulsion program. About six miles of road and perimeter fence exists and creates an outer boundary forming an area that is octagonal in shape (see Figure 2 and Figure A-2). The fence provides a restricted access area for the proposed linac operation. A paved road runs from the TAN/TSF parking lot to the center of the area, and more than 30 two-track roads occur within the fenced area (see Figure A-2).

Construction activities would include constructing a small building to support linac operations, erecting power poles to extend power to the building, connecting to nearby water lines or wells to bring water to the building, installing a septic system, laying down gravel and concrete pads to stage equipment, establishing a down range gravel road that extends north from the building about 1.5 miles, installing a new fence around the very high radiation area (VHRA), and maintaining an existing road and fence surrounding the inner part of the SOX Range (octagonal shaped area) (see Table 1, "Construction Activities"). Nearly all activities would occur within the fenced portion of the SOX Range. The majority of these activities would take place within a few hundred feet of the proposed building (inside the Linac Support Building Activity Area) and along the down-range access road (the Down Range Activity Area). DOE would use the Extended Range, to the north of the Linac Support Building Activity Area, only occasionally, when needing a greater standoff distance. The Bureau of Land Management (BLM) controls livestock grazing allotments to the north and east of the proposed range, where some overlapping land use occurs (see Figure A-1 and Section 5.0).

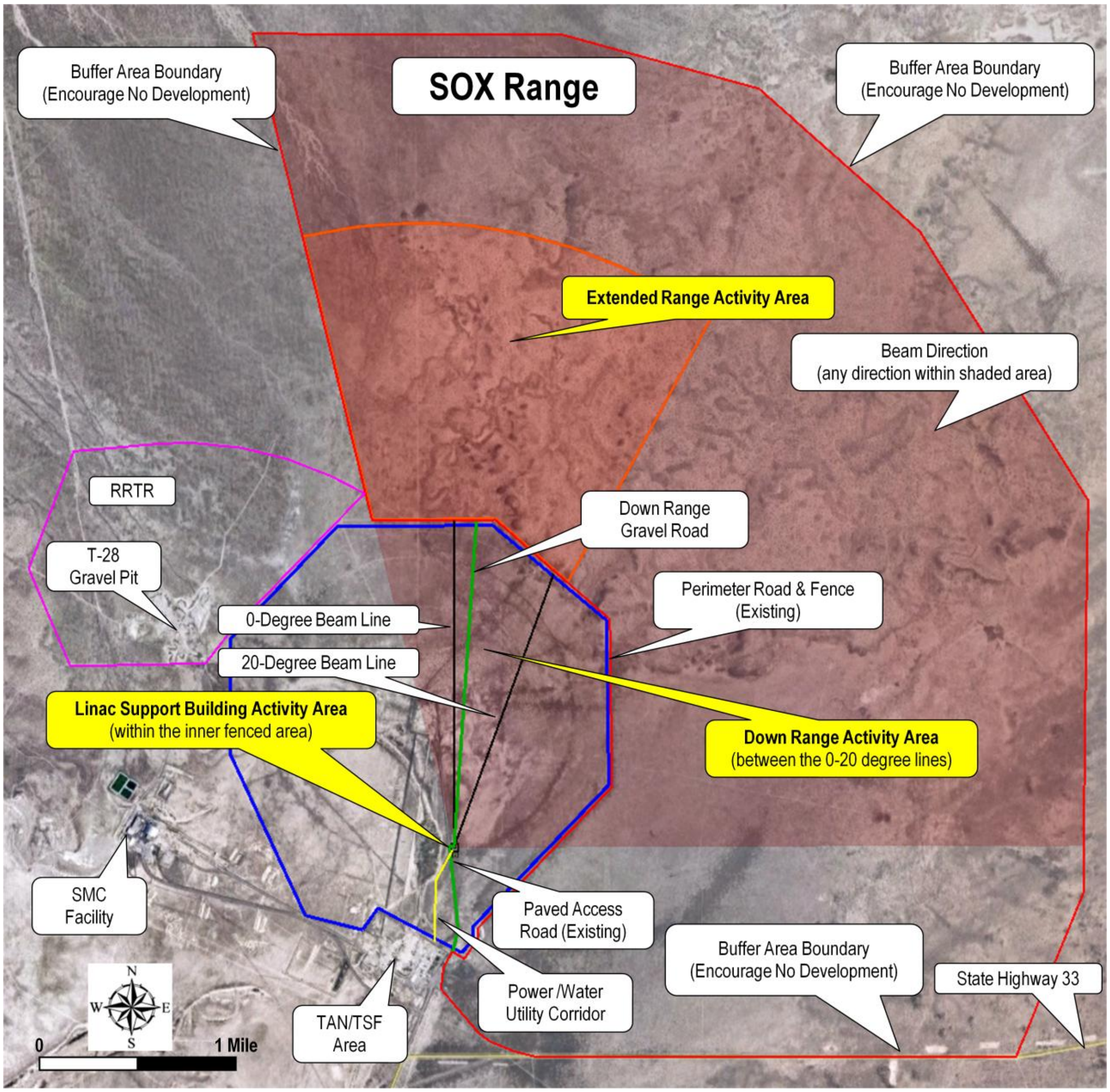


Figure 2. Overhead map showing the SOX Range, which includes the Down Range, the Extended Range, and the Linac Support Building Activity Areas, as well as the Buffer (or no development) Area in relationship to surrounding infrastructure (buildings, fences, and roads).

Table 1. General Project Construction and Operational Activities. Refer to Figures A-1 through A-5 when reading the following construction and operating activities.

Construction Activities
• Construct insulated metal building (Linac Support Building) that is about 40 ft x 60 ft with additional 20 ft-wide concrete pad around the building and 50-ft cleared gravel perimeter around the concrete pad; the overall footprint is about 180 ft x 200 ft (see Figure A-3); the building would have electrical power, water systems, heating, ventilation, and air conditioning. • Construct up to six concrete or gravel pads (40 ft x 40 ft with a 50-ft cleared gravel perimeter around the pad) for control stations, storage areas, and detector laydown areas; except for the 'control trailer' pad (see Figure A-3), the concrete or gravel pads are not shown on maps. However, the pads would occur within the fenced portion of the SOX Range (octagonal shaped area) (see Figure A-2). • Construct a 5-10-foot high fence around the perimeter of the linac support building (see Figure A-3). • Construct a 4-6-foot high fence up to 328 ft wide on either side and behind the building and extending up to 1,640 ft down-range in the northward direction to create a boundary for a VHRA (see Figure A-3). • Construct about 1.5 miles of road down-range from the building (to the north), referred to as the 'Down Range Road' (see Figure A-2). • Improve existing paved access and maintain two-track perimeter road as passable and the perimeter fence (around the octagonal-shaped area) (see Figure A-2). • Erect about 0.5 miles of overhead power lines within existing power/water corridor (see Figure A-2). • Extend potable water lines by following the path of the old lines (existing power/water corridor) or truck in potable water and bottled drinking water (see Figure A-2). • Construct a septic system and drain field. • Install an intrusion detection system (IDS) that would automatically shut off the linac to prevent inadvertent access to the radiation area by humans and large animals as described in the Safety Assessment Document (SAD) and Accelerator Safety Envelope (ASE) (see Figure 3, page 8 and Section 2.3.5) [Ref- SAD-101 ASE-101].[23,24]
Operating Activities (see Section 2.3.1.1 for a typical linac operations)
• Install or assemble and operate electron linacs in accordance with the INL Accelerator Safety Envelope (ASE-101)[24] that allows maximum beam energies of 60 million electron volts (MeV) and maximum beam currents of 100 microamperes (see Figure A-4 for a picture of a linac). • Place shield blocks (see Figure A-5), targets, and detector systems. • Detect actively induced signatures from non-nuclear and nuclear material. • Periodically use the extended range (see Figure 2 and Figure A-1). • Place cargo containers on concrete or graveled surface. • Conduct radiation surveys and monitoring activities in support of operations and beam characterization.

The down-range road would be along the five-degree beam-line and would allow the selection of continuous distances between the linac and the inspection object or measurement device. The road would extend from the linac to the outer perimeter fence (see Figure A-2), which is about 1.5 miles down-range from the linac. Linac operations would also be conducted at other locations within the SOX Range, other than from the Linac Support Building, and powered by a portable electrical generator that can be pulled behind a pickup truck. The generator expected to be used at the range is about 130 KVA or smaller. As with all activities within the SOX Range, project personnel would use and remain on the arc roads created during the previous IET project. Installing and repositioning of a linac is expected to be an infrequent process. For large linacs like INL's Varitron-III, locating the linac involves semi-trucks, cranes, and forklifts; but for smaller linacs, like INL's Varitron-I and Varitron-II, positioning usually only requires a pickup truck and pull-trailer.

The radiation footprint needed to support the accelerator operation and shielding requirements, if any, would be established as necessary per specific test requirements. In some cases, shielding would not be desirable or appropriate, but in most cases, back and/or side shielding would be set up. The SOX Range, including all three work activity areas, would provide the unique ability to allow the high-energy x-rays to attenuate naturally in air. When the natural air attenuation of the x-rays is not desired, shield blocks could be used to minimize the radiation footprint (see Figure A-5).

2.3.1 Typical Linac Operations at the SOX Range

INL personnel associated with linac operations would typically work 10-hour days, four days a week, and fifty weeks. INL's experience with linac operation has shown that on average, only half the potential work hours are actually used operating the linacs. Daily set up and take down of the systems would take about an hour each leaving an average of 8 hours per day to conduct R&D activities. Much of the remaining time would be used to prepare the detection and acquisition systems, clear the area, position materials and detectors, prepare the linac for operations, review data, change material and detector configurations, put materials and detectors away, and shut down the linac leaving about 4 hours a day of actual linac operations. Linac operation could be continuous for hours at a time or short-periods (minutes) operation throughout the day depending on test requirements.

Typical activities that would occur at the SOX Range include installing, assembling, and operating electron linacs (see Table 1, "Operating Activities,"). INL currently has three linacs that could be used at the range, and all are very similar to those used in conventional radiotherapy. However, the linacs at INL are designed to be transportable and have been modified to support R&D. Linacs have targeting capabilities that enable the researchers to aim them at an inspection object. The linac beam would be oriented as noted in Figure 2 and subject to INL's accelerator safety program. When down-range activities will not be needed, shield blocks could be used to limit the size of the radiation footprint (see Figure A-5). If, for example, the beam needed to be pointed to the east to support testing near the building, shield blocks would be installed to limit the VHRA within the fenced area around the building.

Typically, the daily R&D activities at the range could include four to twelve people and three vehicles. The entire area would be carefully controlled to prevent unauthorized persons from inadvertently entering. INL personnel would provide a thorough safety brief to the participants before each day's operation concerning any potential hazards, and the expected course of the day's activities.

INL safety and radiation protection programs control *linac* (see glossary) activities. Linac operations at INL are divided into two classes; those that are 10 MeV and lower are operated in accordance with requirements of the radiation control program, INL institutional safety programs, and American National Standards Institute (ANSI) N43.3, *Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV*.[25] Linacs operating at greater than 10 MeV would be operated in accordance with INL institutional safety programs, the radiation control program, the SAD-101,[23] and the ASE-101[24] per the requirements of the DOE Accelerator Safety Order (DOE O 420.2B).[26] Both classes of linacs would be expected to operate on the SOX Range. Linac operations under either approach implement extensive administrative and engineered controls to safely operate and protect all personnel in the vicinity of the operation.

INL uses the linacs in R&D in conjunction with detector and signal processing systems. The most frequent operations are expected to use beam energies of 2 MeV to 30 MeV at maximum beam currents of 30 microamperes. It is anticipated that the SOX Range will support the use of linacs operating at maximum beam energies of 60 MeV and maximum beam currents of 100 microamperes. These are the maximum allowed parameters on the SOX Range. Operation of a linac at these beam energies may require the use of the Extended Range due to the larger potential radiation footprint.

The SOX Range would not be a nuclear facility, but personnel would use a relatively small amount of radioactive and nuclear materials during activities at the range. These materials are similar to those materials used at other INL locations, and would be handled and disposed in accordance with current INL industrial and radioactive waste streams.

Radiation levels would be monitored with detectors to verify: (1) acceptable linac operations and beam targeting, (2) worker safety, and (3) that machine operational parameters are within the limits established by the INL safety program. Passive radiation dosimetry would also be placed to provide a continuous measure of radiation.[23,24] Operating the linacs would have inherent risks associated with industrial type hazards and radiation related hazards (see SAD-101[23] and ASE-101[24]).[a]

2.3.2 Down Range Activity Area

Down Range Activities would include inspecting objects including nuclear and non-nuclear materials. INL's Radiological Controls Program addresses radiological requirements pertinent to the use of radioactive and nuclear materials in experiments at the SOX Range. The SOX Range would not be a nuclear facility. Evaluations related to nuclear material use would be conducted as required by INL's Nuclear Safety Program to verify non-nuclear facility requirements are satisfied and the SOX Range is maintained as a less than hazard category 3 radiological facility (DOE Standard 1027).[27,28,29] The use of non-nuclear materials in experiments at the SOX Range would be performed in accordance with INL institutional controls for common industrial-type activities.

Inspection objects would be placed along the down-range road and along the several two-track roads between the 0- and 20-degree beam paths within the SOX Range (see Figure A-2).

2.3.3 Extended Range Activity Area

An Extended Range would be established north of the SOX Range outer fence (see Figure 2 and Figure A-1). The additional 3,000 feet would provide an extended radiation area boundary in support of 60 MeV 100 microampere linacs. The Extended Range would allow the high energy x-rays to attenuate naturally in air to where they are indistinguishable above background. The need to use this extended boundary is not expected to be routine. Traffic candles and radiation rope would demark the five (millirem) mrem/hr boundary during the limited use.

Minimal activities would be expected to occur within the Extended Range. Placing boundary markers, postings, detectors, and conducting radiation surveys would be done on foot or by vehicle using existing two-track roads. When the Extended Range is in use, the range perimeter would be expanded to include the Extended Range Activity Area.

2.3.4 Linac Support Building Activity Area

The primary function of the Linac Support Building is to provide power and storage for the linacs and their associated equipment and materials (see Figure A-2 and Figure A-3). The activities in the building would include preparing the equipment for operation and connecting signal and power to the linacs, detectors, and related equipment. It is expected that most linacs would be operated in this building, with the operators stationed over 100 feet away. While the linacs are in the support building, adjustments to the equipment could include installing/removing electron-to-photon converters, which are usually small and can be done by hand; installing/removing collimators, which for the larger linacs would require the use of a forklift; and installing/removing bending magnets, which may require the use of a forklift. Both non-nuclear and nuclear materials would be stored, handled, and used in and around the building and the Down Range Activity Area.

Other activities within the Linac Support Building fenced area could include using cranes and forklifts to move equipment around, storing equipment and materials, and placing shield blocks. Shielding blocks could be placed inside the fenced area to further control the radiation footprint, such as keeping the footprint within the fenced area of the linac support building.

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a. An assessment of hazards is addressed in SAD-101,[23] which included industrial type hazards such as electrical hazards and radiation related hazards. The maximum credible incident was a radiation based potential accidents. For this incident, a person would sprint towards the beam at a speed of about 22.4 mile per hour (10 meters per second). When the person passes the intrusion detection system, the linac would shut off. Before the beam would shut off, some dose would be received by this person; in this case, it is calculated that 0.28 mrem would be received by that person.

2.3.5 Radiation Areas Boundary and Intrusion Detection Systems

Radiation areas would be estimated and a boundary established that is based on the specific linac configuration, operational conditions, and shielding. As shown for a representative deployment in Figure 3, each linac operation will involve a fenced VHRA, a calculated HRA, and a RA. Note, the specific size, shape or extent of these areas will be dependent on the specific performance capabilities of the operating linac and the testing objectives. It is expected that the SOX Range outer perimeter fence would be used as the Radiation Area boundary and would be posted as such even though in most operational cases, actual radiation area boundary would be well within the range perimeter fence and the dose rate at this fence would be undetectable above background. When using the Extended Range Activity Area, project personnel would use traffic candles, rope, and signs or station personnel around the area to maintain a temporary radiation area (see location of Extended Range, Figure 2 and Figure A-1).

Project personnel would also install an Intrusion Detection System (IDS) to prevent access to the high radiation area. The detailed requirements are listed in ASE-101[23] and described in SAD-101.[24] An IDS represents one of several possible technologies capable of terminating linac operations before a man-sized object, traveling at 22.4 miles/hr., can enter into a HRA. Figure 3 includes an example layout for an ASE-approved, IDS tower configuration. The current IDS system is anticipated to consist of small towers spaced about 700 feet apart. Future technology may use alternate detection methods and equipment that have different placement requirements. These towers are small (about six feet tall), self contained (solar-powered), and transmit system status wirelessly to the accelerator control station and accelerator interlock system. The IDS would activate immediate automated shutdown of the accelerator system in the event the perimeter is breached. Two installation configurations are possible, both having a minimal footprint (i.e., 2 ft. × 2 ft.). The first would be to install guy wires to hold the plastic tower directly to the ground, while the second would be to secure individual towers to 2-ft square, 4-inch thick, pre-poured concrete bases.

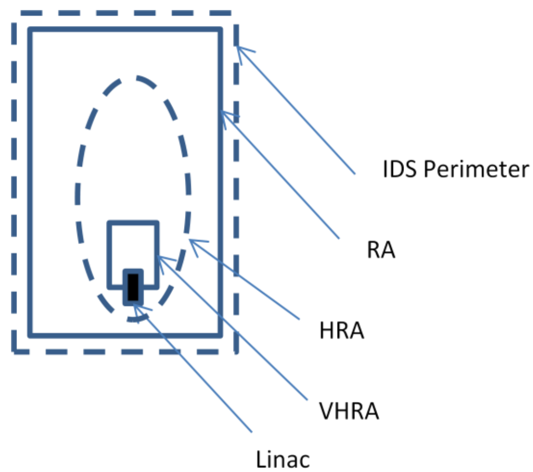

Figure 3. Major components of a typical linac operation.

After the linac and shielding are in place, an incremental start-up process allows operators to verify that the radiation levels would not exceed predetermined limits and boundaries. As an example of this process, a linac power level that is a fraction of the maximum, such as 1/10 would be selected for a particular linac operation. During accelerator operation, a radiological control technician would measure the dose rates at the boundary. Because of the reduced power level of operation, the five mrem/hr boundary should survey much less than 5 mrem/hr (refer to page 13, Section 4.1.1, footnote ‘f,’ for an explanation of ‘rem’). To verify the operation is proceeding as expected, the entire perimeter would be measured by personnel using small handheld instruments. Several increments could be used to verify the boundaries and step increases of linac power. After confirming that the boundaries are appropriate, the linac would be operated at the full power planned for the experiments, and the perimeter measured again to confirm dose rates are in accordance with expectations.

After linac operations are established, detection equipment is set up. A wide range of detector types and sizes may be used. Detectors range in size from less than an inch to systems mounted in trailers. A wide variety of detectors are expected to be used, including High-Purity Germanium (HPGe), Silicon Carbide, scintillation (NaI crystals, plastics, liquids), and gas (He-3, BF3). Detectors would be used to detect a variety of induced signatures (e.g., neutrons, gamma-ray, light, heat, and sound), and could be placed near the linac, the inspected object down-range, or any location between the 0 and 20 degree beam-lines on two-track roads, or hand carried. Detectors would be connected to electronic systems to record and analyze the data. Trailers may be used to house detection systems to provide protection from the weather, enabling the detector to be deployed regardless of the weather. At times, it may be appropriate to shield detectors. In such cases, temporary shielding would be installed as required. In most cases, detector system setup, including any required shielding would occur by hand, but may also include trailer- or truck-based deployment.

2.4 Alternative 2 – No Action

DOE must consider a ‘No Action’ alternative in all of its EAs; the selection of the ‘No Action’ alternative would mean that the proposed activity, as described in Section 2.3, would not take place. For this EA, that means the SOX Range would not be constructed, and the national need for developing AI technologies capable of detecting materials of interest at greater standoff distances would not be met at INL. The ‘No Action’ alternative does not meet the purpose and need to conduct standoff AI R&D activities. INL would continue to conduct AI R&D activities at the ISU Airport and CITRC facilities. The project area would be available for other uses or reclamation activities.

2.5 Construction and Operational Controls

If DOE selects the proposed action, they would adopt operational controls as an integral part of the project to reduce or lessen the impacts of the action and lower the potential for significant impacts, as shown in Table 2 (see page 10).

Table 2. Project Controls to Avoid or Lessen Impacts to Natural, Ecological, and Cultural Resources.

Activity	Project Controls
Vegetation removal or ground disturbance from construction and operational activities	Project controls that would lessen the potential impacts of construction and operational activities include: • Conducting nesting bird surveys for any activities between May 1st and September 1st in any vegetated areas before disturbance may occur, and if nests are found with young or eggs, no disturbance would occur during the nesting season • Minimizing ground disturbance • Revegetating using native species • Installing perch deterrent devices on top of power poles to deter raptor & raven perching • Developing and implementing a weed management plan to control noxious weeds and invasive plant species • Limiting the use of all types of vehicle travel to currently planned or established roads • Obtaining a cultural resource clearance from INL's Cultural Resource Management Office before ground disturbing activities such as road construction or installing intrusion detection system towers • Avoiding identified archaeological sites during project construction and operational activities (e.g., by moving road alignments, identifying turn around areas, limiting some areas to only foot traffic, collecting or relocating artifacts, and relocating boundary lines) • Conducting cultural resource monitoring in sensitive areas to salvage sensitive materials and implement stop work procedure to guide assessment and protection of any unanticipated discoveries of cultural resources • Completing cultural resource sensitivity training for project personnel to discourage unauthorized artifact collection, off-road vehicle use, and other activities that may impact cultural resources • Conducting unexploded ordnance review and survey before disturbing soil • Notifying EPA of soil disturbance before construction or other soil disturbing activities within institutional controlled areas • Securing applicable permits before beginning construction activities at the SOX Range • Encouraging a sense of stewardship for cultural resources, including tribally sensitive plants and animals through sensitivity training of project personal • Minimizing disturbance to wildlife species important to the Shoshone-Bannock Tribes by using appropriate methods, which could include seasonal or time-of-day restrictions, good housekeeping, and awareness training • Securing Stormwater Pollution Prevention Permit for project activities disturbing greater than 1 acre and occurring within the stormwater corridor.
Linac operation	Project controls that would lessen the potential impacts of linac operation include: • Following approved laboratory instructions and the ASE-101 for accelerator operations greater than 10 MeV • Clearing people and large animals from radiation areas before operations are allowed to start • Operating the linac so that the dose to the MEI from airborne radionuclides would be less than 0.1 mrem/yr by requiring beam authorizations before linac operations • Securing applicable permits before operating the linacs • Conducting biota dose assessment • Coordinating timing to allow access for the BBS survey • If use of the Extended Range Activity Area is required between November 15 and the end of February, DOE will coordinate with BLM to implement temporary restrictions with respect to the associated livestock grazing allotment (see Figure A-1) • DOE would conduct soil surveys to verify that no long-term soil contamination exists.

3.0 AFFECTED ENVIRONMENT

INL consists of eight major facilities, each less than 2-square miles, situated on an 890-square-mile expanse of otherwise undeveloped, cool, desert terrain. The INL Site occupies portions of five Idaho counties: Butte, Bingham, Bonneville, Clark, and Jefferson. Most INL buildings and structures are located within the developed facility areas that are separated by miles of primarily undeveloped land. DOE controls all of the INL Site land (see Figure 1). Population centers in the region include large cities (>10,000) such as Idaho Falls, Pocatello, Rexburg, and Blackfoot, located greater than 30 miles to the east and south, and several smaller cities/communities (<10,000) located around the site (about 1-30 miles away), including Arco, Howe, Mud Lake, the Fort Hall Indian Reservation, and Atomic City. Craters of the Moon National Monument is less than 20 miles to the west; Yellowstone and Grand Teton National Parks, and the city of Jackson, WY, are located more than 70 miles northeast. No permanent residents reside on the INL Site.

The five Idaho counties that are part of the INL Site are all *attainment areas* (see glossary) or are unclassified for National Ambient Air Quality Standards (NAAQS) status under the Federal *Clean Air Act (CAA)* (see glossary). The nearest *nonattainment area* (see glossary) is located about 50 miles south of the INL Site in Power and Bannock counties. The INL Site is classified under the *Prevention of Significant Deterioration* (*PSD*) (see glossary) regulations as a Class II area—an area with reasonable or moderately good air quality.

Surface waters on the INL Site include the Big Lost River and Birch Creek; both streams carry water on an infrequent basis, with the majority of the flow diverted for irrigation before entering the INL Site. During high water years or during the shutdown of the diversion, Birch Creek has the potential to flow down its historic channel. Most of the INL Site is underlain by the Snake River Plain Aquifer (SRPA), which lies between 220 feet (at TAN) to 610 feet (at RWMC) below the site. The geology above the SRPA, the *vadose zone* (see glossary), is generally comprised of basalt (95%) with a layer of soil (loess) and/or sediment on top of the basalt with thin layers of sediments (1 to 20-foot intervals) between basalt flows. The SRPA has similar geology as the overlying vadose zone and is generally 250 to 900-feet thick.

The natural vegetation of the INL Site consists of a shrub overstory with a grass and forbs understory. The most common shrub is Wyoming big sagebrush, whereas basin big sage may dominate or co-dominate in areas with deep or sandy soils.[30] Other common shrubs include green rabbitbrush, winterfat, spiney hopsage, gray horsebrush, gray rabbitbrush, and prickly phlox.[31] The shrub understory consists of native grasses such as thickspike wheatgrass, Indian ricegrass, bottlebrush squirreltail, needle-and-thread grass, Sandberg's bluegrass, and bluebunch wheatgrass and native forbs (i.e., tabertip hawksbeard, Hood's phlox, hoary false yarrow, paintbrush, globe-mallow, buckwheat, lupine, milkvetches, and mustards).[31] In a 1999 proclamation, the Secretary of Energy designated a portion of the INL Site as the Sagebrush Steppe Ecosystem Reserve, a resource that provides research opportunities and preserves sagebrush steppe habitat. Representatives of BLM, U.S. Fish and Wildlife Service, and the Idaho Department of Fish and Game co-signed the proclamation. In addition, the INL Site is designated a *National Environmental Research Park* (*NERP*) (see glossary) and parts of the INL Site are used for livestock grazing, that is managed by BLM.

A wide range of vertebrate species are located within the site; several species are considered sagebrush-obligate species, meaning that they rely upon sagebrush for survival. These species include sage sparrow, Brewer's sparrow, northern sagebrush lizard, Greater sage-grouse, and pygmy rabbit.

There are currently no species that occur on the INL Site that are listed as Endangered or Threatened, under the Endangered Species Act (ESA); however, several Species of Concern or Candidate Species—including Greater sage-grouse,[b] long-eared myotis, small-footed myotis, Townsend's big-eared bat, pygmy rabbit,[c] Merriam's shrew, sage-grouse, long-billed curlew, ferruginous hawk, northern sagebrush lizard, and loggerhead shrike—do occur on the site. The Gray Wolf is presently listed as Endangered, but individuals on the INL Site are part of the "experimental, non-essential" population.

Geographically, the INL Site is included within a large territory once inhabited by, and still of importance to, the Shoshone-Bannock tribes. To the Shoshone-Bannock people, cultural resources include not only archaeological sites affiliated with their history, but also many kinds of natural resources as well, including traditionally used plants and animals. Additionally, features of the natural landscape, such as buttes, rivers, and caves, often have particular significance to the tribes.

The INL Site has a rich and varied cultural resource record due to its continuous access restriction and geographic remoteness. This includes localities that provide an important paleontological context for the region and the many prehistoric archaeological sites. These campsites, *cairns* (see glossary), and hunting blinds provide information about the activities of aboriginal hunting and gathering groups who inhabited the area for at least 13,500 years. The archaeological sites, pictographs, caves, and many other features are important to contemporary Native American groups for historic, religious, and traditional reasons. Many historic sites document the area's use during the late 1800s and early 1900s, including the abandoned town of Pioneer/Powell, a northern spur of the Oregon Trail known as Goodale's Cutoff, many small homesteads, irrigation canals, sheep and cattle camps, and stage and wagon trails. During World War II, the military used the central portion of the INL Site to test fire ordnance used by the Pacific Fleet and evidence of this era remain. Finally, many scientific and technical facilities have preserved important information on the historic development of nuclear science in America.[32]

The proposed SOX Range is intentionally located in a previously disturbed area to minimize further disturbance to the natural and cultural environment. Much of the project area has been subjected to disturbance, such as construction and demolition activities, roads and other infrastructure, or previous research activities (the octagonal shaped area); however, a portion of the area to the north and east of the SOX Range is primarily undisturbed (see Figure 2).

4.0 ENVIRONMENTAL CONSEQUENCES

The following sections evaluate direct, indirect, and cumulative environmental impacts that are likely to occur from the alternatives described in Section 2. Section 4.1 discusses the environmental impacts associated with Alternative 1. Section 4.1 discusses cause and effect relationships, including cumulative impacts, of the proposed action on the INL Site's natural, biological, and cultural resources; measures needed to mitigate or lessen impacts; and those permits and regulations required to protect the resources. Section 4.2 discusses the environmental impacts associated with 'No Action'.

During DOE's internal scoping, resource personnel identified that air (i.e., radiological dose), biological (i.e., flora and fauna), and cultural resources are most likely to be affected by the proposed action. The environmental impacts to all of these resources are the focus of this EA. The following sections discuss the environmental impacts of both alternatives on the above resources.

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b. The U.S. Fish and Wildlife Service (FWS) determined that the Greater sage-grouse warrants the protection of the ESA, but that listing the species at this time is precluded by the need to address higher priority species first. As a precluded species, the Greater-sage-grouse becomes a candidate species under the ESA of 1973, as amended (see FR, Vol. 75, No. 187, Tuesday, September 28, 2010).

c. The FWS announced that the pygmy rabbit does not warrant protection under the ESA in several western states, including Idaho (see FR Vol. 75, No. 189, Thursday, September 30, 2010).

4.1 Alternative 1 – Constructing and Operating the SOX Range near TAN

4.1.1 Radiological Dose[d]

The proposed activities at the SOX Range create a potential for radiological exposure due to activation of naturally occurring elements present in the air along the beam path. The degree of activation is dependent upon the power of the particular linac beam, the configuration of the linac, and the length of time the linac is operating. In all cases, the degree of activation attenuates or drops off along the beam path as the distance increases.

4.1.1.1 Atmospheric Pathway

To the Public[e]**—**This section discusses the methodology used to determine the *Effective Dose Equivalent* (*EDE*) (see glossary) to the maximally exposed individual (MEI) at the site boundary and to employees located at facilities near the SOX Range. Federal Regulation 40 CFR 61 Subpart H establishes a dose limit to the public of 10 mrem/yr EDE[f] from DOE activities.[33,34,35] In accordance with these Federal Regulations, the atmospheric transport and radiological dose code, CAP88 PC Version 3,[1] was used to calculate EDEs to an MEI located off the INL Site boundary using the methodology described in the Calendar Year 2009 INL NESHAP Report for Radionuclides.[2]

Before any linac operation at the SOX Range is conducted, a beam authorization sheet must be prepared and approved by the Accelerator Safety Officer. The beam authorization sheet identifies the linac to be operated, the maximum beam energy and average beam current expected (maximum SOX Range values for these parameters are 60 MeV and 100 microamperes, respectively), the type of converter and collimator used (if any), and the maximum hours of operation needed for the specified parameters. The Accelerator Safety Officer uses this information to calculate the maximum radioactive source term that could be generated for the particular linac operation. This source term is then analyzed using CAP88[1] to determine the EDE that would result to the MEI. The Accelerator Safety Officer tallies the cumulative EDE for all linac operations during a calendar year. If the cumulative dose to the MEI for proposed linac operations, when summed with all other approved linac operations within that calendar year is less than 0.1 mrem, then the beam authorization sheet is approved and the proposed linac operation may commence. Any proposed operation of a linac that would result in a cumulative EDE that equals or exceeds 0.1 mrem in a calendar year would not be approved.

This process controls the dose to the MEI resulting from SOX Range operations to less than 1% of the NESHAP standard. A linac operating at the maximum parameters for 1,146 hours per year would reach the 0.1 mrem/yr SOX Range administrative limit. However, expected operations would use a mix of

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d. Radiological dose is quantified in terms of the *Effective Dose Equivalent* (*EDE*) (see glossary) and includes the dose from external radiation and the 50-year committed dose from radionuclides ingested or inhaled. The EDE is the weighted sum of the dose equivalent to each organ of interest. The dose equivalent is the adsorbed dose (i.e., the energy imparted to tissue by ionizing radiation) to a given organ times a quality factor, which is a measure of the relative biological effect of the radiation type (see 10 CFR 835 for more information).[33]

e. The methodology for calculating the releases from accelerator operation is being coordinated with the EPA (as discussed in INL/EXT-10-20220).[34]

f. The EDE in this document is expressed in units of millirem (mrem) which is measure of risk from ionizing radiation. The estimated average annual dose from natural background sources of radiation in southeastern Idaho is 355 mrem (*Site Environmental Report for CY-2009*, DOE/ID-12082(09).[35] Natural background sources include the contributions from terrestrial radiation, cosmic radiation and radon gas. The risk from natural radiation sources is small when compared to other commonly accepted, like using motor vehicles. The maximum dose that a member of the public is allowed under the EPA NESHAP Standard for airborne radionuclides is 10 mrem per year from INL operations. This is less than 3% of the average dose a person receives from natural background sources. Further, the maximum amount of radiation dose from the SOX Range is administratively limited to less than 0.1 mrem per year, small fraction of the allowable dose. The maximum dose from linac operations in a year is equivalent to about three hours of exposure to natural background sources of radiation.

lower beam energies and linac configurations resulting in a more realistic EDE of about 0.02 mrem/yr to the MEI.

For comparison, in 2009 radionuclide air emissions and the resulting EDE to the MEI member of the public from all operations at the INL Site was 0.0687 mrem/yr, 0.69% of the 10-mrem annual standard.[2] The cumulative EDE from current INL Site operations and the proposed action would be a maximum of about of 0.17 mrem/yr, which remains far below the 10 mrem/yr regulatory limit.

To the Worker—Dose to workers located in close proximity to linacs operated at the SOX Range is controlled through INL's Radiation Protection Program. This program establishes administrative control limits, prepares dose estimates prior to work, provides dosimetry, and monitors worker exposures to maintain doses received to levels that are as low as reasonably achievable (ALARA). The dose to workers located about 300 feet from the Linac Support Building is about 7.8 mrem/yr, or about 1.1% of the 700 mrem/yr administrative control level for the expected operations using a mix of lower beam energies and linac configurations. Dose to workers further away would be lower due to decay of the very short-lived radionuclides and dispersion of the airborne radionuclides in the atmosphere. Linacs operated at the maximum parameters for the SOX Range would result in a dose to the worker of 35 mrem/yr.

To the Visitor—Individual visitors at the SOX Range are expected to be present for up to 40 hours per year. The annual dose from airborne radionuclides would be 0.025 mrem assuming they are collocated with the workers.

4.1.1.2 Direct Radiation Pathway

In addition to the airborne radionuclides, X-rays and neutrons are produced by the linac.

To the Public—The calculated dose for a person located 6.2 miles away from the linac point of operation would be 0.0014 mrem/yr. This assumes operation at the maximum operating parameters (1,146 hours). Under normal operating parameters, the expected calculated dose to a person at that location would be less than 0.001 mrem/yr.

To the Worker—INL controls radiation worker doses to the 700 mrem/yr administrative limit in accordance with the regulatory requirements discussed below. Under normal operating conditions, SOX Range workers are expected to receive up to 400 mrem/yr based on 80 hours of exposure to a dose rate of 5 mrem/hr, which could be experienced at the SOX Range boundary.

To the Visitor—Individual visitors are expected to be present for up to 40 hours per year. The dose rate outside the radiological buffer areas are typically less than 0.1 mrem/hr. This would result in an expected annual visitor dose of 4 mrem from direct radiation.

4.1.1.3 Regulatory Requirements

Radioactive dose to members of the public is controlled and restricted by Federal Regulations issued by both EPA and DOE. The EPA regulations are found under 40 CFR 61, Subpart H. The DOE requirements are found under 10 CFR 835[33] (for workers) and DOE Order 5400.5[36] (for the public), as shown in Table 3.

INL conducts radiological operations in a manner that protects the health and safety of all general employees, contractors, and the public. To achieve this objective, INL requires that radiation exposures to its employees and the public and releases of radioactivity to the environment are maintained below regulatory limits; in addition, deliberate efforts are taken to ensure exposures and releases are ALARA.

The purpose of INL's ALARA Program is to reduce and maintain radiation exposures as far below the applicable controlling limits of 10 CFR 835 and INL's Radiological Control Manual (RCM) as is reasonably achievable.[33] Therefore, laboratory management at INL has set administrative control levels to limit possible exposures to INL workers and visitors (see Table 3, see page 16).

4.1.1.4 Putting Calculated Dose in Perspective

As shown in Table 3 (see page 16), the dose to the public would be about 0.2% of the NESHAP limit during normal operations and would be controlled to less than 1% of the annual NESHAP limit for any linac operations. In addition, Table 3 includes typical doses from other radiation-producing activities encountered outside the DOE complex. For example, the average dose to individuals living in southeastern Idaho from background radiation is 355 mrem/yr.

4.1.2 Biological Resources

Potential impacts to vegetation communities, sensitive plant species and species of *ethnobotanical* (see glossary) concern associated with the proposed activity would be minimized by limiting the footprint of the disturbance, revegetating the areas that have been disturbed, and implementing a weed management plan. Revegetating with a diverse mix of native species similar in composition to the plant community may help maintain the diversity of those communities. Revegetation in sagebrush steppe is generally successful in only one of three years because of the variability in availability and timing of precipitation.

Project activities within the fenced portion of the SOX Range would include building a down range road, erecting the linac support building, and pouring concrete pads at various locations within the octagonal area (see Table 1 for a full list of constructing and operating activities). These types of activities would disturb vegetation and soil would have unavoidable impacts to wildlife such as: (1) loss of ground-dwelling wildlife species and associated habitat; (2) displacement of certain wildlife species due to increased habitat fragmentation; and (3) an increase in the potential for negative interaction between wildlife and humans.[37,38] The control measures that would reduce the impact on wildlife include seasonal timing of activities, nesting bird surveys, and awareness programs.

Wildlife species that may be impacted by the proposed action include Greater sage-grouse, migratory birds (including raptors), pygmy rabbits, Great Basin rattlesnakes, and large mammal species.[37,38] Nesting bird surveys would be conducted before any soil or vegetation disturbance occurring between May 1 and September 1. If nesting migratory birds are found, no disturbance would be allowed during the nesting season. No critical habitat for threatened or endangered species, as defined in the Endangered Species Act (ESA), exists on the INL Site, including that of the Greater sage-grouse, a Candidate species for listing under ESA. It is likely the proposed activity would have a direct impact on pygmy rabbits and indirect effects on sage-grouse, pygmy rabbits, or other sensitive species through habitat alteration.[37,38] If a species such as the Greater sage-grouse is listed before or during construction of the facility, DOE would initiate formal consultation with the FWS.

Table 3. Regulatory and Administrative Dose Limits, Linac Calculated Dose, and Comparisons.

Regulatory Requirements (Federal & INL)	**Effective Dose Equivalent (EDE) (mrem/yr)**	
Public-Airborne Pathway (40 CFR 61 Subpart H)	10	
Public-All Pathways[1] (DOE O 5400.5)	100	
SOX Range Public-Airborne Pathway Administrative Control Level	0.1	
INL Workers (10 CFR 835)	5000	
INL Workers-Administrative Control Level	700	
INL Visitors	100	
INL Visitor-Administrative Control Level	10	
Linac Calculated Dose	**Effective Dose Equivalent (EDE) (mrem/yr)**	
	Normal operations	Maximum operations
Public-Airborne Pathway	0.02	0.1
Public-Direct Radiation Pathway	0.001	0.007
INL Worker-Airborne Pathway	7.8	35
INL Worker-Direct Radiation Pathway	400	700
INL Visitor[2] Airborne Path	0.025	0.025
INL Visitor[2]-Direct Radiation Pathway	4	4
Other Radiation Dose Producing Activities	**Average Dose (mrem)**	
Annual dose *natural* background sources in southeastern Idaho	355	
Airline Flight from New York to London	4	
Abdominal X-Ray	70	
Mammography	40	
X-Ray Spine series	500	
Abdominal CT Scan	800	

[1] All pathways represent the sum of the radiation doses from airborne radionuclides and direct exposure to radiation produced by a linac.

[2] Assumes 40 hours per year.

4.1.2.1 Plant Communities

The SOX Range covers several different vegetation community types including green rabbitbrush/winterfat shrubland, sickle saltbush dwarf shrubland, shadscale dwarf shrubland, horsebrush/greasewood shrubland, and short statured Wyoming big sagebrush/green rabbitbrush shrubland, as well as crested wheatgrass and halogeton monocultures. The area designated for the building, power structures, and water lines are all crested wheatgrass monocultures with some non-native annual species in the mix. There are very few native species. There is no shrub cover in the proposed linac support building location. No noxious weeds were identified at the SOX Range location. Musk thistle (*Carduus nutans)* has been observed in the area in the past, but was not located in September 2010. Ten plant species of ethnobotanical interest were found at the proposed SOX Range.[38] Field surveys specifically for sensitive plant species could not be conducted because the appropriate season (mid- to late-June) had passed. However, the SOX Range location is not an appropriate habitat for any of the sensitive species on the list due to the very high alkalinity and fine textured soils in the area. These species are unlikely to occur on the proposed project area.[37]

Some of the proposed activities would result in vegetation and soil disturbance, and vegetation community fragmentation (see Section 4.1.2.4). An increase in soil disturbance would likely lead to an associated increase in weedy non-native and invasive species. The potential to displace native species in the communities adjacent to the selected site would also be amplified. This impact would be greatest associated with the construction of a new road between the 0 and 20 degree beam-lines (along the five degree beam-line).

Potential impacts to the vegetation communities at locations where vegetation removal is proposed could be minimized by limiting the size of the footprint of the disturbance. Weed management would also lessen the impact of invasive and non-native species. Prompt revegetation of disturbed areas with native species would limit the potential impact to native plant communities. Operational controls to minimize invasive and non-native species would include the development and implementation of a weed management plan.

Use of the Extended Range could lead to habitat fragmentation and increased invasive species even though planned use in that area is minimal. Three sides are two-track roads, which would help alleviate disturbance in the Extended Range. Visual surveillance of the area after use for the next year would allow INL to determine the need to treat any non-native infestations that may occur or to revegetate areas that are not recovering adequately. Because the soil and vegetation disturbance and risk of non-native species invasion could impact local populations of species of ethnobotanical concern, the most effective operational control to protect those populations would be to minimize the amount of soil disturbed. Potential impacts to populations of plant species of ethnobotanical concern would be further minimized by revegetating disturbed areas.

4.1.2.2 Greater Sage-Grouse

No historical sage-grouse leks have been reported near the SOX Range.[39] Sage-grouse were not observed or heard at any of the sampling locations.[37] Additionally, no grouse sign (i.e., scat) was observed at the SOX Range. Although suitable habitat was found, minimal impacts to sage-grouse are anticipated due to the limited amount of disturbance planned in the areas with habitat. However, adding perch locations, such as tall fencing or power poles, gives raptors and ravens more places from which to hunt. Placing raptor deterrents on top of power poles would lessen the opportunity for raptors and ravens to prey on sage-grouse or pygmy rabbits passing through the SOX Range or located nearby.

4.1.2.3 Pygmy Rabbit

Sitewide survey of pygmy rabbit burrows, conducted since 2006, found no active burrows systems within the SOX Range Area or in the proposed buffer area (Figure 2). However, one pygmy rabbit burrow system was discovered in September 2010 (about ¾ mile down range from the proposed linac location) during surveys conducted in the area between the down-range access road and the 20-degree beam-line (see Figure A-2). Investigators set a motion-sensor camera at this burrow from 14 September to 22 September 2010 to document the potential presence of pygmy rabbits at this burrow system. During the time the camera was set, 851 pictures of at least one pygmy rabbit were documented on three days. This burrow, however, appears to be relatively isolated with little of the sagebrush habitat needed by pygmy rabbits in the surrounding area.

While the activities associated with the SOX Range may have negative consequences on the individuals that occupy the active burrow system within the range, the protection of this area in the buffer area from further development will provide habitat for pygmy rabbits and potentially sage-grouse. Indeed, some inactive burrow systems have been located in the buffer area, indicating that this area likely has been suitable pygmy rabbit habitat. Additionally, active burrow systems exist directly south of the buffer area.

4.1.2.4 Habitat Fragmentation

Nearly all of the sites where the proposed activities could impact habitat have been previously disturbed. The SOX Range is transected numerous times by the old two-track roads that run in circles around the former IET facility location. The proposed gravel road would traverse the length of the five-degree beam-line. The first half of this road is in a disturbed area, as evidenced by the crested wheatgrass monoculture. The road would exert some force on fragmentation, but the potential for increasing that effect would be increased due to the potential loss of vegetation at the further end of the road. This impact could be reduced by minimizing the footprint of the disturbance, promptly revegetating the areas that have been disturbed, and implementing a weed management plan.

Construction of fences can impede the movements of, and at times may trap, mule deer and pronghorn within the enclosed area.[40] The construction of an inner and outer fence around the linac support building serves as a barrier to humans and large animals. The inner fence (closer to the building) would range from 100 ft × 150 ft to 200 ft × 200 ft, be at least 10 ft high, and constructed of chain-link material. An outer fence (going further out from the building) would be about 330 ft (either side of the building) × 1,640 ft, at least four to six ft high, and constructed of plastic snow fence or other types of net fencing, barbwire, or a combination. These fences would help prevent access to the VHRA by humans as well as by large wildlife (see Figure A-3). These new fences would be built within the existing perimeter fence (see Figure 2). A potential exists for trapping ungulates within the chain-link fence area; however, since 1985, only two pronghorn and no elk or mule deer have been observed within the SOX Range existing perimeter fence (see Figure 2). Further, this new fence would not be left open and the area within the fence would be patrolled for humans and ungulates before initiating linac operation. If humans or ungulates are observed within the VHRA, they will be removed from the area before initiating linac operations.

4.1.2.5 Radiological Impacts

To assess the environmental impacts of the proposed action, radiological impacts to biota must be considered.[36,41] The impact of environmental radioactivity at the INL Site on nonhuman biota can be assessed using *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*[3] and the associated software, RESRAD-Biota.[4] Dose limits of 1.0 rad/day for terrestrial plants and 0.1 rad/day for terrestrial animals are intended to provide protection from chronic exposure of whole populations of individual species rather than individual members of the population.[3,38]

The doses from the proposed action will be direct radiation dose primarily from Bremsstrahlung x-rays with a calculated maximum of 10,780,000 rad[g]/hr at 3 feet in front of the linac at 60 MeV and 100 microamperes average beam current limits.[42] This dose rapidly attenuates the further you get from the linac. A fence surrounds the linac and would encompass the VHRA where dose rates exceed 500 rad/hour (see Figure A-3). The high radiation area where the dose rate exceeds 100 mrem/hr is surrounded by an intrusion detection system that shuts down the linac if a person or large animal crosses the boundary. The dose rate outside the perimeter fence will normally be less than 5 mrem/hr. Under maximum SOX Range operational parameters, the dose rate at the perimeter fence would be about 20 mrem/hr requiring the use of the Extended Range Activity Area (see Figure 2 and Figure A-1). In this case, a temporary radiation area boundary is extended beyond the perimeter fence into the Extended Range Activity Area.

Large mammal and bird populations would not be impacted because they are present site- and region-wide. Radiological impacts to individuals of large mammal species would be negated by automatic shut-off of the accelerator were they to breach the intrusion detection system and further due to their inherent mobility. It is very unlikely that large mammals would spend enough time in high radiation areas to exceed the 0.1 rad/day limit. The same would be true for migratory birds or raptors flying through the beam, unless they nest in the radiologically impacted areas. If nesting occurs, the linac beam would be above ground nests, so only those placing nests in the tallest sagebrush may be impacted. However, sagebrush is not abundant within the SOX Range, so it is unlikely that nesting or perching birds would receive a significant radiation dose from operations.[38] All birds within the impacted area are common throughout the INL Site and thus adverse radiological impacts to the INL Site bird populations would not occur even if some individuals were excessively exposed. None of the plant species present are considered rare, and all are common INL- and region-wide, so radiological impact to the population is unlikely. Individual terrestrial plants in the area could be impacted by the high exposures.

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g. The basic unit of absorbed dose equal to absorption of 0.01 joule per kilogram of absorbing material.

DOE does not anticipate long-term soil contamination since soil activation would be minimal. Linacs produce predominantly short-lived radionuclides and only a small fraction of longer-lived radionuclides. The mechanism for soil activation is from photonuclear reactions and capture of neutrons. The same reactions cause the activation of air noted in section 4.1.1.1. Using some of the long-lived radionuclides (Ca-41, K-40, and FE-55), back calculations were made to determine the concentrations necessary to reach the most restrictive limit of 0.1 rad/day. Concentrations required to reach those levels were 3.5 E6 pCi/g and 3.7 E3 pCi/g for Ca-41 and K-40, respectively. Under the maximum operation scenario soil activation would be several orders of magnitude below these calculated concentrations. Further, INL's experience with a variety of linacs at ISU and at the Site has shown no detectable radiation above background levels. When operations are complete, DOE would conduct soil surveys to verify that no long-term contamination exists.

4.1.2.6 Ecological Research and Monitoring

Limiting access to the large area surrounding the SOX Range would impact the continuity and management utility of the Breeding Bird Survey (BBS) route at TAN. Coordinating timing of access to this route as an operational control would eliminate this impact. Continuation of the monitoring route would also provide information on the potential impacts the proposed action could be having on local bird populations.

4.1.2.7 Regulatory Requirements

Soil and vegetation disturbing activities, including those associated with mowing, blading, and grubbing, have the potential to increase noxious weeds and invasive plant species that would be managed according to 7 USC § 2814, "Management of Undesirable Plants on Federal Lands,"[43] and Executive Order 13112, "Invasive Species."[44] INL would follow the applicable requirements to manage undesirable plants.

In analyzing the potential ecological impacts of the action alternative for this project, DOE-ID has followed the requirements of the Endangered Species Act (16 USC §1531 et seq.)[45] and has reviewed the most current lists for threatened and endangered plant and animal species. Other federal laws that could apply include the Fish and Wildlife Coordination Act (16 USC § 661 et seq.),[46] the Bald Eagle Protection Act (16 USC § 668),[47] and the Migratory Bird Treaty Act (16 USC § 715–715s).[48]

4.1.3 Cultural Resources

Cultural resource investigations within the proposed SOX Range project area provide the basis for an evaluation of the nature and extent of cultural resources that may be impacted by the proposed project. Of the twenty archaeological sites identified during field surveys, nine prehistoric sites that were recorded within the SOX Range beam-line could be directly impacted by project activities. In addition, representatives from the Shoshone-Bannock Heritage Tribal Office have indicated that a variety of resources, both cultural and natural, that are of traditional, cultural, and sacred importance also occur in the area.

Cultural resource surveys of the proposed SOX Range covered 379 total square acres that included a 374-acre pie shaped area encompassing the 0 to 20 degree beam-lines and the down-range access road, the linac support building administrative area with about a 325-foot buffer area outside of marked building areas, and a utility corridor that extends south from the administrative area on the west side of the paved access road (see Figure 2 and Figure A-2).[49] An additional five acres were surveyed along the western and eastern arms of the Extended Range perimeter area (see Figure 2 and Figure A-1). The northern arc and southern boundaries of the Extended Range were not surveyed for cultural resources because they are two-track roads.

Only one cultural resource investigation has occurred within the SOX Range project area before the surveys conducted for the purpose of this EA. In 1984, the INL Site Livestock Grazing Boundary, which transects the Extended Range, was surveyed.[50] One prehistoric archaeological resource was located within the boundaries of the proposed Extended Range Area (see Figure 4).[50]

Some areas within the proposed SOX Range are located along the historic shoreline of Pleistocene Lake Terreton, which was located at the 4,800 ft. (above sea level) elevation. Based on observations during cultural surveys, the area within the 0- and 20-degree beam that intersects with this historic shoreline has been determined to be archaeologically sensitive. Recorded archaeological resources, ranging from early 20th century ranching activities to 10,000-year-old hunting camps, exist in this area. Nine prehistoric sites potentially eligible to the National Register of Historic Places (NRHP) and six prehistoric isolated finds as defined by INL's Cultural Resource Management Plan[32] were recorded within the SOX Range beam-line area. One additional prehistoric site potentially eligible to the NRHP and four isolated finds were located along the Extended Range fan perimeter for a total of twenty different recorded archaeological sites.

Figure 4. An "Elko" dart point used in conjunction with a shaft and atlatl some 3,000–5,000 years ago and found on near the SOX Range.

Of the twenty archaeological resources, nine sites could potentially be directly impacted by project activities; however, avoidance strategies would minimize impacts to these sites as follows:

- Moving road alignments
- Identifying turn around areas
- Limiting some areas to pedestrian traffic only
- Collecting or relocating artifacts
- Relocating boundary lines.

In the event disturbance to recorded archaeological sites were unavoidable, each affected site would be assessed for eligibility to the NRHP and consultation with the Idaho State Historic Preservation Office and Shoshone-Bannock Tribes would occur before ground disturbance occurs. If proposed activities extend outside the boundaries of survey coverages, additional surveys would be required.

In addition, archaeological sites and Native American resources identified within the project area could be subject to indirect impacts during project activities because of higher visibility on the landscape and overall increases in activity levels in an area that has recently been somewhat remote. Artifacts may be subject to unauthorized collection or impacted by unauthorized off-road vehicle use. Resident and migratory birds and animals of importance to the Shoshone-Bannock Tribes may be disturbed and noxious and invasive weeds may increase to the detriment of native plant species with tribal value.

Operational controls would be implemented before and during project activities to minimize the potential for adverse direct and indirect impacts to cultural resources in the area. A tiered approach with initial efforts focusing on identification and assessment, followed by various protection strategies as necessary, would be adopted. Table 2 (see page 10) summarizes the strategies that project personnel would implement to protect, avoid, or lessen the impact of project activities.

4.1.3.1 Regulatory Requirements

A variety of laws, regulations, and statutes manage or protect cultural resources. Such resources include buildings, sites, structures, or objects, each of which may have historical, architectural, archaeological, cultural, and scientific importance. Most of these requirements have been tailored to the unique needs of the INL through strategies outlined in the "INL Cultural Resource Management Plan"[32] as legitimized through Programmatic Agreement between DOE-ID, the Idaho SHPO, and the Advisory

Council on Historic Preservation. A complete requirements list appears in Appendix A of the INL Cultural Resource Management Plan.[32] Primary among the requirements that pertain to this project are:

- Antiquities Act of 1906 (Public Law 59-209)[51]
- National Historic Preservation Act of 1966 (Public Law 89-665)[52]
- National Environmental Policy Act of 1969 (42 USC § 4321 et seq.)[53]
- American Indian Religious Freedom Act of 1978 (Public Law 95-341)[54]
- Archaeological and Historic Preservation Act of 1974 (Public Law 93-291)[55]
- Archaeological Resources Protection Act of 1979 (Public Law 96-95)[56]
- Native American Graves Protection and Repatriation Act of 1990 (43 CFR 10).[57]

4.1.4 Other Resources

Section 4.1.1, ‘Radiological Dose,’ considers the potential impacts to air resources. This section briefly discusses potential impacts from greenhouse gas (GHG) emissions and climate change. Currently, INL estimates its contribution of GHG emissions to be about 100,000 metric tons annually. Those INL activities contributing to this value include purchased electricity (~65,000 Metric Ton CO_2-equivalent), stationary combustion (gas boilers, non-emergency diesel generators) (~15,000 Metric Ton CO_2-equivalent), and mobile combustion (car and bus fleet) (~10,000 Metric Ton CO_2-equivalent). Project activities that would contribute to the GHG emissions include the use of light-duty vehicles and portable generators. The intermittent use of ground transportation and use of generators during project activities is likely an insignificant portion of INL’s total GHG emissions. In addition to the above sources, the SOX Range would emit about 60 pounds of sulfur hexafluoride (SF6) /year[h] that is used as a gaseous dielectric medium. This amount of SF6 would generate about 650 Metric Ton CO_2-equivalent or about 0.7% of INL’s total contribution to GHG emissions.

Under the proposed action, livestock grazing in the area of the BLM livestock grazing allotment that falls within the SOX Range buffer area would continue to be allowed only during the winter months (November 15 through the end of February) unless unforeseen mission needs require excluding livestock grazing from those areas (see Figure A-1).

4.1.5 Cumulative Impacts

Those resources that would be most at risk to cumulative impacts from project activities include native vegetation, sage-grouse, pygmy rabbits, and cultural resources. These resources are found throughout the INL Site, including near the proposed range as described in this EA. However, surveys revealed poor quality vegetation and limited sage-grouse and pygmy rabbit habitat on the SOX Range. The geographic boundaries of these species vary from locally to regionally. Sage-grouse on the INL Site migrate off site and travel many miles both on- and off-site. Pygmy rabbits also occur throughout the INL Site, but likely move little. Both species are sagebrush obligates and closely associate with sagebrush on the INL Site. Cultural resources are found in very specific areas across the INL Site, including certain locations within the project areas and their locations marked to help protect them from adverse impacts.

The INL Site is (and has been) the home to different projects and includes several primary facility areas situated on an expanse of otherwise undeveloped, high-desert terrain. Most facilities are located within facility boundaries and are generally contained within two-square mile facility areas (see section 3). Current facilities and activities located near the proposed SOX Range include the Specific Manufacturing Capability (SMC), Test Area North (TAN), the Radiological Response Training Range (RRTR), and the T-28 gravel pit (see Figure 2). The SOX Range (including the Extended Range) would use about 3,300 acres out of 569,600 acres, or less than 0.6% of the INL Site. Considering that the majority of the SOX Range would be located within an already disturbed area, the widely spread nature of

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h. Estimate based on current linac operations at the INL.

INL facilities and that most of the INL Site remains pristine, the cumulative impact of the SOX Range is likely small.

DOE is always planning for future projects on the INL Site. Recent and ongoing EAs are indicative of foreseeable future actions, such as the Low-level Waste Disposal Facility. Other projects recently approved by DOE include the Multipurpose Haul Road[58] and the RRTR.[59] The SOX Range is adjacent to the RRTR North Test Range. In addition, there are a number of non-paved (two-track) roads throughout the INL Site and adjacent to and within the proposed range.

The proposed action would add an EDE of 0.02 mrem/yr under normal operations and 0.1 mrem/yr under maximum operation. This would result in cumulative radionuclide emissions to the MEI from all operations at the INL Site based on actual 2009 emission of 0.0887 mrem/yr, (normal operations) and 0.1687 mrem/yr (maximum operations).[2] The cumulative EDE would remain far below the 10 mrem/yr regulatory limit.

Section 3.0, ‘Affected Environment,’ Section 4.1, ‘Alternative 1,’ and the referenced report[37] give a baseline for sage-grouse and pygmy rabbits both on the INL Site and specific to the project areas. In addition, recent fires on the INL Site resulted in a substantial loss of sagebrush on the INL Site. However, the potential for loss of sagebrush, as a result of this project (as proposed in ‘Alternative 1’), is minimal and would not significantly increase the impact caused by that wildland fire because sagebrush within the SOX Range is limited due to previous disturbance of the area.

DOE reviewed the resources at risk; their geographic boundaries; past, present, and reasonable foreseeable future actions; and baseline information in determining the significance of cumulative impacts. The impacts associated with Alternative 1 have a small footprint, low intensity, and are near areas with much larger impacts to ecological and cultural resources. Operational controls described in Section 2 (see Table 2, see page 10) would help keep direct and indirect impacts to sage-grouse, pygmy rabbit, migratory birds, vegetation, and cultural resources small.

Project personnel would minimize these impacts by limiting the disturbance footprint, implementing a weed management strategy to control invasive and noxious weeds, and following up with revegetation when the range closes. Additionally, by completing cultural resource sensitivity training, implementing stop work procedures, and including an archaeologist in pre-project planning activities with the objective to avoid known cultural resources would minimize the potential for cumulative impacts. Any activity potentially disturbing vegetation or soils would require a nesting bird survey before disturbance, and if nesting migratory birds were found, no disturbance would be allowed during the nesting season. Therefore, while impacts and cumulative effects to those species and their habitat are not zero, they are likely insignificant given other habitat exists on the INL Site.

4.2 Alternative 2 – No Action

The ‘No Action’ alternative means that none of the actions described in ‘Alternative 1’ would occur. Choosing this alternative would limit the current linac research to that already being done at the CITRC and the ISU Airport accelerator facilities. The purpose and need to establish the SOX Range to support and enhance INL AI R&D capabilities for detecting materials of interest at greater standoff distances would not be met. Under ‘No Action’, project activities would not occur and those environmental impacts, as described in Section 4, would not occur.

4.3 Summary of Proposed Impacts

Following is a summary of proposed impacts from ‘Alternative 1’:

Radiological Dose

SOX Range personnel would use atmospheric modeling before operating the linac to control the public dose to less than 1% of the 10 mrem/yr EDE limit. This small dose would not produce any adverse impacts. In addition, the risk to workers would be managed and controlled in accordance with INL's Radiation Protection Program.

Biological Resources

The proposed action would likely impact some wildlife species by removing sage-grouse and pygmy rabbit habitat along the down-beam access road and areas proposed for disturbance and the associated use of those roads. In addition, the disruptive behavior would magnify the habitat fragmentation already caused by two-track roads. Proposed operational controls would minimize impacts to these resources.

Cultural Resources

The proposed action would cause minor direct and indirect impacts on the cultural resources and archaeological sites at the SOX Range. Operational controls would be implemented before and during project activities to minimize the potential for adverse direct and indirect impacts to cultural resources in the area. A tiered approach with initial efforts focusing on identification and assessment, followed by various protection strategies, as necessary, would be adopted.

Other Impacts

Under the proposed action, livestock grazing would continue to be allowed only during the winter months (November 15 through the end of February) unless unforeseen mission needs require excluding livestock grazing from those areas.

Linac operations at the SOX Range would generate about 650 Metric Ton CO2-equivalent from SF6 emissions or about 0.7% of INL's total contribution to GHG emissions.

Cumulative Impacts

The project would have the potential to affect cultural and biological resources by its activities, which include road construction and use, removing vegetation and disturbing soil, and other disruptive activities. However, from a cumulative impact perspective, the incremental amount is not expected to be significant. These resources are found throughout the INL Site, including near the proposed range as described in this EA. Considering the widely spread nature of INL facilities and that most of the site remains pristine, the cumulative impact of the SOX Range is small. The area of greatest impact occurs within the fenced portion of the SOX Range (or the octagonal area of 2,022 acres) and the Extended Range (an area of 1,465 acres); this equates to about 0.6% of the INL Site's 569,600 acres. Therefore, cumulative impacts to cultural artifacts, sage-grouse, pygmy rabbits, and other resources is low.

'Alternative 1' would result in cumulative radionuclide emissions to the MEI from all operations at the INL Site of 0.0887 mrem/yr, (normal operations) and 0.1687 mrem/yr (maximum operations).[2] The cumulative EDE would remain far below the 10 mrem/yr regulatory limit.

5.0 COORDINATION AND CONSULTATION

DOE notified the Shoshone-Bannock Tribe and the Idaho Department of Environmental Quality of the proposed project and the intent to prepare a draft EA. In addition, DOE consulted with the EPA and obtained approval of a methodology to calculate diffuse source radionuclide emissions under the provisions of 40 CFR 61.96(b) and the 1995 Memorandum of Understanding between the EPA and DOE concerning CAA Emission Standards for Radionuclides, as outlined in 40 CFR Part 61, including Subparts H, I, Q, and T.

DOE provided a project briefing to BLM personnel from the Idaho Falls Field Office that included discussions on potential impacts to livestock grazing activities within the areas associated with the proposed alternative. Based on those discussions and the need to fulfill project requirements, grazing may occur within the area of the allotment affected by the proposed action during the winter months (November 15 through the end of February), unless unforeseen mission needs require excluding livestock grazing from those areas. In such a case, DOE would coordinate with BLM to implement the required temporary restrictions.

DOE also notified INL Stakeholders (by postcard) in advance of the release of the draft EA, announced the release of the draft EA to the public through the issuance of a news release, posted the release and draft EA on the DOE website, and provided project briefings to the State of Idaho Governor's Office and Congressional Offices, and the Shoshone-Bannock Tribes. In addition, DOE would consult with the Idaho State Historic Preservation Officer in the event archaeological resources could not be avoided or regular monitoring indicated that they were being adversely impacted by project activities.

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47. 16 USC § 668, 1940, "Bald Eagle Protection Act," *United States Code*.

48. 16 USC § 715-715s, 1918, "Migratory Bird Treaty Act," *United States Code*.

49. Gilbert, Hollie K. and Julie Braun Williams, 2010, Summary of Cultural Resource Investigations for on the Stand-Off Experiment Range (SOX) Environmental Assessment, November 2010.

50. Miller, S.J., 1985, "A Cultural Resources Inventory of the Perimeter Boundary, Grazing Boundary, and 1984 Project Areas, Idaho National Engineering Laboratory, Southeastern Idaho," *EG&G C84-110380*.

51. Public Law 59-209, 1906, "Antiquities Act of 1906," as promulgated in 16 USC 431–433.

52. Public Law 89-665, 1966, "National Historic Preservation Act of 1966," as amended, as promulgated in 16 USC 470, et seq.

53. 42 USC § 4321 et seq., 1969, "National Environmental Policy Act," as amended, *United States Code*.

54. Public Law 95-341, "American Indian Religious Freedom Act of 1978," as amended, as promulgated in 42 USC 1996 and 1996a.

55. Public Law 93-291, 1976, "Archaeological and Historic Preservation Act of 1974," as amended, as promulgated in 16 USC 469–469c.

56. Public Law 96-95, 1979, "Archaeological Resources Protection Act of 1979," as amended, as promulgated in 16 USC 470aa-mm.

57. 43 CFR 10, 2010, "Native American Graves Protection and Repatriation Regulations," *Code of Federal Regulations*, Office of the Federal Register.

58. DOE/EA-1772, 2010, "Environmental Assessment for the Multipurpose Haul Road Within the Idaho National Laboratory Site," August 2010.

59. DOE/EA-1776, 2010, "Idaho National Laboratory Radiological Response Training Range Environmental Assessment," October 2010.

Appendix A – SOX Range Footprint and Operational Characteristics

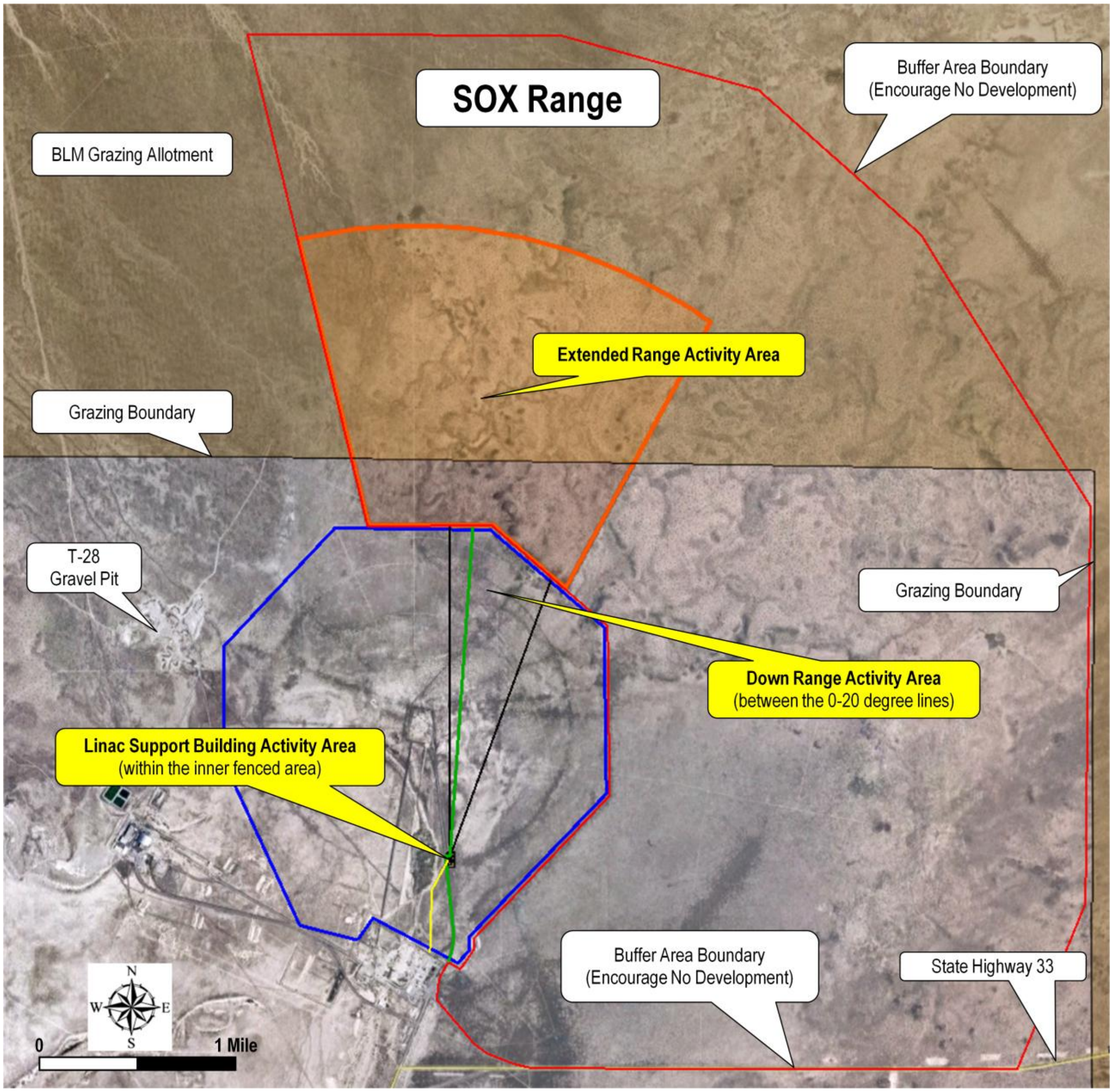

Figure A-1. SOX Range Activity Areas and Buffer Area in relationship to the BLM Livestock Grazing Allotment.

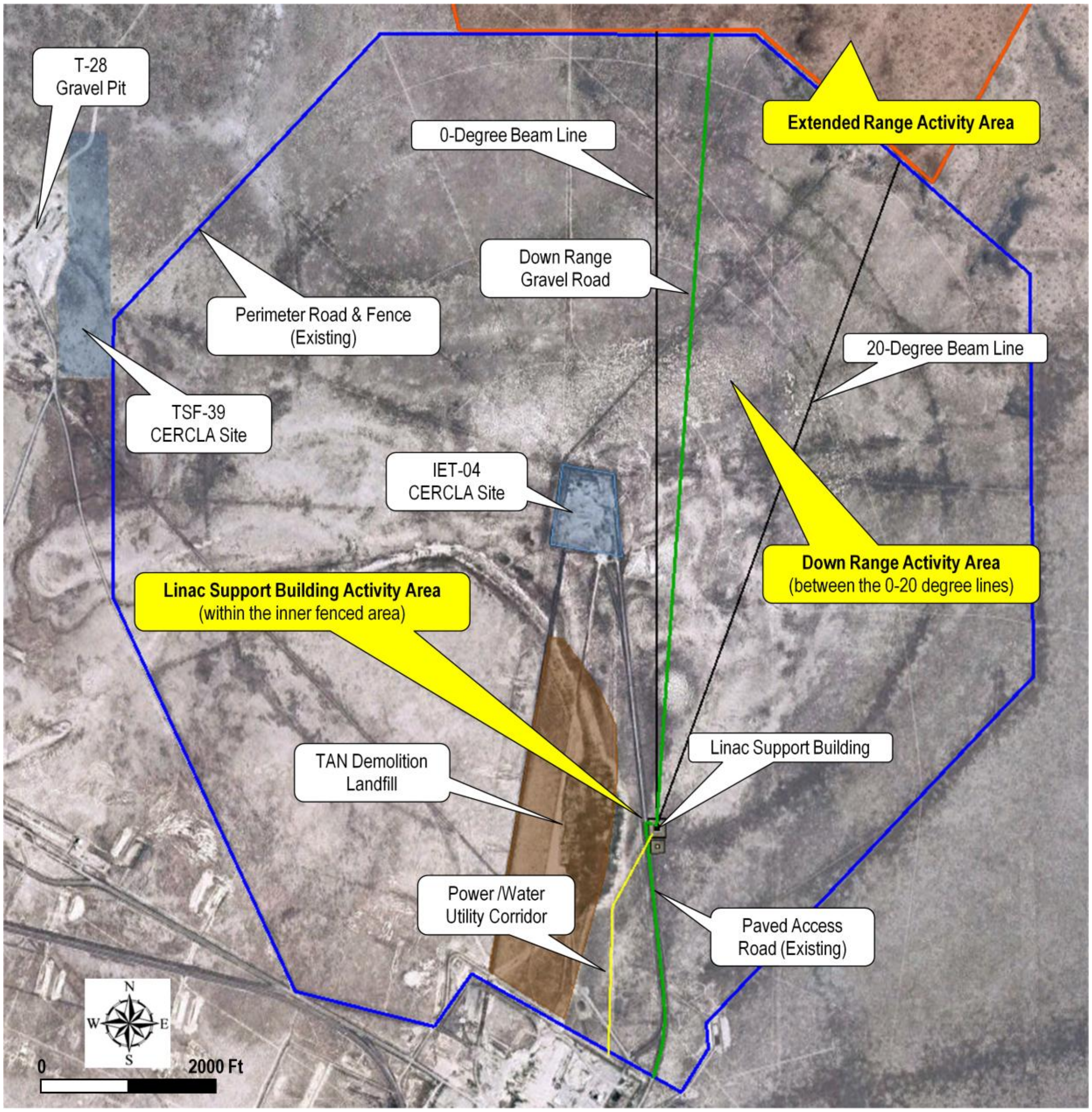

Figure A-2. Down Range and Linac Support Building Activity Area, including the 0- and 20-degree beam lines, down range road, and project infrastructure (the Linac Support Building, the power/utility corridor, and existing access and perimeter roads and fence). The figure also shows the location of nearby CERCLA sites and the TAN Demolition Landfill.

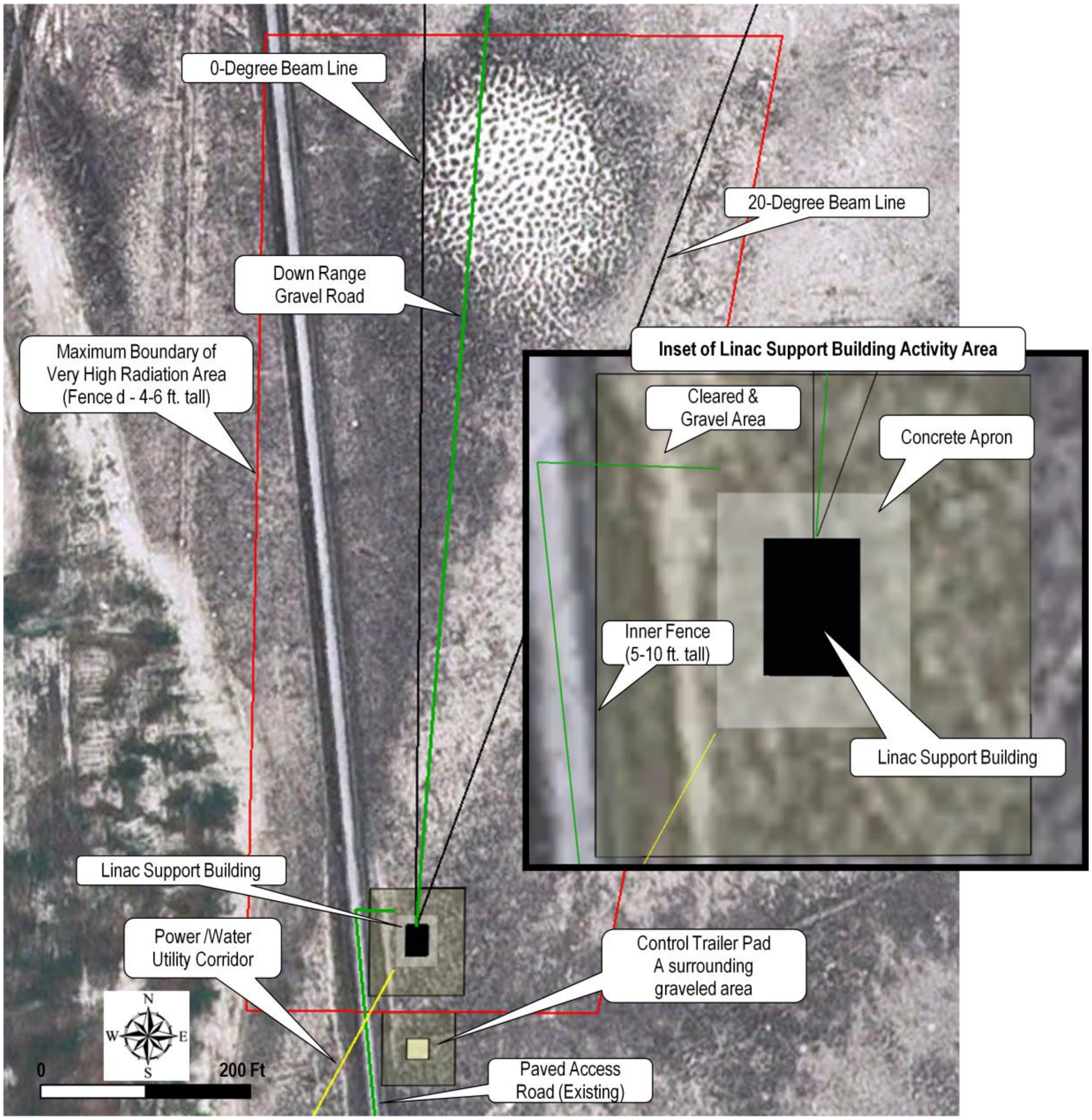

Figure A-3. Map showing the Linac Support Building Activity Area in relationship to the maximum expected VHRA and project infrastructure (power line, access road, and trailer pad). Inset shows Linac Support Building, concrete apron surrounding the building, and the cleared gravel area around both.

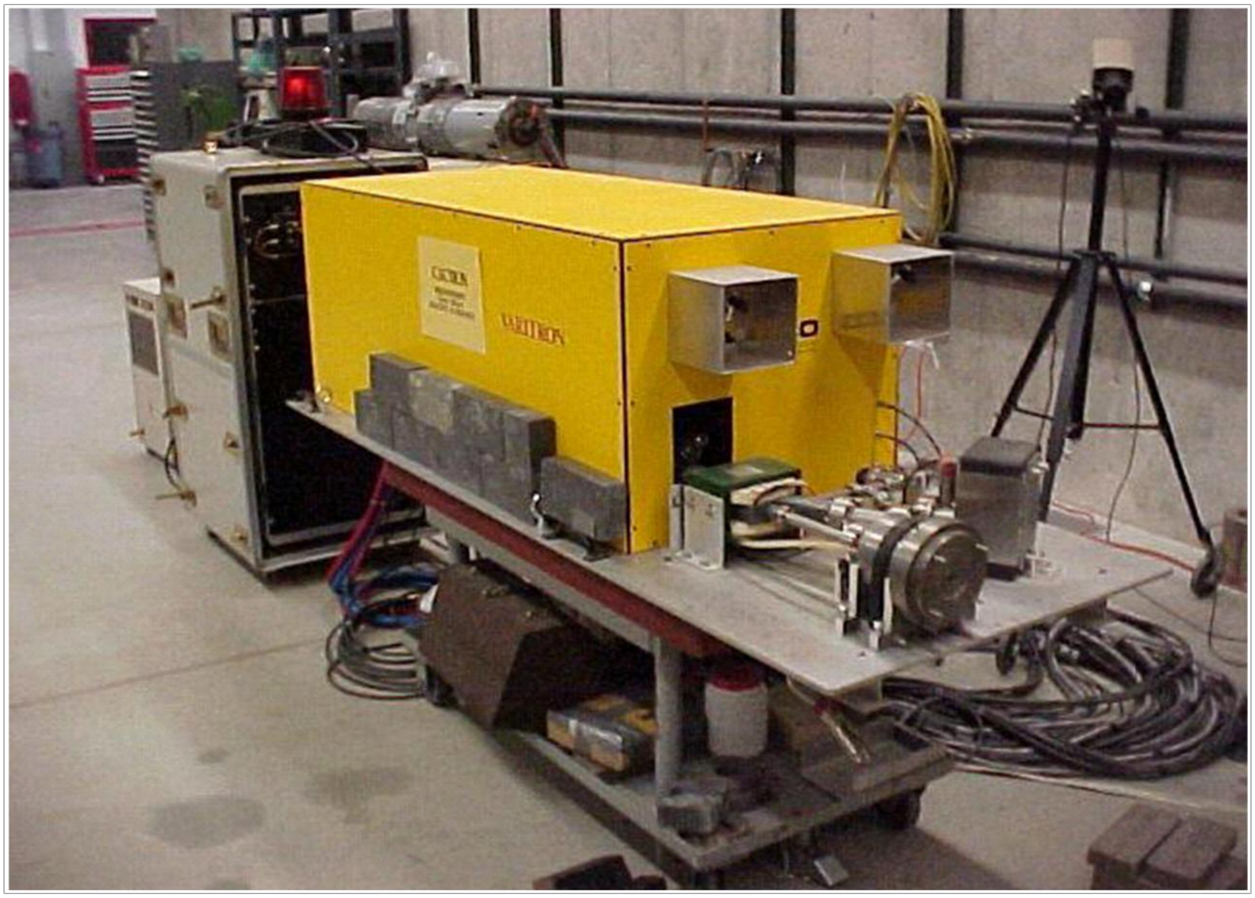

Figure A-4. Typical linac in use at INL.

Figure A-5. Example of beam stop assembled using concrete blocks; this picture shows a typical beam stop for the Varitron-III shielding. Each block is 2 ft. thick, 2 ft. tall and 6 ft. long. The delivery and assembly of shield blocks requires semi trucks and forklifts; the movement of a large number of blocks usually only happens once every few years. For example, shield blocks could be placed in front of a trailer or control station pad, along the sides of the linac support building for uncollimated operations or so work could be conducted within the building, to prevent the beam from traveling outside the linac support building fenced area (see Figure A-3), or placed along the down range road to stop the beam from leaving the fenced portion of the SOX Range. This allows work with shorter beam lines, reducing the size of the radiologically control footprint or area.

Appendix B – Public Comment and Response

DOE-ID published the draft EA on December 22, 2010, making it available to the public and agencies for review and comment through January 28, 2011. In addition, DOE-ID sent out news releases, posted the draft EA on DOE-ID's website, and sent out postcards to stakeholders, including federal and state agencies (e.g., U. S. Fish & Wildlife Service, Bureau of Land Management, Idaho Department of Fish and Game, and the sage-grouse local working groups).

DOE-ID received two comment letters and/or emails: one from a member of the public and one from the Idaho Department of Environmental Quality. The following table summarizes the comments received on the draft EA and DOE-ID's response to those comments.

Comments and Responses
Comments from Walt Hampson – Comment 1–6
Comment 1: "This appears to be an exceptionally well done EA Draft." **Comment 2:** "This seems to be an especially desirable project, i.e., serves an immediate cost savings need plus provides an important R&D research tool for future needs." **Response:** Thank you for your comments. DOE agrees that this project is important and provides the needed expansion in R&D capability at the Idaho National Laboratory to address important national security mission needs. **Comment 3:** "The proposed intrusive detection system (IDS) is a particularly important factor to insure protection for humans and large animals." **Response:** DOE agrees on the importance of the intrusion detection system for the protection of large animals and for the safety of workers. **Comment 4:** "I think large animals should be excluded from the reservation. Livestock, in particular, constitutes a potential interruption of continuity of operations and possibly a commercial liability risk therefore seems to be entirely unnecessary. The money received by BNL for livestock grazing would (sic) seem to be insignificant compared to the aforementioned disadvantages." **Response:** Livestock grazing would only occur during the winter months and then only in a portion of the Extended Range Area. This is not anticipated to be a constraint on SOX Range operations. In the event that research requirements necessitate the use of the Extended Range Area during the winter months, livestock grazing in the area would be curtailed for a defined period. This approach reasonably supports the SOX Range operation while allowing for continued use of the grazing allotment. **Comment 5:** "The 'No Action' alternative does not seem to be acceptable if continued progress on R&D is to be sustained." **Response:** The 'No Action' alternative is required to be considered by DOE in the preparation of all environmental assessments. DOE agrees that the 'No Action' alternative would not satisfy the stated purpose and need to conduct further research in support of the development of active interrogation technologies for the detection of materials of interest at greater standoff distances at the Idaho National Laboratory. **Comment 6:** "Is it wise or necessary to term the SOX Range a 'non-nuclear facility' since it has very similar characteristics to a nuclear facility? Stating that it is not a nuclear facility may tend to lessen the emphasis on radiation safety in the minds of all the people involved." **Response:** Under DOE regulations (10 CFR 830), accelerators are not considered to be a nuclear facility. However, Occupational Radiation Protection regulations (10 CFR 835) are fully applicable to accelerators. Radiation safety is foremost in the minds of the personnel involved in this facility and activity.

Susan Burke, INL Coordinator, Department of Environmental Quality (State of Idaho) – Comments 7–16

Comment 7: "On page 5, under Table 1, *Construction Activities*, please know that applicable permits or approvals are necessary for potable water and sewer systems. In addition, applicable state laws must be adhered to for such systems. It is recommended that the DOE review whether there are any institutional controls in this area, which may affect the proposed water or sewer systems."

> **Response:** DOE is aware of required permits, such as those for potable water, septic system, and notices of soil disturbance that must be secured before construction and operation of the SOX Range. In addition, DOE will also review any institutional controls related to CERCLA Sites or other areas before beginning construction activities.
>
> **Changes to EA:** One of the bullets in Table 2 states that a 'project control' includes "Securing applicable permits before operating the linacs." A similar control was added to Table 2 for activities involving construction activities.

Comment 8: "The T-28 gravel pit is noted on page 20 of the EA, but it is not stated to be a CERCLA site. Please note that any activities at a CERCLA site will require completion of a Notice of Disturbance. In addition, the location of T-28 should be shown on Figure 2 on page 4."

> **Response:** DOE is aware of the nearby CERCLA sites (TSF-39, near the T-28 Gravel Pit; and IET-04, near the center of the SOX Range). Project activities will not disturb those areas.
>
> **Changes to EA:** DOE revised Figure A-2 in Appendix A to include the location of nearby CERCLA sites (TSF-39 and IET-04) and the T-28 Gravel Pit. In addition, a 'control' to prepare a 'Notice of Soil Disturbance,' when appropriate, was added to Table 2 (see page 10).

Comment 9: "Only the boundary for the very high radiation area is shown in the figures in the EA. The high radiation area and the radiation area boundaries should be clearly described in the text and also show in the figures. If the high radiation area and the radiation area are to be newly established for each operation of a linac then this should be clarified."

> **Response:** Figure A-4 was deleted from Appendix A and replaced with Figure 3 in the main document to show a typical arrangement of the three radiological areas (VHRA, HRA, and RA) and the IDS. In addition, changes were made to Section 2.3.5 to clarify the relationship between the different radiation areas and how they relate to linac operations.
>
> **Changes to EA:** As stated in the response above, changes were made to the EA, including Appendix A (see Section 2.3.5 on page 8 and Appendix A).

Comment 10: "The ASE-101 document referenced in the EA discusses operator shutdown if an earthquake is felt. The DOE might consider also using an automatic engineering control for a large earthquake event. The DOE may be able to tie into the controls used at the Advanced Test Reactor."

> **Response:** A linac is not a system that could have its configuration altered as a result of an earthquake in a way which would subsequently preclude its safe shutdown. In addition to the administrative requirement that operators shut down the linac in the event an earthquake is detected there is also an engineered control required by the ASE that would mitigate any adverse impacts. The particular hazard associated with an earthquake to the operation would be displacement of the linac such that the beam direction and radiation footprint is changed. Safety radiation monitors are positioned to detect anomalies in the radiation dose either as result of unexpected beam power or misalignment. Upon such an indication power is automatically secured shutting down the accelerator.

Comment 11: "Section 4.4 of the ASE-101 document referenced in the EA describes requirements for warning beacons for the Administrative Control Area (ACA). DEQ understands that this would be all areas 5 millirem an hour and greater, and thus at times would continue past the perimeter fence and into the Extended Range Activity

Area. Section 2.3.3 of the EA on page 7 notes that 'Traffic candles and radiation rope would demark the five (millirem) mrem/hr boundary during the limited use' of the Extended Range Activity Area. This does not meet the safety requirements stated in section 4.4 of ASE-101 ['Control 4.21 – A rotating or flashing beacon shall be activated preceding initiation of LINAC beam power (during the same period of time that the audible alarm sounds) and whenever beam power is on. If the beacon is not observable from the ACA boundary, additional beacons shall be established so that they may be observed from the ACA boundary.']."

Response: The ASE will be followed. As written, one or more flashing beacons may be needed to permit viewing when the ACA extends into the Extended Range Area.

Comment 12: "DEQ recommends a better description of the Intrusion Detection System (IDS) network, especially where it would be located and what the spacing would be like between units. Section 4.3 of ASE-101 states ["Control 4.11 – An IDS shall be provided which provides a trip input to the accelerator interlock system upon intruder detection if walls, fences or equivalent natural or man-made barriers do not completely satisfy the requirements of 10CFR835 for preventing personnel access to the high radiation area during LINAC operations. IDS coverage shall be provided for the Administrative Control Area (ACA) (see section 5) for those areas not covered by walls, fences, etc. IDS coverage may extend further out from the ACA if desired *as long as it covers the ACA as a minimum.* The IDS shall be capable of tripping the LINAC before an intruder moving at 10 m/sec can reach the high radiation boundary." (Italics added.) Later in Section 5.6.1 of ASE-101 the ACA is defined under Control 5.14 as "The ACA is either established at the radiation area boundary…" Figure A-4 of the SOX Range EA shows the IDS established well inside of what appears to be the radiation area. (The clarification requested in Comment #2 above regarding where the high radiation area and the radiation area boundaries are to be established would help clarify where the IDS is to be placed."

Response: The requirements of the ASE will be followed. Figure A-4 has been deleted and replaced by Figure 3 in section 2.3.5 to show the typical layout for the radiological area boundaries. Section 2.3.5 has been revised to provide additional clarity for the boundary requirements and the IDS.

Changes to EA: See changes in the text in section 2.3.5 and that Figure 3 has replaced Figure A-4.

Comment 13: "DEQ strongly encourages the implementation and use of the operational controls listed in the EA."

Response: DOE expects INL and those performing construction activities and those operating the linac to implement all applicable controls found in the EA.

Comment 14: "Section 4.1.2.5, Radiological Limits, Page 17, Third Paragraph —
"The reference for the dose limit of 0.1 rad/day is not presented; presumably it is the DOE document cited in the first paragraph, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*. It would be useful to present more information about this dose limit; for example, whether it is based on impacts to populations or individual organisms."

Response: The first paragraph in Section 4.1.2.5 has been updated to address your comments on the dose limit and population.

Changes to EA: See changes in Section 4.1.2.5, page 18.

Comment 15: "Section 4.1.2.5, Radiological Limits, Page 17, Third Paragraph —
"It is stated that bird nests or on the ground should not be impacted, as they would be below the linac beam. The potential risk to birds perching in the taller sagebrush, and flying through the beam during foraging and other behaviors should be addressed. This kind of exposure would appear to be inherently less controllable than exposure to large mammals, which is more easily monitored."

Response: Section 4.1.2.5 was updated to clarify the impacts to birds, perching or on the ground. It also clarifies the impact is based on populations of the birds, not the individuals.

Changes to EA: See changes in Section 4.1.2.5, page 18.

Comment 16: "Section 4.1.2.5, Radiological Limits, Page 17, Fourth Paragraph —
"The potential for long-term soil contamination is characterized as low, because soil activation would be minimal. Although quantitative estimates of exposures and doses are presented throughout the document, there is not description of the mechanism of soil activation, or the potential associated doses to biota. Some additional detail would be helpful."

Response: DOE determined that 3 radionuclides (Ca-41, 103,000 yrs; K-40, 1.28 E9 yrs; and Fe-55, 2.7 years) caused by soil activation would have long enough half-lives (years) to produce dose to biota if sufficient quantities were produced. Using dose conversion data from ICRP 60 (1991) and Amiro (1997) DOE back-calculated the concentration required to achieve the most restrictive dose (0.1 rad/day) from soil activation radionuclides. Our results (presented in the revised document) indicated that concentrations many orders of magnitude above what will be produced would be required to impact biota radiologically leading us to the conclusion that soil activation would not cause radiological impacts to biota. Both references cited above are found in 'Hafla, et al. 2010,' which is referenced in this EA.

Changes to EA: Section 4.1.2.5 was updated to clarify mechanism for activation of soil and to provide additional clarifying detail (see page 19).