COVER SHEET

RESPONSIBLE AGENCY:
U.S. Department of Energy (DOE)

TITLE:
Final Environmental Impact Statement (FEIS), Construction and Operation of the Spallation Neutron Source (DOE/EIS-0247)

LOCATIONS OF ALTERNATIVE SITES:
Illinois, New Mexico, New York, and Tennessee.

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ABSTRACT:
DOE proposes to construct and operate a state-of-the-art, short-pulsed spallation neutron source comprised of an ion source, a linear accelerator, a proton accumulator ring, and an experiment building containing a liquid mercury target and a suite of neutron scattering instrumentation. The proposed Spallation Neutron Source would be designed to operate at a proton beam power of 1 megawatt. The design would accommodate future upgrades to a peak operating power of 4 megawatts. These upgrades may include construction of a second proton accumulator ring and a second target.

The United States needs a high-flux, short-pulsed neutron source to provide the scientific and industrial research communities with a much more intense source of pulsed neutrons for neutron scattering research than is currently available, and to assure the availability of a state-of-the-art facility in the decades ahead. This next-generation neutron source would create new scientific and engineering opportunities. In addition, it would help replace the neutron science capacity that will be lost by the eventual shutdown of existing sources as they reach the end of their useful operating lives in the first half of the next century.

This document analyzes the potential environmental impacts from the proposed action and the alternatives. The analysis assumes a facility operating at a power of 1 MW and 4 MW over the life of the facility. The two primary alternatives analyzed in this FEIS are: the proposed action (to proceed with building the Spallation Neutron Source) and the No-Action Alternative. The No-Action Alternative describes the expected condition of the environment if no action were taken. Four siting alternatives for the Spallation

Neutron Source are evaluated: Oak Ridge National Laboratory, Oak Ridge, TN, (preferred alternative); Argonne National Laboratory, Argonne, IL; Brookhaven National Laboratory, Upton, NY; and Los Alamos National Laboratory, Los Alamos, NM.

PUBLIC COMMENT AND DOE DECISION:

The Draft EIS (DEIS) was released to the public for review and comment on December 24, 1998. The comment period extended until February 8, 1999, although late comments were accepted to the extent practicable. All of the received comments were considered in preparation of the FEIS[1]. DOE will use the analysis in this FEIS and prepare a Record of Decision on construction and operation of the proposed SNS and selection of a site for implementing this proposed action. This decision will be no sooner than 30 days after the Notice of Availability of the FEIS is published in the *Federal Register*.

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[1] Text additions made since publication of the DEIS are marked with vertical margin bars and the underlining of text in this FEIS. Vertical bars without underlining indicate the deletion of text or the addition of new tables.

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Environmental Impact Statement

Volume I

U.S. Department of Energy
Office of Science

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ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
ADT	average daily trips
AEA	Atomic Energy Act
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
ANS	Advanced Neutron Source
AOC	area of concern
APS	Advanced Photon Source
ARAP	Aquatic Resource Alteration Permit
ATDD	Atmospheric Turbulence and Diffusion Division
AWQS	Ambient Water Quality Standards
BESAC	Basic Energy Sciences Advisory Committee
BGRR	Brookhaven Graphite Research Reactor
BMAP	Biological Monitoring and Abatement Program
BNL	Brookhaven National Laboratory
BSR	biodiversity significance ranking
CAA	Clean Air Act
CCDTL	coupled-cavity drift-tube linac
CCL	coupled-cavity linac
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CHP	Central Heating Plant
CSF	Central Steam Facility
CWA	Clean Water Act
DARHT	Dual Axis Radiographic Hydrodynamic Test
DCG	derived concentration guide
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
DOE-AL	U.S. Department of Energy Albuquerque Operations Office
DOE-CH	U.S. Department of Energy Chicago Operations Office
DOE-ORO	U.S. Department of Energy Oak Ridge Operations Office
DOI	U.S. Department of the Interior
DOT	U.S. Department of Transportation
DTL	drift-tube linac
ECL	Environmental Conservation Law
EDE	effective dose equivalent
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESD	Environmental Sciences Division
ETNG	East Tennessee Natural Gas Company

ACRONYMS AND ABBREVIATIONS – Continued

ETTP	East Tennessee Technology Park
FEIS	Final Environmental Impact Statement
FR	*Federal Register*
FY	fiscal year
GWQS	Groundwater Quality Standards
HEBT	high-energy beam transport
HEPA	high-efficiency particulate air (filter)
HFBR	High Flux Beam Reactor
HFIR	High Flux Isotope Reactor
HVAC	heating, ventilation, and air conditioning
ICRP	International Commission on Radiation Protection
IEPA	Illinois Environmental Protection Agency
ILCS	Illinois Compiled Statutes
IPNS	Intense Pulsed Neutron Source
JINS	Joint Institute for Neutron Science
K	hydraulic conductivity
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
LBNL	Lawrence Berkeley National Laboratory
LCF	latent cancer fatality
LEBT	low-energy beam transport
LILCO	Long Island Lighting Company
linac	linear accelerator
LLLW	liquid low-level radioactive waste
LLW	low-level radioactive waste
LMER	Lockheed Martin Energy Research Corporation
LMES	Lockheed Martin Energy Systems
LOS	level of service
MAP	Mitigation Action Plan
MEBT	medium energy beam transport
MEI	maximally exposed individual
MIT	Massachusetts Institute of Technology
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIOSH	National Institute of Occupational Safety and Health

ACRONYMS AND ABBREVIATIONS – Continued

NIST	National Institute of Standards and Technology
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMEDAQB	New Mexico Environment Department Air Quality Bureau
NMSA	New Mexico Statutes Annotated
NMWQCC	New Mexico Water Quality Control Commission
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NSC	National Safety Council
NSNS	National Spallation Neutron Source
NYSDEC	New York State Department of Environmental Conservation
NYSDWS	New York State Drinking Water Standards
OECD	Organization for Economic Cooperation and Development
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PGA	peak ground acceleration
PM_{10}	particulate matter (less than 10 microns in diameter)
PSD	prevention of significant deterioration
RCRA	Resource Conservation and Recovery Act
rf	radio-frequency
RfC	reference concentration
RFQ	radio-frequency quadrupole
RHIC	Relativistic Heavy Ion Collider
RLW	radioactive liquid waste
RLWTF	radioactive liquid waste treatment facility
RMO	Reservation Management Organization
ROD	Record of Decision
ROI	region-of-influence
RTBT	ring-to-target beam transport
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Officer
SNL	Sandia National Laboratory
SNS	Spallation Neutron Source
SR	state road
STP	sewage treatment plant
SWEIS	Site-wide Environmental Impact Statement
SWMU	Solid Waste Management Unit

ACRONYMS AND ABBREVIATIONS – Continued

SWTP	Sanitary Wastewater Treatment Plant
TA	Technical Area
T&E	threatened and endangered
TCPs	Traditional Cultural Properties
TCRR	Tennessee Compilation of Rules and Regulations
TDEC	Tennessee Department of Environment and Conservation
TDFCMP	Temperate Deciduous Forest Continuous Monitoring Program
TLV-TWA	threshold limit value—time-weighted average
TSCA	Toxic Substances Control Act
TSD	treatment, storage, or disposal
TVA	Tennessee Valley Authority
USACOE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
WAC	waste acceptance criteria
WCRRF	waste characterization, reduction, and repackaging facility

UNITS OF MEASURE

ac	acre
bcf	billion cubic feet
Bq/L	becquerels per liter
Btu/hr	British thermal units per hour
C	celsius
cc	cubic centimeter
cfm	cubic feet per minute
Ci	curie
Ci/g	curies per gram
Ci/ml	curies per milliliter
cm	centimeter
cm/yr	centimeters per year
cm/s	centimeters per second
dB	decibel
dBA	decibel A-weighted
F	fahrenheit
$(fCi)/m^3$	femtocuries per cubic meter
ft	feet
ft/d	feet per day
ft/mi	feet per mile
ft^2	square feet
ft^3	cubic feet
ft^3/hr	cubic feet per hour
ft^3/s	cubic feet per second
g	grams
g/L	grams per liter
gal	gallon
GeV	billion electron volts
gpd	gallons per day
gpm	gallons per minute
gwh	gigawatt hour
ha	hectare
hr	hour
Hz	hertz
in	inch
K	kelvin
keV	thousand electron volts
kg/ft^2	kilograms per square feet
Km	kilometer
km^2	square kilometer
km/hr	kilometers per hour
kPa	kilopascal
kV	kilovolt
L	liter
Lb	pound
lb/ft^2	pounds per square feet
lb/hr	pounds per hour

UNITS OF MEASURE – Continued

lpd	liters per day
lpm	liters per minute
lps	liters per second
m	meter
m^2	square meter
m^2/d	square meters per day
m^3	cubic meter
m^3/yr	cubic meters per year
MA	milliamperes
m/d	meters per day
MeV	million electron volts
mg/L	milligrams per liter
mg/ m^3	milligrams per cubic meter
Mgpd	million gallons per day
mi	mile
mi^2	square mile
min	minute
ml	milliliter
mmhos	micro ohm^{-1}
mph	miles per hour
mrem	millirem (one thousandth of a rem)
mrem/yr	millirems per year
mR/y	millirads per year
m/s	meters per second
m^3/s	cubic meters per second
mSv	milliseivert
MW	megawatt
m/y	meters per year
pCi/g	picocuries (one trillionth of a curie) per gram
pCi/L	picocuries per liter
PCi/m^3	picocuries per cubic meter
Ppm	parts per million
Psig	pounds per square inch guage
R/hr	roentgen per hour
Rad/hr	rads per hour
Rem	roentgen equivalent man
Rem/yr	rems per year
S	second
Tns/yr	tons per year
μCi	microcurie
μg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
μs	a millionth of a second
yd^3	cubic yards
yr	year

CHEMICALS AND ELEMENTS

Ag	silver
Al	aluminum
Ba	barium
Ca	calcium
Cd	cadmium
Cl	chlorine
CO	carbon monoxide
CO_2	carbon dioxide
Cr	chromium
Cu	copper
D_2O	deuterium
Fe	iron
H	hydrogen
H_20	water
HCl	hydrochloric acid
Hg	mercury
Mg	magnesium
Mn	manganese
Na	sodium
NH_4	ammonium
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NO_3-N	nitrate--nitrogen
O_2	oxygen
P	phosphorus
Pb	lead
SiO_2	quartz
SO_2	sulfur dioxide
SO_4	sulfate
SO_x	oxides of sulfur
Zn	zinc

RADIONUCLIDES

Al-26	aluminum-26	^{26}Al
Am-241	americium-241	^{241}Am
Ar-37	argon-37	^{37}Ar
Ar-39	argon-39	^{39}Ar
Ar-41	argon-41	^{41}Ar
Be-7	beryllium-7	^{7}Be
Be-10	beryllium-10	^{10}Be
C-10	carbon-10	^{10}C
C-11	carbon-11	^{11}C
C-14	carbon-14	^{14}C
Ca-41	calcium-41	^{41}Ca
Cl-36	chlorine-36	^{36}Cl
Co-60	cobalt-60	^{60}Co
Cs-137	cesium-137	^{137}Cs
Fe-55	iron-55	^{55}Fe
H-3	tritium	^{3}H
I-122	iodine-122	^{122}I
I-125	iodine-125	^{125}I
K-40	potassium-40	^{40}K
Mn-53	manganese-53	^{53}Mn
Mn-54	manganese-54	^{54}Mn
N-13	nitrogen-13	^{13}N
N-15	nitrogen-15	^{15}N
Na-22	sodium-22	^{22}Na
O-14	oxygen-14	^{14}O
O-15	oxygen-15	^{15}O
Pu-238	plutonium-238	^{238}Pu
Pu-239	plutonium-239	^{239}Pu
Pu-240	plutonium-240	^{240}Pu
Pu-249	plutonium-249	^{249}Pu
Sr-89	strontium-89	^{89}Sr
Sr-90	strontium-90	^{90}Sr
Tc-99	technetium-99	^{99}TC
Te-123m	tellurium-123m	^{123m}Te
U-234	uranium-234	^{234}U
U-235	uranium-235	^{235}U
U-238	uranium-238	^{238}U
Xe-127	xenon-127	^{127}Xe

METRIC CONVERSION CHART

To Convert into Metric			To Convert out of Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092903	square meters	square meters	10.7639	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
fahrenheit	Subtract 32 then multiply by 5/9ths	celsius	celsius	Multiply by 9/5ths, then add 32	fahrenheit

METRIC PREFIXES

Prefix	Symbol	Multiplication Factor
Exa-	E	1 000 000 000 000 000 000 = 10^{18}
Peta-	P	1 000 000 000 000 000 = 10^{15}
Tera-	T	1 000 000 000 000 = 10^{12}
Giga-	G	1 000 000 000 = 10^{9}
Mega-	M	1 000 000 = 10^{6}
Kilo-	K	1 000 = 10^{3}
Hecto-	H	100 = 10^{2}
Deca-	Da	10 = 10^{1}
Deci-	D	0.1 = 10^{-1}
Centi-	C	0.01 = 10^{-2}
Milli-	M	0.001 = 10^{-3}
Micro-	μ	0.000 001 = 10^{-6}
Nano-	N	0.000 000 001 = 10^{-9}
Pico-	P	0.000 000 000 001 = 10^{-12}
Femto-	F	0.000 000 000 000 001 = 10^{-15}
Atto-	A	0.000 000 000 000 000 001 = 10^{-18}

RADIOACTIVITY UNITS

Part of this report deals with levels of radioactivity that might be found in various environmental media. Radioactivity is a property; the amount of a radioactive material is usually expressed as "activity" in curies (Ci). The curie is the basic unit used to describe the amount of substance present, and concentrations are generally expressed in terms of curies per unit mass or volume. One curie is equivalent to 37 billion disintegrations per second or is a quantity of any radionuclide that decays at the rate of 37 billion disintegrations per second. Disintegrations generally include emissions of alpha or beta particles, gamma radiation, or combinations of these.

RADIATION DOSE UNITS

The amount of ionizing radiation energy received by a living organism is expressed in terms of radiation dose. Radiation dose in this report is usually written in terms of effective dose equivalent and reported numerically in units of rem. Rem is a term that relates ionizing radiation and biological effect or risk. A dose of 1 millirem (0.001 rem) has a biological effect similar to the dose received from about a 1-day exposure to natural background radiation. A list of the radionuclides discussed in this document and their half-lives is included in Appendix F.

CHAPTER 1: INTRODUCTION

In the context of carrying out its mission to support continued U.S. leadership in science and technology, the Department of Energy (DOE) is proposing to construct and operate a major new scientific research facility, the Spallation Neutron Source (SNS). The proposed SNS is designed to be a world-class neutron scattering science user facility serving a broad national community of researchers from federal laboratories, academia, and private industry. It is anticipated that this facility would be used by 1,000 to 2,000 scientists and engineers annually and that it would help meet the nation's demand for research capabilities in neutron scattering science well into the next century. This chapter provides background information about neutron scattering science and associated research facilities, describes the environmental analysis process, introduces the proposed action and alternatives included in this Final Environmental Impact Statement (FEIS), and describes how this document is organized.

1.1 BACKGROUND ON NEUTRON SCATTERING SCIENCE AND FACILITIES

Neutron scattering science is a specialized field of basic research having to do with using a subatomic particle, the neutron, as a means to probe and derive an understanding of the fundamental structure and behavior of matter. Among all types of radiation used to probe materials (including X-rays, protons, and electrons), neutrons are uniquely capable of penetrating deeply beneath the material's surface to reveal its innermost characteristics. In basic terms, this is accomplished by directing a beam of neutrons at a material sample, detecting the neutrons that are scattered from collisions with atomic nuclei within the sample, and measuring the angles of their scattering paths and their post-collision energies. From these data, scientists can determine a wide range of characteristics about how a solid or liquid material's molecules are structured and how they behave under various physical conditions.

Development of neutron scattering techniques as a means to analyze material properties was pioneered by U.S. scientists beginning in 1945 when the first nuclear reactors became available for research. This type of research eventually spread to Europe and Japan as neutron sources became available there. DOE (and its predecessor agencies) has served as the prime steward of this field throughout the entire course of its development. Two of the leaders in this field, Clifford Shull of the Massachusetts Institute of Technology (MIT) and Bertram Brockhouse of McMaster University in Canada, were jointly awarded the 1994 Nobel Prize for Physics for their development of neutron diffraction and neutron spectroscopy, respectively. Diffraction refers to patterns followed by the scattered neutrons; these patterns are a direct result of the molecular structure of a material sample. The diffraction patterns can be used to understand how atoms in the molecules are arranged. This information can, in turn, be used to predict how a material will behave under various physical conditions (e.g., high temperature or extreme pressure). Spectroscopy involves measuring the energies of the scattered neutrons, which can be used to reveal information about the movements of atoms within a material sample (e.g., their individual and collective oscillations).

Neutron beams can be either continuous (steady streams of neutrons) or pulsed (short bursts of neutrons). Both types are used and are uniquely valued in neutron scattering research. Continuous beams can be easily generated by nuclear reactors, and reactor sources were used exclusively up through the 1970s for neutron scattering experiments. These reactors tend to be relatively small and specially designed for neutron research purposes, in contrast to those built for commercial power generation. Pulsed neutron beams can be optimally produced from short bursts of high energy protons or electrons from a particle accelerator impinging on a heavy metal target, such as tungsten, tantalum, or mercury, to generate bursts of neutrons through a nuclear process called spallation. Spallation occurs when an incoming high energy proton hits a heavy atomic nucleus and knocks one or more neutrons out of it (Figure 1.1-1). Other neutrons are "boiled off" as the bombarded nucleus heats up. For every proton striking the nucleus, 20 to 30 neutrons are expelled. The power of a spallation source is characterized by the power [in kilowatts (kW) or megawatts (MW)] of the proton beam coming from the accelerator and directed onto the target. The first pulsed spallation source was built at Argonne National Laboratory (ANL) and began operation in 1973.

Regardless of whether the neutron source is continuous or pulsed, the emerging neutrons must be slowed

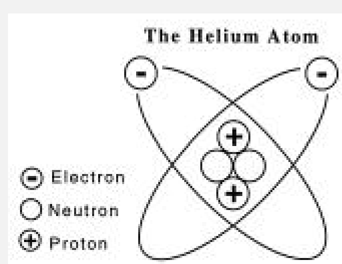
What Are Neutrons and What Can They Do?

Neutrons are one of the fundamental particles that make up matter. They were first identified in 1932 by Sir James Chadwick in England, for which he was awarded the 1935 Nobel Prize in Physics. This uncharged particle exists in the nucleus of a typical atom along with its positively charged counterpart, the proton. Protons and neutrons each have about the same mass, and both can exist as free particles apart from the atomic nucleus. In the universe, neutrons are abundant, making up more than half of all visible matter.

Neutrons traveling on their own can collide with the atomic nuclei of any material that they encounter and bounce off in a new direction, usually at a different speed or energy. This interaction is referred to as neutron scattering, which can be used to identify the positions of atoms in a molecule. It is especially good at locating light atoms such as hydrogen, carbon, and oxygen. Since these light atoms are prevalent in organic compounds, neutron scattering is a particularly effective means of studying biological materials. Because neutrons weakly interact with materials, they are highly penetrating and can be used to study bulky or highly complex samples, as well as samples inside thick-walled metal containers.

As an alternative to scattering, neutrons can be absorbed into a nucleus upon colliding with it. This can result in the formation of a nucleus of a different element, which can be either stable or radioactive. This is the process used to produce radioactive isotopes for medical applications such as implants for treating some forms of cancer. When neutrons are absorbed into the nuclei of certain heavy elements, such as uranium, those nuclei can be split apart. This is the fission process that occurs in a nuclear reactor, generating heat and producing more neutrons.

Lastly, another valuable feature of neutrons is that they are slightly magnetic, which makes them one of the best probes for the study of magnetic structure and magnetic properties of materials.



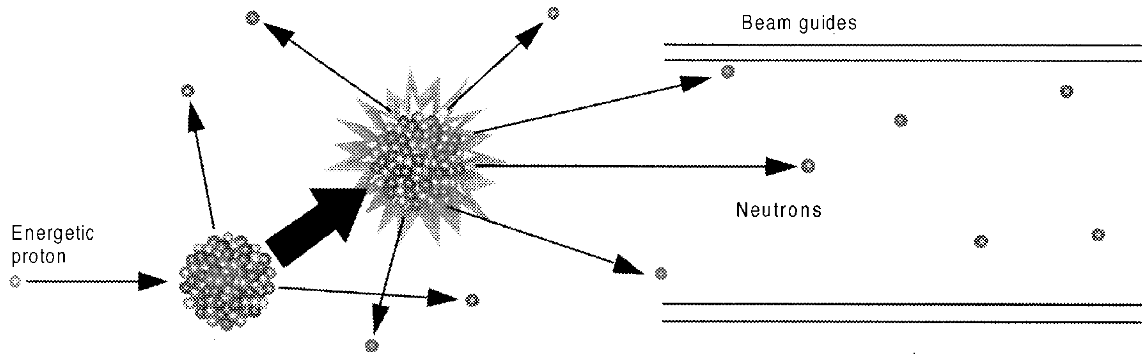


Figure 1.1-1. Neutron spallation process.

down, or moderated, to energies that are applicable to studying the kinds of materials chosen by the scientist conducting a particular experiment. This is usually accomplished by surrounding the reactor core or spallation target with a material containing hydrogen (e.g., water), which is most effective at slowing neutrons. The neutrons are then channeled in a beamline to an experiment station equipped with instruments capable of collecting and processing the desired kinds of information. Neutrons that are moderated to the energy or temperature of their surroundings are called thermal neutrons [0.010 to 0.100 electron volts (eV)], and those that slow down even further are termed cold neutrons (0.001 eV to 0.010 eV). In the late 1960s, neutron guides were developed for cold neutrons. These guides, which are evacuated glass channels with a metallic coating, can transport neutrons long distances with low losses. More recently, guides were developed for thermal neutrons. Guides for cold and thermal neutrons enable remote placement of instruments in buildings or rooms that are removed from the reactor core or the spallation target; such structures are called guide halls. The geometry involved in locating the instruments farther away from the neutron source allows more instruments to be installed, which makes the facility far more scientifically productive and flexible.

It is important to note that continuous and pulsed neutron sources are complementary and equally valuable as research tools. While many classes of experiments can be performed at some level with either type of source, there are some kinds of experiments that cannot be done with one or the other. For instance, with a pulsed source it is possible to achieve much higher neutron beam intensities (i.e., a greater number of neutrons per unit of time or higher flux) enabling deeper penetration into a material sample, and its pulsed nature permits time-of-flight analysis of the scattered neutrons. Time-of-flight analysis is based on the fact that each pulse contains neutrons with a range of energies, so neutrons of different energies can be separated by letting them run down a path of several meters. The highest energy neutrons reach the sample ahead of the rest, and because the neutron energies are spread out in time, the energy of an individual neutron is determined by its time-of-flight to the sample. Another area where pulsed sources are desirable is neutron scattering from samples subjected to very high pressures or very high magnetic fields that can be sustained only for brief periods of time. A reactor source is superior for performing experiments requiring cold neutrons, such as studying polymer dynamics. Apart from neutron scattering, reactors are better suited to conducting radiation damage studies and producing radioisotopes, both of which require neutron fluxes over large volumes. The neutron science community has expressed its view that both reactor and spallation neutron sources must remain available to support a strong, comprehensive U.S. neutron scattering research program (DOE 1993a).

Future advances in neutron scattering science and its applications depend to a large extent upon the number, technical capability, and research capacity of neutron sources available to the scientific research community. In addition to the previously mentioned distinction of continuous versus pulsed beams, the technical capability of a neutron source can be described by several other principal characteristics. Probably the most important is the flux or brightness of the neutron beam, and like a flashlight in a dark room, a high flux beam allows the researcher to look deeper inside a sample specimen and more clearly discern its structural features. Because neutrons only interact weakly with matter, most neutrons pass through a sample without producing a detectable interaction. As a result, experiments tend to be extremely flux-limited. This situation is further exacerbated because, unlike X-rays and charged particles, neutrons cannot be easily focused. The combination of weak interaction and focusing difficulties has driven the quest for higher-flux neutron sources. Existing spallation sources have produced beams with higher brightness than reactor-based sources, and unlike reactors, they have the potential to achieve even higher levels of brightness by employing even higher power proton accelerators. Lastly, pulsed sources can be characterized by their pulse repetition frequency (generally in the range of 10 to 100 Hertz). Research capacity can be characterized by the number of beamlines a facility has and the capability of their associated instrumentation, how many weeks per year it typically operates, and its operational reliability.

1.2 CURRENT AND FUTURE NEUTRON SOURCES

A worldwide scientific community, on the order of 6,000 scientists, presently uses approximately 20 major neutron sources worldwide, most of these being nuclear reactors and the remainder being spallation sources (see Table 1.2-1). Among the seven U.S. sources are five reactors: the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory (BNL), the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL), the Neutron Beam Split-Core Reactor at the National Institute of Standards and Technology (NIST), the Missouri University Research Reactor, and a smaller reactor at MIT. The other two are pulsed spallation sources: the Intense Pulsed Neutron Source (IPNS) at ANL and the Los Alamos Neutron Science Center (LANSCE) at Los Alamos National Laboratory (LANL). All of these facilities except the smaller reactors at MIT, NIST, and the Missouri University Research Reactor are supported by DOE, and all are currently in operation except HFBR. The HFBR has been shut down since 1997 to resolve issues related to a tritium leak into the groundwater from its spent fuel storage pool. A decision expected in June of 1999 on the future of HFBR will be made by DOE after completing an Environmental Impact Statement, which is now being prepared.

Table 1.2-1. Present and future neutron sources worldwide.

Facility	Location	Type	Age (years)	Status
HIFAR	Australia	Reactor	40	Operating
HIFAR II	Australia	Reactor	NA	Planned replacement for existing HIFAR in 2005
Austron	Australia	Spallation	NA	Planned
Riso	Denmark	Reactor	39	Operating
IRF	Canada	Reactor	NA	Planned
ILL[a]	France	Reactor	27	Operating; further instrument upgrades planned
Orphee	France	Reactor	18	Operating; further instrument upgrades planned
KFA	Germany	Reactor	36	Operating
KFA Replacement	Germany	Reactor	NA	Planned replacement for existing KFA reactor
Berlin	Germany	Reactor	7	Operating
FRM II	Germany	Reactor	NA	Under construction; operation planned for 2001
KENS	Japan	Spallation	18	Operating
JRR[b]-3	Japan	Reactor	8	Operating
JHF[c]	Japan	Spallation	NA	Project start and funding approved
NSRP	Japan	Spallation	NA	Planned
Petten	Netherlands	Reactor	37	Operating
IBR-2	Russia	Reactor	14	Operating; upgrades planned
PIK	Russia	Reactor	NA	Planned
IN-06	Russia	Spallation	NA	Planned
Studsvik	Sweden	Reactor	38	Operating
SINQ	Switzerland	Spallation	2	Operating (continuous; not pulsed)
ISIS	United Kingdom	Spallation	23	Operating; power upgrade planned (ISIS II)
ESS[d]	Europe	Spallation	NA	Planned to be world's best spallation source (5 MW); R&D underway; site TBD
HFBR	USA (BNL)	Reactor	33	Shut down; decision to restart or remain shut down pending completion of an EIS
HFIR	USA (ORNL)	Reactor	32	Operating; cold source and instrument upgrades in progress; new guide hall proposed
IPNS	USA (ANL)	Spallation	17	Operating
LANSCE	USA (LANL)	Spallation	13	Operating; power upgrade in progress
NBSR[e]	USA (NIST)	Reactor	29	Operating; upgraded (cold neutron research facility)
MURR[f]	USA (U of MO)	Reactor	33	Operating
MIT	USA (MIT)	Reactor	40	Operating
SNS	USA (the Proposed Action)	Spallation	NA	Project authorized by Congress in FY 1999; initiating preliminary design

[a] Institut Laue-Langevin
[b] Japanese Research Reactor
[c] Japanese Hadron Facility
[d] European Spallation Source
[e] Neutron Beam Split-Core Reactor
[f] Missouri University Research Reactor
NA – Not applicable
Sources: DOE 1993a: 37–38; OECD 1998

PRACTICAL BENEFITS OF NEUTRON SCATTERING SCIENCE

Over the past 40 years, neutrons have become an increasingly essential tool in broad areas of the physical, chemical, and biological sciences, as well as in nuclear medicine and materials technology. In the latter area alone, neutron probes have made invaluable contributions to the understanding and development of many classes of new materials ranging from high temperature superconductors to polymers (plastics) — materials with enormous industrial applications and future potential.

Some specifics:

- In materials science, neutron scattering research can be used to study diffusion, crystal structures, impurity concentrations, and residual stresses in forgings, castings, and welds. Residual stress studies have been used to predict failure modes in critical structural components (e.g., aircraft engines) and to help design ways to avoid these failures.

- In condensed matter physics, neutron scattering has vastly improved our understanding of the static and dynamic aspects of glasses, liquids, amorphous solids, and phase behavior. This, in turn, has enabled the optimized design of a variety of useful materials: metallic glasses with unique mechanical and magnetic properties that make them the preferred choice for many industrial uses; amorphous semiconductors that have wide use in the electronics industry and solar energy conversion; molten salts that have important applications in electrochemical processes that are as wide ranging as plating of steel and waste treatment; integrated optical systems including lasers and fiber optic transmission channels; and thin films for use in various magnetic data storage systems.

- Neutron scattering, particularly with cold neutrons, is becoming increasingly important to the investigation of molecular structures in biological materials. This has opened new opportunities to obtain information crucial to understanding biological functions and processes. Neutrons are already being used to study the role of water and hydrogen bonds in enzyme reactivity and protein chemistry and to make major contributions to the design of new drugs to treat a wide range of medical conditions.

- Neutron research on polymers and other complex fluids has led to improved pressure-sensitive adhesives, better oil additives, light-weight durable plastics, and improved detergent and emulsification products. Measurement of real-time changes in scattering profiles caused by changes in an externally applied field (e.g., pressure, shear stress, temperature) is valuable to chemical manufacturers, who are interested in improving the design, control, and reliability of industrial manufacturing processes like extrusion, molding, and cold drawing.

- Neutron research on magnetism has led to the development of higher strength magnets for more efficient electric generators and motors and better magnetic materials for magnetic recording tapes, high density computer hard drives, and other information storage devices.

Although not obvious to most people, the benefits of applying scientific knowledge gained from neutron scattering research are all around us in the form of products that have markedly improved our standard of living. Thus, neutron science lies at the foundation of the ability of American industry to develop, produce, and market new or improved products vital to the future growth of our nation’s economy.

In Europe, the leading neutron scattering research facilities are the Institut Laue-Langevin reactor in Grenoble, France; the ISIS short-pulsed spallation source at the Rutherford Appleton Laboratory in England; and the SINQ steady-state spallation source in Switzerland. Smaller reactors are also in operation in Australia, Canada, Denmark, France, Germany, the Netherlands, Russia, and Sweden. With its guide halls, Institut Laue-Langevin accommodates more instruments than the two largest U.S. reactor sources (HFIR and HFBR) combined. The ISIS and SINQ spallation sources are far more powerful than the best U.S. spallation source (LANSCE), although work is now underway to upgrade LANSCE to the same power level as ISIS. Germany is constructing a new reactor neutron source, FRM II, with world-class cold source capabilities roughly equal to those of the Institut Laue-Langevin. It is scheduled to be completed and to enter operation within the next few years. Lastly, a joint European effort is in the early stages of design for a next-generation spallation source, the European Spallation Source.

The Japanese have a sizable neutron scattering program that is supported by a research reactor (JRR-3) and a relatively modest spallation source (KENS). The JRR-3 research center, commissioned approximately 6 years ago, represents a substantial investment (~$300 million in 1992 dollars), far more than all U.S. investments in neutron sources over the past decade. As will be described later, the Japanese government has also embarked on an ambitious plan to build two large spallation sources in the coming decade.

A study published by the European Science Foundation (European Science Foundation 1996) provided a forward look at the likely increase in worldwide demand for neutron scattering experimentation. It demonstrated that research using neutrons can be expected to grow in both traditional fields such as solid-state physics, materials science, and physical chemistry, and new and rapidly developing areas for neutron research such as biotechnology, drug design, engineering, and earth sciences. This will involve an increase in the complexity and sophistication of the scientific work rather than a mere growth in the number of experiments. In addition, the study confirmed that non-neutron tools for matter investigation (e.g., X-rays, electron beams) cannot be adequate substitutes for neutron beams.

Thus, the availability of neutron sources in the face of increasing demand is a global concern. In recognition of this, a Neutron Sources Working Group was established in January 1996 under the auspices of the Organization for Economic Cooperation and Development (OECD). This OECD Working Group, comprising government officials and scientists from 25 countries including the United States, is investigating the refurbishment and upgrading of existing facilities, as well as the prospects for international collaboration on developing new instrumentation and new neutron sources. The group has concluded that by the year 2020, there could be a "neutron gap" caused by more than two-thirds of the world's neutron sources reaching the end of their useful operating lives. It therefore recommended that new, advanced neutron sources be built in each of the three major user regions (Japan, Europe, and the United States). This is consistent with plans for next generation spallation sources that are already being planned for construction. Specifically, a consortium of European countries is designing a 5-MW short-pulsed spallation source, the previously mentioned European

Spallation Source; Austria has designed a 100-kW short-pulsed spallation source, the Austron; and Japan has formally announced a plan to build a 600-kW short-pulsed spallation source, the Japanese Hadron Facility, that will be progressively upgraded to 1.2 MW and is part of the high-energy physics Japanese Hadron Project. Japan is also planning another 1-MW spallation source that will be upgraded to 5 MW for nuclear technology development and neutron scattering. The construction of the proposed SNS in the United States would then complete the worldwide set of new neutron sources recommended by the OECD Working Group.

When compared with the global "neutron gap," the shortfall in our nation's neutron science capability is even more acute; this shortfall has been developing over the past two decades as a result of insufficient funding to invest in building new sources and upgrading existing facilities. It is clear from Table 1.2-1 and the preceding discussion that among the world's major neutron sources, those in the United States are older and becoming less capable than their foreign counterparts. Although there are modest efforts to upgrade and extend the useful life of these facilities (already underway at LANSCE and HFIR), a new neutron source has not been built in the United States in well over 10 years.

1.3 PROPOSED ACTION AND ALTERNATIVES ANALYZED

This section introduces DOE's proposed action and provides background information about the proposed neutron source. This section also introduces the alternatives analyzed in the FEIS. Chapter 3 of this document provides a detailed description of the proposed action and alternatives.

1.3.1 THE PROPOSED ACTION

The proposed action is to construct and operate a state-of-the-art short-pulsed spallation neutron source comprising an ion source, a linear accelerator (linac), a proton accumulator ring, and an experiment building containing a liquid mercury target and a suite of neutron scattering instrumentation. The proposed SNS facility would be designed to operate at a proton beam power of 1 MW and to be upgradable in the future (see Figure 1.3-1). The scope of these upgrades over the operating life of the facility is envisioned to encompass, in chronological stages:

1. Adding a second experiment building, including a second mercury target with its own suite of instrumentation (space for this is included in the facility footprint analyzed in this FEIS).

2. Increasing the proton beam power to 2 MW by doubling the ion source output.

3. Increasing the proton beam power to 4 MW by adding a second ion source, modifying the linac, and adding a second proton storage ring (again, space for the upgrades is included in the facility footprint analyzed in this FEIS).

The implementation of these upgrades would depend largely on availability of future funding. DOE would perform further National Environmental Policy Act (NEPA) review if and when the decision to upgrade the facility is

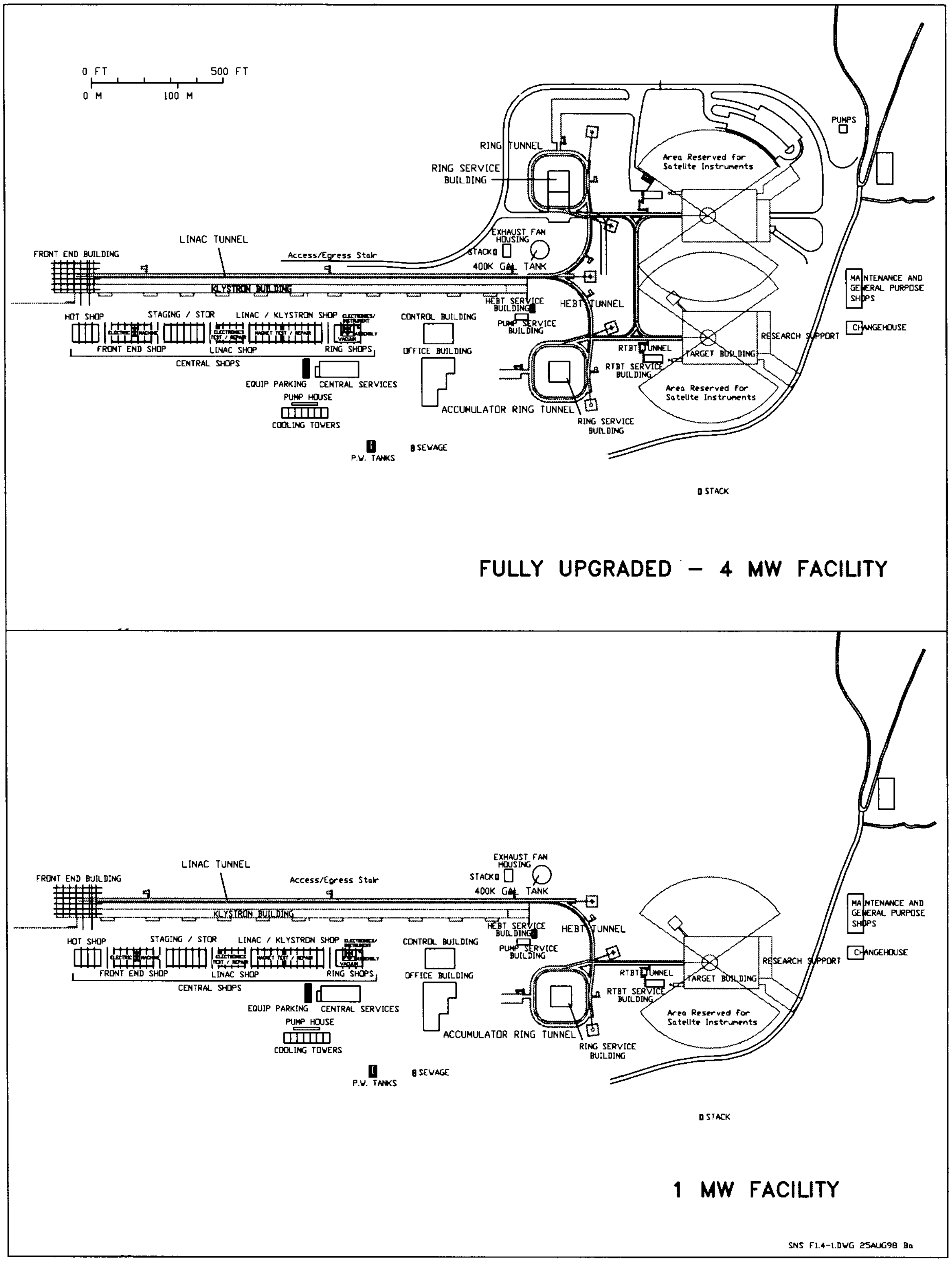


Figure 1.3-1. Site plan for SNS.

made. For the sake of completeness, however, this FEIS analyzes the impacts of the SNS facility as it would originally be built as well as those corresponding to its fully upgraded configuration.

The proposed SNS would be designed to operate for 40 years beginning in the year 2006, but the fate of the facility beyond this projected life span has not been determined. Advances in technology over the next 46 years may allow the life of the facility to be extended beyond 40 years, provided there is a continued need for the facility. However, in all probability, it would eventually be decommissioned.

The proposed action does not include decommissioning of the SNS. DOE would prepare a decommissioning plan for the proposed SNS at the selected site after release of the Record of Decision (ROD) and before the start of construction. This plan would include estimates of the amount of scrap and wastes that would be generated during decommissioning of the facility. In the *Spallation Neutron Source Project Execution Plan* (DOE 1997d), the estimated cost of decommissioning the facility is $150 million (year 2006 dollars). DOE is committed to preparing the appropriate NEPA documentation prior to decommissioning the facility.

1.3.2 BASIS OF PROPOSED ACTION

DOE has been charged with the responsibility for planning, constructing, and operating the major scientific user facilities to provide special research capabilities (*Energy Policy Act of 1992*; Public Law 102-486, Section 2203). This is in recognition of the fact that these kinds of facilities tend to be large-scale, physically complex, and hence very expensive (hundreds of millions or even billions of dollars)—well beyond the means of most private and industrial organizations to build and operate. High performance neutron sources, based on reactors or accelerators, naturally belong in this category.

The use of these DOE facilities is open to all researchers (federal, industrial, and academic), usually at no charge as long as the scientific information derived from their experiments is kept in the public domain for the benefit of the entire scientific community.

The scientific justification and need for additional and more capable neutron sources in the United States has been established by numerous studies dating back to the 1970s. Two National Research Council studies (*Neutron Research on Condensed Matter* 1977 and *Current Status of Neutron Scattering Research and Facilities in the U.S.* 1984) urged DOE to build new neutron sources in order to keep up with research demand and to sustain U.S. scientific leadership in this field. The earlier study led to the construction of IPNS and LANSCE in the early 1980s. In 1984, the broad-based study *Major Facilities for Materials Research and Related Disciplines* recommended construction of four major new materials research facilities including an advanced, high-flux, steady-state neutron source, and a high-intensity pulsed neutron source. As a result, in 1987 DOE tasked ORNL with developing a design for a high-flux, steady-state source based on a nuclear reactor, a project that later became known as the Advanced Neutron Source (ANS). Action on the recommendation for a high intensity pulsed neutron source was to be deferred, due to funding constraints, until after the ANS was completed.

By 1992, a conceptual design for the ANS had been completed, and at the same time, a special panel under the DOE’s Basic Energy Sciences Advisory Committee (BESAC) was asked to assess the importance of neutron science for the nation’s science, technology, health, and economy, and to make recommendations for both short-term and long-term strategies for neutron sources. The panel was chaired by Professor Walter Kohn (University of California, Santa Barbara, winner of the 1998 Nobel Prize in Chemistry) and included both specialists and generalists from government laboratories (7 panelists), private industry (4 panelists), and universities (3 panelists). Their report, *Neutrons for America’s Future* (DOE 1993) (1) reaffirmed the need for constructing ANS as the top priority, (2) recommended that DOE immediately initiate the design of a complementary, 1-MW pulsed spallation source, and (3) urged that existing neutron sources be upgraded. In their judgment, “failure to move ahead quickly with the construction of the ANS and development of a complementary 1-MW pulsed spallation source would have serious, long-lasting consequences for the nation’s competitiveness in cutting-edge science, technology, industry, and medicine. The construction of these facilities represents a cost-effective and productive investment in the nation’s future.”

Although the President’s budget requests to Congress for fiscal years 1994 and 1995 included funding to start the ANS construction project, no funds were ever appropriated for construction, and DOE elected to cancel the project in 1996. Concern over the high cost of the project (approximately $3 billion) was the primary factor in the decision. In lieu of ANS, the administration advised that a next-generation pulsed spallation source be pursued (since this was assumed to be much less expensive and was also consistent with the Kohn Panel’s second recommendation) and that upgrades to existing DOE neutron sources be considered.

In response to this guidance, a collaboration of DOE laboratories was organized to develop a conceptual design for a new state-of-the-art spallation neutron source. Given ORNL’s long history in neutron scattering research (which dates back to Shull’s pioneering work on the ORNL Graphite Reactor in the 1940s), their extensive materials research and testing program, and the project management infrastructure remaining from ANS, ORNL assumed the lead role. Together with four other national laboratories [ANL, BNL, LANL, and Lawrence Berkeley National Laboratory (LBNL)] the design work was carried out with each laboratory having lead responsibility for a major technical system in which they have prominent expertise:

- ANL–Instrumentation
- BNL–Proton storage ring and high energy beam transport
- LANL–Linac
- LBNL–Ion source and low energy beam transport
- ORNL–Target, moderators, and conventional construction

This collaborative design approach was chosen because it:

- Assembled the best available expertise to complete a conceptual design in the shortest time with limited funds,
- Accessed the best and most current technologies,
- Incorporated insights from existing feasibility studies done by U.S. and foreign laboratories, and
- Conserved DOE resources by using a “system-of-laboratories.”

The collaboration's design work was guided by BESAC, which formed a panel under Dr. Thomas Russell (IBM Research Division) in late 1995 to evaluate technical aspects and basic design requirements. The panel's report (BESAC 1996) made several recommendations that were accepted by DOE and that served to establish the fundamental characteristics for the conceptual design of the SNS:

- Short-pulsed operation in the 1-MW power range (1 microsecond proton pulses).
- Design that preserves long-pulsed operation as an option.
- Upgradable to a significantly higher power at some point after commissioning.
- Horizontal proton beam injection into the target.
- One target and the capability to produce neutron pulses at frequencies in the range of 30 to 60 Hz, with the potential for installing additional targets and instrumentation in the future.
- Carefully selected initial set of instruments to maximize early scientific impact.
- Set of moderators to provide neutrons with appropriate characteristics to meet user needs.
- Highly predictable and reliable operation for at least 240 days/year.
- Use of low-risk technology initially, with parallel research and development on certain critical systems to advance the state-of-the-art while reducing risks to acceptable levels.

By mid-1997, the five-laboratory collaboration had produced a conceptual design for the SNS (ORNL 1997a, see Figure 1.3-1) that was favorably reviewed by a committee of outside experts (DOE/ER-0705 1997). This site-independent conceptual design is the basis for the proposed action.

1.3.3 ALTERNATIVES ANALYZED

The two primary alternatives analyzed in this FEIS are (1) the alternative to proceed with building an accelerator-based neutron source and (2) the No-Action Alternative.

Under the to-build alternative, the FEIS analyzes the environmental impacts associated with constructing and operating the neutron facility. Four individual siting alternatives are analyzed in the FEIS. The effects from the No-Action Alternative serve as a basis for comparison of the effects from the other alternatives. In addition, alternatives considered, but eliminated from consideration, are presented for completeness. Other conceivable technical design options for a spallation source have been evaluated; these technology alternatives and the elimination process are discussed at length in Chapter 3.

1.3.4 SITING ALTERNATIVES CONSIDERED IN THIS FEIS

DOE used a systematic process to select suitable alternative sites for the proposed action (refer to Appendix B). The site-selection process began by identifying four major site exclusion criteria. When these criteria were defined, the process continued in two major phases. Phase 1 focused on using the exclusion criteria to identify the reasonable siting locations for the proposed SNS on a national level. Phase 2 focused on identifying a specific alternative site for the proposed SNS at each of these locations.

Specific SNS project requirements were used to develop the site exclusion criteria. These criteria were as follows:

- A site with a minimum area of 110 acres (45 ha) and a rectilinear shape to accommodate the length of the proposed linear accelerator and possible future expansion of the facility.
- A one-mile (1.6 km) buffer zone around the proposed SNS site to restrict uncontrolled public access and to insulate the public from the consequences of a postulated accident at the facility.
- Proximity and availability of an adequate electric power source. The regional power grid must be able to supply 40 MW of power during periods of operation. The site must be within one quarter to one mile (0.4 to 1.6 km) of existing transmission lines to minimize collateral construction impacts and costs.
- Presence of existing neutron science programs and infrastructure to provide a pool of neutron science expertise and experience to meet mission goals. The site must have major facilities and programs utilizing neutron scattering techniques.

As a result of this process, DOE identified four reasonable alternative locations for the proposed SNS. These facility locations were ORNL, LANL, ANL, and BNL.

In Phase 2 of the site-selection process, each of the four national laboratories conducted its own systematic site-selection process to identify specific locations for the proposed SNS. These processes focused primarily on laboratory lands, and they involved the identification and evaluation of alternative sites at each laboratory. Site-selection criteria included project requirements and environmental protection considerations. These criteria were applied to the alternative locations to identify one specific location for the proposed SNS at each national laboratory.

This FEIS assesses the environmental impacts associated with the four siting alternatives that would result from the construction and operation of the proposed SNS.

ORNL Alternative (Preferred Alternative): To construct and operate the proposed SNS at ORNL in Oak Ridge, Tennessee.

LANL Alternative: To construct and operate the proposed SNS at the LANL in Los Alamos, New Mexico.

ANL Alternative: To construct and operate the proposed SNS at the ANL in Argonne, Illinois.

BNL Alternative: To construct and operate the proposed SNS at the Brookhaven National Laboratory in Upton, New York.

1.4 ENVIRONMENTAL ANALYSIS PROCESS

This FEIS is being prepared pursuant to NEPA (42 USC 4321 et seq.), the President's Council on Environmental Quality (CEQ) NEPA regulations in 40 CFR 1500-1508, and DOE NEPA regulations in 10 CFR 1021.

This FEIS analyzes the potential environmental impacts of two primary alternatives: the proposed action (to construct and operate an accelerator-based neutron source) and the No-Action Alternative. This proposed facility would meet many of the nation's neutron science needs well into the next century. An artist's conception of the completed neutron facility is shown in Figure 1.4-1.

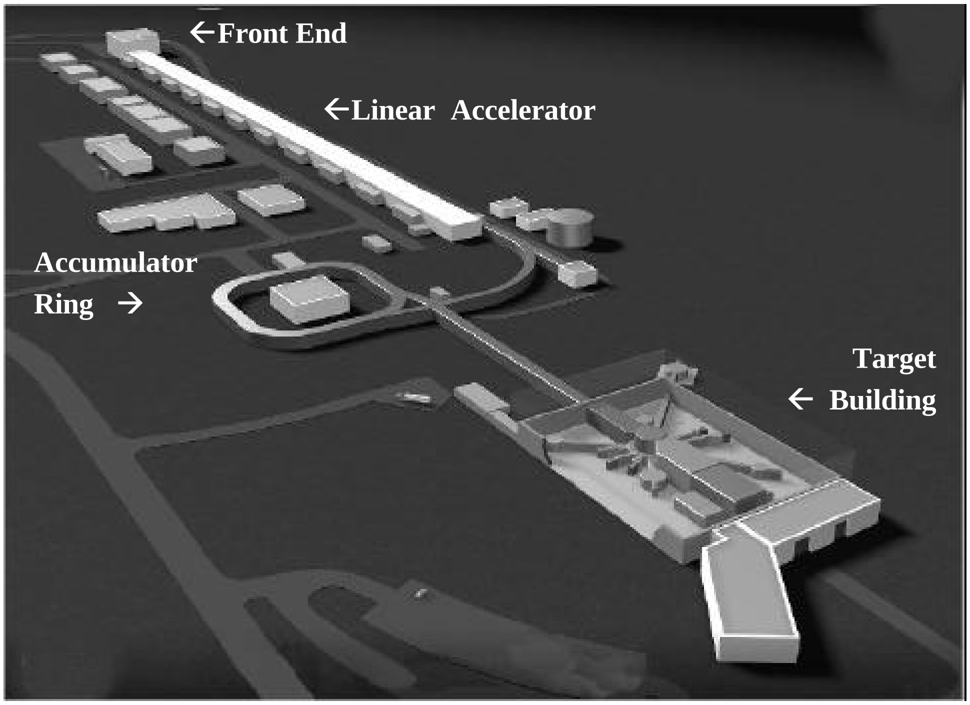


Figure 1.4-1. Artist's conceptual drawing.

1.4.1 THE SCOPING PROCESS AND MAJOR ISSUES IDENTIFIED FOR ANALYSIS

The preliminary scope of this FEIS was defined through examination of the NEPA and safety assessment documents for other DOE accelerator facilities. This review indicated that appropriate topics to address in the Environmental Impact Statement (EIS) analysis would include land use, facility waste streams, and accident scenarios that might impact human health or the environment (ORNL 1997b: 9-1 to 9-2). Other issues of public concern, including socioeconomics and waste management issues, were documented through the public scoping process for each of the four alternative sites.

DOE published the Notice of Intent to prepare this EIS in the *Federal Register* (62 FR 40062) on July 25, 1997. The public comment period was from July 25 to September 12, 1997. During this period, public meetings were held in Oak Ridge, Tennessee; Argonne, Illinois; Los Alamos, New Mexico; and Upton, New York. A total of 61 individuals representing 15 citizen groups, 14 government organizations, one Native American pueblo, one educational institution, and four elected officials representing themselves and their constituents submitted comments during the public scoping period. Comments received included 152 oral and written comments and 21 endorsements and resolutions. These comments were analyzed and classified according to 21 subject categories.

The subject categories that contained the most substantive comments were socioeconomics, siting alternatives, waste management, and project justification. Nineteen socioeconomics comments were received. The majority of these comments requested analyses of the beneficial effects the proposed action would have in terms

About NEPA

NEPA was enacted to ensure that federal decision-makers consider the effects of proposed actions on the human environment and to open their decision-making process for public scrutiny. NEPA also created the President's Council on Environmental Quality (CEQ) to establish a NEPA review process. DOE's NEPA regulations (10 CFR 1021) augment the CEQ regulations (40 CFR 1500).

An EIS documents a federal agency's analysis of the environmental consequences that might be caused by major federal actions, defined as those proposed actions that might result in a significant impact to the environment. An EIS:

- Explains the purpose and need for the agency to take action.
- Describes the proposed action and the reasonable alternative courses of action that the agency could take to meet the need.
- Describes what would happen if the proposed action were not implemented—the "No-Action" (or Status Quo) Alternative.
- Describes what aspects of the human environment would be affected if the proposed action or any alternative were done.
- Analyzes the changes, or impacts, to the environment that would be expected to take place if the proposed action or an alternative were implemented, compared to the expected condition of the environment if no action were taken.

The DOE EIS process follows these steps:

- Notice of Intent, published in the *Federal Register*, identifies potential EIS issues and alternatives and asks for public comment on the scope of the analysis.
- Public scoping period with at least one public meeting, during which public comments on the scope of the document are collected and considered.
- Draft EIS, issued for public review and comment, with at least one public hearing.
- Final EIS, which incorporates the results of the public comment period on the draft EIS.
- Record of Decision that states:
  - The decision.
  - The alternatives that were considered in the EIS and the environmentally preferable alternative.
  - All decision factors, such as cost and technical considerations, that were considered by the agency along with environmental consequences.
  - Mitigation measures designed to reduce adverse environmental impacts.
  - Mitigation Action Plan, as appropriate, which explains how the mitigation measures will be implemented and monitored.

of new jobs, personal income, tax revenues, spin-off businesses, need for support from the host state, and other economic factors. Nineteen comments were received on siting alternatives for the proposed action. Most of these comments were in support of or against siting the proposed action at one of the alternative national laboratories, and one recommended consideration of the Hanford site. Others requested more detailed analyses of the criteria used to select alternative sites for the proposed action and analyses of the potential effects that would result from implementing the proposed action on these sites. Fifteen comments on waste management were received. These comments were concerned with waste generation, particularly radioactive waste and hazardous metals, and the proper management of these wastes in compliance with federal and state regulatory requirements. Project justification received 13 comments, most of which were supportive of the proposed action with several opposed to the project. One comment suggested pursuing a cooperative agreement with European countries to use their existing neutron sources.

All of the scoping comments received were summarized in a document entitled *Results of Public Scoping for the Spallation Neutron Source/Environmental Impact Statement* (DOE-ORO 1997). This document and other documents pertinent to the overall environmental analysis are available to the public in the following reading rooms:

1. U.S. Department of Energy
   Freedom of Information Public
   Reading Room
   Forrestal Building, Room 1E-190
   1000 Independence Avenue, S.W.
   Washington, D.C. 20585
   Telephone: (202) 586-3142

2. U.S. Department of Energy Reading Room
   Oak Ridge Operations Office
   230 Warehouse Road
   Building 1916T2
   Suite 300
   Oak Ridge, Tennessee 37831
   Telephone: (423) 241-4780

3. Los Alamos National Laboratory
   Public Outreach and Reading Room
   MS-A117
   Los Alamos, New Mexico 87545
   Telephone: (505) 665-2127

4. Argonne National Laboratory
   c/o Documents Department
   University Library, Third Floor Center
   University of Illinois at Chicago
   801 South Morgan Street
   Chicago, Illinois 60607
   Telephone: (312) 996-2738

5. BNL Research Library
   Bldg. 477A Brookhaven Avenue
   Upton, New York 11973
   Telephone: (516) 344-3483

6. Longwood Public Library
   800 Middle Country Road
   Middle Island, New York 11953
   Telephone: (516) 924-6400

7. Mastics-Moriches-Shirley Community
   Library
   301 William Floyd Parkway
   Shirley, New York 11967
   Telephone: (516) 399-1511

1.4.2 PREPARATION AND PUBLIC REVIEW OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

DOE considered all of the public scoping comments during preparation of DEIS for the SNS. The DEIS was completed, published, and made available for public review in December 1998. The Notice of Availability (NOA) to the public was published in the *Federal Register* on December 24, 1998.

The DEIS was distributed to U.S. congressional members and committees; the states of Illinois, New Mexico, New York, and Tennessee; the tribal governments of Cochiti, Jemez, Santa Clara, and San Ildefonso Pueblos; the county governments of Anderson/Roane County (Tennessee), DuPage County (Illinois), Los Alamos/Santa Fe County (New Mexico), and Suffolk County (New York); and the general public for review and comment. DOE invited comments to correct factual errors or to provide insights on matters related to the environmental analysis. In addition to its invitation for written comments, DOE held public hearings to solicit both oral and written comments on the DEIS. To accommodate as many commenters as possible, comments were accepted after closure of the formal review and comment period. DOE considered all late comments.

DOE received 206 public review comments on the DEIS. These comments and the complete responses to them have been included in Appendix A of this FEIS. All comments and responses are also available for public review in the DOE reading rooms.

1.4.3 PRINCIPAL ISSUES OF PUBLIC CONCERN

The texts of the comments on the DEIS were collectively analyzed to identify principal issues of concern to the public. As a result of this analysis, the following four issues were identified:

- **Radioactive Contamination of Groundwater**. Operation of the proposed SNS has the potential for neutron activation of soils in the shielding berm surrounding the linear accelerator and accumulator rings. This would result in the contamination of berm soils by radionuclides. A principal issue of concern to stakeholders is the potential for water infiltrating the berm soils to transport radionuclide contamination to saturated groundwater zones, especially those that are sources of potable water.

- **Selection of the Proposed SNS Site on the Oak Ridge Reservation (ORR)**. The DOE-Oak Ridge Operations Office (ORO) has actively sought public input on the future use of ORR land. An Oak Ridge citizens advisory organization, the End Use Working Group, has recommended a set of final land use guidelines to DOE-ORO. One of these guidelines recommends the siting of additional DOE facilities on brownfield sites instead of greenfield sites. Brownfield sites are previously contaminated and/or developed areas, whereas greenfield sites are natural, undeveloped areas. The proposed SNS site at ORNL is a 110-acre (45-ha) tract of undeveloped forest land near the top of Chestnut Ridge. Selection of this greenfield site instead of a brownfield site for the proposed SNS is an issue of concern among stakeholders in the Oak Ridge area.

- **Effects of the Proposed Action on Research Projects in the Walker Branch Watershed on the ORR**. The Walker Branch Watershed is an important research area located approximately 0.75 mi (1.2 km) east of the proposed SNS site at ORNL. It is one of the few sites in the world characterized by long-term, intensive environmental studies. Environmental monitoring and ecological research projects in the area are being conducted by the National Oceanic and Atmospheric Administration/Atmospheric Turbulence and Diffusion Division (NOAA/ATDD) and the ORNL Environmental Sciences Division

(ESD). The proposed SNS site is located within a buffer zone designed to protect research in the watershed. During construction and operation of the proposed SNS, CO_2 emissions from vehicles and small sources may adversely affect this research. During SNS operations, CO_2 emissions from natural gas boilers would affect such research. Operational emissions of water vapor from the SNS cooling towers may also affect this research. The principal effects would be loss of data quality and comparability over time. These potential effects on research in the Walker Branch Watershed are a principal issue of concern to stakeholders in the Oak Ridge area.

- **Mitigation Action Plan.** Several commenters expressed concern about mitigation measures to minimize potential impacts of the SNS on research activities in the Walker Branch Watershed on the Oak Ridge Reservation. One commenter suggested specific mitigation measures.

The formal DOE responses to these issues are presented in Chapter 2 of Appendix A in this FEIS. The analysis of potential environmental consequences resulting from the proposed action considers the groundwater contamination and Walker Branch Watershed issues in Chapter 5. The analytical findings pertinent to these issues are also briefly summarized under the Impacts on Water Resources and Impacts on Land Use headings in the tabular summary of environmental impacts at the end of Chapter 3. The complete report on selection of the proposed SNS site on the ORR is in Appendix B of this FEIS.

1.4.4 FEIS

After considering the 206 comments on the DEIS and the principal issues of public concern reflected by them, DOE revised the DEIS, as appropriate, and published this FEIS. This FEIS is being distributed to tribal, state, and local governments; other federal agencies; all parties who commented on the DEIS; and any interested parties.

Preparation of this FEIS allowed a full dialogue between DOE and all interested parties regarding the potential environmental consequences of the proposed action and alternatives. Potential interested parties or stakeholders may include the general public; state, county, municipal, and tribal governments; and other federal agencies. The FEIS provides the environmental input for decision-making and also the basis for appropriate mitigation measures, if needed, for the course of action selected.

1.4.4.1 DEIS Revisions Reflected in the FEIS

DOE prepared formal written responses to all 206 of the public review comments on the DEIS (refer to Appendix A). In addition, DOE responded to many of these comments by revising the text of the DEIS to produce this FEIS. Many of these revisions involved minor corrections of information or data and the clarification of statements in the text.

Several major revisions involved the addition of new information, data, and analyses to the text. Such revisions were prompted by public review comments on the DEIS, agency compliance with applicable environmental protection requirements, and decisions to improve the quality of the document for the FEIS. The following major revisions are reflected in the text of this FEIS:

- Inclusion of a Floodplain/Wetlands Assessment to evaluate the potential effects of the proposed action on wetlands in the vicinity of the proposed SNS site at ORNL and floodplains/wetlands on the proposed SNS site at ANL. This document was prepared in accordance with the DOE regulations in 10 CFR 1022.12 to comply with the federal floodplain and wetlands protection requirements in Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*, both dated May 24, 1977. The results of this assessment were used to extensively revise sections of the DEIS that address floodplains, wetlands, and the potential effects of the proposed action and alternatives on them. The Floodplain/ Wetlands Assessment is in Appendix H of this FEIS.

- A reanalysis of the potential effects of the proposed action on visual resources at ANL. This analysis indicated that the potential effects would be minimal because existing views from points near the ANL fence in the Waterfall Glen Nature Preserve and on ANL land already contain buildings and other features indicative of development.

- If the ROD selects implementation of the proposed action, DOE will prepare a Mitigation Action Plan (MAP) to address the mitigation of environmental effects from the proposed action. This plan will be specific to the effects of the proposed action on the environment in the vicinity of the siting alternative selected in the ROD. The MAP will identify, evaluate, and commit DOE to the implementation of appropriate measures to mitigate these effects.

1.4.4.2 Issues to Be Resolved

The identification and implementation of appropriate mitigation measures for the effects of the proposed action on the environment are dependent upon selection of the proposed action and a siting alternative for the proposed SNS. The DOE decision on whether or not to construct and operate the proposed SNS and selection of a siting alternative for this proposed action will be resolved and documented in the ROD. DOE will issue the ROD at least 30 days following the Environmental Protection Agency's Notice of Availability of this FEIS. The identification, evaluation, and commitment to mitigation measures will be resolved after publication of the ROD and prior to construction on the proposed SNS. As described in Section 1.4.4.3, this process for selecting appropriate mitigation measures will be documented in a MAP.

1.4.4.3 Record of Decision and Mitigation Action Plan

At least 30 days following the issuance of the U.S. Environmental Protection Agency's Notice of Availability of the FEIS, DOE will issue a ROD that will explain all factors, including environmental impacts, that DOE considered in reaching its decision on selecting the alternative to be implemented. The ROD will specify the selected alternative after due consideration of environmental consequences. DOE anticipates that, in addition to environmental impacts, the ROD will be based on cost and infrastructure considerations. Any mitigation measures, monitoring, or other conditions adopted as a part of DOE's decision will be summarized in the ROD, as applicable, and included in a MAP.

DOE will prepare a MAP to explain how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures over time to ensure their effectiveness. DOE would not prepare a MAP if the No-Action alternative is selected in the ROD. The ROD and MAP will be placed in the public reading rooms and will be available to interested parties upon request.

1.5 ORGANIZATION OF THE FEIS

This FEIS is organized into two volumes. Volume I contains the Summary and Chapters 1 through 6, which are further outlined below. Volume II contains the appendices that are referenced throughout Volume I.

Chapter 1 – Introduction. Background information on the state of neutron science in the United States and its relationship to a next-generation neutron source are discussed. The internal organization of the FEIS is presented in this chapter, and the environmental analysis process under NEPA is covered.

Chapter 2 – Purpose and Need for DOE Action. This section includes the reasons DOE proposes to take action at this time.

Chapter 3 – Proposed Action and Alternatives. This chapter describes how DOE proposes to meet the specified needs and alternative ways the specified needs could be met. It includes a summary of expected environmental impacts if the preferred alternative or any of the other analyzed alternatives were to be implemented.

Chapter 4 – Affected Environment. The various aspects of the existing environment (natural, social, and manmade) that might be affected by the preferred alternative or any of the other alternatives are described.

Chapter 5 – Environmental Consequences. The changes or impacts that the alternatives would be expected to have on elements of the affected environment are analyzed. Impacts are compared to the environment that would be expected to exist if no action were taken (the No-Action Alternative).

Chapter 6 – Permits and Consultations. The CEQ NEPA regulations require preparation of an EIS in coordination with other applicable environmental requirements that may involve permits and consultations with federal, state, tribal, local, and other agencies. The additional requirements and consultations applicable to the alternatives are described in this chapter.

CHAPTER 2: PURPOSE AND NEED FOR DOE ACTION

The Department of Energy (DOE) is proposing to construct and operate a state-of-the-art neutron source to:

- Satisfy the future needs of U.S. researchers in neutron scattering science for a pulsed-neutron source with much higher intensity, more comprehensive instrumentation, better experimental flexibility, and greater potential for future upgrades than offered by existing U.S. facilities.
- Facilitate new scientific discoveries and develop cutting-edge technologies.
- Augment the capabilities of reactor-based neutron sources.

The United States needs a high-flux, short-pulsed neutron source to provide the scientific and industrial research communities with a much more intense source of pulsed neutrons for neutron scattering research than is currently available and to assure the availability of a state-of-the-art facility in the decades ahead. This next-generation neutron source would create new scientific and engineering opportunities as well as help replace the capacity that will be lost by the eventual shutdown of existing sources in the first half of the next century as they reach the end of their useful operating lives.

As explained in the preceding chapter, the neutron science community has long recognized the need for both high intensity pulsed (accelerator-based) and continuous (reactor-based) neutron sources. The two types of sources are complementary. For many scattering techniques, having neutrons available in a series of pulses is preferable to having them in a continuous beam. In addition, spallation sources can generally produce pulsed beams with a much higher peak intensity than those available from comparable sized reactor-based sources. This enables scientists to carry out a number of important flux-limited experiments. In recent years, steady improvements in accelerator technology have made it possible to design and construct sources that can produce even more intense neutron pulses. The proposed SNS, with a proton beam power of 1 MW, would initially produce pulses with a neutron intensity over five times higher than those obtainable from today’s best operational spallation source, ISIS in the United Kingdom.

A valuable feature of a pulsed spallation neutron source is the ability to tune the beam of neutrons for particular experiments (the time-of-flight technique). Each pulse of neutrons from the proposed SNS would contain neutrons with a range of energies. The energy level of the neutrons could be determined by noting the length of time it takes for the neutron to travel from the source to the detectors. The high-energy (faster) neutrons would reach the sample ahead of the medium-energy neutrons, and the lowest-energy (slower) neutrons would reach the sample last. Because the neutron energies would be spread out over time, the researcher could tune the neutron beam by selecting the energy level of interest by simply turning the detectors off and on at the appropriate time. Time-of-flight techniques enable the collection of many data points for each pulse of neutrons reaching the sample. Experience has shown that neutron pulses lasting approximately 1 μs (one millionth of a second), each with a pulse occurring from 10 to 60 times per second, are optimal (BESAC 1996).

2.1 NEUTRON RESEARCH AND SOURCES

There are approximately 20 major neutron sources worldwide that produce neutron beams for materials research (refer to Table 1.2-1). Although these facilities are primarily located at large government-owned science laboratories, small research teams based at universities, research institutes, and industrial laboratories typically carry out neutron scattering experiments at these centers. The majority of users require recurrent, short-term access to the facilities, often for no more than a few days at a time. The research carried out at these sources contributes to the scientific and technological infrastructure in their regions and also contributes toward their industrial competitiveness.

Based on the conclusions of the Organization for Economic Cooperation and Development (OECD) Neutron Science Working Group, which has studied this topic since 1996, there is a growing disparity between the worldwide need for neutron scattering research and the availability of facilities (reactor and spallation sources) to meet these needs. It was estimated that as the oldest sources continue to age, only about one-third of the present sources would remain available by 2010. The next-generation neutron sources are then needed not only to create new scientific and engineering opportunities, but also to replace out-dated capacity. In the United States, the shortfall in neutron scattering resources compared with growing research demand and the lag in experimental capabilities compared with newer and more extensively upgraded foreign facilities have been major concerns for over ten years. As stated most recently in the Kohn and Russell Panel Reports (BESAC 1993, 1996), the present U.S. sources are inadequate to meet the needs of the American scientific community, both in terms of flux and availability. The current generation of neutron sources in the United States has lower neutron beam intensities, lower operating powers, and less advanced measuring instruments, when compared to what is currently technologically feasible and desirable.

Given the long lead time from starting conceptual design to the commissioning of a new source (at least 10 years), decisions on new facilities are necessary in the next few years and certainly before 2005. Access to European and Japanese neutron sources by U.S. researchers and manufacturers is difficult, unreliable, and costly. The logistics of scheduling time and configuring instrumentation to conduct specialized experiments are prohibitive because of the commuting distance to these facilities. Because of its proprietary nature, much of the research desired by U.S. industry simply cannot be carried out at foreign facilities.

Scientific discoveries and the new technologies derived from neutron scattering research, as summarized in Chapter 1, have contributed significantly to the development of new products for sale in the international marketplace. Because of the longstanding relationship between basic science and the world of business, scientific and technological advances like these have become major drivers of national economic progress and competitiveness among the industrialized nations of the world. The same type of relationship has developed between basic science and national defense. Since the end of World War II, the United States has used scientific discoveries to develop and sustain military capabilities that surpass those of potential international adversaries. These important relationships will continue into the foreseeable future.

Without future investments in major new science facilities, such as the proposed SNS, the nation's economic strength and competitiveness in the world economy, its national defense posture, and the health of its people may be jeopardized as the newest and best related technological developments are made overseas. The construction of a next-generation spallation neutron source in the United States would go far in providing a competitive edge for the nation in the physical, chemical, materials, biological, and medical sciences.

2.2 RELATIONSHIP OF THE SNS PROJECT TO OTHER DOE PROJECTS

DOE proposes to build the SNS to satisfy the nation's need for a world-class pulsed neutron scattering research facility. The projects discussed below, while supporting U.S. neutron scattering science in general, are independent actions. These projects are not related to the proposed SNS, and any decisions involving these projects are independent of the determination of whether or not to build the proposed SNS. The projects are summarized in the following sections.

2.2.1 DESIGN AND CONSTRUCTION OF THE ADVANCED NEUTRON SOURCE

Work on an advanced steady-state neutron source was initiated by ORNL in 1987, and by 1992, a conceptual design was completed for a 330-MW reactor-based Advanced Neutron Source (ANS). Congress did not appropriate construction funding in FY 1994 or FY 1995 for ANS, and DOE chose to cancel the project shortly thereafter, principally due to concerns over the high cost of the facility (approximately $3 billion). This occurred after public scoping for an Environmental Impact Statement (EIS); however, the EIS was not completed (DOE 1993a; ORNL 1997a).

2.2.2 THE HIGH FLUX BEAM REACTOR TRANSITION PROJECT

Upgrade of the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory (BNL) was recommended by the 1996 BESAC report on neutron facility upgrades.

Shortly afterward (late 1996), HFBR was shut down for a normal refueling, but before the reactor's planned restart, its spent fuel storage pool was identified as the likely source of elevated tritium concentrations in the groundwater at BNL. The reactor has remained shut down in a defueled condition, and DOE has initiated a Tritium Remediation Project that will continue to prevent the tritium plume from spreading off-site.

DOE has published a Notice of Intent to prepare an EIS concerning the HFBR. The alternatives being considered in the HFBR EIS include the following:

- No Action Alternative (maintain present shutdown, defueled condition)
- Resume Operation Alternative
- Resume Operation and Enhance Facility Alternative
- Permanent Shutdown Alternative

2.2.3 UPGRADE THE HIGH FLUX ISOTOPE REACTOR

The 1996 BESAC recommended extensive upgrades to the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL). These upgrades include development of an internationally competitive cold neutron scattering facility; establishment of premier thermal neutron capabilities; and improvement of isotope production, materials irradiation facilities, and neutron activation analysis capabilities (DOE 1996b).

DOE determined that the HFIR upgrades are categorically excluded from environmental review under NEPA, and these upgrades are being implemented. These upgrades include modifications of test facilities to perform research, development, and experimental testing using the existing beam lines and added cold neutron source capabilities.

2.2.4 INSTITUTE FOR NEUTRON SCIENCE

ORNL and The University of Tennessee are collaborating on establishing the Joint Institute for Neutron Science (JINS). This proposed facility is being funded by the State of Tennessee and would provide overnight accommodations, as well as meeting rooms and lecture halls, for scientists visiting the neutron science facilities at ORNL. The JINS is not part of the proposed action in this FEIS; it will be built regardless of which alternative action is taken for the proposed SNS. This facility is currently being designed by the Division of Facilities Planning at the University of Tennessee. Construction is expected to begin in the summer of 1999 with occupancy in the summer of 2000. The JINS is to be constructed on the Oak Ridge Reservation (ORR), at a location across from the ORNL 7000 area on Bethel Valley Road. DOE will lease the land for JINS to the University of Tennessee; therefore, DOE will complete the appropriate National Environmental Policy Act (NEPA) documentation prior to commitment of the land to this facility.

CHAPTER 3: PROPOSED ACTION AND ALTERNATIVES

The regulations of the Council on Environmental Quality (CEQ) (40 CFR Parts 1500-1508) direct federal agencies to identify and assess, in the environmental impact statement (EIS), reasonable alternatives to the proposed action that meet the purpose and need for action and could have effects on the quality of the human environment. Additionally, CEQ regulations require a presentation in a comparative format of the potential effects each alternative may have on the quality of the human environment.

This chapter describes the proposed action, the siting alternatives for implementation of the proposed action, and the No-Action Alternative. It also describes the technological and siting alternatives that were previously considered and eliminated from detailed analysis in this FEIS, along with the reasoning for their elimination. The description of the proposed action and alternatives, coupled with the description of the affected environment (Chapter 4), enables the analysis of the potential environmental consequences of construction and operation of the proposed Spallation Neutron Source (SNS) (Chapter 5 and summarized in Section 3.5).

3.1 OVERVIEW

The proposed action is to design, construct, and operate a state-of-the-art neutron science facility based on a linear accelerator (linac) coupled with proton accumulator rings and a mercury spallation target. This facility, referred to as the proposed SNS, would satisfy the purpose and need for actions by the Department of Energy (DOE). The SNS would initially have an operating power of 1 MW. Additional structures and components are planned that could allow future increases in operating power to 4 MW and additional research capabilities.

This chapter of the proposed SNS FEIS provides a statement of the proposed action and gives a description of the activities that would be undertaken to implement it in Section 3.2. The description of the proposed action is divided into four major sections. Section 3.2.1 identifies the facility components of the proposed SNS at 1 MW and at 4 MW. Section 3.2.2 describes the activities that would be required to construct the proposed SNS. The description entails initial construction and future upgrades that could be proposed for the facility. Section 3.2.3 characterizes operational activities in terms of resource requirements, emissions, discharges, and waste generation that would be involved in operating the proposed SNS over its planned 40-year life span.

Because the facility is being designed to allow future upgrades, discussions evaluating the proposed SNS activities and potential effects include the proposed 1-MW facility and the potential 4-MW-upgraded facility as the upper bounding condition. Furthermore, the discussion emphasizes specific activities with environmental protection implications and includes any known pollution source terms that would be associated with them.

A screening process was used to identify and evaluate potential siting alternatives for the proposed SNS. Initially, a pool of 39 DOE sites were examined as potential host sites for the proposed SNS (refer to Appendix B). Using specific evaluation criteria, all but four sites were eliminated from detailed analysis in the FEIS (refer to Appendix B). The remaining four alternative DOE sites, Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory (LANL), Argonne National Laboratory (ANL), and Brookhaven National Laboratory (BNL), each contain a selected on-site location that is identified in Sections 3.2.5.2 through 3.2.5.5 and described in detail in Chapter 4. The screening process used to select these four DOE sites from the original 39 alternatives is described in Section 3.2.4. Because each of the selected sites has unique characteristics (especially with regard to road access, availability of utilities, and existing waste management systems), implementation of the construction and operational portions of the proposed action would be somewhat different at each site. The unique site characteristics and the various activities required to deal with these differences are accounted for in this FEIS. (Refer to Appendix B for the site selection reports.)

Under the No-Action Alternative, DOE would not build the proposed SNS. Impacts associated with this option are discussed in Section 3.3 and used for comparison to the action alternatives throughout this FEIS.

A number of technological alternatives to the proposed action were identified and screened prior to initiation of the proposed SNS EIS process. As a result of these evaluations, none were deemed to be viable technological alternatives to the proposed action, and all were eliminated from detailed analysis in the FEIS. These alternatives and the reasoning behind their elimination are discussed in Section 3.4.

The discussion of the proposed action and alternatives concludes in Section 3.5 with a comparison of the potential environmental impacts associated with constructing and operating the proposed SNS at each of the four alternative DOE sites.

3.2 THE PROPOSED ACTION

The proposed action is to construct and operate a state-of-the-art neutron science facility to help satisfy the nation's future needs for neutron scattering research. The key attributes of such a facility are the ability to provide (1) an array of neutron beams with varied, discrete energy levels that can be adapted to the particular experiment to be conducted and (2) the highest possible neutron flux onto the research samples. Therefore, it is proposed to construct a new spallation neutron source based on a non-superconducting, linear accelerator with 1-MW beam power coupled with proton accumulator rings and a mercury target. Sufficient design flexibility would be incorporated into the project to allow significant facility modification at some time in the future to increase the power of the proton beam to 4 MW. The proposed SNS would produce short pulses of neutrons through the spallation process. A description of the proposed action is divided into the following three subsections:

- 3.2.1 Facility Description
- 3.2.2 Construction
- 3.2.3 Operations

Descriptions in these sections reflect the current details of planning and engineering at the conceptual design stage of the project. Because detailed site engineering studies have not been performed, this discussion is generic in nature;

the facility described here could be constructed at any of the four alternative sites. Details that would be site-specific are presented in Section 3.2.4. This descriptive information is condensed from the information included in the *National Spallation Neutron Source Conceptual Design Report/ Volumes 1 and 2* (ORNL 1997a and 1997b). For a more in-depth technical discussion, the reader is directed to that document, which is available in the DOE reading rooms listed in Chapter 1.

The Production of Neutrons for Research: "Spallation"

The production of neutrons by the spallation process would begin with the acceleration of high-energy particles within a linac (linear accelerator). The linac would accelerate charged particles, in this case hydrogen atoms, with an extra electron (H^- ions). Electrons would be stripped from the H^- ions during injection of the particle into an accumulator ring, leaving protons. Protons would be added to the ring until a sufficient number have been accumulated. The protons would then be directed to a target of liquid mercury. High-energy protons would impact mercury molecules in the target, which, in turn, would eject neutrons to dissipate the proton-impact energy. These high-energy neutrons would travel through a substance that decreases or moderates their energy. The neutrons would then be directed through beam tubes to experiment stations.

The number of neutrons produced in the spallation process would depend on the number and energy of the protons bombarding the target. The number of neutrons available per unit of time for experimental use would depend on the target/moderator system efficiency. The total number of neutrons generated for scattering experiments would depend upon the repetition rate of the proton pulse.

3.2.1 FACILITY DESCRIPTION

This summary includes a brief physical description of each of the four main components of the proposed SNS and an explanation of their functions. These basic components for the proposed 1 MW facility include a proton ion source (the front end), the linac, the beam transport and ring system, and the target building that houses the target (Figure 3.2.1-1). This summary description of the proposed SNS facility concludes with a discussion of future upgrade options (Section 3.2.1.5) that would enable the proposed SNS to operate at 4 MW.

3.2.1.1 Front End

The Front End is the part of the proposed SNS accelerator that initially produces the charged hydrogen ions and injects them into the linac. It comprises several components: the ion source, the low-energy beam transport (LEBT), the radio frequency quadrupole (RFQ) accelerator, and the medium-energy beam transport (MEBT). The Front End would be approximately 32.81 ft (10 m) in length. Figure 3.2.1.1-1 presents a schematic diagram of the Front End and linac systems, showing ion source, RFQ accelerator, drift-tube linac (DTL), coupled-cavity drift-tube linac (CCDTL), and coupled-cavity linac (CCL) structures of the proposed SNS.

3.2.1.1.1 Low-Energy Beam Transport

The charged particles produced by the ion source are made to move as a beam, much like a beam of light produced by a laser. The particle beam would leave the ion source and immediately enter the LEBT section of the Front End. During passage through the LEBT, the particles would be grouped into bundles, focused, and accelerated to 65 keV. The LEBT would contain two electromagnetic lenses to focus the beam of particles before it enters the next component of the Front End, the RFQ accelerator.

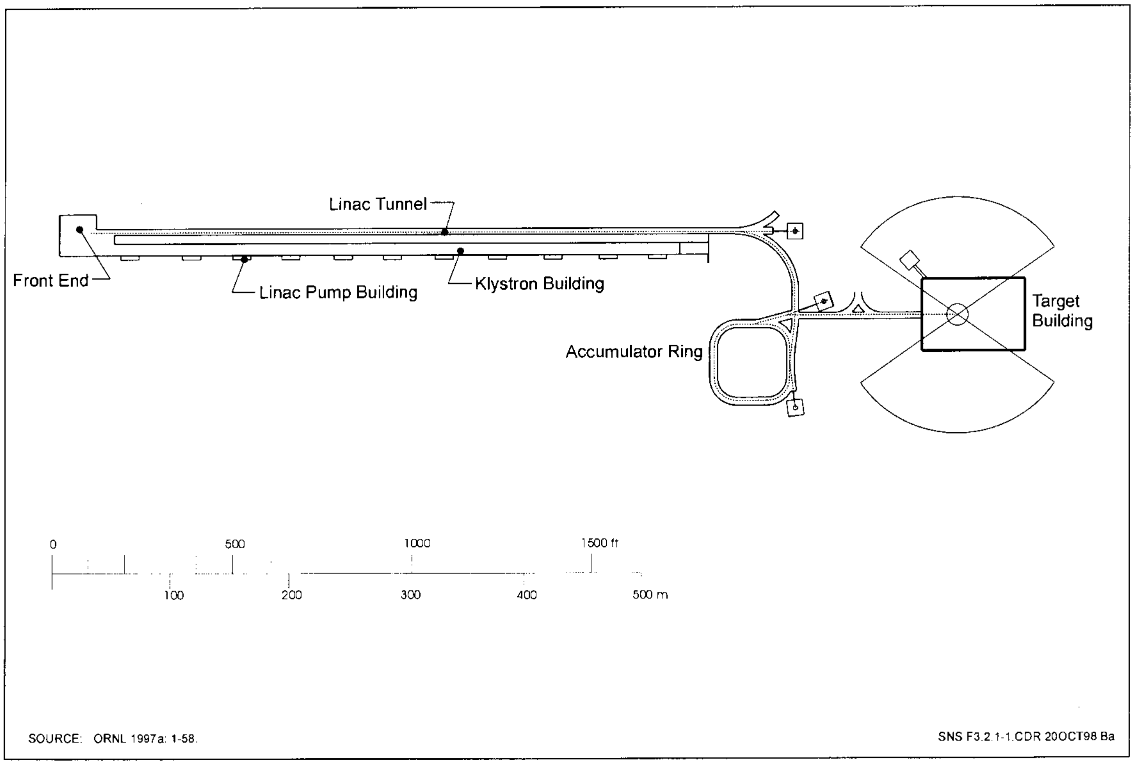


Figure 3.2.1-1. Footprint of the proposed SNS accelerator components.

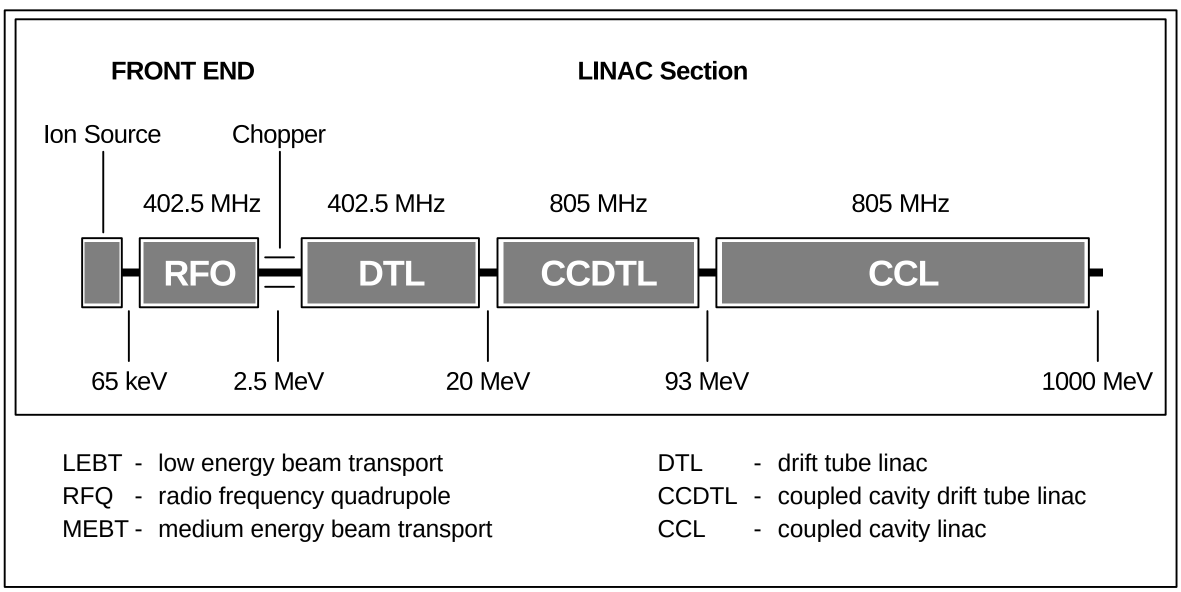


Figure 3.2.1.1-1. Schematic layout of the LEBT Front End and linac section.

3.2.1.1.2 Radio-Frequency Quadrupole Accelerator

The RFQ takes the beam and converts it into a continuous controlled stream consisting of many bunches of particles. The RFQ is named for the symmetrical arrangement of four triangle-shaped vanes that form a small hole through which the beam would pass. These vanes assist in converting the ion stream into packets, or bunches of particles, and controlling the beam within the RFQ. During operation of the RFQ, an oscillating voltage from a 402-MHz klystron would be applied that would accelerate the particles. During this acceleration process, the RFQ would increase the energy of the particle beam from 65 keV to a medium energy of 2.5 MeV. The particles leaving the RFQ would enter the MEBT.

3.2.1.1.3 Medium-Energy Beam Transport

The MEBT would allow the particles from the RFQ to enter the next stage of energy increase or acceleration. The MEBT would finish forming the beam and would also transport the fully organized medium-energy particle beam to the linac to further increase the energy of the particles. The beam would be focused and grouped together with gaps between successive bunches. The particles leaving the MEBT would proceed to the next stage of acceleration in the linear accelerator proper.

> *Klystron*: a specialized electron tube designed to amplify microwave signals or radio waves. There would be a total of 58 klystrons contained in the gallery of the proposed SNS. The klystrons provide the radio frequency (rf) power at the appropriate frequency to accelerate the particles in the linac.

3.2.1.2 Linear Accelerator System

The 1,614-ft (492-m) long linac accepts the beam that has been accelerated by the Front End and accelerates the beam further from 2.5 MeV to 1.0 GeV. The major components of the linac system are the drift-tube linac (DTL), which accelerates the beam from 2.5 MeV to 20 MeV; a coupled-cavity drift-tube linac (CCDTL), which further accelerates the beam to around 93 MeV; and a coupled-cavity linac (CCL), which accelerates the beam to 1.0 GeV. All of the alternative sites would be able to accommodate the linac footprint. The functions of each of the linac components are summarized below.

3.2.1.2.1 Drift-Tube Linac

The DTL is a well-understood structure and has been the workhorse in low-energy accelerators for years. The drift tubes are copper cylinders with a small hole through which the particle beam passes. As the beam passes through the tubes, the particles are subjected to an electric field of rapidly oscillating (402.5-MHz) microwaves. The electric field attracts or repels the particles, depending upon the polarity of the field. The oscillation of the electric field and the length of the drift tubes are such that the particles would be subjected to an accelerating force when they emerge from the end of each tube. The particles enter the next tube before the electric field changes polarity, thus avoiding a deceleration of the particle. The increasing lengths of the drift tubes are calibrated to match the accelerating polarity of the oscillating field, thus providing continued acceleration of the particles throughout the length of the DTL. The drift tubes also contain magnets to ensure the particle beam remains focused (i.e., always accelerating through the center of the drift tubes).

The DTL for the proposed SNS would consist of two sets of drift tubes each housed in a cylindrical tank. The first tank would contain 46 tubes and the second tank would hold 36 drift tubes. The total length of the DTL would be approximately 28.3 ft (8.7 m). The particles would have an energy of 20 MeV as they exit the DTL and enter the CCDTL.

3.2.1.2.2 Coupled-Cavity Drift Tube Linac

The CCDTL would produce the next stage of energy increase or acceleration of the particles. The CCDTL structure would be optimized to accelerate the beam from 20 MeV to 93 MeV. The CCDTL would be a hybrid structure consisting of a coupled-cavity design into which a drift tube has been added in each cavity to allow for the longer transit time through the cavity. Approximately 40 sections, each consisting of several cavities, would be placed end to end to form a single unit, each with an approximate length of 4.9 ft (1.5 m). Focusing magnets and instruments for analyzing the beam would be installed between these units of the CCDTL. The energy required to accelerate the particles would be 805 MHz rf energy from the klystrons. The total length of the CCDTL structure would be 193 ft (60 m). This portion of the linac would accelerate the particles to an energy of 93 MeV. Particles leaving the CCDTL would enter the CCL.

3.2.1.2.3 Coupled-Cavity Linac

The CCL would consist of a series of specially shaped cavities. As the particles travel through the accelerator, gaining speed, the cavities would become longer. The accelerator segments would form the basic building blocks for the accelerator. The modules would be mounted on support structures that would allow them to be aligned. Each module would be connected to a vacuum manifold and a cooling-water system. Magnets for focusing the beam would be located in the drift spaces between segments. Each module would be designed to use the total power output of a single klystron, the cavities being energized by microwaves delivered from the klystrons by waveguides. Upon leaving the CCL, the particle beam would have an energy of 1.0 GeV and would enter the beam transport and ring system.

3.2.1.3 Beam Transport and Ring System

This part of the accelerator system would function to receive the particle beam from the linac, store it in an accumulator ring, and transport the beam to the target. The beam transport and ring system would contain three major components: the high-energy beam transport (HEBT), the accumulator ring, and the ring-to-target beam transport (RTBT). As described below, these systems are designed to collect large numbers of protons (H^+) and deliver them onto the target in a series of short pulses.

The HEBT would carry the fully accelerated beam from the linac to the accumulator ring. The HEBT would contain equipment for beam diagnostics, which would facilitate maintaining the focus of the beam. The configuration of the HEBT would allow the beam to enter the accumulator ring with a minimum of beam loss.

The accumulator ring would receive the beam of H^- ions from the HEBT. This beam would pass through a thin carbon foil that strips the electrons off the particles, converting them to protons (H^+). Magnets in the ring would be used to guide the protons into a beam circulating around the ring. Over 1,200 proton pulses could be accumulated in the ring prior to transfer to the target. The design circumference of the ring would be 722 ft (220 m). The beam would circulate in a clockwise direction. The energy and focus of the beam would be maintained by magnets, rf energy, and instrumentation. Once a full charge from the linac has been accumulated in the ring, the kicker system would be turned on to direct the beam to the target. The kicker would consist of a series of electromagnets that bend the beam, directing it to the RTBT. The RTBT would take the beam from the accumulator ring to the target located inside the target building.

3.2.1.4 Target and Experiment Building

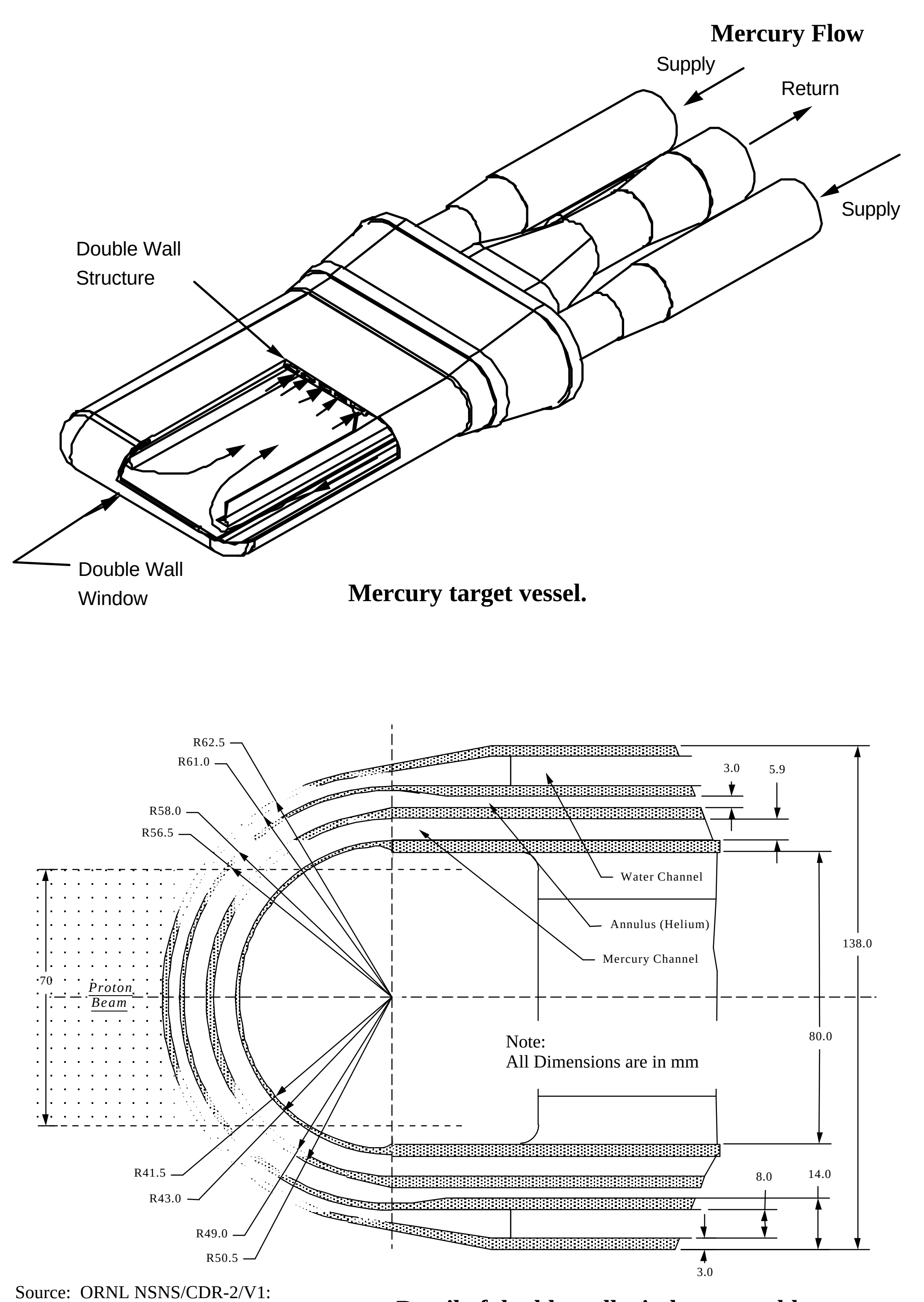
The target and experiment stations would be located inside the target building. This section describes the target, moderator system, shutter system, neutron beam guides, beam stops, and experiment stations.

3.2.1.4.1 Target

The high-energy protons from the accumulator ring would be directed through the RTBT to the target. Upon hitting the target, the protons would cause neutrons within the nuclei of the target material to be ejected as the heavy metal molecules release excess impact energy. Heavy metals provide the most effective source of neutrons for the spallation process because of the high neutron-to-proton ratios. Target materials used at existing spallation neutron sources include uranium, tungsten, and tantalum. However, at proton beam powers above 1 MW, problems from thermal shock would arise while cooling a target made of solid materials. As a result, these solid targets would have a short life span and would require frequent replacement, thereby greatly increasing the amount of radioactive waste generated by the facility. The proposed SNS would use liquid mercury as the target material. The mercury target would have the following advantages over a solid target:

- Mercury, being a liquid, is not as susceptible to thermal shock stresses. Therefore, mercury target material would last for the entire 40-year life span of the proposed SNS.
- The mercury in the target would not be consumed or need to be replaced during the life of the facility. Therefore, much less radioactive waste would be generated than would result from a series of solid targets.
- A liquid target has higher yields of neutron production at higher powers.
- Mercury would be circulated in and through a stainless steel target vessel, thus increasing the thermal mass of the mercury target and facilitating the cooling process. Cooling water would be circulated through the target structure and a heat exchanger to remove heat. This cooling water is isolated from the mercury within the target vessel.

Approximately 35.3 ft^3 (1 m^3) of mercury would be needed for the proposed SNS target and would be contained in the target vessel and associated heat exchangers. Several layers of containment would be designed into the target assembly. At the point of beam impact, the mercury would circulate inside a rectangular, double-walled chamber (Figure 3.2.1.4.1-1) with cooling water in the outer annulus space and helium in the inner space. The helium chamber would isolate the mercury from the water and provide a leak detection mechanism in the event of partial vessel failure. If the target vessel components begin to fail, the helium layer would help isolate the mercury from the water. If the entire assembly should fail, the mercury and water would be contained in a 71-ft^3 (2-m^3) shielded vessel below the target assembly. (See



Source: ORNL NSNS/CDR-2/V1: 1997a 5-18 5-19.

Figure 3.2.1.4.1-1. Mercury target vessel.

Appendix C for a description of postulated accidents at the proposed SNS.)

The target assembly would be constructed on a mobile cart system housed in a heavily shielded structure. The target cart would be designed to support all of the mercury- and water-circulating equipment and would provide a means of transporting the target to the hot cell area for maintenance. The target hot cell, located behind the target assembly's normal operating position, would be shielded and equipped to allow for remote handling of the target during maintenance.

Two collection and storage tanks would be located below the floor of the target hot cell. Both tanks would be shielded and self-cooled. One of these tanks, the spill tank, would have open, gravity-feed connections to the target vessel, target hot cell floor, and mercury processing equipment. This tank would contain the mercury and water in the event of equipment failure or spill. The other tank, the mercury storage tank, would be used to temporarily store the mercury during maintenance operations.

Maintenance operations would include replacement of the target window. The proton beam travels through this window to impinge on the mercury. Although the window is made of stainless steel, the proton beam would deteriorate this window over time, requiring replacement. Other maintenance activities would include servicing the pumps that circulate the mercury, replacing vacuum seals, and performing routine inspections. During maintenance activities, the mercury would be drained into the shielded mercury storage tank. The mercury would not be removed from the target hot cell.

3.2.1.4.2 Moderator Systems

Neutrons emitted directly from the target assembly would be traveling too fast to be useful in neutron scattering experiments. Moderators would be designed to slow the neutrons in order to optimize their interactions with the materials being studied. Neutrons are slowed in a moderator by transferring part of their energy to the moderator through their successive collisions with moderator molecules. The energy gained by the moderator material is in the form of heat that is transferred to a cooling system.

The proposed SNS would have two types of moderators. Ambient-temperature water moderators would use deionized water maintained at a temperature below 86°F (30°C). Cryogenic moderators would use liquid hydrogen to maintain a temperature between 16 and 25°K (-430.6 and -414.4°F; -257 and -248°C). The hydrogen would be contained in a continuous, inert blanket of helium. This safety measure would provide insulation of the hydrogen from atmospheric air and prevent air from entering the moderator systems.

3.2.1.4.3 Shutter System

Shielding shutters would be installed on each of the neutron beam lines. The shutters would be used to interrupt the neutron beam to allow samples to be removed or inserted into individual experimental chambers while the overall spallation source is operational. The shutters would be massive structures made of tungsten. The shutters would provide 6.6 ft (2 m) of shielding and would be approximately 13.1 ft (4 m) in height. Each would weigh approximately 16 tons and would be moved by an electric-motor-powered screw drive. When open, the shutters would permit the flow of neutrons through the beam guides to the experiment stations.

3.2.1.4.4 Neutron Beam Guides

The neutrons would be guided to the experiment stations through beam guides. These guides would be shielded tubes that conduct the moderated neutrons beyond the bulk shielding of the target assembly to the experiment stations containing neutron detection instrumentation. A target system building would have a maximum of 18 beam guides, 9 from each moderator set (thermal and cold).

3.2.1.4.5 Beam Stops

Beam stops are engineered structures designed to receive the beam whenever circumstances require the beam to be diverted from the target station or the accumulator ring. These large masses of steel and concrete would absorb the beam energy and would shield the staff and the environment from any residual radiation. Beam stops would be constructed at strategic locations along the beam path where they would be available for use in emergency situations (such as downstream equipment failure) or as a beam tuning tool for upstream system testing.

3.2.1.4.6 Target and Experiment Building

The proposed SNS initially would have one target providing 60 pulses of neutrons every second. A second target that would provide 10 to 20 pulses of neutrons every second is a potential future upgrade (Section 3.2.1.5). Each of these targets would be contained in a separate target building, providing the planned total of 36 neutron beams. Each target building would contain an experiment hall and experiment support buildings. All the instrumentation for conducting neutron scattering experiments would be constructed in the experiment support buildings. Most of the neutron detection instruments would fit entirely within the associated experiment halls. However, a few long-flight-path instruments would be on neutron beam lines that extend through the walls of the experiment halls (refer to Figure 1.3-1).

3.2.1.5 Future Upgrade Options

A recommendation in the Basic Energy Sciences Advisory Committee (BESAC) reports has been to build into the original design a clear upgrade capability to higher-power operation. This has played a key role in selection of technology, as well as in the layout and configuration of the baseline 1-MW design. The decision of whether or not to upgrade the facility would be made after the 1-MW facility is operational. In anticipation of the decision to upgrade the SNS, the facility would be constructed in stages. Only one of the target stations (60 Hz) would be included in the first construction stage. The baseline project includes only the first 10 neutron beam lines, instrumentation, and support equipment. They would be installed and ready for commissioning at the time the source becomes operable. A scientific program could begin within a few months after startup.

It is expected that additional instruments would be installed at the rate of one or two per year to fill the first target building. Thus, all the available neutron scattering beams on the first target station would be expected to be occupied by operational instruments within approximately five years after the source begins operating. At that time in the future when the second target station is proposed, several of the existing neutron scattering instruments would be moved from the first target station to the second, where they could operate even more effectively. The fully upgraded SNS facility would have 4 MW of beam power available for two target stations, one optimized for operation at approximately 60 Hz and the other at approximately 10 Hz. Achieving 4 MW would require building a second front end system and a second accumulator ring. Each set would then be capable of delivering beams suitable for 2-MW operation. Figure 3.2.1.5-1 shows a site plan for the proposed SNS as it would look when fully upgraded at a future time.

3.2.1.5.1 Second Target Station

A high priority for the user community would be the addition of a second target station to increase experimental flexibility and to accommodate additional instruments. Target station optimization is influenced by the pulse repetition rate required for a specific research experiment.

The first target station would be optimized for a repetition rate of approximately 60 Hz. The second target station would allow an instrument group to be optimized at a lower beam repetition rate in the range of 10 to 20 Hz. No technical challenges have been identified that must be resolved before adding the second target building. Plans for upgrading the facility would be designed such that no interruption in user programs would last for more than six months.

The second target building would be built adjacent to the first target building (refer to Figure 3.2.1.5-1). For cost savings, structural design in the first hall could be duplicated. A crossover beam line would be built, and a switching magnet would be added to the first RTBT to send pulses to the second station.

3.2.1.5.2 Upgrade from 1 MW to 2 MW

An inherent feature of the baseline 1-MW design would be the relative ease in reaching the 2-MW level of performance. In general, this upgrade would consist of increasing the output of the ion source and upgrading the power systems of the linac. The overall footprint of the facility [the 110 acres (45 ha) encompassing the buildings and associated support facilities] would not change. Table 3.2.1.5.2-1 summarizes what would be involved in this upgrade.

The specifications for beam loss for the proposed SNS would be very strict to avoid excessive activation of components. Maintenance of the strict beam-loss specifications at the higher current level would be a challenge, but incrementally increasing the beam current and resolving beam loss problems as they occur would result in an overall increase in performance.

3.2.1.5.3 Upgrade from 2 MW to 4 MW

The second stage of power upgrade would require more significant expansion of accelerator capabilities. The requirements are summarized in Table 3.2.1.5.3-1.

The upgrade would consist of constructing a second front end and a second accumulator ring. The second front end would be housed in the same building as the first front end. The second accumulator ring would be constructed on the other side of the linac, mirroring the first ring (refer to Figure 3.2.1.5-1). The rings would be connected to the two target buildings with RTBTs that would allow the operators to direct the beam from either ring to either target. To reach maximum beam power, the particles in both rings would be directed to one target.

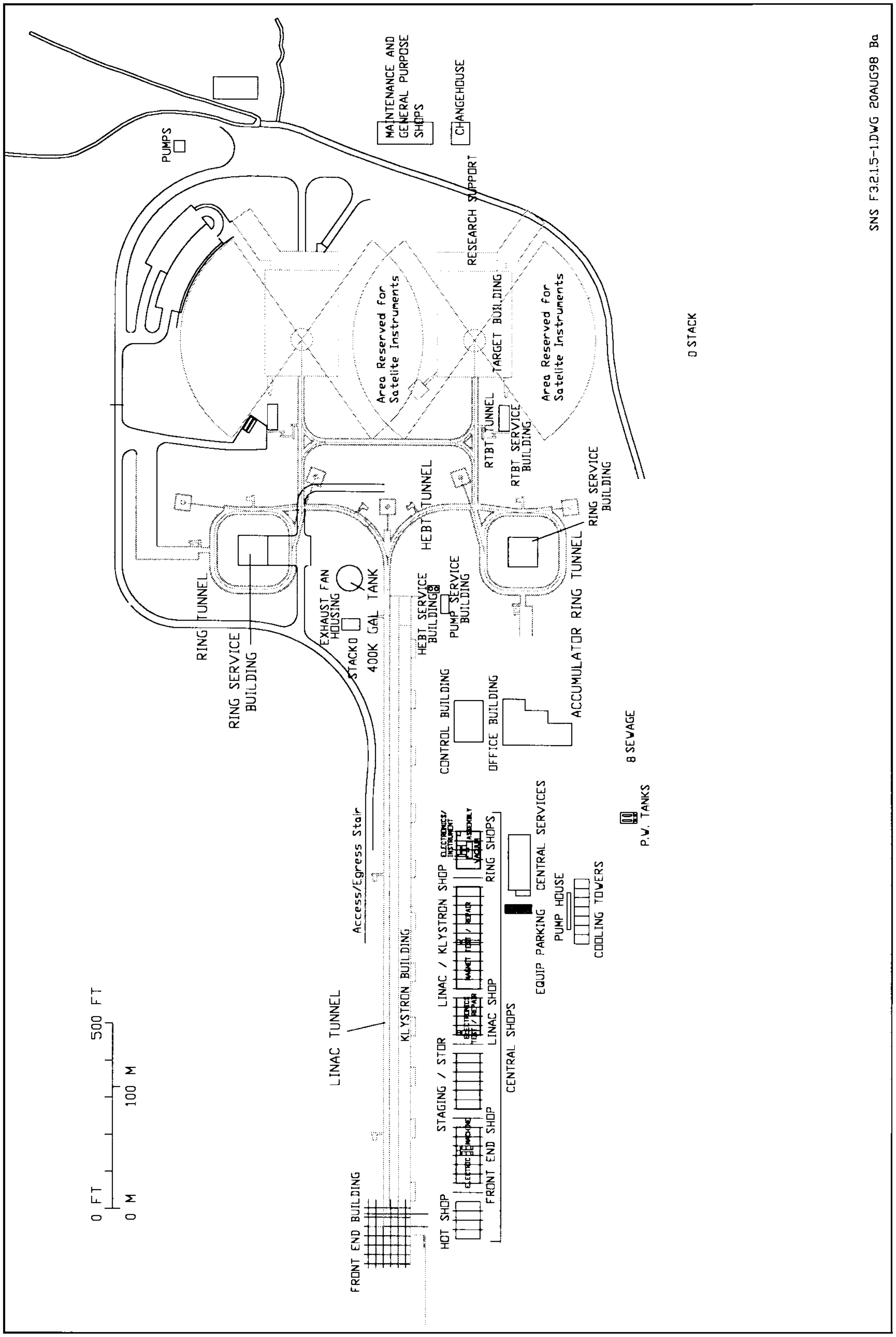


Figure 3.2.1.5-1. Site plan for fully upgraded facility.

Table 3.2.1.5.2-1. Requirements for upgrade to 2-MW beam power on target.

Proposed SNS Component	Requirements
Ion source	The current of the ion source (front end) would be doubled to 70 mA. The ion source would have to be engineered to dissipate the increase in thermal loading at 70 mA, as compared to 35 mA.
LEBT and RFQ	No changes. Designed to handle the increased beam power.
Linac	All of the components installed for 1-MW operations would be designed to deliver a beam power of 2-MW on target. Some of the linac power and support systems would be upgraded.
MEBT, HEBT, accumulator ring, and RTBT	No changes. Components installed for 1-MW operations would be designed to produce a beam power of 2 MW on target.
Beam chopper	May require enhancement in performance, particularly to ensure that specifications of the chopper gap are met.
Klystrons	Additional 12 klystrons required. The rf waveguides, feeds, and coupling between the CCDTL and CCL modules would be redistributed.
Target	An increase in beam power on target would require an improved target design and an upgrade of the target cooling system. Technical improvements indicated by lower-power operations would be incorporated.
Balance of proposed SNS facilities	Power distribution and cooling system capacities would be upgraded. The initial design would include sufficient space for these upgrades.

Table 3.2.1.5.3-1. Requirements for upgrade to 4-MW beam power on target.

Proposed SNS Component	Requirements
Ion Source, LEBT, RFQ, and MEBT	Duplicate all components by constructing a second front end capable of 70 mA. A funnel would be needed to combine the two front end beams into one beam for the linac injection.
Linac	Add 14 additional klystrons. The rf waveguides, feeds, and coupling between the CCDTL and CCL modules would be redistributed.
HEBT	Construct a second HEBT from the linac to the second accumulator ring.
Accumulator ring	Construct a second accumulator ring capable of handling a 2-MW beam. Crossover beam transports would also be constructed.
RTBT	Construct an additional RTBT to connect the new accumulator ring to the targets.
Beam Chopper	May require enhancement in performance, particularly to ensure that specifications of the chopper gap would be met.
Target	No changes. The mercury target would be designed to handle 4 MW of beam power. The capacity of the target cooling system would be increased.
Balance of proposed SNS Facilities	Power distribution and cooling system capacities would be upgraded. The initial design would include sufficient space for these upgrades.

3.2.2 CONSTRUCTION

This section of the FEIS provides a description of the activities that may be required to construct the proposed SNS, with specific activities depending on individual site requirements. In addition to outlining site preparation and construction of various facilities and systems, it includes the projected size of the construction workforce, worker safety during construction, construction traffic levels, and generation of waste through construction activities. Figure 3.2.2-1 outlines the proposed project schedule by phases of construction and operation.

3.2.2.1 Workforce

During the first year of construction (FY 2000), only 35 out of the 166 full-time design and construction employees on the proposed SNS project nationwide would be dedicated to construction (refer to Figure 3.2.2-1). In the third year (currently scheduled for FY 2002), full-time project employees would peak at 578, of which 480 would be dedicated to construction. Prior to construction completion in the fifth year (currently scheduled for FY 2004), the full-time project employees would decrease to 313, including 110 construction workers (Brown 1998a).

3.2.2.2 Traffic

Most of the vehicular traffic related to construction of the proposed SNS would be created by construction managers and workers, suppliers of construction materials, and service providers. Table 3.2.2.2-1 summarizes the type and number of vehicles for each category. A significantly smaller amount of traffic would consist of intermittent site inspection visits by personnel from DOE, the host laboratory contractor, design laboratories/contractors, and others with an interest in the conduct of operations at the construction site. This traffic would consist of vehicular movement confined to construction areas and vehicular movement between the proposed SNS construction areas and points outside of these areas.

Traffic between points inside construction areas would be a direct function of specific construction demands. This traffic would consist almost entirely of frequent, short distance trips by earthmoving equipment such as bulldozers, backhoes, heavy trucks, and light trucks.

The heaviest daily traffic would consist of round-trip vehicular movement between the proposed SNS construction areas and outside points. This traffic would consist of commuting by construction managers and workers, movement of heavy trucks between construction areas and off-site facilities (such as borrow areas), visits by supply trucks and service providers, and intermittent business-related visits. Table 3.2.2.2-2 presents a conservative estimate of the number of truck trips to the site during construction. These materials correlate with the construction activities described in Section 3.2.2. Traffic would begin at relatively low levels with the onset of physical construction activities in the second year (FY 2000) and would increase to its maximum in the third (FY 2001) and fourth (FY 2002) years, the peak construction years for the proposed SNS. During this time, worker commutes would constitute a maximum of about 466 daily round trips to the proposed SNS construction areas; material transport would add 7 daily round trips and service providers would add an additional 3 daily round trips.

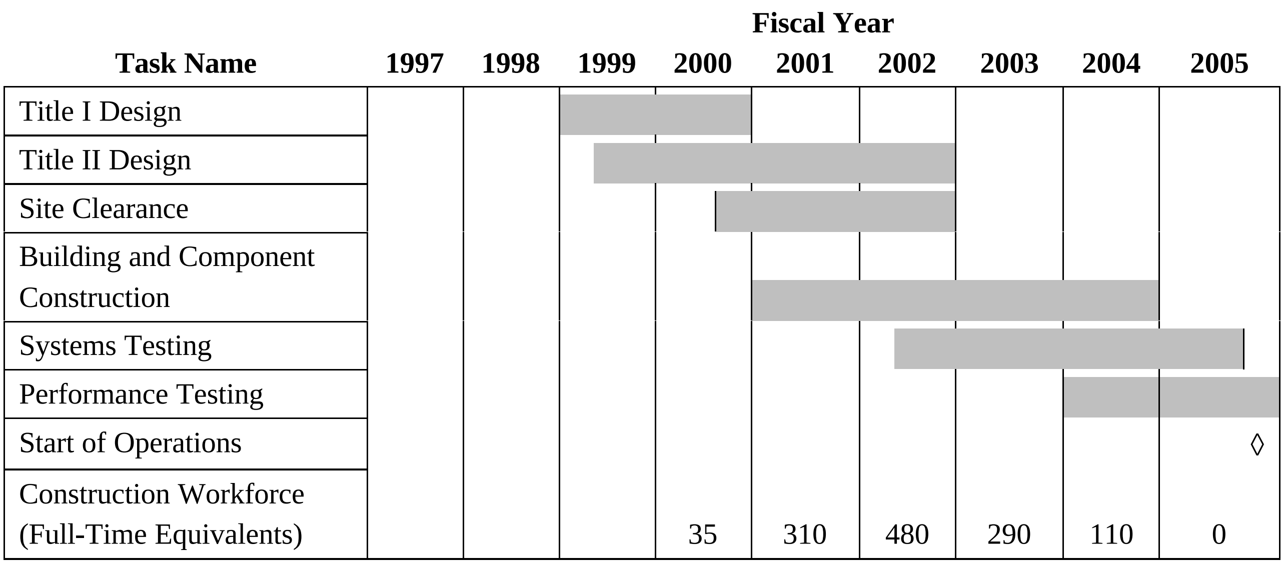


Figure 3.2.2-1. Proposed SNS summary schedule for design and construction.

Table 3.2.2.2-1. Construction traffic.

Activity	Vehicle	Daily Round Trips
Managers/workers	Passenger	466/dy[1]
Material transport	Truck	7/dy[2]
Service providers	Truck	3/dy[3]
		Total 476

[1]Based on Tables 5.2.10.1-2, 5.3.10.1-1, 5.4.10.1-2, and 5.5.10.1-1.
[2]Value calculated per Table 3.2.2.2-2.
[3]Best professional judgement.

Table 3.2.2.2-2. Construction truck material shipments.

Material	Number of Trucks
Concrete (Sect. 3.2.2.4)	2,250
Steel (Sect. 3.2.2.4)	200
Crushed stone for UNAC (Sect. 3.2.2.9)	1,278
Temporary employee parking (Sect. 3.2.2.6)	361
Permanent employee parking (Sect. 3.2.2.6)	48
4 miles of paved roads (Sect. 3.2.2.6)	3,911
Sanitary waste during construction (Sect. 3.2.2.11)	468
Total trucks during construction	8,516

8,516 ÷ 5 yr construction = 1,703 trucks per yr
1,703 trucks per yr ÷ 250 workdays per yr = 7 truck round trips per workday.

This level of traffic would diminish with the decrease in construction activities between FY 2002 and FY 2004.

3.2.2.3 Site Preparation

The central buildings and systems of the proposed SNS would be constructed within a hammer-shaped footprint of approximately 110 acres (45 ha) (ORNL 1997b: 8-1). This area would accommodate the fully upgraded facility. During construction of the 1-MW facility, the land not needed for the construction of facilities would be used as a lay-down area and as temporary parking lots for construction workers.

Construction of the proposed SNS would start with site preparation and grading activities. These activities would begin with the removal of existing vegetation in specific areas designated for construction and construction-support operations. Where possible, natural vegetation on or adjacent to the site would be preserved and protected (ORNL 1997b: 8-30).

Construction locations within the site would be graded and backfilled using heavy equipment. Earth-moving would be performed in accordance with DOE Standard Specification CV-1.3 (ORNL 1997b: 8-30). Laydown areas for construction materials and areas for temporary construction facilities would be created (ORNL 1997b: 8-30).

All topsoil would be scraped and stockpiled in a designated location for on-site landscaping and revegetation efforts. Any excess topsoil would be stockpiled and preserved for future use. To the extent possible, maintainable slopes would be used at all changes in elevation. Newly graded slopes over 3:1 (three units horizontal to one unit vertical) would be considered for retaining walls, soil stabilization, and maintenance-free landscaping. Appropriate provisions would be made for the disposal of rock and other excavated debris. On-site burying of debris would be prohibited (ORNL 1997b: 8-30).

The removal of vegetation and the loosening of soils during site preparation could enhance the potential for soil erosion and transport to surface water bodies during periods of precipitation. Permanent and temporary erosion-control measures would be used at the earliest feasible times to minimize such effects. Temporary stormwater management and silt retention facilities, such as silt fences, would be provided where early placement of permanent improvements would be impractical. As soon as possible, denuded and disturbed areas would be revegetated with appropriate native plant species to minimize erosion and downstream siltation. Cut-and-fill slopes would be sufficiently stabilized by mechanical methods or planting vegetation to prevent failure and erosion (ORNL 1997b: 8-30).

A permanent retention basin would be constructed as part of the overall runoff control to mitigate the amount of sediment loading to receiving streams. The basin would also serve to equalize the flow of water to the receiving stream. At the conceptual design stage, the size of the retention basin required is estimated at approximately 2 acres (0.81 ha).

3.2.2.4 Construction Materials

Based on the conceptual design, approximately 50,000 yd^3 (38,228 m^3) of concrete and 4,000 tons of steel would be used for construction of the proposed SNS and for shielding. At this time, estimates of other building materials are not available.

Concrete and steel shielding blocks may be available from existing DOE facilities. For example, concrete and steel shielding blocks may be available from the decommissioning of the Bevatron facility at the Lawrence Berkeley National Laboratory (LBNL). In addition, recycled steel from other DOE facilities may be available. Concrete and steel from these sources may be slightly radioactive. Reuse of slightly contaminated material was established as waste minimization policy by DOE. If DOE decides it is feasible to use the concrete and steel blocks in the proposed SNS, an assessment of the potential radiation doses to workers and the general public would be made prior to transporting the material to the proposed SNS site.

3.2.2.5 Utilities

Utility construction would extend electricity, telephone/data communications, natural gas, potable water, and sanitary sewer service to the proposed SNS facilities (ORNL 1997b: 8-34). Where possible, these services would be extended from the points where existing sources of sufficient quantity and capacity make their nearest approaches to the proposed SNS site. Doing this would limit the total area of land that would be disturbed by new utility construction.

The extension of utility services into the proposed SNS site would entail vegetation clearing throughout the utility corridors. With respect to overhead electricity and telephone/data communications lines, vegetation removal would focus primarily on trees where forested areas intersect the transmission line corridors. Ground cover and understory vegetation would be cleared for the laying of pipelines and sanitary sewage lines, since these components require the excavation of pits and trenches. Some shallow soil excavation and augering would be necessary to extend electrical service to the proposed SNS site. Activities would involve the setting of utility poles, transmission line towers, and other such components of overhead utility systems.

3.2.2.6 Roads and Parking Lots

A system of roads and parking lots would be constructed on the proposed SNS site. These would be both temporary and permanent. Temporary roads and parking lots (dirt and gravel) would be established at the beginning of construction activities to provide construction vehicles with ease of access to and among the various on-site construction locations. Where feasible, the locations of temporary roads and parking lots would coincide with planned roadways and parking lots or planned construction areas, to minimize zones of disturbance on the site (ORNL 1997b: 8-28). Temporary parking lots would be provided for construction vehicles (ORNL 1997b: 8-34). If necessary, temporary parking could be established a short distance from the construction site, with buses transporting the workers. By the end of construction, 4 miles (6.4 km) of permanent, paved roads and parking areas for 250 persons would be constructed. On a site-specific basis, additional construction and improvement of permanent, paved roads would be necessary to effectively connect the on-site roads and parking lots with the system of existing roads in the vicinity of the proposed SNS site. Permanent roads and parking lots would be subject to finish grading; excavation of trenches for drainage features, such as concrete curbs and guttering; paving; and the painting of paved surfaces with traffic control symbols and parking lines (ORNL 1997b: 8-29).

3.2.2.7 Stormwater Drainage System

A stormwater drainage system would be constructed for the proposed SNS site. The stormwater drainage system would collect, detain, carry, and discharge stormwater runoff from the site so that water neither interferes with the safe operation and maintenance of the proposed SNS facilities nor causes erosion or other damage to natural or man-made features of the site (ORNL 1997b: 8-30). The system would include the drainage of newly constructed and improved roads connecting the proposed SNS site to existing roads. It would consist of contoured landforms and a system of subsurface pipes, junction boxes, and culverts to route stormwater to a retention basin. The retention basin would have sufficient capacity for a 100-year, 24-hour design storm. The system would mitigate the effects of excess runoff on downstream systems and would be monitored as required (ORNL 1997b: 8-30).

3.2.2.8 Proposed SNS Facilities

Temporary and permanent facilities would be constructed by the proposed SNS project. The temporary facilities would be established to support construction of the permanent proposed SNS facilities. The following types of temporary support facilities may be needed during construction of the proposed SNS (ORNL 1997b: 8-33 and 8-34):

- Storage, staging, and laydown areas for pipe, reinforced concrete, steel, cabling, conduit, rebar, fuel, and other construction materials.
- Shops, sheds, and test laboratories.
- Concrete batch plant and its aggregate stockpiles.
- Containment for aggregate stockpile runoff.
- Spoil disposal areas.
- Stockpile areas for excavated soil and rock.
- Borrow areas.
- Construction offices.
- Waste concrete disposal facility.
- Truck wash.
- Toilet facilities.
- Class IV landfill for disposal of construction debris.
- Facility to receive sanitary waste.

Most of these facilities would be established within the 110-acre (45-ha) proposed SNS footprint. However, borrow areas, stockpile areas for excavated soil and rock, spoil disposal areas, and a landfill for construction debris could be at off-site locations in the vicinity of the proposed SNS site.

To minimize the footprint area, all temporary facilities on the proposed SNS site would be located within areas subject to disturbance by site preparation activities. Facilities not slated for reuse as permanent facilities would be removed from the proposed SNS site when they are no longer needed. Construction of the temporary facilities would result in the generation of spoil, construction debris, and possibly other types of waste, which would be managed in accordance with the requirements identified in Section 3.2.2.11. Whenever practical, some facilities initially required for temporary use would be located and constructed with the potential to be reused as permanent shop or warehouse space. Construction would be in accordance with appropriate requirements in the Uniform Building Code (ORNL 1997b: 8-33 and 8-34).

Earth fill for the proposed SNS site would be obtained from off-site borrow areas. This fill would consist of excavated soil or excavated soil mixed with rock and would meet engineering requirements for foundation support and settling parameters. Borrow areas would be selected to minimize travel distances to the proposed SNS site.

Temporary security fencing would be erected around the construction site. This fencing would protect construction equipment and building materials. In addition, it would control access during construction and restrict vehicular traffic to authorized roads (ORNL 1997b: 8-34). This barrier would also limit the total area of land disturbed by construction activities.

The construction and use of several temporary facilities would involve minor discharges. Operation of the concrete batch plant would entail some water discharges. Operation of the truck wash facility would result in short-term discharges of wash and rinse waters, possibly containing small amounts of oil and other hydrocarbons. Construction wastewater would be collected in tank trucks and transported to appropriate waste management facilities for treatment. Thus, pollutant discharges to soil, surface water, and groundwater would be minimized.

The fuel storage facility would be equipped with sufficient secondary containment to prevent spills to the environment. Any releases from wash or fuel storage facilities would be pumped to tanks for transport to the local process water treatment facility. No release to local drainages would be permitted.

Permanent facilities on the proposed SNS site would consist of major buildings and several ancillary structures. Buildings would house the accelerator equipment and instrumentation, described in Section 3.2.1, that comprise the proposed SNS, as well as the support systems, laboratories, and offices necessary for its safe and effective operation. Ancillary structures would support the proposed SNS operations in the buildings, prevent soil erosion, provide structural support for equipment, and bolster site security. These structures would include cooling towers, an electrical substation, foundation pads for transformers, a fire water tank, retaining walls, fencing, and security inspector posts.

Fifteen permanent buildings would be constructed on the proposed SNS site for the 1-MW facility. These buildings would cover more than 6 acres (2.43 ha) of land within the 110-acre (45-ha) proposed SNS footprint. The constructed floor space in these buildings would be nearly 364,942 ft^2 (33,903 m^2) (ORNL 1997b: 8-1). The buildings that would be constructed, the major equipment that would be assembled within them, and their designed interior areas are listed in Table 3.2.2.8-1. Duplicates of existing buildings, such as the Target Building, would be constructed in association with later upgrades to an operating power of 4 MW (see Section 3.2.1.5). Refer to Figures 3.2.1-1 and 3.2.1.5-1 for the building layout.

Construction of the permanent buildings and ancillary structures would begin with excavations for building foundations, ancillary structure foundations/support pads, and retaining walls. These excavations would be performed with heavy equipment. Completion of the proposed SNS buildings would proceed as a standard construction project, except for the possible inclusion of slightly radioactive steel and concrete materials in the beam line tunnel buildings (refer to Section 3.2.2.4). These buildings would be constructed to resist natural

Table 3.2.2.8-1. Buildings to be constructed for the proposed SNS.

Building	Equipment Summary and Function	Size (ft^2)
Front End	Ion source; LEBT, RFQ, and MEBT; vacuum system, power supplies, cooling and service system storage, local control room.	18,345
Linac Tunnel	Linac structure; power, electrical, cooling, and service distribution systems; access towers.	23,778
Klystron Gallery	Klystrons, modulators, and rf power systems; magnet power systems; HVAC systems; waveguides to linac; 4 capacitor rooms.	54,810
HEBT Tunnel	HEBT structures; power, electrical, and service distribution systems.	9,255
Ring Tunnel	Ring structures; power, electrical, and service distribution systems.	14,482
RTBT	RTBT structures; power, electrical, and service distribution systems.	8,672
Target	Target, target moderator systems, shielding, target maintenance cell, experiment systems; electrical, cooling, and service systems for target, moderators, and experiment systems; waste collection systems; shops, equipment rooms, laboratories, and offices to support research instruments and activities. Compressor area.	120,565
Ring Service	Power supplies (including rf), electrical systems, cooling systems, vacuum systems, and HVAC systems.	7,500
RTBT Service	Power supplies, electrical systems, cooling systems, vacuum systems, and HVAC systems.	1,960
Beam Stop Service	Target, shielding, electrical, and service systems.	6,240
Central Utilities	Deionized cooling water system, chilled water system, compressed air, and heat exchangers.	9,000
Central Shop	Machine shop, storage, electrical shop, office space, shielded decay area, test and repair shops for klystrons and magnets, electronic equipment, vacuum systems and equipment, and tools and parts storage. Hot shop.	64,500
Integrated Control	Integrated control room, electrical and mechanical support equipment, service systems for control room, office and storage space to support control room activities.	8,660
Administration	Office and support space for operating personnel.	17,175
Site (miscellaneous foundations, pads, etc.)	Tank, transformer, pumps, switchyard, diesel generators, etc. Foundations, pads and structural features.	NA*

*NA – Not available.

phenomena such as earthquakes, wind, and flooding (ORNL 1997b: 8-40). Construction of the proposed SNS buildings would include the erection of structural support members and construction of the soil shielding berms (refer to Section 3.2.2.9). In addition, it would include the installation of utility, communications, environmental control, mechanical, data management, safety, fire protection, and waste system components. Construction would be completed with the finish and trim work and final installation of the accelerator equipment, controls, and instrumentation.

Erection of the ancillary structures would begin with the laying of foundations, support pads, and retaining walls. Completion of the ancillary structures would entail the erection of the cooling towers, electrical substation, security inspector posts, and permanent fencing. In addition, it would include the installation of transformers on their foundation pads.

3.2.2.9 Exterior Shielding Design

The conceptual design of the proposed SNS has exterior shielding to protect the environment from ionizing radiation. The beam line tunnels (linac, HEBT, rings, RTBT, and beam stops) would be backfilled with a soil cover contoured to match the natural slope (Figure 3.2.2.9-1). The thickness of the berm would be approximately 26 ft (7.9 m). The shielding calculations done by ORNL were for a representative soil type and were not site-specific. No significant differences are expected in the shielding properties of soils at different sites.

This berm would be constructed from fill set aside during excavation (with additional soil from a local borrow area, if needed). A diversion trench would carry any surface runoff away from the facility and the berm. A water-diverting barrier would be placed just below the surface of the soil berm to repel water from infiltration. A groundwater interceptor system would be constructed under the tunnel building. It would capture any groundwater that might breach the barrier and hold it for sampling within a leak-proof collection system. Foundation drains would be incorporated into the system. The system would be connected to the site's stormwater drainage system to allow the release of uncontaminated water. Other connections would allow transport of contaminated water to appropriate waste systems for treatment (ORNL 1997b: 8-31).

Beam loss is a term used to describe particles that escape the beam. These accelerated particles travel through the surrounding material. Many of them end up in the soil berm surrounding the linac tunnel. These particles would interact with the molecules in the soil, causing "activation" or the creation of slightly radioactive molecules within the soil. The soils nearest the tunnel would contain approximately 99.95 percent of radionuclides within the first 13 ft (4 m) of soil in the berm. At decommissioning, soils adjacent to the tunnel would constitute a radioactive source term that may require mitigation or monitoring.

Construction of the proposed SNS would incorporate features into the design of the berm shield (Figure 3.2.2.9-2) to protect against infiltration of groundwater and migration of radionuclides. The linac tunnel would be covered with an impermeable clay material (obtained by compaction of native soils possessing a high clay content).

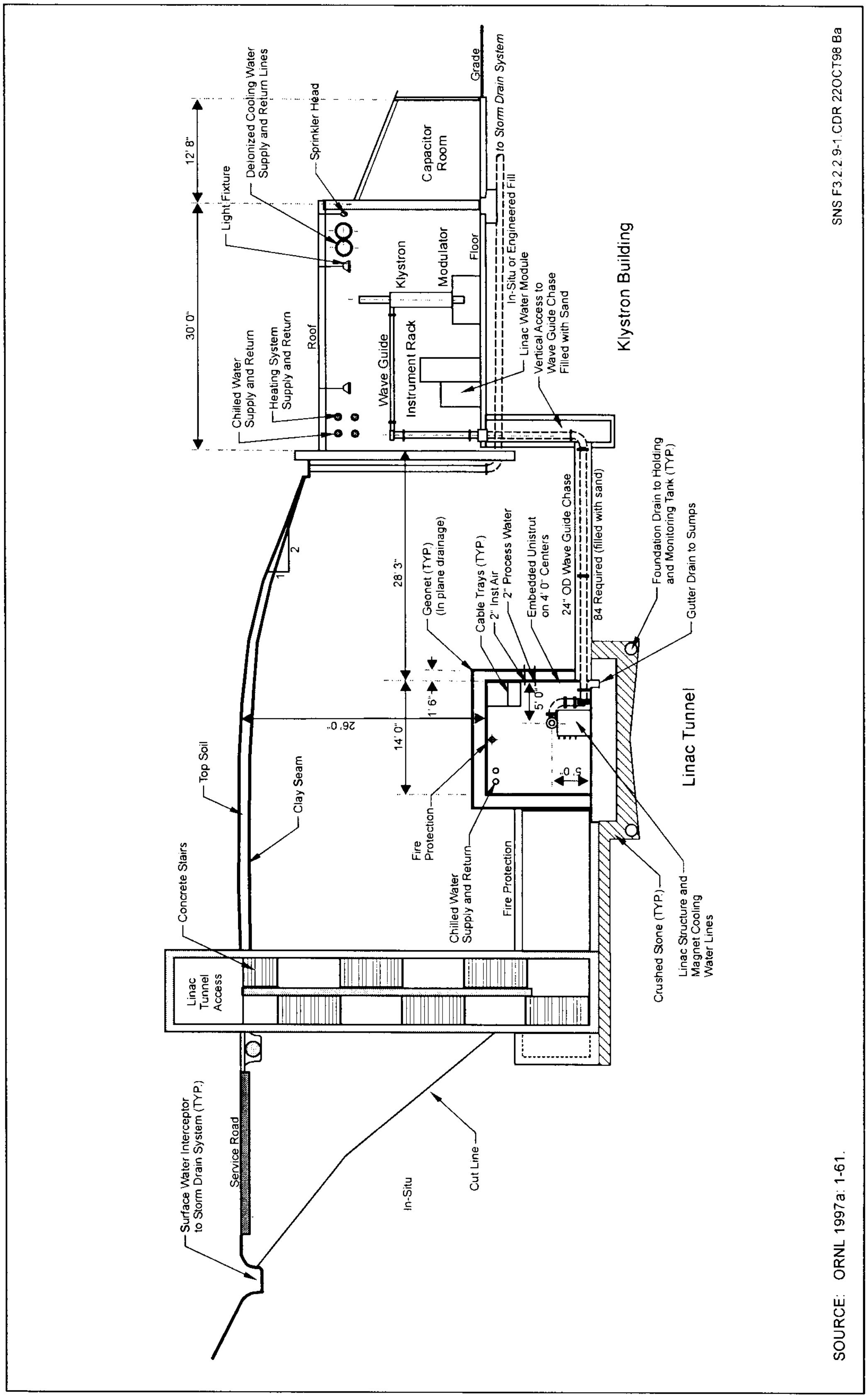


Figure 3.2.2.9-1. Detail of linac tunnel and shielding berm.

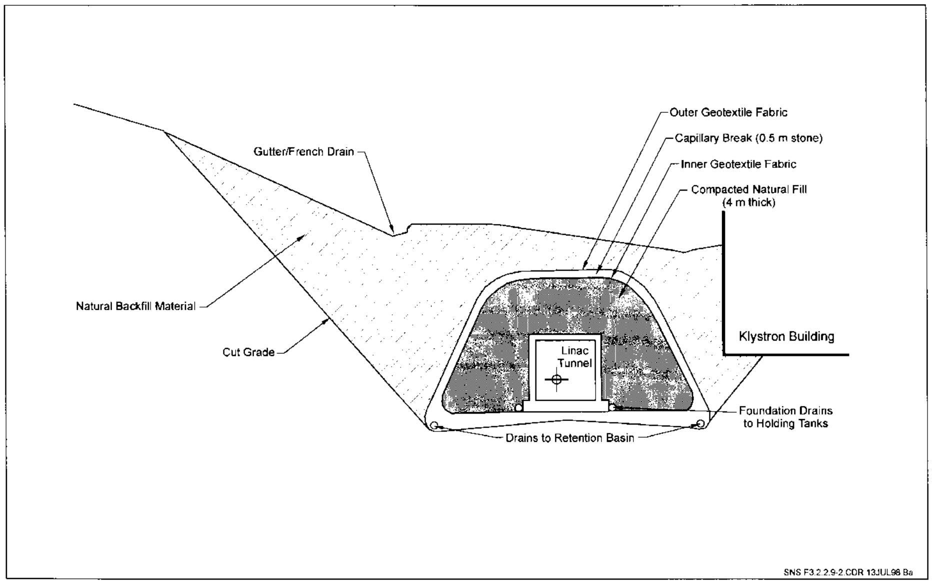


Figure 3.2.2.9-2. Linac berm shield.

The clay layer would then be backfilled with native soils, and the surface would be contoured to a natural slope. Foundation drains would be placed at the base of the linac tunnel to capture any infiltrating water that might by-pass the impermeable clay layer. These drains would channel this water into holding tanks for monitoring and proper disposal.

If, after the site for the proposed SNS is selected, site characterization shows that further mitigation would be necessary to prevent radionuclides from reaching the groundwater, the berm design would include a capillary break, a layer of crushed stone approximately 1.5 ft (0.5 m) thick placed between the clay layer and the native soils. The stronger capillary attraction of the finer-grained native soils would divert infiltrating groundwater away from the compacted clay materials. Drains at the base of the capillary break would carry diverted water to a retention basin for later discharge. To maintain its effectiveness, a porous but fine-mesh geotextile fabric membrane would be placed above and below the crushed stone to prevent the migration of soil particles into the stone interval. The capillary break would provide redundant protection to the impermeable clay layer permitting the shield materials and the tunnel structures to remain dry, thereby eliminating a mechanism for nuclide transport.

3.2.2.10 Landscaping

The proposed SNS site would be landscaped during the construction phase of the project. The landscaping would primarily involve the finishing of on-site landforms and the revegetation of cleared areas. This activity would simultaneously establish the final erosion control measures for the site and promote a variety of desirable aesthetic and environmental conditions (ORNL 1997b: 8-27).

The landscaping techniques, final landforms, and revegetation activities would be chosen to promote the recovery of natural resources disturbed during construction. For example, natural flora in unlandscaped areas would be reestablished and proper selection of final land contours and cover vegetation would prevent the erosion of topsoil. Landscape elements would be selected to enhance the diversity of native wildlife on the proposed SNS site. They would give prominence to attractive site features and de-emphasize or obscure less desirable features (parking areas, loading docks, and storage areas) and would provide visual buffers between security zones. Where feasible, trees would be used as elements of energy conservation for the proposed SNS buildings and for on-site control of noise. Where appropriate, open areas would be developed as environmental research zones (ORNL 1997b: 8-32).

Geotechnical systems, rip-rap, or other appropriate landscaping materials would be used in the construction of retaining walls to avoid the negative visual effect of massive retaining structures. Retaining walls that are part of buildings would be integrated structurally with the requirements of the groundwater interceptor system (ORNL 1997b: 8-31).

3.2.2.11 Waste Generation

The site preparation and excavation activities at the proposed SNS site could result in excess quantities of excavated material consisting of soil and rock. (ORNL 1997b: 8-33). None of this spoil material would be hazardous or radioactive waste. That portion of spoils material that could not be used on-site would be disposed of at a nearby borrow area. The disposed materials would be spread and compacted at the disposal area to maintain current drainage patterns. Construction materials waste would not be disposed of at this facility (ORNL 1997b: 8-33), but at a permitted construction debris landfill in accordance with current procedures at the selected site.

Nonradioactive and nonhazardous construction debris would be shipped to a permitted disposal site. This waste would consist of nonrecyclable excess materials (i.e., wood, drywall, and masonry) from facility construction and the demolition of temporary facilities. Any similar waste materials from the operation of temporary shops and test laboratories would also be disposed of in this facility.

Waste concrete would be disposed of in a disposal facility with appropriate waste acceptance criteria. No concrete contaminated with hazardous or radioactive materials would be disposed of in this facility.

Some hazardous wastes would be generated by construction activities at the proposed SNS. In addition, radioactive scrap steel and concrete waste could be generated as a consequence of reusing slightly radioactive steel and/or concrete from other DOE sites in the construction of several permanent proposed SNS buildings. Any hazardous wastes generated during construction at the proposed SNS would be managed in accordance with applicable requirements under the Resource Conservation and Recovery Act (RCRA).

Portable toilets would be used as sanitary waste facilities during construction of the proposed SNS. The waste in these toilets would be removed on a regular schedule by a qualified sanitary waste contractor. In the latter phases of construction, some of the new buildings would be connected to the permanent sanitary waste system for the proposed SNS site. In such cases, these facilities would be used instead of the portable toilets.

3.2.2.12 Noise

Construction activities at the proposed SNS site would generate noise produced by heavy construction equipment, trucks, power tools, and percussions from pile drivers, hammers, and dropped objects. In all cases, the levels of noise would be representative of levels at large-scale building sites. Table 3.2.2.12-1 describes peak and attenuated noise levels expected from operation and construction equipment.

Relatively high and continuous levels of noise would be produced by heavy equipment operations during the site preparation phase of construction. However, after this time, heavy equipment noise would become more sporadic and brief in duration. The noise from trucks, power tools, and percussion would be sustained through most of the building erection and equipment installation activities on the proposed SNS site. As construction activities reach their conclusion, sound levels on the proposed SNS site would decrease to levels typical of daily SNS operations.

3.2.2.13 Air Emissions

Construction of the proposed SNS would result in some pollutant emissions to the atmosphere. However, these emissions would be temporary. The primary emission during construction would be fugitive dust during the clearing and grading of the site. Dust suppression techniques, primarily water sprays with a dust suppressant, would be used to control dust.

Table 3.2.2.12-1. Peak and attenuated noise levels (in dBA) expected from operation of construction equipment.

Source	Peak Noise Level	Distance from Source			
		50 ft	100 ft	200 ft	400 ft
Heavy trucks	95	84-89	78-83	72-77	66-71
Dump trucks	108	88	82	76	70
Concrete mixer	108	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Bulldozer	107	87-102	81-96	75-90	69-84
Generator	96	76	70	64	58
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Forklift	100	95	89	83	77

Source: Golden et al. 1980.

3.2.3 OPERATIONS

Operation of the proposed SNS in the 1-MW configuration would begin in FY 2005, when most of the construction activities at the proposed SNS site would have been completed. These operations would continue for the 40-year design life of the facility. However, this design life would not preclude operational extensions beyond 40 years (DOE 1997c). This section identifies the workforce required for operations and characterizes the proposed SNS operations in terms of resource requirements and operational activities that have the potential to cause impacts, such as air emissions and waste discharges.

3.2.3.1 Workforce

The proposed SNS would be operated by a permanently assigned staff and visiting scientists. Permanent staffing would begin with facility commissioning, currently scheduled for FY 2004-2005. By the first full year of operation, FY 2006, approximately 250 individuals would be working at the proposed SNS—approximately 180 resident employees (scientists and support personnel) and 70 visiting scientists. Approximately 125 additional people would be added to the workforce when the second target is completed.

It is anticipated that 1,000 to 2,000 visitors and sightseers would tour the proposed SNS each year. This level of visitation would begin during the first full year of operations and continue throughout the life of the facilities. The proposed SNS would have a visitor center as an integral part of the facility. In addition, portions of the facility would be designed to allow viewing by the visiting public.

3.2.3.2 Traffic

The commuting by proposed SNS staff and visiting scientists would constitute the heaviest operations-related traffic in the vicinity of the proposed SNS. This traffic would begin at relatively low levels with commissioning of the proposed SNS site in FY 2004-2005. By the first full year of operations in 2006, a substantial increase in daily round trips to the proposed SNS site would occur. This level of commuter traffic would continue until the proposed SNS is supplied with an additional ring and target and operated at 4 MW. After this upgrade and an attendant increase to approximately 375 employees, the daily round trips would increase to approximately 302. The addition of a small number of visiting scientists after the upgrades would minimally increase daily round trips to the proposed SNS.

The traffic generated by delivery vehicles, service vehicles, and visitors (3/day) to the proposed SNS site would always be a much smaller component of the operations-related traffic than the commuter traffic. However, later upgrades to the proposed SNS may be associated with small increases in such traffic. For the remaining life of the proposed SNS, daily round trips would stabilize at approximately 305 per weekday (refer to Table 3.2.3.2-1).

3.2.3.3 Material Consumption

Operational activities at the proposed SNS would consume a wide array of raw materials. Table 3.2.3.3-1 lists the major raw materials that would be used by proposed SNS operations. However, at this time the quantities of materials that would be consumed are not known.

Table 3.2.3.2-1. Operations traffic.

Activity	Daily Round Trips
Maximum employee commutes/day	302/day[1]
Service vehicles and supply trucks	3/day
Total number of vehicles	**305/day**

[1]Value taken from Table 5.2.10.1-2.
Source: Tables 5.1.10.1-2, 5.2.10.1-1, 5.3.10.1-2, and 5.4.10.1-1

Table 3.2.3.3-1. Proposed SNS raw material usage.

Materials	Use
Charcoal absorbent	Absorber system in gaseous waste system. Removes mercury from off-gases
Refrigerant fluid	Air conditioning equipment in the linac tunnel
Helium gas	Gas distribution and cryogenic systems
Nitrogen gas	Gas distribution and cryogenic systems
Hydrogen gas	Gas distribution and cryogenic systems, moderators, and targets
Deuterium gas	Gas distribution and cryogenic systems
Argon gas	Gas distribution system and beam loss monitoring
Oxygen gas	Gas distribution system
Acetylene gas	Gas distribution system
Diesel fuel	Electrical system (emergency generators)
Gasoline	Yard and ground maintenance operations
Oil	Yard and ground maintenance operations and electrical system
Scintillation cocktail	Research laboratories
Laboratory chemicals (acids, bases, solvents, etc.)	Research laboratories

Source: ORNL 1997b

3.2.3.4 Utilities

Daily operations at the proposed SNS would be heavily dependent upon the utility systems that serve the site. This would be especially true for the accelerator systems and target systems that require large supplies of electrical power for operation and water for cooling.

Table 3.2.3.4-1 shows the utility systems that would serve the proposed SNS, their operational functions, and the projected quantities of utility-based energy and raw materials that would be used per unit time during operation of the proposed SNS. The listed quantities reflect projected peak use of energy and raw materials per unit time for the facility at 1 MW and fully upgraded at 4 MW.

3.2.3.5 Air Emissions

Air emissions from the proposed SNS during operations would be primarily ventilation air from the linac tunnel, accumulator rings, and target building. The linac and ring tunnels would be ventilated to allow hands-on maintenance when the facility is not operating. The ventilation system would be designed to include a short retention time before the air is released to the environment. The type and amount of radionuclides that would be released during operations at both 1-MW and 4-MW

Table 3.2.3.4-1. Proposed SNS utility systems.

Utility System	Operational Functions in Proposed SNS	Projected Use / Unit Time
Natural gas	Feeds fuel to the boilers and localized unit heaters in the building heating system.	1,000 lb/hr - maximum
Water	Supplies water to the tower water cooling system, deionized cooling water system, chilled water system, building heating system, process water system, potable water system, demineralized water system, fire suppression system, and two target moderators.	800 gpm - 1 MW 1,600 gpm - 4 MW
Electrical	Supplies electrical power to the accelerator and target systems, instrumentation and control systems, communications and alarm systems, lighting systems, cathodic protection systems, and all other systems/equipment that use electricity.	62 MW power supply to deliver a 1-MW beam 90 MW power supply to deliver a 4-MW beam

Source: ORNL 1997b.

beam powers are shown in Table 3.2.3.5-1. Only radionuclides that make up one percent or more of the total number of curies released are included in the table.

There would be air emissions from the proposed SNS target system, primarily during periods of maintenance. Ventilation air from the target system would be compressed into tanks for a minimum of seven days to allow many of the short-lived radionuclides to decay. The air would then be released through charcoal and HEPA filters to the atmosphere. The type and amount of radionuclides that would be released from the target systems are included in Table 3.2.3.5-1.

Air pollutants would be emitted from the beam stops. The release of radionuclides from the beam stops would only occur during maintenance. No releases would occur during normal operations of the proposed SNS. Gases released from the beam stops would be compressed into tanks to allow radionuclides to decay for a minimum of seven days. The air would then be released through HEPA filters to the atmosphere. The type and amount of radionuclides that would be released from the cooling systems, target systems, beam stops, and tunnel confinement are included in Table 3.2.3.5-1. All air releases would be through monitored stacks on the proposed SNS buildings.

3.2.3.6 Effluent Discharges

Operation of the cooling towers, groundwater interceptor system, and stormwater drainage system would result in effluent discharges to soil and/or surface water bodies at the proposed SNS. These discharges would consist of cooling tower blowdown, any groundwater that might collect in the groundwater interceptor system under the concentric shielding design, and stormwater runoff from the proposed SNS site.

During operation of the proposed SNS, excess heat must be removed from many of the components. Many components of the linac are water-cooled. The beam stops would be designed to dissipate the energy of the beam and thus would be water-cooled. Components of the target assembly would also be water-cooled. Some of this heat would be recovered and used for general space heating; however, most of this heat would be dissipated to the environment

Table 3.2.3.5-1. Projected annual emissions of radionuclides from proposed SNS facilities.

	Target Building Exhaust (Ci)						Tunnel Confinement Exhaust (Ci)			
	Cooling Systems[a]		Target Off-Gas[a]		Beam Stops[b]		Linac, Ring, and Beam Transfer Tunnels[b]		Total	
Nuclide[c]	1 MW	4 MW	1 MW	4 MW	1 MW	4 MW	1 MW	4 MW	1 MW	4 MW
H-3	2.8	11.1	22.4	89.6	0	0	0	0	25.2	100.7
C-10	0	0	0	0	0	0	25.5	40.4	25.5	40.4
C-11	0	0	0	0	0	0	40.6	60.4	40.6	60.4
N-13	0	0	0	0	0	0	318	483	318	483
O-14	0	0	0	0	0	0	89.9	133	89.9	133
O-15	0	0	0	0	0	0	341	519	341	519
Al-28	0	0	0	0	0	0	8.6	0	8.6	0
Ar-37	126	502	0	0	250	467	0	0	376	969
Xe-125	0	0	1.2	5	0	0	0	0	1.2	5
Xe-127	0	0	80.5	322	0	0	0	0	80.5	322
Hg-197	0	0	3.6	14.4	0	0	0	0	3.6	14.4
Hg-203	0	0	3.3	13.2	0	0	0	0	3.3	13.2
Total	128.8	513.1	111	444.2	250	467	823.6	1235.8	1313.4	2660.1

[a] DeVore 1998h.

[b] DeVore 1998c.

[c] Nuclides listed contribute one percent or more of the total activity released from a given system.

through a bank of eight mechanical cooling towers. Approximately 500 gpm (1,892 lpm) of water would be required for operation of the cooling towers; approximately half of this water would be released to the atmosphere, mostly in the form of water vapor. The other half of the water would be released as blowdown to surface water. In order to upgrade the proposed SNS to 4-MW beam power, five additional cooling towers would need to be installed and approximately 700 gpm (2,650 lpm) of water would be required for operation of the cooling towers.

The cooling tower blowdown water would not contain any radioactivity. The water would contain biocides and anti-scaling agents required for proper operation of the tower. Cooling towers dissipate heat primarily by evaporation. Therefore, the constituents in the water would be concentrated by a factor of four. The temperature of the blowdown would be between 90 and 95 °F (32 and 35 °C).

The blowdown water would be dechlorinated, if necessary, and released to the approximate 2 acre (0.81 ha) retention basin. The retention basin would be designed with an appropriate residence time to allow the water to cool further, before being released to the environment. If necessary, the retention basin would include fountain or water sprays to assure that the temperature of the water released to the environment would be within 5°F of the temperature of the receiving stream.

The groundwater interceptor system beneath the beam shielding berms would collect any water that might penetrate the water-diverting barrier in the berms and infiltrate through the berm soil. Only a minimal amount of water would be expected in this system. This water would be collected in a sump that would be inspected monthly, and any water found in the sump would be removed and sampled. If contamination were found, the water would be transported to the appropriate waste treatment systems. Water with no contamination would be released to the stormwater drainage system.

The stormwater drainage system on the proposed SNS site would intercept precipitation runoff from the proposed SNS buildings, walks, plazas, roads, parking lots, and landscape surfaces. The majority of this water would be directed to the retention basin. The retention basin would allow excess silt to settle out before the water would be released through the surface water discharge. This discharge would require a National Pollutant Discharge Elimination System (NPDES) permit.

3.2.3.7 Waste Generation

All wastes generated by the proposed SNS would be handled according to procedures already in place at the selected site for the SNS would result in the generation of four types of waste (Table 3.2.3.7-1).

Sanitary and hazardous wastes are considered solid waste under RCRA and state-administered waste management rules. Solid waste can occur in the form of solids, liquids, or gases. The types of solid waste generated by operations at the proposed SNS would include hazardous waste, primarily liquids such as solvents, and nonhazardous and nonradioactive waste generated by human sanitation activities at the proposed SNS. This waste would be generated in both solid and liquid form. It would include trash, human waste, and waste liquids such as personal shower wash and rinse water. In addition, the generated solid waste would include mixed waste, which is waste that contains both hazardous and radioactive constituents.

Low-level radioactive waste would be generated by operations at the proposed SNS. This waste would be generated in liquid form [liquid low-level waste (LLLW)] and solid form (solid low-level waste) (ORNL 1997b: 8-139 to 8-140). Further details of waste generation and disposal can be found in Chapter 5.

3.2.3.8 Safety

Daily operations at the proposed SNS would entail a number of potential hazards to human safety and health. The proposed SNS would be designed, constructed, and operated to protect workers and the public from these potential hazards.

The potential hazards associated with operations at the proposed SNS would fall into two major categories: standard industrial hazards and nonstandard industrial hazards. Most of the hazards posed by the proposed SNS operations would be standard industrial hazards. These hazards would be posed by the presence of combustible materials (general materials, hydrogen gas, and natural gas); electrical energy (high voltage); potential energy (cranes); mechanical energy (forklifts and other vehicles); asphyxiants (refrigerant fluid and helium); and toxic, corrosive, or oxidizing materials. Additional potential hazards common to the proposed SNS and many other industrial facilities would include laser operations, electrical power outages, and general fires. The potential nonstandard industrial hazards would consist of ionizing radiation; nonionizing radiation; magnetic fields; and toxic, corrosive, or oxidizing materials (mercury target) not

Table 3.2.3.7-1. Annual waste generation by the proposed SNS.

Waste Type	Generation Rate 1-MW Beam	Generation Rate 4-MW Beam
Hazardous Waste		
Liquid	41 m^3/yr	41 m^3/yr
Low-Level Radioactive Waste		
Liquid	166 m^3/yr	665 m^3/yr
Process waste (potentially LLW)	3,940 m^3/yr	15,800 m^3/yr
Solid	513 m^3/yr	1,026 m^3/yr
Mixed Waste		
Liquid	10.8 m^3/yr	10.8 m^3/yr
Solid	3.5 m^3/yr	7 m^3/yr
Sanitary Waste		
Liquid	47 m^3/yr	69 m^3/yr
Solid	900 m^3/yr	1,349 m^3/yr

normally classified as standard industrial hazards (ORNL 1997b: 9-6 to 9-8). Engineering and administrative controls would be implemented to protect the proposed SNS workers and the public from these operational hazards.

Engineering controls would be incorporated during design and construction of the proposed SNS. The buildings, systems, and equipment that comprise the proposed SNS would be designed and constructed in accordance with the Uniform Building Code; National Electric Code; fire, life safety, and piping codes; and other applicable and appropriate consensus standards (ORNL 1997b: 9-5). The use of combustible materials in construction and equipment would be limited (ORNL 1997b: 9-19). Smoke and fire detection systems would conform to National Fire Protection Association standards relevant to their construction and installation, as would the fire suppression systems installed throughout the proposed SNS (ORNL 1997b: 9-20).

Workers would be protected from ionizing radiation during operations by established distances from sources and installed shielding. The shielding design policy for the proposed SNS (ORNL 1997b: 9-12) limits the radiation dose rate to that specified in 10 CFR 835 (less than 100 mrem annually for a maximally exposed nonradiological worker). The shielding, consisting of steel, lead, concrete, and earth, would be supplemented by a variety of engineered systems and controls, including beam containment and monitoring systems, radiation detectors and monitors, audible/visible radiation warning devices, scram buttons in areas subject to irradiation, locked doors, and interlock systems to disable the beam if anyone attempts to enter the tunnels or target area during beam operations (ORNL 1997b: 9-12 to 9-16). The proposed SNS would be equipped with additional engineering features to prevent the uncontrolled release of radioactive mercury and other radioactive materials in the event of an operational accident (ORNL 1997b: 9-16 to 9-19).

The proposed SNS would be operated in strict compliance with a variety of administrative, safety, and health controls. These controls would include all applicable portions of the Occupational Safety and Health Administration

(OSHA) regulations; federal, state, and local environmental statutes and regulations; "Work Smart Standards" derived from DOE orders and guidance; and current safety and health procedures of the Management and Operations contractor organization. The continuation of safe operations would be bolstered by a regular program of safety evaluations and compliance audits.

The proposed SNS would be a low-hazard facility with no significant potential to affect off-site residents or nearby travelers. Emergency preparedness planning would emphasize operational contingencies that support impacted workers or equipment at the facility. An emergency plan would be developed to ensure that emergency response resources could be applied quickly and efficiently at the proposed SNS (ORNL 1997b: 9-22).

3.2.3.9 Noise

Operations at the proposed SNS would not produce continuous noise at high or extreme (>90 dB) levels. The same would be true for intermittent noises, although an unforeseeable incident might occur that would briefly spike a high noise level. The highest level of noise among proposed SNS operations would be produced by the cooling towers. Overall noise levels on the proposed SNS site, including operation of the cooling towers, would be comparable to existing noise levels at the host national laboratory. During the landscaping process, trees would be strategically planted to create noise barriers (ORNL 1997b: 8-27).

3.2.4 ALTERNATIVE SITES

Four alternative sites are considered in detail in this FEIS (refer to Appendix B). Through the screening process discussed below, four alternative sites for construction and operation of the proposed SNS were identified: ORNL, LANL, ANL, and BNL. DOE used a phased approach to identify potential siting alternatives for the proposed SNS. The first phase narrowed the potential sites for placement of the proposed SNS to four of the DOE national laboratories. The second phase involved identifying a specific location within each of the four national laboratories. The approach to site selection is summarized below. Further details are provided in Appendix B.

3.2.4.1 Identification of Alternative Sites

This section describes the requirements and processes that were used to determine sites for the construction and operation of the proposed SNS.

3.2.4.1.1 Technical/Logistical Requirements

The initial task in the site-selection process involved the definition of specific project requirements. These requirements were used to develop technical and logistical site exclusion criteria. For siting the proposed SNS, the following criteria were deemed necessary to meet the mission goal of supporting neutron science research and providing neutrons for materials research:

- A site with a minimum area of 110 acres (45 ha) and a rectilinear shape to accommodate the length of the proposed linear accelerator and possible future expansion of the facility.
- A 1-mi (1.6-km) buffer zone around the proposed SNS site to restrict uncontrolled public access and to insulate the public from the consequences of a postulated accident at the facility.

- Proximity and availability of an adequate electric power source. The regional power grid must be able to supply 40 MW of power during periods of operation. The site must be within 0.25 to 1 mile (0.4 to 1.6 km) of existing transmission lines to minimize collateral construction impacts and costs.
- Presence of existing neutron science programs and infrastructure to provide a pool of neutron science expertise and experience to meet mission goals. The site must have major facilities and programs utilizing neutron scattering techniques.

3.2.4.1.2 Phase 1 Site Selection

DOE conducted a site-selection process (Appendix B) to systematically identify suitable alternative sites for the proposed SNS. This process followed a two-tiered approach. The first level consisted of a decision to limit potential proposed SNS sites to existing DOE facilities. The second was identification of the basic technical and logistical requirements for meeting the mission goals of the proposed SNS Project (refer to Appendix B).

3.2.4.1.3 Use of Existing DOE Facilities

The logical universe of candidate sites for the proposed SNS in the United States was classified into three major categories: (1) existing DOE sites; (2) DOE acquisition and development of other federal property or a new, privately owned site; or (3) joint use of a nonfederal site (i.e., an academic facility).

DOE has an estimated 2.37 million acres (0.96 million ha) of land and many facilities nationwide from which to select candidate sites (DOE 1997b). Not suitable for the development of the proposed SNS are DOE operations offices, site offices, power administrations, and special purpose offices. The search was limited to facilities, such as national laboratories, that would likely have sufficient land holdings to accommodate the proposed SNS.

Other existing federal sites included Department of Defense facilities (e.g., closed U.S. Air Force bases) or lands managed by other federal agencies, such as the Department of the Interior. DOE also had the option of acquiring a new, privately owned site through purchase, trade, or possible condemnation. However, acquisition of these properties would have required lengthy, costly, and detailed site selection, environmental compliance, and jurisdictional transfer processes. In addition, while some of these sites might have offered the physical, power, and infrastructure requirements needed to meet the proposed SNS Project mission goals, none of them could offer the necessary neutron science and infrastructure support requirements.

A final candidate site category included co-location of the proposed SNS facility at a nonfederal location, such as an academic center or private research facility. This category was dropped from further consideration because few, if any, non-DOE facilities could offer neutron science and infrastructure support needed for efficient operation of the SNS. Also, establishing a facility with the overall magnitude of the proposed SNS would be similar to establishing another national laboratory. This site category would not maximize the use of existing federal and/or DOE resources, would not be cost efficient, and could duplicate existing DOE missions, thereby being in direct conflict with current DOE initiatives, as defined in several recently released studies and reports (DOE 1997b).

Therefore, it was deemed appropriate to limit the search for alternative proposed SNS sites to federal properties. Furthermore, this search was limited to specific types of DOE facilities, such as the national laboratories, because of their scientific and technical infrastructures.

Most of the DOE-owned or -operated facilities were immediately eliminated from consideration because of the nature of the sites or the uniqueness of the programs carried out at the sites. For example, DOE operations offices were excluded from the list of considered sites because they are typically in office buildings located in or near downtown population areas, and they lack sufficient land to meet proposed SNS Project objectives. DOE power administration offices and most special project offices are specialized, and they do not have the necessary program experience or infrastructure to support the proposed SNS. Examples would include the oil reserves in California and Louisiana and the oil shale reserves in Colorado and Wyoming. Based on the 4 DOE facility-screening criteria, 39 DOE facilities or sites were carried forward as the universe of potential sites for the proposed SNS.

Each of the 39 facilities was reviewed against the 4 major exclusion criteria. Failure of a site to meet any of the four criteria resulted in its elimination from further consideration. Through this process, 35 facilities were eliminated. The four remaining sites represent the array of reasonable site alternatives for the proposed SNS. These sites are ORNL, LANL, ANL, and BNL. They are the siting alternatives considered for detailed analysis in this FEIS (refer to Sections 3.2.4.2. through 3.2.4.5).

3.2.4.1.4 Phase 2 Site Selection

Phase 2 of the site-selection process involved selecting a specific location for the proposed SNS at each of the four national laboratories. DOE sent the proposed SNS site requirements to each of the four national laboratories, each of which was responsible for selection of their preferred site for the proposed SNS. The four site alternatives identified by the site-selection process are described briefly below. Detailed characterization of each site is presented in Chapter 4.

3.2.4.2 Oak Ridge National Laboratory (Preferred Alternative)

As required by CEQ regulations for implementing NEPA [40 CFR 1502.14(e)], DOE has identified the preferred alternative: to construct and operate the proposed SNS at ORNL in Oak Ridge, Tennessee. This alternative would allow DOE to take advantage of the highly trained staff at ORNL and the experience gained during development of the conceptual design for the Advanced Neutron Source.

The Oak Ridge Reservation (ORR) is located in and around the city of Oak Ridge, Tennessee. It was acquired by the federal government in 1942 for the wartime Manhattan Project. The ORR contains three major facilities: ORNL, the Y-12 Plant, and the East Tennessee Technology Park (ETTP, formerly the K-25 Site), and occupies approximately 35,516 acres (14,379 ha) in Roane and Anderson counties. The ORR and the proposed site for the SNS are shown in Figure 3.2.4.2-1. This site was selected through a formal evaluation process. The site-selection report describing this process is provided in Appendix B.

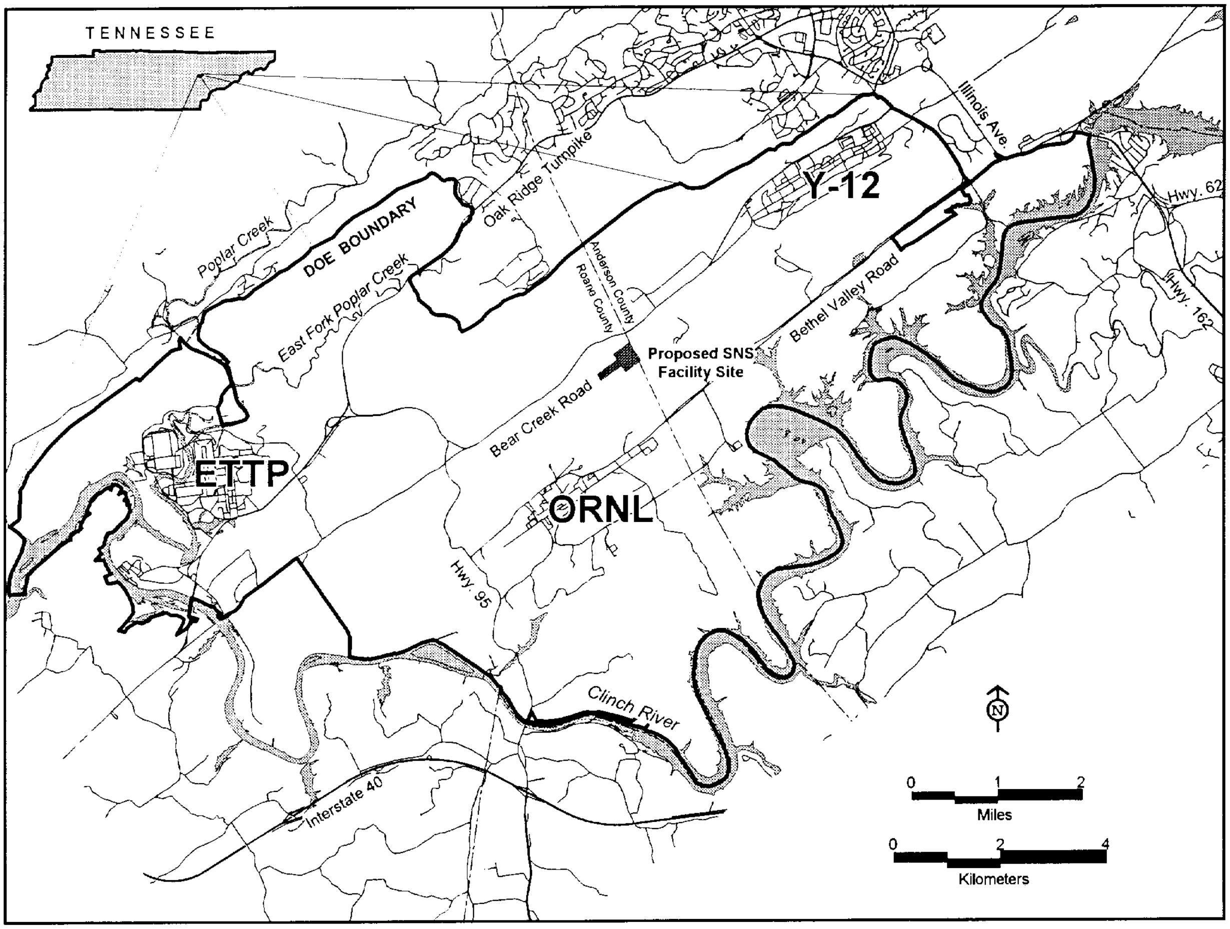


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Figure 3.2.4.2-1. ORNL proposed SNS site.

In response to a request received during the public review of the DEIS, DOE also investigated the potential of a brownfield site, the White Wing Scrap Yard, for siting the SNS. The White Wing Scrap Yard is a major brownfield site located on the ORR near the intersection of State Highways 58 and 95. It consists of approximately 30 acres of land known to be radioactively contaminated. This contamination extends to areas of land immediately adjacent to this area on all sides and extends along two unnamed tributaries of Bear Creek that flow out of this area to the south and southeast. This site would not be an environmentally desirable location for the proposed SNS because of its location relative to environmentally sensitive areas and the presence of a potentially unstable geological feature (refer to Appendix A, comment P-1-1).

The proposed site along Chestnut Ridge comprises a long, wide, and gently sloping ridge top with a broad saddle area at its eastern end. This area is planned for the target station and would require a minimum of excavation. The linac, transport line, and ring tunnels would be notched into the south side of the ridge using cut-and-fill techniques, providing economical construction and effective shielding strategies. Initial characterization of the site indicates bedrock located approximately 150 feet below the planned level of the accelerator components with very stable soil being the primary matrix for emplacement of the physical plant.

Appropriate foundations would provide the required stability for the accelerator and support structures. The entire site is currently undeveloped.

Table 3.2.4.2-1 describes site-specific information concerning utilities and infra-structure requirements at the ORNL site. Detailed characterization of the ORNL site is provided in Section 4.1.

3.2.4.3 Los Alamos National Laboratory

This alternative would involve the construction and operation of the proposed SNS on a site at LANL. The geographic location of LANL is illustrated in Figure 3.2.4.3-1. The site was selected through a formal evaluation process. Appendix B contains the site-selection report describing this process.

LANL is located in Los Alamos County in north-central New Mexico, approximately 60 miles (97 km) north-northwest of Albuquerque and 25 miles (40 km) northwest of Santa Fe. The 43-mi² (111-km²) laboratory is situated on the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep east-to-west oriented canyons cut by intermittent streams.

Table 3.2.4.2-1. Utility and infrastructure requirements for the proposed SNS site at ORNL.

Facility Requirements	Site-Specific Attributes
Site access	Primary access is by Chestnut Ridge Road from Bethel Valley Road. The condition of Chestnut Ridge Road is passable and of gravel construction. The road is currently accessible through a gate with virtually no traffic on this road. Approximately 2 miles (3.2 km) of Chestnut Ridge Road would be upgraded in accordance with the Tennessee Department of Transportation (DOT) standards and specifications to support heaviest anticipated traffic, including emergency vehicles weighing up to 20 tons.
Borrow material and spoils disposal	The proposed SNS will have soil berms shielding the linac, storage rings, and beam transfer lines. The source of the material for the berms is stockpiled material from the site excavation. New service road would be constructed from the proposed SNS site to the West Borrow Area, located approximately 1,500 ft southwest of the proposed site. The West Borrow Area is an operating source of dirt and fill material for projects on the ORR.
Electrical power	Power required for the proposed SNS (62 MW for 1-MW beam; 90 MW for 4-MW beam) would be provided by the DOE-owned 161-kV transmission line located less than 3,000 ft (914 m) west of the site. A feed line would be constructed from the existing line to a new primary substation at the proposed SNS site.
Potable water	Potable water [800 gpm (3,028 lpm) for 1-MW beam; 1,600 gpm (6,057 lpm) for 4-MW beam] would come from 24-in (61-cm) ORNL water main, which runs through the eastern end of the proposed site. Existing capacity within the plant and supply lines is available to meet anticipated demand.
Natural gas	Natural gas (1,000 lb/hr in winter months) would be piped from the ORNL 100-psig distribution header from the East Tennessee Natural Gas Company (ETNG) B-Station. Approximately 5,000 ft (1,524 m) of pipeline would be constructed along Chestnut Ridge Road to the site. The ETNG line is sized sufficiently to supply the demand at the proposed SNS.
Steam	The proposed SNS facility would include steam generation. Steam is available from the ORNL steam plant but would require a minimum of 1.5 miles (2.4 km) of insulated steam pipe, a condensate collection system, and/or a return system.
Compressed air	The proposed SNS facility would include air compressors.
Chilled water	The proposed SNS facility would include water chillers (32,000 tons).

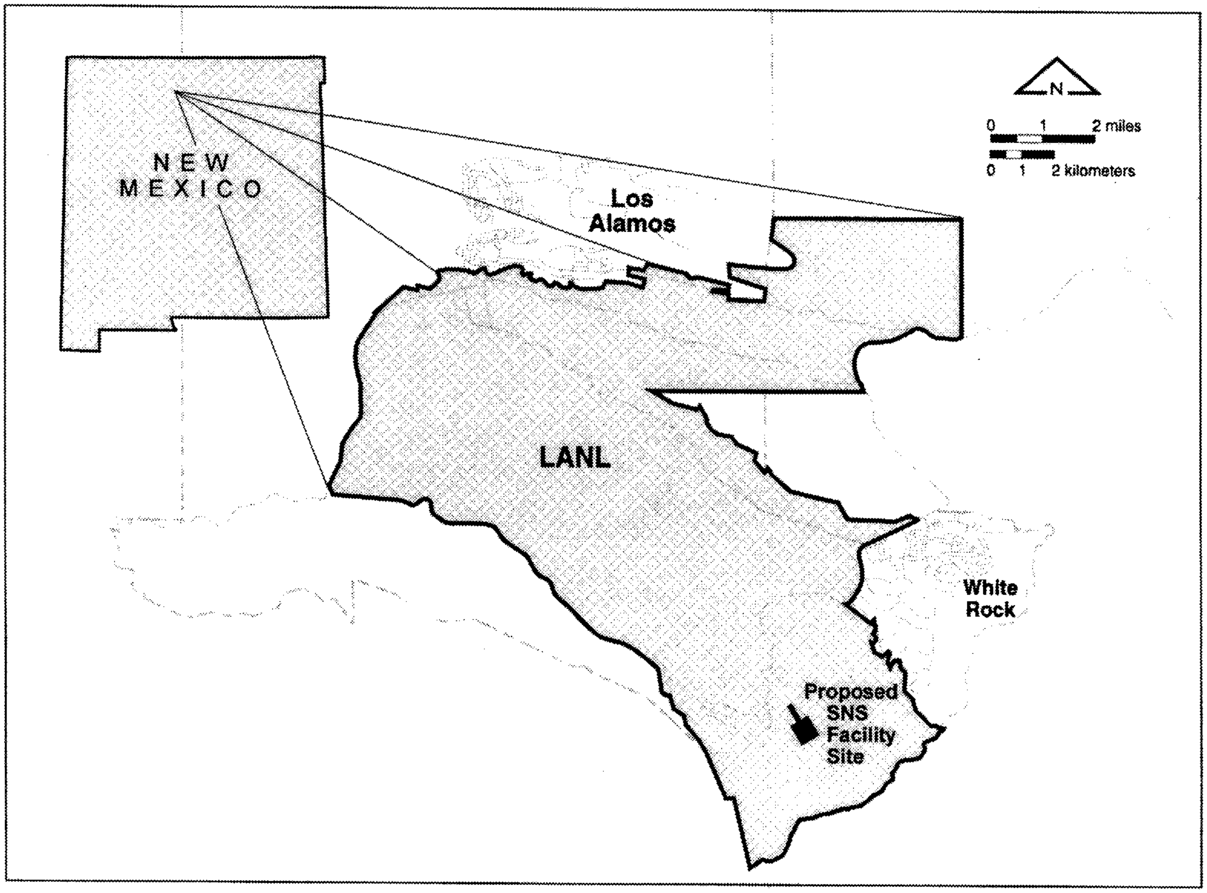

Figure 3.2.4.3-1. LANL proposed SNS site.

Since its inception in 1943 as the Manhattan Project's site for development of the first nuclear weapons, LANL's primary mission has been nuclear weapons research and development and related projects.

Most laboratory and community development is confined to the mesa tops. The surrounding land is largely undeveloped, and large tracts of land north, west, and south of the laboratory are held by the Santa Fe National Forest, Bureau of Land Management, Bandelier National Monument, General Services Administration, and Los Alamos County. The Pueblo of San Ildefonso borders the laboratory to the east. Table 3.2.4.3-1 describes site-specific information concerning utilities and infrastructure requirements at the LANL site. Detailed characterization of the proposed project site is provided in Section 4.2.

3.2.4.4 Argonne National Laboratory

The implementation of this alternative would involve constructing and operating the proposed SNS on a site at ANL. Like ORNL, ANL was established in 1942 as a part of the Manhattan Project. ANL's mission is research and development in basic energy and related sciences and is an important engineering center for the study of nuclear and nonnuclear energy sources. Figure 3.2.4.4-1 shows the geographic location of ANL. This site was selected through a formal evaluation process. The site-selection report outlining this process is provided in Appendix B.

Table 3.2.4.3-1. Utility and infrastructure requirements for the proposed SNS site at LANL.

Facility Requirements	Site-Specific Attributes
Site access	Primary access would be via a new access road off State Road 4 to the proposed SNS site. State Road 4 is a rural state highway, and any highway upgrades would have to be negotiated with the New Mexico State Highway Department. Other traffic concerns may be associated with access to Bandelier National Monument.
Borrow material and spoils disposal	Borrow material sources within LANL are limited and are not located near the proposed SNS site. One option would be to negotiate with Los Alamos County for borrow material currently located at the Los Alamos County Landfill.
Electrical power	LANL's existing electrical power system infrastructure is not adequate to support an additional 62-MW (1-MW beam) or 90-MW (4-MW beam) demand. It would be necessary to bring in a new 115 kV line from east of the site or to construct an SNS site-specific power generator. The specific siting of a new line is still under evaluation.
Potable water	Accommodating this need [800 gpm (3,028 lpm) for 1-MW beam; 1,600 gpm (6,057 lpm) for 4-MW beam] would require extensive potable water delivery system upgrades, including many lines, lift stations, and storage tanks. The nearest potable water system at Technical Area (TA)-39 would not be able to provide the required demand.
Natural gas	Natural gas is not available. Alternate energy source (e.g., electricity) would be necessary for space heating and hot water.
Steam	The proposed SNS facility would include steam generation.
Compressed air	The proposed SNS facility would include air compressors.
Chilled water	The proposed SNS facility would include water chillers.

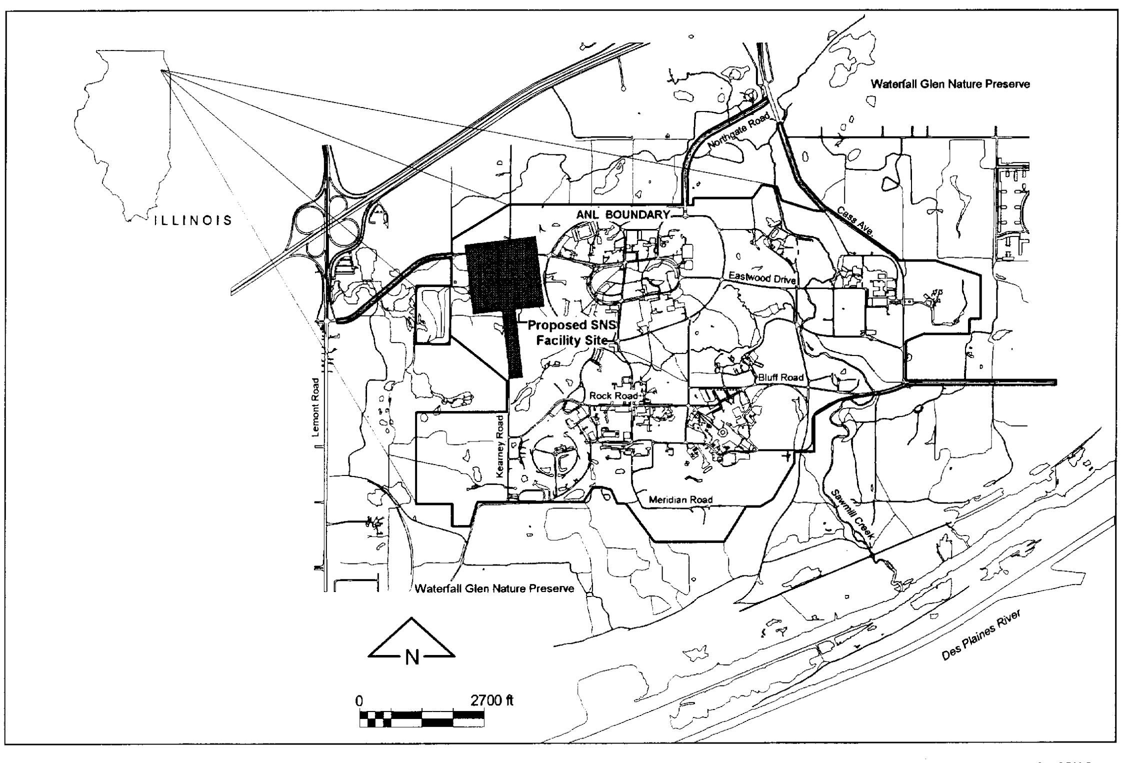

Figure 3.2.4.4-1. ANL proposed SNS site.

ANL occupies 1,500 acres (610 ha) of gently rolling land in the Des Plaines River Valley of DuPage County, Illinois. It is about 27 miles (43 km) southwest of downtown Chicago and 24 miles (39 km) west of Lake Michigan. Surrounding the ANL site is the Waterfall Glen Nature Preserve, a 2,040-acre (826-ha) greenbelt forest preserve of the DuPage County Forest Preserve District. This land was deeded to the DuPage County Forest Preserve District in 1973 for use as a public recreation area, nature preserve, and demonstration forest. Nearby highways are Interstate 55 to the north and Illinois Highway 83 to the east. The Des Plaines River is located about 0.4 mi (0.6 km) south of ANL. The Chicago Sanitary and Ship Canal is about 0.6 mi (1.0 km) south of the laboratory. The section of the Illinois and Michigan Canal that lies within the Illinois and Michigan Canal National Heritage Corridor is located about 0.8 mi (1.3 km) south of ANL. The Calumet-Sag Channel is located about the same distance to the southeast of the laboratory boundary.

Table 3.2.4.4-1 describes site-specific information concerning utilities and infrastructure requirements at the ANL site. Detailed characterization of the proposed ANL site is provided in Section 4.3.

3.2.4.5 Brookhaven National Laboratory

This alternative would involve the construction and operation of the proposed SNS on a site at BNL. The geographic location of BNL on Long Island is illustrated in Figure 3.2.4.5-1. A formal evaluation process was used to select this site. The site-selection report describing this process is provided in Appendix B.

The BNL is located in Suffolk County on Long Island, approximately 60 miles (97 km) east of New York City. The BNL is situated on 5,263 acres (2,130 ha) of land, most of which is wooded and undeveloped. The BNL was established in 1947 as a part of the Manhattan Project. It was established on the former site of Camp Upton, a U.S. Army facility during World Wars I and II. The BNL's current mission is to conceive, design, construct, and operate large, complex research facilities for fundamental scientific studies and to conduct basic and applied research in the physical, biomedical, and environmental sciences and in selected energy technologies. Table 3.2.4.5-1 provides site-specific information concerning utilities and infrastructure requirements at the BNL site. Detailed characterization of BNL is provided in Section 4.4.

3.3 NO-ACTION ALTERNATIVE

This alternative serves as a basis for comparison against other alternatives evaluated in the FEIS. It describes continuation of the current (status quo) situation into the future, if the proposed action is not implemented.

The No-Action Alternative for this FEIS would be to continue using the existing neutron science facilities in the United States without construction and operation of the proposed SNS at the preferred site or one of the three alternative sites. Because of currently high and ever-increasing demand for access to neutron science facilities, the existing U.S. facilities would increasingly fail to meet domestic experimentation demand under the No-Action Alternative.

Table 3.2.4.4-1. Utility and infrastructure requirements for the proposed SNS site at ANL.

Facility Requirements	Site-Specific Attributes
Site access	Primary access is from Westgate and Northgate Roads. Westgate Road is a two-lane blacktop road that currently handles mostly automobile traffic and handles intermittent heavy truck traffic. Westgate Road is capable of handling construction traffic. Approximately 1 mile (1.6 km) of Westgate Road would have to be constructed, circumventing the proposed SNS site, to replace the access to ANL from the West Gate.
Borrow material and spoils disposal	Borrow material could be obtained by providing retention ponds and replacement wetland areas. Any additional material would be obtained from clean fill sources outside of ANL.
Electrical power; Connected	Electrical power of 62 MW for a 1-MW beam and 90 MW for a 4-MW beam are required for the proposed SNS. Remaining capacity of 50 MW exists from substation 549A. This substation would have to be upgraded to provide the necessary power. A 6,600-ft (2,012-m) long 138-kV overhead line is needed to connect the proposed SNS site to substation 549A. The route for the 138-kV line is from substation 549A, up Southwood Drive and along Outer Circle Road to Watertower Road to the 800 Area.
Potable water	Potable water is supplied to ANL from Lake Michigan. The current system can meet the proposed SNS demand [800 gpm (3,028 lpm) for 1-MW beam; 1,600 gpm (6,057 lpm) for 4-MW beam].
Non-potable water	Non-potable water, suitable for cooling tower operation, is available from the ANL Canal Water Distribution System [remaining capacity is about 2 mgpd (7.6 million lpd)]. Approximately 2,000 ft (610 m) of pipeline would be constructed along Westgate Road.
Natural gas	The ANL gas distribution system delivers 10 psig. Approximately 2,000 ft (610 m) of gas line would be constructed from the existing distribution system along Westgate Road to the proposed site. The natural gas lines around the ANL site are scheduled to be upgraded next year. Any capacity increases and/or line extensions could be incorporated in this upgrade.
Steam	Steam heat would require about 1,500 ft (457 m) of steam lines. ANL can accommodate about 300,000 lb/hr of additional steam demand.
Compressed air	The proposed SNS facility would include air compressors.
Chilled water	The proposed SNS facility would include water chillers.

3.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

There are several different methods for producing high-power, short-pulse beams of protons in the 1-GeV power range that were evaluated during the conceptual design of the proposed SNS. The following alternatives were considered; however, DOE concluded that they are technically inferior. Additional details of the technical rationale can be found in the *Conceptual Design Report* (ORNL 1997a and 1997b).

3.4.1 PARTIAL-ENERGY LINAC AND A RAPID-CYCLING SYNCHROTRON

The partial-energy linac and a rapid-cycling synchrotron is a well-understood, proven accelerator technology. However, significant drawbacks to this approach make it unsuitable for the proposed SNS. The most important concern is associated with future upgrades to a higher operating power and thus increased research capability. Unlike the full-energy linac of the proposed SNS, which allows upgrading the facility to 2-MW beam power without a major construction project, any and all updates to a synchrotron facility would require major construction activity. Even modest upgrading (2-MW) of the facility would be a major construction project, entailing the building of a second booster synchrotron to reach the proton energy necessary for the higher beam power. A fully upgraded facility (4 MW) would require a beam energy on target of 10 GeV. This upgrade would require changing the design of the target, moderators, and shielding, thereby undertaking another large-scale construction project.

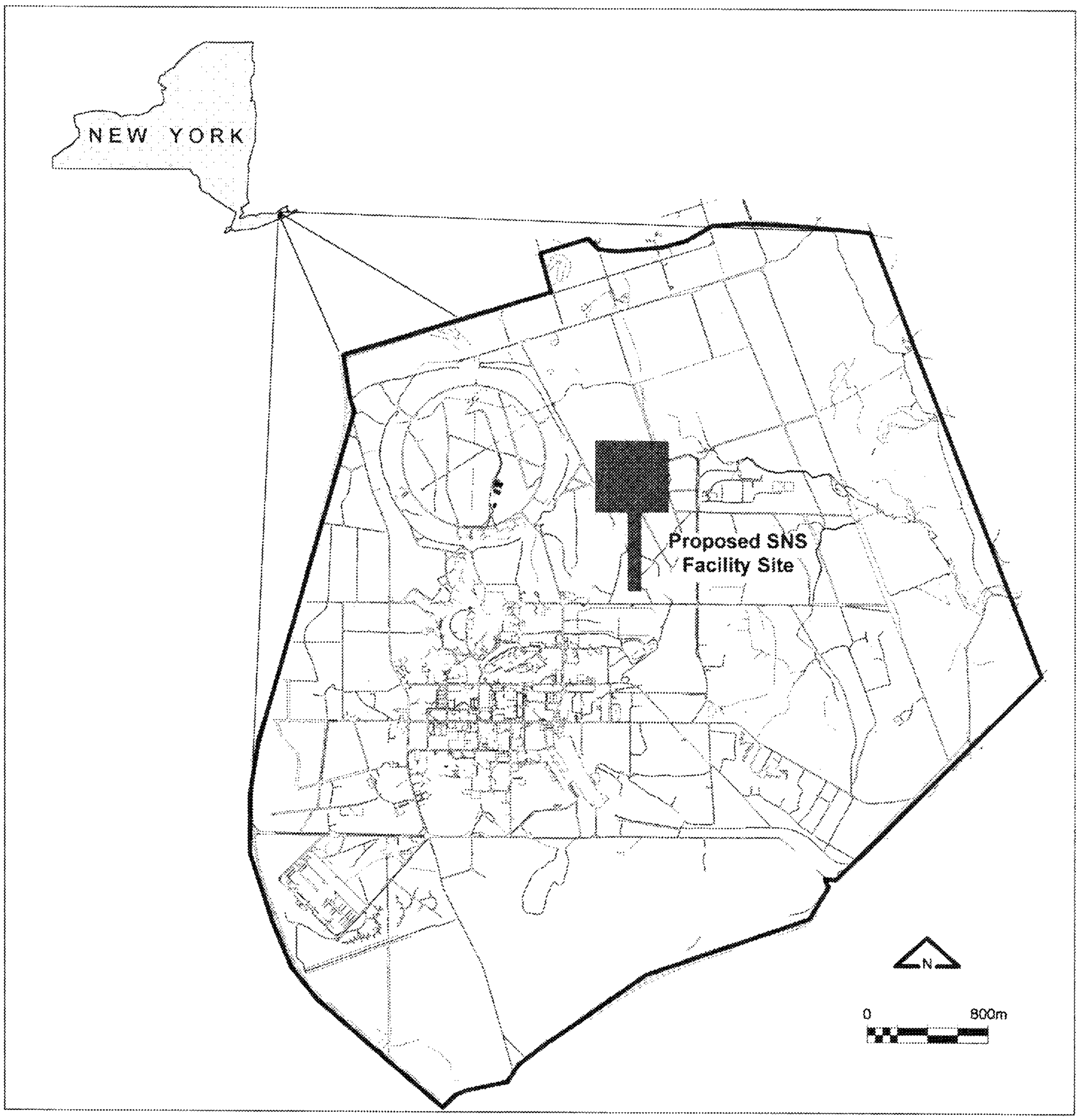

Figure 3.2.4.5-1. BNL proposed SNS site.

Table 3.2.4.5-1. Utility and Infrastructure requirements for the proposed SNS site at BNL.

Facility Requirements	Site-Specific Attributes
Site access	Primary access is from East Fifth Avenue and Relativistic Heavy Ion Collider Road. Existing roads are adequate for anticipated traffic.
Borrow material and spoils disposal	Material for the soil berm would come from various firebreaks on BNL. Spoils would be stored in the BNL transfer station.
Electrical power	For the demands of 62-MW (1-MW beam) or 90-MW (4-MW beam) a new 69-kV transmission line would have to be constructed to the LILCO 138-kV grid. The length of the line would be approximately 1 mile (1.6 km), and it would run parallel to BNL's existing stand-by 69-kV transmission line. The LILCO grid would require a new 138-to-69-kV substation.
Potable water	Potable water demands [800 gpm (3,028 lpm) for a 1-MW beam; 1,600 gpm (6,057 lpm) for 4-MW beam] could be supplied by three domestic water wells in the area, each capable of producing approximately 1,200 gpm (4,542 lpm).
Natural gas	The present usage peaks at approximately 200,000 ft^3/hr, and 40,000 ft^3/hr is available. The gas line is approximately 4,000 ft (1,219 m) from the proposed site.
Steam	The present steam load at BNL peaks at 170,000 lb/hr. The present steam plant has a firm capacity of 295,000 lb/hr. There is sufficient capacity for an estimated load of 1,500 lb/hr, which is required for the Long Island climate.
Compressed air	The proposed SNS facility would include air compressors.
Chilled water	The proposed SNS facility would include water chillers.

The second most important concern with the partial-energy linac and rapid-cycling synchrotron option is the limited flexibility for accommodating different pulse frequencies. The proposed SNS would be designed to produce neutron pulses at varying rates of 10 to 60 Hz. The normal operating mode of the synchrotron would be 30 Hz. Higher repetition rates are not possible and lower rates can only be achieved by discarding some of the 30-Hz pulses, which would result in a loss of overall power delivered to the target.

This alternative would not allow DOE to meet the purpose and need for action. Therefore, it is not analyzed further in this FEIS.

3.4.2 FULL-ENERGY SUPERCONDUCTING LINAC WITH AN ACCUMULATOR RING

This alternative incorporates superconductivity technology into the design of the proposed SNS. Superconductivity technology is quite mature for fabricating magnets and constructing several radio-frequency linacs. The Continuous Electron Beam Accelerator Facility, located in Newport News, Virginia, and the Large Electron-Positron located in Switzerland are examples of superconducting cavities that have met stringent accelerator requirements for technical performance and reliability. Both of these structures are designed for electron beams, and they operate in continuous wave mode.

However, the requirements for the proposed SNS include pulsed operations. Anticipated problems with pulsed operation using superconducting linacs have been identified and characterized, but they have not been resolved (Alonso 1998). Although there is an ongoing research and development program in Europe, it is unknown whether good technological solutions can be found within the necessary time frame. This could result in an indefinite delay in providing the required neutron source that fulfills the purpose and need (refer to Chapter 2).

The research and development of super-conducting pulsed linacs will be closely watched to possibly incorporate breakthroughs that may come. However, the proposed SNS Project has insufficient resources to conduct the extensive research and development program that would be required to resolve the technical uncertainties associated with this technology. Therefore, this alternative is not analyzed further in this FEIS.

3.4.3 INDUCTION LINAC, EITHER FULL-ENERGY OR INJECTING A FIXED-FREQUENCY ALTERNATING GRADIENT ACCELERATOR

The induction linac offers the attractive possibility of producing very short pulses of very high current without the need for an accumulator or synchrotron ring. However, no existing induction linac has accelerated protons to the energies required by the next-generation neutron source. Designing such an accelerator is viewed as straightforward and, in fact, an initial feasibility study has been performed. However, costs would be greater than for options utilizing rings, and the reliability of the high-power switches for the required service life is viewed as problematic. Although a concerted development effort for this technology is currently underway at LBNL, too much technical uncertainty remains to accept this technology as viable for the proposed SNS.

The fixed-frequency alternating gradient accelerator component of the induction linac presents some attractive features, most notably the ability to efficiently accelerate high-current beams injected by either an rf linac or, most intriguingly, by an induction linac. Studies on the viability of a fixed-frequency alternating gradient accelerator design have been conducted for spallation source application in both Europe and the United States. However, as is the case with the induction linac, no fixed-frequency alternating gradient accelerator has been built in the range of performance required for the proposed SNS, and the technology is not viewed as mature enough to be technically viable at this time. Therefore, this alternative is not analyzed further in this FEIS.

3.5 ENVIRONMENTAL CONSEQUENCES

This section provides a comparative summary of the potential environmental impacts that would result from implementing the proposed action at each of the four SNS siting alternatives and from implementing the No-Action Alternative. All impacts are described in terms of the various aspects of the existing environment that might be expected to change over time as a result of their implementation. This summary is based on the detailed environmental impacts identified and described in Chapter 5 of this FEIS.

Table 3.5-1 covers the environmental impacts, which are presented according to internal headings that correspond to the major impacts analysis subheadings in Chapter 5 of this FEIS. Under the other internal headings, this table covers impacts on long-term productivity of the environment and cumulative impacts. Cumulative impacts are the effects on the existing environment that would result from the incremental effects of the proposed action when added to the effects from other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal), private industry, or individuals undertake these other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

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INDEX

Table 3.5-1 Comparison of impacts among alternatives.

Category **Page**

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Table 3.5-1. Comparison of impacts among alternatives.

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
1a. Impacts on Geology and Soils (Construction)				
No effects from seismicity.				No effects from seismicity.
Erosion and siltation during construction. Minimal effects on soils or site stability.				No effects on soils or site stability.
No effects on prime or unique farmlands because none are present on or near any of the proposed SNS sites.				No effects on prime or unique farmlands.
1b. Impacts on Geology and Soils (Operations)				
The soil in the berm used to shield the linac tunnel would be subject to neutron activation caused by a small portion of particles (hydrogen ions) escaping from the particle beam as it travels down the linac. An estimated total of 3.09 E05 Ci of radioactive isotopes would be generated in the soil berm by neutron activation over the life of the facility. The maximum design beam loss rate is 1.0 E-09 amps per meter of linac. This design limit is the same for all linac beam power levels, hence soil activation would be the same at both 1 and 4 MW. For the analysis of potential effects, the beam loss is assumed to be 10.0 E-09. The total curies (3.09 E05) is based on this conservative limit.				No effects on soils.
No effects from seismicity or on site stability because of design to meet known seismic hazards at ORNL, LANL, ANL, or BNL.				No effects from seismicity.
No effects on prime or unique farmlands because none are present on or near any of the proposed SNS sites.				No effects on prime or unique farmlands.
2a. Impacts on Water Resources (Construction)				
No effects on floodplains. Minimal increase in run-off and siltation from improvements to Chestnut Ridge Road.	No effects on floodplains.	Construction in small areas on the 100-year floodplains of two unnamed tributaries of Sawmill Creek and Freund Brook. The areas of floodplain that would be affected are, respectively, 5 acres (2 ha) and <1 acre (0.40 ha).	No effects on floodplains.	No effects on floodplains.
Minimal effects on surface water (see Impact 1a).				No effects on surface water.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
2b. Impacts on Water Resources (Operations)				
No effects on floodplains.				No effects on floodplains.
Overall effects expected to be minimal. Discharges to surface water would increase average base flow, resulting in increased stream velocity and channel erosion in White Oak Creek. Minimal effects from biocides and antiscaling agents relative to flow. Slight increase in radionuclide flux over White Oak Dam.	Overall effects expected to be minimal. Discharges to surface water would result in channel erosion in intermittent TA-70 drainages. Most flow would infiltrate soil before reaching Rio Grande River. Minimal effects from biocides and antiscaling agents relative to flow.	Overall effects expected to be minimal. Discharges to surface water would increase base flow, resulting in increased stream velocity and channel erosion in an unnamed tributary of Sawmill Creek. Minimal effects from biocides and antiscaling agents relative to flow.	Overall effects expected to be minimal. Discharges to surface water would increase base flow, resulting in increased stream velocity and channel erosion in the headwaters of the Peconic River. Most flow would infiltrate the subsurface in the river channel before reaching the BNL boundary. Minimal effects from biocides and antiscaling agents relative to flow.	No effects on surface water resources.
Potential localized increase in groundwater radionuclide concentrations (at a depth of 100 ft or more) due to leaching of neutron-activated soil in the shielding berm for the linac tunnel. Three radionuclides would equal or exceed the 10 CFR Part 20 limit (shown in parentheses) at 10 m away from the site: ^{14}C 4.4 E-04 μCi/cc (3E-04 μCi/cc), ^{22}Na 5.5 E-05 μCi/cc (6 E-06 μCi/cc), and ^{54}Mn 3.0 E-05 μCi/cc (3 E-05 μCi/cc).	Pumping may lower water levels in nearby wells and affect productivity of main aquifer. Potential localized increase in groundwater radionuclide concentrations due to leaching of neutron-activated soil in the shielding berm for the linac tunnel. Groundwater effects would be least likely at LANL because of low infiltration rate and greater depth [820 ft (250 m)] to main aquifer.	Potential localized increase in groundwater radionuclide concentrations due to leaching of neutron-activated soil in the shielding berm for the linac tunnel. A potable groundwater aquifer lies at a depth of 165 ft (50 m). The downward rate of water movement through the saturated zone of the Wadsworth Till is only 3.0 ft/yr (0.9 m/yr). High clay content of the till would retard radionuclide migration, (continued on next page)	Highest potential for increase in groundwater radionuclide concentrations due to leaching of neutron-activated soil in the shielding berm for the linac tunnel. The sole source aquifer for Long Island would lie only 20 ft (6.1 m) below the SNS. High permeability of the soils [17 ft/yr (5.2 m/yr)] would allow higher levels of radionuclides in the aquifer in the immediate vicinity of the SNS. Exceedance of (continued on next page)	No effects on groundwater resources.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
2b. Impacts on Water Resources (Operations) — continued				
		but accurate prediction of migration rates and potential for aquifer contamination would be difficult because of the complex deposits.	drinking water limits for a human receptor at an off-site location would be unlikely.	
3a. Impacts on Climate and Nonradiological Air Quality (Construction)				
Temporary increases in suspended particulates (PM_{10}) during work hours (10-hr day). Primarily fugitive dust from vegetation clearing, excavation, and land contouring.				No effects on nonradiological air quality.
3b. Impacts on Climate and Nonradiological Air Quality (Operations)				
No effects on local or regional climate.				No effects on local or regional climate.
Combustion of natural gas would emit air pollutants, CO_2, CO, NO_2, and PM_{10}, limited by NAAQS. Off-site levels of pollutants would all be less than 20% of the NAAQS limit. Diesel back-up generators would only run in an emergency. Effects on nonradiological air quality would be expected to be minimal.	Combustion of natural gas would emit air pollutants, CO_2, CO, NO_2, and PM_{10}, limited by NAAQS. Off-site levels of pollutants would all be less than 5% of the NAAQS limit. Diesel back-up generators would run only in an emergency. Effects on nonradiological air quality would be expected to be minimal.			No effects on nonradiological air quality.
4a. Impacts on Noise Levels (Construction)				
Short-term increase in noise to continuous moderate levels (approximate average level of 86 dBA). Effects on humans and wildlife would be minimal because of distances (more than 400 ft) from sources, natural barriers, and worker hearing protection.				No effects on noise levels.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
4b. Impacts on Noise Levels (Operations)				
Elevated continuous noise levels from cooling towers, compressors, and ventilation fans/blowers (approximate average level of 86 dBA). Minimized with landscape barriers. Periodically increased traffic noise. Minimal overall noise effects to human and wildlife populations.				No effects on noise levels.
5a. Impacts on Ecological Resources (Construction)				
Removal of vegetation from 110 acres (45 ha) of land (less than 0.5% of the total forested area of the ORR) would result in increased forest fragmentation. This would have a minimal effect on terrestrial wildlife movement because a forested path along Chestnut Ridge would be retained. Only a portion of the ridge and ORR would be affected.	Removal of vegetation from 110 acres (45 ha) of land. Minimal effects on wildlife movement or the roosting, feeding, and reproduction of birds because 90% of TA-70 would remain undeveloped.	Removal of vegetation from 110 acres (45 ha) of land partially developed in the past. This would result in a long-term reduction of wildlife habitat and populations on the SNS site and in adjacent areas. These effects would be minimal because the species that would be involved are neither rare nor game species and other habitat exists in the region.	Removal of vegetation from 110 acres (45 ha) of land would displace wildlife to surrounding areas. The displacement of this wildlife may exceed the wildlife carrying capacity of the adjacent areas, resulting in a small but permanent population reduction for one or more species. The proposed site lies within the Compatible Growth Area of the Pine Barrens. The 110 acres represent less than 20% of the Pine Barrens Protection Area.	No effects on terrestrial resources.
Construction would temporarily disturb wildlife occupying areas adjacent to the proposed site. This could result in emigration of some sensitive species from the surrounding area.				No effects on terrestrial resources.
Construction of the SNS facility would not directly impact wetlands. The Chestnut Ridge Road upgrade would elimate 0.23 acres (0.09 ha) of wetland, which includes parts of three wetlands. Clearing and (continued on next page)	No effects on wetlands within the SNS site or in TA-70 because there are no wetlands on or in the vicinity of the proposed site.	Approximately 3.5 acres (1.4 ha) of wetlands would be destroyed by construction. DOE would consult with regulatory agencies on plans to mitigate their loss. Temporary, minor effects on other wetlands surrounding (continued on next page)	There are no wetlands within the proposed SNS site. Minimal effects on Peconic River wetlands from runoff and sedimentation because of implementing runoff and erosion control measures.	No effects on wetlands.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
5a. Impacts on Ecological Resources (Construction) — continued				
grading for a proposed detention pond has the potential to indirectly affect a nearby wetland. Indirect impacts may include increased runoff and siltation and long-term impacts such as altered hydrology and changes in the vegetation community. There would be minimal effects on four additional wetlands located outside of the construction area. Appropriate mitigation measures, including implementation of proper construction techniques to control erosion and surface runoff and wetland replacement or enhancement would be employed to minimize effects on these wetlands.		the proposed site may occur during construction. These indirect impacts would be avoided or minimized through the implementation of proper construction techniques to control erosion and surface runoff.		
Minimal effects on aquatic resources from increased runoff and sediment loading in White Oak Creek due to runoff and erosion control measures. Minimal effects on cool water fish (banded (continued on next page)	No effects on aquatic resources. There are no aquatic resources on or in the vicinity of the proposed site.	Minimal effects on aquatic resources, particularly bottom-dwelling fauna, from increased runoff and sediment loading in Freund Brook, because of establishing a 100- to 200-ft (continued on next page)	Minimal effects on aquatic resources from increased runoff and sediment loading in the Peconic River, because of establishing a minimum 300-ft (91-m) uncleared vegetation buffer zone (continued on next page)	No effects on aquatic resources.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
5a. Impacts on Ecological Resources (Construction) — continued				
sculpin and blacknose dace) habitat from vegetation clearing and associated solar radiation increase of water temperature in White Oak Creek, because of leaving a 100- to 200-ft (30- to 60-m) uncleared vegetation buffer zone along the creek for shade.		(30- to 60-m) uncleared vegetation buffer zone along the brook and implementing erosion control measures.	between the SNS site and the river and implementing erosion control measures.	
Potential effects on threatened and endangered (T&E) plant species would be minimal due to implementation of protective measures. No T&E or other protected animal species were identified within the proposed footprint of the SNS.	Potential effects on American peregrine falcon and bald eagle population from small reductions in non-nesting habitat would be minimal. No T&E plant species were identified on the SNS site.	No protected species were identified on the proposed SNS site. Therefore, no effects on T&E or other protected species.	Potential effects on state-protected plant species identified on the SNS site due to implementation of protective measures would be minimal. No T&E or other protected animal species were identified on the SNS site.	No effects on T&E or other protected species.
5b. Impacts on Ecological Resources (Operations)				
During operations, cooling water and runoff from the site would be directed to the retention basin and discharged into White Oak Creek downstream of Bethel Valley Road; thus, increased runoff and sedimentation in wetlands in the vicinity of the site is not expected to occur. Road runoff would be (continued on next page)	Minimal effects on wetlands in arroyos of Ancho Canyon and unnamed canyon to the northeast because cooling water flow could not reach these areas, except possibly during a heavy rain event.	During operations, runoff from the site would be directed to the retention basin; thus, increased runoff to wetlands in the vicinity of the site would be expected to be minimal.		No effects on wetlands.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
5b. Impacts on Ecological Resources (Operations) - (continued)				
diverted to stormwater control structures, such as swales, to avoid the effects of increased runoff in wetlands.				
Minimal effects on aquatic resources in the headwaters area of White Oak Creek. Cooling water and runoff from the proposed site would be collected in the retention basin. Discharge to White Oak Creek would be south of Bethel Valley Road. If necessary, the cooling tower blowdown would be dechlorinated. The retention basin would allow for reduction in the temperature of the water prior to discharge in White Oak Creek. Only minimal effects to aquatic resources downstream from the discharge point would be expected.	No effects on aquatic resources.	Biotic communities in Sawmill Creek may change as a result of increased flow from cooling water and runoff discharged into it from the retention basin. These effects on aquatic resources would be minimal because the temperature of the discharge would be reduced to ambient temperature in the retention basin.	No effects on aquatic resources in the upper reaches of the Peconic River because cooling water and runoff in the retention basin would be released to the river near the current Sewage Treatment Plant outfall. Downstream flow increase would be less than a routine rain event, resulting in minimal effects to aquatic resources. If necessary, the cooling tower blowdown would be dechlorinated. The retention basin could allow for reduction in the temperature of the water prior to discharge to the Peconic River. Only minimal effects to aquatic resources would be expected.	No effects on aquatic resources.
May affect T&E plant species. Protective measures would be implemented. No T&E or other protected animal species were (continued on next page)	No T&E plant species were identified on the proposed SNS site. May affect the American peregrine falcon and bald eagle populations (continued on next page)	No known T&E or other protected species at ANL would be affected.	May affect state-protected plant species. Protective measures would be implemented. No T&E or other protected animal (continued on next page)	No effects on T&E or other protected species.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
5b. Impacts on Ecological Resources (Operations) — continued				
identified on the proposed SNS site. Two plants protected by the State of Tennessee, pink lady's slipper and American ginseng, were found in areas adjacent to the proposed site.	because their use of the SNS site area would be less likely after development.		species were identified on the proposed SNS site.	
6a. Impacts on Socioeconomics (Construction)				
Peak construction workforce of 578 workers would occur during construction of the 1-MW facility. Approximately 25% of workers may come from outside the Region of Influence (ROI). Based on experience with past major construction projects, most in-migrating workers would not relocate their families. However, if all in-migrating workers brought families into the area, the regional population would increase by approximately 0.01–0.02%. This would have minor effects on housing and regional community services.				No effects on regional population growth.
Design and construction employment would peak in FY 2002 during construction of the 1-MW facility. Based on modeling of regional economics, there would be an estimated 1,499 new jobs created, including direct, indirect, and induced jobs. Unemployment rate may potentially decrease from 3.2 to 3.0%.	Design and construction employment would peak in FY 2002 during construction of the 1-MW facility. Based on modeling of regional economics, there would be an estimated 1,447 new jobs created, including direct, indirect, and induced jobs. Unemployment rate may potentially decrease from 6.6 to 5.8%.	Design and construction employment would peak in FY 2002 during construction of the 1-MW facility. Based on modeling of regional economics, there would be an estimated 1,795 new jobs created, including direct, indirect, and induced jobs Because of the very large regional population, no decrease in the regional unemployment rate would be expected.	Design and construction employment would peak in FY 2002 during construction of the 1-MW facility. Based on modeling of regional economics, there would be an estimated 1,481 new jobs created, including direct, indirect, and induced jobs. Unemployment rate may potentially decrease from 3.4 to 3.3%.	No economic benefit.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
6b. Impacts on Socioeconomics (Operations)				
Workforce for operation of the proposed SNS would be 250 persons for the 1-MW facility and 375 for the 4-MW facility. Regional population growth of approximately 0.01–0.03% due to worker in-migration would have minor effects on housing and regional community services.				No effects on regional socioeconomics.
Operation of the proposed SNS at 4 MW would result in substantial regional spending for operator salaries, supplies, utilities, and administrative support. Operation of the proposed SNS would result in a maximum of 1,704 direct, indirect, and induced jobs. Operations would result in approximately $68.7 million in local wages, $7.5 million in business taxes, and $75.9 million in personal income. Unemployment rate may potentially decrease from 3.2 to 3.0%.	Operation of the proposed SNS at 4 MW would result in substantial regional spending for operator salaries, supplies, utilities, and administrative support. Operation of the proposed SNS would result in a maximum of 1,486 direct, indirect, and induced jobs. Operations would result in approximately $66.8 million in local wages, $7.6 million in business taxes, and $71.4 million in personal income. Unemployment rate may potentially decrease from 6.6 to 5.8%.	Operation of the proposed SNS at 4 MW would result in substantial regional spending for operator salaries, supplies, utilities, and administrative support. Operation of the proposed SNS would result in a maximum of 1,776 direct, indirect, and induced jobs. Operations would result in approximately $82.9 million in local wages, $8.7 million in business taxes, and $91.2 million in personal income. Unemployment rate may potentially decrease from 5.2 to 5.1%.	Operation of the proposed SNS at 4 MW would result in substantial regional spending for operator salaries, supplies, utilities, and administrative support. Operation of the proposed SNS would result in a maximum of 1,551 direct, indirect, and induced jobs. Operations would result in approximately $71.6 million in local wages, $10.3 million in business taxes, and $80.5 million in personal income. Unemployment rate may potentially decrease from 3.4 to 3.2%.	No economic benefits.
The effects of operation of the proposed SNS at the 1-MW power level would be similar but slightly less than the 4-MW case.				

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
6b. Impacts on Socioeconomics (Operations) — continued				
Operation of the proposed SNS would not cause high and/or adverse impacts to any of the surrounding populations. Therefore, there would not be a disproportionate risk of significantly high and adverse impact to minority and low-income populations.				The No-Action alternative would not cause high and/or adverse impacts to any of the surrounding populations. Therefore, there would not be a disproportionate risk of significantly high and adverse impact to minority and low-income populations.
7a. Impacts on Cultural Resources (Construction)				
No effects on prehistoric resources. No prehistoric cultural resources have been identified on or in the vicinity of the proposed SNS site.	Five prehistoric archaeological sites within the 65% survey area at the SNS site and eligible for listing on the NRHP would be destroyed by site preparation activities. In the unsurveyed area of the proposed SNS site, any prehistoric sites listed on or eligible for listing on the NRHP could also be destroyed by site preparation. If this site were chosen for construction of the SNS, the remaining 35% would be surveyed and assessed for specific effects prior to the initiation of construction activities. Effects on	Prehistoric site 11DU207, adjacent to the proposed SNS site, may be disturbed or destroyed by construction activities. ANL has not assessed the NRHP eligibility of site 11DU207. If this site were chosen for construction of the SNS, an assessment of eligibility would be performed prior to the initiation of construction activities. If it is determined that a cultural resource would be affected, the effects would be mitigated by avoidance, if possible, or data recovery.	No effects on prehistoric resources. No prehistoric No effects on prehistoric resources. No prehistoric cultural resources have been identified on or in the vicinity of the proposed SNS site.	No effects on prehistoric resources.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
	(continued on next page)			
7a. Impacts on Cultural Resources (Construction) — continued				
	prehistoric archaeological sites would be mitigated by data recovery.			
No effects on historic resources. No historic cultural resources have been identified on or in the vicinity of the proposed SNS site.	No effects on historic resources within the surveyed 65% of the SNS site and buffer zone because no such resources have been identified in these areas. Site preparation activities in the unsurveyed area of the proposed SNS site would destroy any historic sites, structures, or features listed on or eligible for listing on the NRHP. If this site were chosen for construction of the SNS, the 35% area would be surveyed and assessed for specific effects prior to the initiation of construction activities. Effects would be mitigated by data recovery.	No effects on historic resources. No historic cultural resources have been identified on or in the vicinity of the proposed SNS site.	A number of earthen features (potentially NRHP-eligible) at Stations 2, 4, 8, and 10 on the SNS site may have been associated with World War I trench warfare training at Camp Upton. They would be destroyed by construction activities. Effects would be mitigated by data recovery.	No effects on historic resources.
No effects on traditional cultural properties (TCPs). No TCPs identified on or in the vicinity of the proposed SNS site.	Five TCPs (prehistoric archaeological sites) within 65% survey area at SNS site would be destroyed by site preparation activities. If any prehistoric archaeological sites are located within the unsurveyed 35% of the SNS (continued on next page)	No effects on TCPs. No TCPs identified on or in the vicinity of the proposed SNS site.		No effects on TCPs.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
7a. Impacts on Cultural Resources (Construction) — continued				
	site, these TCPs would also be destroyed. Because specific identities and locations of other on-site TCPs are not known, potential effects on such specific resources are uncertain.			
7b. Impacts on Cultural Resources (Operations)				
No effects on prehistoric or historic resources. Operational activities would be largely confined to the SNS site. No prehistoric or historic cultural resources have been identified on or in the vicinity of the proposed SNS site.	No effects on prehistoric or historic resources. Operational activities would be largely confined to the SNS site. No prehistoric archaeological sites would be present on the site after construction. No historic cultural resources have been identified on the proposed SNS site.	No effects on prehistoric or historic resources. Operational activities would be largely confined to the SNS site. No prehistoric or historic cultural resources have been identified on the proposed SNS site.	No effects on prehistoric or historic resources. Operational activities would be largely confined to the SNS site. No prehistoric cultural resources have been identified on or in the vicinity of the proposed SNS site. No historic cultural resources would be present on the site after construction.	No effects on prehistoric or historic resources.
No effects on TCPs. No TCPs identified on or in the vicinity of the proposed SNS site.	American Indian tribal groups have identified water resources (surface water and groundwater) as TCPs. See Impacts 2b and 10b for operational effects on these TCPs. Because specific identities and locations of on-site TCPs are not known, potential operational effects on such specific resources are uncertain.	No effects on TCPs. No TCPs identified on or in the vicinity of the proposed SNS site.	No effects on TCPs. No TCPs identified on or in the vicinity of the proposed SNS site.	No effects on TCPs.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
8a. Impacts on Land Use (Construction)				
Introduce large-scale development to the proposed SNS site, utility corridors, and new rights-of-way. Considering that about 64% of the 34,516 acres (13,794 ha) of ORR land is undeveloped, this would be a minimal overall effect. A greenfield site is proposed because no brownfield sites that meet SNS requirements are available.	Introduce large-scale development to the proposed SNS site, utility corridors, and new rights-of-way. Considering the 16,000 acres (6,478 ha) of undeveloped land at LANL, the effect on undeveloped laboratory lands as a whole would be minimal.	Displace the remaining support services operations in the 800 Area. Demolition of the three remaining 800 Area buildings. These would be minimal effects. Introduce large-scale development to Open Space areas due to limited ANL land. Increase the pace of remediation on numerous Solid Waste Management Units (SWMUs) within the proposed SNS site. A beneficial effect would be use of a partial brownfield site for constructing the SNS.	Introduce large-scale development to the proposed SNS site, utility corridors, and new rights-of-way. Considering the large amounts of Open Space land at BNL, the effects would be minimal.	No effects on current land use.
The National Oceanic and Atmospheric Administration/ Atmospheric Turbulence and Diffusion Division (NOAA/ATDD) is conducting the Temperate Deciduous Forest Continuous Monitoring Program (TDFCMP) in the Walker Branch Watershed [0.75 mi. (1.2 km)] east of the proposed SNS site. This long-term program is monitoring the continuous exchange of CO_2, (continued on next page)	No effects on the use of land by environmental research projects. Land on and in the vicinity of the SNS site is not being used for environmental research projects, and none are planned.	No effects on the use of land by environmental research projects. Land on and in the vicinity of the SNS site is not being used for environmental research projects, and none are planned. The ecology plots at ANL are areas of land potentially suitable for ecological research, but little, if any, actual ecological research has ever been conducted in these areas. Currently, there are no on- (continued on next page)	No effects on the use of land by environmental research projects. Land on and in the vicinity of the SNS site is not being used for environmental research projects, and none are planned.	No effects on the use of land by environmental research projects.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
8a. Impacts on Land Use (Construction) — continued				
H_2O vapor, and energy between the deciduous forest and atmosphere. CO_2 from construction vehicles could affect the TDFCMP and one long-term ORNL ecological research project in the Walker Branch Watershed. Potential effects would be loss of CO_2 data quality and data comparability over time.		going or planned ecological projects in Ecology Plots 6, 7, and 8 on the proposed SNS site.		
Potential limitations on future use of the proposed SNS site and land areas adjacent to it.				No effects on future land use.
Reduce the area of ORR land open to recreational deer hunting by 110 acres (45 ha). Effect would be minimal because about 26,406 acres (10,735 ha) would still be open to hunting.	Potential restriction or end of public hiking trail use near the SNS site in TA-70.	No reasonably discernible effects on parks, preserves, and recreational resources. The effects from the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses outside ANL and within the laboratory boundaries.	No reasonably discernible effects on parks, preserves, and recreational resources. The effects from the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses in the vicinity of BNL.	No effects on parks, preserves, or recreational resources.
The proposed SNS would come into view only along the upper reaches of the Chestnut Ridge Road and southwest road accesses to the proposed SNS site. This (continued on next page)	Change views in SNS site area from piñon-juniper woodlands to industrial development. SNS facilities visible to public from points on State Route 4, access road (continued on next page)	The proposed SNS facilities would be visible from points near the ANL fence in the Waterfall Glen Nature Preserve, especially on the west side during late autumn, (continued on next page)	Most visual panoramas in the area around BNL and within the laboratory contain features indicative of development. The proposed action would add the SNS (continued on next page)	No effects on visual resources.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
8a. Impacts on Land Use (Construction) — continued				
effect would be minimal because these roads would be traveled primarily by DOE and ORNL personnel, construction workers, and service providers. It would not be visible to the public from land-based vantage points outside the ORR, most points on the ORR, or frequently traveled roads such as Bear Creek Road and Bethel Valley Road. No established visual resources on the ORR would include the proposed SNS.	to proposed SNS site, the site, and hiking trails in TA-70. Highly visible at night—absence of other lighted facilities. Not visible from White Rock and popular public use areas in Bandelier National Monument.	winter, and early spring. They would also be visible from points within the laboratory boundaries. Because the current views at these locations contain buildings and other features characteristic of development, these effects would be minimal.	facilities to this visual environment, and they would be compatible with it. This effect on visual resources would be minimal.	
8b. Impacts on Land Use (Operations)				
Land use change from Mixed Research/Future Initiatives to Institutional/Research.	Change in current land use from Environmental Research/Buffer to Experimental Science.	Change in current land use from Ecology Plots (Nos. 6, 7, and 8), Support Services, and Open Space to a programmatic land use category specific to SNS operations or Programmatic Mission-Other Areas.	Change in current land use from Open Space to Commercial/Industrial.	No effects on current land use.
CO_2 from SNS stacks would adversely affect TDFCMP (NO_x minimal) and one ORNL research project in the Walker Branch Watershed. (continued on next page)	No effects on the use of land by environmental research projects. Land on and in the vicinity of the proposed SNS site is not being used for environmental research projects, and none are planned.			No effects on the use of land by environmental research projects.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
8b. Impacts on Land Use (Operations) — continued				
H_2O vapor from cooling towers may affect the TDFCMP and two ORNL research projects. Effects would be loss of data quality and data comparability over time.				
No effects on DOE zoning (SNS operations compatible). Through a DOE process called Common Ground and a citizen stakeholder group referred to as the End Use Working Group, citizens in the Oak Ridge area have developed future ORR land use recommendations for DOE. Use of the proposed SNS site for the proposed action would be at variance with recommended Common Ground zoning of the site for Conservation Area Uses. It would also be at variance with an End Use Working Group recommendation advisory to use brownfield sites for new DOE facilities. A greenfield site is proposed for the SNS because no brownfield sites that meet project requirements are available.	No effects on DOE zoning (SNS operations compatible).	The SNS operations would be at variance with Support Services, Ecology Plot No. 8, and Open Space zoning on the SNS site. However, a guiding principle behind ANL zoning is the expansion of other land uses into the Ecology Plots and Open Space. The amount of Support Services land used would be negligible.	The SNS operations would be at variance with Open Space zoning on the SNS site. However, a guiding principle behind BNL zoning is expansion of other land uses into Open Space. Operation of the SNS would probably result in an eventual change in end use zoning of the SNS site and adjacent land from predominantly Open Space to Commercial/ Industrial.	No effects on zoning for future land use.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
8b. Impacts on Land Use (Operations) — continued				
Future adverse CO_2 effects on the TDFCMP and two ORNL research projects. Minimal No_x effects from SNS stacks. Potential future H_2O vapor effects on the TDFCMP and eight ORNL research projects. Potential future effects on strategic ORNL ecological research initiatives. Effects would be loss of data quality and data comparability over time.	No future uses of SNS site and vicinity land for environmental research are planned. As a result, effects on specific future research projects cannot be assessed.	No future uses of SNS site and vicinity land for environmental research are planned. The ecology plots at ANL are areas of land potentially suitable for ecological research, but little, if any, actual ecological research has ever been conducted in these areas. There are no planned environmental research projects in the portions of Ecology Plots 6, 7, and 8 adjacent to the proposed SNS site. As a result, effects on specific future research projects cannot be assessed.	No future uses of SNS site and vicinity land for environmental research are planned. As a result, effects on specific future research projects cannot be assessed.	No effects on the future use of land by environmental research projects.
Potential limitations on future use of the proposed SNS site and land areas adjacent to it.				No effects involving future land use limitations.
Continued restriction of recreational deer hunting on 110-acre (45-ha) SNS site. Effect would be minimal because about 26,406 acres (10,735 ha) would still be open to hunting.	Continued restriction or end of public hiking trail use near the SNS site in TA-70.	No reasonably discernible effects on parks, preserves, and recreational resources. The effects from the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses outside ANL and within the laboratory boundaries.	No reasonably discernible effects on parks, preserves, and recreational resources. The effects from the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses in the vicinity of BNL.	No effects on parks, preserves, or recreational resources.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
8b. Impacts on Land Use (Operations) — continued				
The proposed SNS would come into view only along the upper reaches of the Chestnut Ridge Road and southwest road accesses to the proposed SNS site. This effect would be minimal because these roads would be traveled primarily by DOE personnel, SNS employees, service providers, and visitors to the SNS facilities, including visiting scientists. It would not be visible to the public from land-based vantage points outside the ORR, most points on the ORR, and frequently traveled roads such as Bear Creek Road and Bethel Valley Road. No established visual resources on the ORR would include the proposed SNS.	Change views in proposed SNS site area from piñon-juniper woodlands to industrial development. SNS facilities visible to public from points on State Route 4, access road to proposed SNS site, the site, and hiking trails in TA-70. Highly visible at night—absence of other lighted facilities. Not visible from White Rock and popular public use areas in Bandelier National Monument.	The proposed SNS facilities would be visible from points near the ANL fence in the Waterfall Glen Nature Preserve, especially on the west side during late autumn, winter, and early spring. They would also be visible from points within the laboratory boundaries. Because the current views at these locations contain buildings and other features characteristic of development, these effects would be minimal.	Most visual panoramas in the area around BNL and within the laboratory contain features indicative of development. The proposed action would add the SNS facilities to this visual environment, and they would be compatible with it. This effect on visual resources would be minimal.	No effects on visual resources.
9a. Impacts on Human Health (Construction)				
Based on rates for general industrial construction accidents, 110 potential occupational injuries but less than 1 fatality are predicted.				No effects on human health.
		Due to the preferred location of the SNS within the 800 Area SWMU, construction activities may expose workers to organic compounds and possibly radioactive materials.		

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
9b. Impacts on Human Health (Operations)				
Considering population density and proximity, minimal effects on the health of workers or the public. For operation at 1-MW power, the maximally exposed individual (MEI) would receive an annual radiation dose of 0.40 mrem, or 4% of the 10-mrem limit (40 CFR Part 61). For operation at 4-MW power, the MEI would receive an annual dose of 1.5 mrem, or 15% of the limit. Operation of the SNS at 1-MW power for 10 years and at 4-MW power for 30 years would result in 0.2 latent cancer fatalities (LCFs) in the off-site population attributable to the SNS.	Considering population density and proximity, minimal effects on the health of workers or the public. For operation at 1-MW power, the MEI would receive an annual radiation dose of 0.47 mrem, or 4.7% of the 10-mrem limit (40 CFR Part 61). For operation at 4-MW power, the MEI would receive an annual dose of 1.8 mrem, or 18% of the limit. Operation of the SNS at 1-MW power for 10 years and at 4-MW power for 30 years would result in 0.09 LCFs in the off-site population attributable to the SNS.	Considering population density and proximity, minimal effects on the health of workers or the public. For operation at 1-MW power, the MEI would receive an annual radiation dose of 3.2 mrem, or 32% of the 10-mrem limit (40 CFR Part 61). For operation at 4-MWpower, the MEI would receive an annual dose of 12 mrem, or 120% of the limit. Operation of the SNS at 1-MW power for 10 years and at 4-MW power for 30 years would result in 1.3 LCFs in the off-site population attributable to the SNS.	Considering population density and proximity, minimal effects on the health of workers or the public. For operation at 1-MW power, the MEI would receive an annual radiation dose of 0.91 mrem, or 9.1% of the 10-mrem limit (40 CFR Part 61). For operation at 4-MWpower, the MEI would receive an annual dose of 3.4 mrem, or 34% of the limit. Operation of the SNS at 1-MW power for 10 years and at 4-MW power for 30 years would result in 1.2 LCFs in the off-site population attributable to the SNS.	No effects on human health.
Potential effects on off-site population for combined operations at 1- and 4-MW power. Potential effects on off-site population predicted to maximally exposed individual for initial 1-MW (continued on next page)	Potential effects on off-site population for combined operations at 1- and 4-MW power. Potential effects on off-site population predicted to maximally exposed individual for initial 1-MW (continued on next page)	Anticipated effects on off-site population for combined operations at 1- and 4-MW power. Potential effects on off-site population predicted to maximally exposed individual for initial 1-MW (continued on next page)	Anticipated effects on off-site population for combined operations at 1- and 4-MW power. Potential effects on off-site population predicted to maximally exposed individual for initial 1-MW (continued on next page)	

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
9b. Impacts on Human Health (Operations) — continued				
and upgraded 4-MW operations — 0.2 excess LCFs over 40 years.	and upgraded 4-MW operations — 0.09 excess LCFs over 40 years.	and upgraded 4-MW operations — 1.3 excess LCFs over 40 years.	and upgraded 4-MW operations — 1.2 excess LCFs over 40 years.	No effects on human health.
No observable effects on workers or public from mercury emissions. Mercury levels would be approximately 100,000 times less than OSHA and NIOSH recommendations and the EPA reference concentration for members of the public.				No effects on human health.
9c. Impacts on Human Health (Accidents)				
Extremely unlikely that workers would be exposed to levels of direct radiation that could induce radiation effects. The SNS shield design would be such that with a high-consequence, low-probability design-basis accident, the dose to a maximally exposed individual would be 1 rem in an uncontrolled area and 25 rem for a worker in a controlled area.				No impacts on health.
No effects expected at 1 MW. At 4 MW, only "beyond-design-basis" accident estimated to occur less than once per 1,000,000 years would induce 31 excess LCFs in off-site population.	No effects expected.	No effects expected at 1 MW. At 4 MW, LCFs expected in off-site population for three accident scenarios: one "beyond-design-basis" accident (120 LCFs) occurring less than once per 1,000,000 years; one extremely unlikely accident (2.7 LCFs) occurring between once per 10,000 and once per 1,000,000 years; and one anticipated accident (2.1 LCFs).	No effects expected at 1 MW. At 4 MW, LCFs expected in off-site population for three accident scenarios: one "beyond-design-basis" accident (85 LCFs) occurring less than once per 1,000,000 years; one extremely unlikely accident (1.9 LCFs) occurring between once per 10,000 and once per 1,000,000 years; and one anticipated accident (1.6 LCFs).	No effects on human health.
10a. Impacts on Support Facilities and Infrastructure (Construction)				
Traffic on ORNL access roads would increase approximately 7%. The estimated peak construction workforce of 578 employees (continued on next page)	Traffic on LANL access roads would increase approximately 7%. The estimated peak construction workforce of 578 employees (continued on next page)	Approximately 1 mile (1.6 km) of the existing Westgate Road would have to be relocated to the north in order to circumvent the SNS (continued on next page)	Traffic on BNL access roads would increase approximately 16%. The estimated peak construction workforce of 578 employees would be (continued on next page)	No effects on support facilities and infrastructure.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
10a. Impacts on Support Facilities and Infrastructure (Construction) — continued				
would be expected to add approximately 466 daily round trips and 10 material/service trucks to the total ORNL traffic of 7,810 vehicle trips. Effects on traffic could include increased general congestion on existing access roads to the ORR.	would be expected to add approximately 466 daily round trips and 10 material/ service trucks to the total LANL traffic of 6,980 vehicle trips. Presently, the access route (State Highway 4) to the proposed site is a relatively lightly-traveled road providing access to Bandelier National Monument. Construction traffic would increase traffic on this road by approximately 45%, causing some congestion.	site and replace the existing Westgate Road access to ANL. Traffic on ANL access roads would increase approximately 7%. The estimated peak construction workforce of 578 employees would be expected to add approximately 466 daily round trips and 10 material/ service trucks to the total ANL traffic of 6,290 vehicle trips. Construction traffic would affect the composition and speed of the traffic, resulting in an increase in the general congestion on existing access roads.	expected to add approximately 466 daily round trips and 10 material/service trucks to the projected total BNL traffic of 2,500 vehicle trips. Because of the condition of the access roads to BNL, this increase is not considered significant.	
10b. Impacts on Support Facilities and Infrastructure (Operations)				
Operation of the proposed SNS at 4 MW would add 305 daily round trips and 3 service trucks per day, or a 5% increase over current traffic levels. Effects on traffic could increase general congestion on existing access roads to the ORR.	Operation of the proposed SNS at 4 MW would add 305 daily round trips and 3 service trucks per day, or a 4% increase over current traffic levels. Effects on traffic could increase general congestion on existing access roads to LANL.	Operation of the proposed SNS at 4 MW would add 305 daily round trips and 3 service trucks per day, or a 5% increase over current traffic levels. Effects on traffic could increase general congestion on existing access roads to ANL.	Operation of the proposed SNS at 4 MW would add 305 daily round trips and 3 service trucks per day, or a 12% increase over current traffic levels. Effects on traffic could increase general congestion on existing access roads to BNL. Because of the condition of the access roads to BNL, this increase is not considered significant.	No effects on support facilities and infrastructure.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
10b. Impacts on Support Facilities and Infrastructure (Operations) — continued				
Existing electrical service is adequate for the proposed 1-MW SNS and the 4-MW upgrade. Existing transmission lines would be extended approximately 3,000 ft. Environmental effects of construction the electrical feeder would be negligible.	The existing electrical power system at LANL does not have adequate capacity to meet the demands of the proposed SNS for a 1-MW or 4-MW facility. Meeting these demands would require construction of a 115-kV transmission line from the east side of the site, which would require a major reconfiguration of the system. Additional required efforts could include new power grid configurations and an SNS site-specific power generation station.	The existing electrical power system at ANL has sufficient capacity for the proposed SNS operating at 1-MW power. However, there is not sufficient capacity at ANL for the 4-MW SNS. Sufficient power is available from Commonwealth Edison. Approximately 6,600 ft of new 138-kV transmission line would be constructed to connect the proposed SNS to an adequate substation. The transmission line would be constructed in developed areas, so environmental effects would be minimal.	Existing electrical service at BNL is adequate for the proposed 1-MW SNS. However, in order to accommodate the 4-MW facility, a new 69-kV transmission line would be required extending to the Long Island Lighting Company's (LILCO's) 138-kV grid. This line would be approximately 1 mile in length and would parallel the existing 69-kV line. All upgrades would occur within existing utility corridors; therefore, environmental effects would be minor.	No effects on electrical service.
The existing steam supply at ORNL is adequate to meet the needs of the proposed SNS. If the decision is made to use ORNL steam, approximately 2 miles of steam line would be constructed. Much of the construction would be on previously disturbed land. Environmental effects would be expected to be minimal.	Steam is not available at or in the vicinity of the proposed SNS site. The SNS facility would include steam generation.	The existing steam supply at ANL is adequate to meet the needs of the proposed SNS. If the decision is made to use ANL steam, approximately 1,500 ft of steam line would be constructed, crossing developed land. Environmental effects would be expected to be minimal.	The existing steam supply at BNL is adequate to meet the needs of the proposed SNS. If the decision is made to use BNL steam, approximately 4,000 ft of steam line would be constructed, crossing developed land. Environmental effects would be expected to be minimal.	No effects on the steam supply.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
10b. Impacts on Support Facilities and Infrastructure (Operations) — continued				
The existing East Tennessee Natural Gas 22-in. gas main has adequate capacity to supply the proposed SNS. Approximately 5,000 ft of new gas line would be constructed along Chestnut Ridge Road, the main access road to the proposed site. If the gas line will be on the southwest side of Chestnut Ridge Road, no wetland impacts should occur. If it is on the northeast side of the road, there may be an additional small area of wetland encroachment above that necessary for road construction.	There is adequate capacity from the existing natural gas system at LANL to meet the needs of the proposed SNS. However, there are no existing gas lines in the vicinity of the proposed site. An expansion of the natural gas infrastructure would be necessary.	There is adequate capacity from the existing natural gas system at ANL to meet the needs of the proposed SNS. The natural gas system at ANL is scheduled to be upgraded in FY 1999. A high-pressure gas main is located near the proposed site. Modifications necessary to accommodate the proposed SNS could be accomplished during the scheduled upgrade.	There is sufficient capacity in the existing natural gas system at BNL to meet the needs of the proposed SNS. Approximately 4,000 ft of new gas line would be constructed, primarily across developed land. Environmental effects would be expected to be minimal.	No effects on natural gas system.
The existing 24-in. water main located adjacent to the proposed site has adequate capacity to supply water to the SNS.	The domestic water system at LANL can not meet the projected demands for LANL, including the proposed SNS and the surrounding communities. Accommodating the proposed SNS would require extensive upgrades to the delivery system, including new water mains, lift stations and storage tanks.	The domestic water system at ANL has sufficient capacity to meet the needs of the proposed SNS. In addition, ANL has a non-potable laboratory water supply the could be used for cooling tower makeup.	The domestic water system at BNL has sufficient capacity to meet the needs of the proposed SNS.	No effects on the domestic water system.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
10b. Impacts on Support Facilities and Infrastructure (Operations) — continued				
The existing sewage treatment plant at ORNL has adequate capacity to treat wastes from the proposed SNS.	The existing sewage treatment plant at LANL has adequate capacity to treat wastes from the proposed SNS. The plant is several miles from the proposed site. Sanitary sewage would have to be trucked to the treatment plant or a small package plant included in the SNS facilities.	The existing sewage treatment plant at ANL has adequate capacity to treat wastes from the proposed SNS.	The existing sewage treatment plant at BNL has adequate capacity to treat wastes from the proposed SNS.	No effects on sewage treatment.
11a. Impacts of Waste Management (Construction and Operations)				
Hazardous Wastes Treatment No hazardous waste treatment facilities at ORNL. Storage Projected generation, excluding SNS, 1998–2040: 160 m^3/yr.	**Hazardous Wastes** Treatment No hazardous waste treatment facilities at LANL. Storage Projected generation, excluding SNS, 1998–2040: 942 m^3/yr.	**Hazardous Wastes** Treatment No hazardous waste treatment facilities at ANL. Storage Projected generation, excluding SNS, 1998–2040: 115 m^3/yr.	**Hazardous Wastes** Treatment No hazardous waste treatment facilities at BNL. Storage Projected generation, excluding SNS, 1998–2040: 200 drums/yr.	**Hazardous Wastes**
Total capacity available for SNS wastes: 139 m^3/yr.	Total capacity available for SNS wastes: No long-term storage.			
Amount generated by SNS: 40 m^3/yr.				

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				**NO-ACTION ALTERNATIVE**
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
11a. Impacts of Waste Management (Construction and Operations) — continued				
Hazardous Wastes (cont'd) Conclusion Standard DOE practice has been to dispose of hazardous waste at off-site, DOE-approved, licensed commercial facilities. Implementation of proper handling, disposal, and waste minimization practices would result in minimal effects to the environment.				**Hazardous Wastes (cont'd)** Conclusion No waste generated, thus no effects from SNS on the environment.
Low-Level Radioactive Wastes Treatment Projected generation, excluding SNS, 1998–2040: 282,000 m^3/yr (7.45E07 gal/yr). Total capacity available for SNS wastes: 423,920 m^3/yr (1.12E08 gal/yr).	**Low-Level Radioactive Wastes** Treatment Projected generation, excluding SNS, 1998–2040: 21,880 m^3/yr (5.78E06 gal/yr). Total capacity available for SNS wastes: 4,600 m^3/yr (1.22E06 gal/yr).	**Low-Level Radioactive Wastes** Treatment Projected generation, excluding SNS, 1998–2040: 413,000 m^3/yr (1.09E08 gal/yr). Total capacity available for SNS wastes: 1.00E06 m^3/yr (2.64E08 gal/yr).	**Low-Level Radioactive Wastes** Treatment Projected generation, excluding SNS, 1998–2040: 190 m^3/yr (50,000 gal/yr). Total capacity available for SNS wastes: 300 m^3/yr (70,000 gal/yr).	**Low-Level Radioactive Wastes**
Amount generated by SNS: 16,400 m^3/yr (4.33E06 gal/yr).				
Conclusion No effects on low-level radioactive waste (LLW) treatment facilities would be anticipated, thus no effects to the environment are anticipated.	Conclusion Current treatment facilities do not have the capacity to treat all of the LLW from the proposed SNS. LLW with accelerator-produced tritium would not meet the waste acceptance criteria for the existing LLW treatment facility (RLWTF TA-50). However, a new facility is under construction that will accept these wastes, thus no (continued on next page)	Conclusion No effects on LLW treatment facilities would be anticipated. Tritium discharge would increase from 0.75 Ci/yr to 40 Ci/yr, potentially resulting in minor adverse impacts.	Conclusion SNS volume exceeds capacity. Wastes can be processed at a higher rate. Additional treatment capacity may be necessary, thus production of waste may have minor adverse impacts.	Conclusion No waste generated, thus no effects from SNS on the environment.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
11a. Impacts of Waste Management (Construction and Operations) — continued				
Low-Level Radioactive Wastes (cont'd)	**Low-Level Radioactive Wastes (cont'd)** effects to the environment are anticipated.	**Low-Level Radioactive Wastes (cont'd)**	**Low-Level Radioactive Wastes (cont'd)**	**Low-Level Radioactive Wastes (cont'd)**
<u>Storage</u> Projected generation, excluding SNS, 1998–2040: 2,520 m^3/yr. Total capacity available for SNS wastes: Limited storage available; long-term storage would not be necessary because contracts are in place that would allow for disposal of waste. Amount generated by SNS: 1,026 m^3/yr.	<u>Storage</u> Facilities are under construction for treatment and disposition.	<u>Storage</u> Projected generation, excluding SNS, 1998–2040: 232 m^3/yr. Total capacity available for SNS wastes: 30 m^3 Amount generated by SNS: 1,026 m^3/yr.	<u>Storage</u> Projected generation, excluding SNS, 1998–2040: 283 m^3/yr. Total capacity available for SNS wastes: 270 m^3/yr. Amount generated by SNS: 1,026 m^3/yr.	
<u>Conclusion</u> Additional storage capacity may be necessary to accommodate SNS wastes; however, long-term storage would not be necessary because standard DOE practice has been to dispose of wastes at off-site, DOE-approved, licensed commercial facilities, thus no effects to the environment are anticipated.	<u>Conclusion</u> Long-term storage facilities for LLW are not necessary at LANL. No effects to the environment are anticipated.	<u>Conclusion</u> Additional storage capacity may be necessary to accommodate SNS wastes; however, long-term storage would not be necessary because standard DOE practice has been to dispose of wastes at off-site DOE-approved, licensed commercial facilities. Implementation of proper handling, disposal, and waste minimization practices would result in minimal effects to the environment.		<u>Conclusion</u> No waste generated, thus no effects on the environment.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
11a. Impacts of Waste Management (Construction and Operations) — continued				
Low-Level Radioactive Wastes (cont'd) <u>Disposal</u> No LLW disposal at ORNL, thus no effects on the environment.	**Low-Level Radioactive Wastes (cont'd)** <u>Disposal</u> Projected generation, excluding SNS, 1998–2040: 2,500 m^3/yr. Total capacity available for SNS wastes: 35,000 m^3/yr. Amount generated by SNS: 1,026 m^3/yr. <u>Conclusion</u> No effect on LLW disposal facilities would be anticipated, thus no effects on the environment.	**Low-Level Radioactive Wastes (cont'd)** <u>Disposal</u> No LLW disposal at ANL or BNL, thus no effects on the environment.		
Mixed Wastes <u>Treatment</u> No mixed waste treatment facilities at ORNL, thus no effects on the environment.	**Mixed Wastes** <u>Treatment</u> No mixed waste treatment facilities at LANL, thus no effects on the environment.	**Mixed Wastes** <u>Treatment</u> Projected generation rate, excluding SNS, 1998–2040: 215 m^3/yr. Amount generated by SNS: 18 m^3/yr.	**Mixed Wastes** <u>Treatment</u> No mixed waste treatment facilities at BNL, thus no effects on the environment.	**Mixed Wastes**

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
11a. Impacts of Waste Management (Construction and Operations) — continued				
Mixed Wastes (cont'd)	**Mixed Wastes (cont'd)**	**Mixed Wastes (cont'd)** Conclusion Design capacity is much greater than anticipated volumes. If necessary, permitted volumes could be increased, thus no effects on the environment.	**Mixed Wastes (cont'd)**	**Mixed Wastes (cont'd)**
Storage Projected generation rate, excluding SNS, 1998–2040: 20 m^3/yr.	Storage Projected generation rate, excluding SNS, 1998–2040: 622 m^3/yr.	Storage Projected generation rate excluding SNS, 1998–2040: 215 m^3/yr.	Storage Projected generation rate, excluding SNS, 1998–2040: 2 m^3/yr.	
Long-term storage of SNS waste is not anticipated. Shippable quantities of waste would be transferred to laboratory waste management for transport to a licensed, DOE approved, commercial disposal facility. Amount generated by SNS: 18 m^3/yr.				
Conclusion No effect on mixed waste storage facilities would be anticipated because DOE has contracts in place for disposal of wastes as generated, as per the standard DOE practice of off-site disposal in licensed facilities. Implementation of proper handling, disposal, and waste minimization practices would result in no environmental effects.				Conclusion No waste generated, thus no effects on the environment.
All laboratories have waste certification processes in place to assure LLW and mixed wastes sent to off-site disposal facilities meet the waste acceptance criteria (WAC) of the facility. Because of the uncertainty of the composition of the LLW and mixed waste generated by the SNS, the waste may not meet the current WAC. Pretreatment of the waste at the SNS may be necessary. DOE may have to amend the licenses at the current disposal facilities to allow acceptance of wastes from the SNS.				

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
11a. Impacts of Waste Management (Construction and Operations) — continued				
Sanitary Wastes Treatment Projected generation rate, excluding SNS, 1998–2040: 300,000 gal/day. Total capacity available for SNS wastes: 42,000 gal/day.	**Sanitary Wastes** Treatment Projected generation rate, excluding SNS, 1998–2040: 692,827 m^3/yr. Total capacity available for SNS wastes: 368,000 m^3/yr.	**Sanitary Wastes** Treatment Projected generation rate, excluding SNS, 1998–2040: 350,000 gal/day. Total capacity available for SNS wastes: 150,000 gal/day.	**Sanitary Wastes** Treatment Projected generation rate, excluding SNS, 1998–2040: 800,000 gal/day. Total capacity available for SNS wastes: 1.5 million gal/day.	**Sanitary Wastes**
Amount generated by SNS: 25,900 m^3/yr (18,000 gal/day).				
Conclusion No effect on sanitary waste treatment, thus no environmental impacts are anticipated.				Conclusion No effect on sanitary waste facilities, thus no effects on the environment.
Disposal Projected generation rate, excluding SNS, 1998–2040: 7,645 m^3/yr. Total capacity available for SNS wastes: 1,090,000 m^3/yr.	Disposal Projected generation rate, excluding SNS, 1998–2040: 5,453 m^3/yr. Total capacity available for SNS wastes: Not applicable. Sanitary wastes would be disposed of in off-site landfills.	Disposal Projected generation rate, excluding SNS, 1998–2040 not provided. Total capacity available for SNS wastes: Not applicable. Sanitary wastes would be disposed of in off-site landfills.	Disposal Projected generation rate, excluding SNS, 1998–2040: 1,700 tons/yr. Total capacity available for SNS wastes: Not applicable. Sanitary wastes are disposed of in off-site landfills.	

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
11a. Impacts of Waste Management (Construction and Operations) — continued				
Sanitary Wastes (cont'd) Amount generated by SNS: 1,350 m^3/yr.				**Sanitary Wastes (cont'd)**
Conclusion No environmental effect anticipated.	Conclusion No effect anticipated. Sanitary wastes would be disposed of in off-site landfills, thus no environmental impacts are anticipated.			Conclusion No effect on sanitary waste facilities, thus no environmental impacts are anticipated.
12a. Impacts on Long-Term Productivity of the Environment (Operations)				
Localized effects on groundwater productivity would occur at the ORNL SNS site but not on the corresponding watershed.	Sustained use of groundwater by the SNS over time could lower water levels in wells and reduce long-term main aquifer productivity.	Localized effects on groundwater productivity would occur at the ANL SNS site but not on the corresponding watershed.		No effects on groundwater productivity.
Permanent commitment of 110 acres (45 ha) of forested land to the SNS. This represents less 0.5% of the forested area on the ORR.	Permanent commitment of 110 acres (45 ha) of piñon-juniper habitat to the SNS. This represents approximately 10% of the piñon-juniper habitat in TA-70.	Permanent commitment of 110 acres (45 ha) of land to the SNS. A large portion of this land has been previously disturbed.	Permanent commitment of 110 acres (45 ha) of land to the SNS. This represents less than 2% of the legally established Pine Barrens Protection Area. The proposed SNS site is entirely within the Compatible Growth Area.	No effects on the long-term productive potential of land.
13a. Cumulative Impacts (Construction and Operations)				
The proposed action would contribute to cumulative impacts through localized radionuclide contamination of groundwater.				This alternative would not contribute to cumulative impacts involving radionuclide contamination of groundwater.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
13a. Cumulative Impacts (Construction and Operations) — continued				
The potential cumulative impact of incremental emissions would be evaluated and permitted on a case-by-case basis by the state and federal air quality agencies at the appropriate juncture in order to protect public health and welfare.				This alternative would not contribute to cumulative impacts on incremental emissions.
No cumulative impacts are predicted for noise.				This alternative would not contribute to cumulative impacts on noise.
The proposed action would not contribute to cumulative impacts on terrestrial resources.	The proposed action would not contribute to cumulative impacts on terrestrial resources.	Clearing 15% of the undeveloped land at ANL for the SNS and APS would significantly decrease the terrestrial wildlife inhabiting ANL. Except for fallow deer, no rare or important game animals would be affected.	The proposed action would not contribute to cumulative impacts on terrestrial resources.	This alternative would not contribute to cumulative impacts on terrestrial resources.
Cumulative impacts on wetlands would be minimal because wetlands would be created or restored to replace those lost to construction.				This alternative would not contribute to cumulative impacts on wetlands.
No cumulative impacts are anticipated on aquatic resources.				This alternative would not contribute to cumulative impacts on aquatic resources.
Cumulative impacts on protected species would be expected to be minimal.				This alternative would not contribute to cumulative impacts on protected species.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
13a. Cumulative Impacts (Construction and Operations) — continued				
The activities at ORNL account for only about 7% of the employment, wage and salary, and business activities of the area. Cumulative impacts of SNS on the economy, housing, and community infrastructure would be minimal.	The activities at LANL account for about one-third of the employment, wage and salary, and business activities of the area. Some positive benefits would occur in the form of new jobs but cumulative impacts of SNS on the economy, housing, and community infrastructure would be minimal overall.	The activities at ANL account for much less than 1% of the employment, wage and salary, and business activities of the area. Cumulative impacts of SNS on the economy, housing, and community infrastructure would be minimal.	The activities at BNL account for much less than 1% of the employment, wage and salary, and business activities of the area. Cumulative impacts of SNS on the economy, housing, and community infrastructure would be minimal.	No cumulative impacts on the economy, housing, and community infrastructure.
There would be no cumulative impacts involving environmental justice issues.				This alternative would not contribute to cumulative impacts involving environmental justice issues.
The proposed action would not contribute to cumulative impacts on prehistoric cultural resources.	Twenty prehistoric archaeological sites in the 65% surveyed area would be destroyed by construction of the proposed SNS and expansion of LLW Disposal Facility in TA-54. The potential contribution of the other 35% of the proposed SNS site cannot be accurately assessed. If the proposed SNS site is chosen for construction of the SNS, this area would be surveyed and assessed for cumulative impacts on prehistoric cultural resources prior to construction.	Prehistoric site 40DU207, adjacent to the proposed SNS site, may be disturbed or destroyed by SNS construction. ANL has not assessed the NRHP eligibility of this site. Site 40DU189 on the Advanced Photon Source (APS) site was once thought to be potentially NRHP-eligible, but it was later determined to not be a prehistoric cultural resource. If 40DU207 is a cultural resource, the proposed action, along with the APS project, (continued on next page)	The proposed action would not contribute to cumulative impacts on prehistoric cultural resources.	This alternative would not contribute to cumulative impacts on prehistoric cultural resources.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
13a. Cumulative Impacts (Construction and Operations) — continued				
		would not contribute to cumulative impacts on prehistoric cultural resources at ANL because 40DU189 is not a prehistoric cultural resource.		
The proposed action would not contribute to cumulative impacts on historic cultural resources.	Implementation of the proposed action within the 65% surveyed area at the proposed SNS site would not contribute to cumulative impacts on historic cultural resources. The potential contribution of the other 35% cannot be accurately assessed. If this site is chosen for construction of the proposed SNS, this area would be surveyed and assessed for cumulative impacts on historic cultural resources prior to construction.	The proposed action would not contribute to cumulative impacts on historic cultural resources.		This alternative would not contribute to cumulative impacts on historic cultural resources.
The proposed action would not contribute to cumulative impacts on TCPs.	Cumulative impacts on 20 prehistoric archaeological sites (all TCPs) destroyed by construction of the proposed SNS and expansion of LLW Disposal Facility in TA-54. If any prehistoric archaeo-logical sites are located	The proposed action would not contribute to cumulative impacts on TCPs.	The proposed action would not contribute to cumulative impacts on TCPs.	This alternative would not contribute to cumulative impacts on TCPs.

(continued on next page)

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
13a. Cumulative Impacts (Construction and Operations) — continued				
	within the unsurveyed 35 percent of the proposed SNS site, these TCPs would also be destroyed during construction. Cumulative impacts on water resources are also impacts on TCPs (see related entries under this table heading). Because specific identities and locations of TCPs at sites of the proposed SNS and other analyzed actions are not known, cumulative impacts on such specific resources would be uncertain.			
The proposed action would contribute minimally to cumulative impacts on undeveloped ORR land.	The proposed action would contribute minimally to cumulative impacts on undeveloped LANL land.	The SNS and APS would introduce development to about 160 acres (65 ha) of undeveloped land. This would reduce the already limited area of undeveloped ANL land available for development by about 15%.	The proposed action would contribute minimally to cumulative impacts on undeveloped land at BNL.	This alternative would not contribute to cumulative impacts on undeveloped land.
The proposed action would contribute minimally to cumulative impacts on areas of ORR land in current use categories.	The proposed action would contribute minimally to cumulative impacts on areas of LANL land in current use categories.	The SNS and APS would reduce Open Space land at ANL by 145 acres (59 ha). This would further reduce the already limited area of Open Space ANL land available for development by about 15%.	The proposed action would contribute minimally to cumulative impacts on areas of BNL land in current use categories.	This alternative would not contribute to cumulative impacts on areas of land in current use categories.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
13a. Cumulative Impacts (Construction and Operations) — continued				
The proposed action, CERCLA Waste Disposal Facility, Parcel ED-1, and JINS would reduce the environmental research potential of 981 acres (391 ha) of National Environmental Research Park (NERP) land on the ORR. This cumulative impact would be minimal because only 4.5% of the NERP land on the ORR would be affected. The cumulative impacts of these actions on environmental research projects are uncertain.	The proposed action, construction of a new LLW disposal facility in TA-67, and construction of a new road to support pit production would reduce the environmental research potential of 177 acres (72 ha) of NERP land. This cumulative impact would be Minimal because only 0.6% of the NERP land at LANL would be affected. The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects. As a result, the proposed action would not contribute to cumulative impacts on uses of the land by environmental research projects. Because no future environmental research projects are planned for this land, cumulative impacts on specific future projects cannot be assessed.	No NERP land is present at ANL. Consequently, the proposed action would not reduce the environmental research potential of NERP land. The land on and in the vicinity of the proposed SNS site, including Ecology Plot Nos. 6, 7, and 8, is not being used by environmental research projects. As a result, the proposed action would not contribute to cumulative impacts on the use of land by such projects. Because no future environmental research projects are planned for this land, cumulative impacts on specific future projects cannot be assessed.	No NERP land is present at BNL. Consequently, the proposed action would not reduce the environmental research potential of NERP land. The land on and in the vicinity of the proposed SNS site is not being used by environmental research projects. As a result, the proposed action would not contribute to cumulative impacts on the use of land by such projects. Because no future environmental research projects are planned for this land, cumulative impacts on specific future projects cannot be assessed.	No cumulative impacts on NERP land or environmental research projects.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
13a. Cumulative Impacts (Construction and Operations) — continued				
The SNS and CERCLA Waste Management Facility [White Wing Scrap Yard (high-end scenario)] would be collectively at variance with Common Ground zoning for future use of their sites in Conservation Area Uses.	The proposed action would not contribute to cumulative impacts on zoning of land for future use.			This alternative would not contribute to cumulative impacts on zoning of land for future use.
The proposed action would contribute minimally to cumulative impacts on recreational land use but not at all on parks and preserves.				This alternative would not contribute to cumulative impacts on parks, preserves, or recreational land uses.
The proposed action would not contribute to cumulative impacts on visual resources.	The proposed action would not contribute to cumulative impacts on visual resources.	Current views within ANL and along the ANL fence inside the Waterfall Glen Nature Preserve already contain buildings and other features characteristic of development. Consequently, the cumulative impacts of the SNS and APS facilities on visual resources would be minimal.	The proposed action would not contribute to cumulative impacts on visual resources.	This alternative would not contribute to cumulative impacts on visual resources.
Minimal cumulative radiological impacts on human health from normal ORNL and SNS operations.	Minimal cumulative radiological impacts on human health from normal LANL and SNS operations.	Potential for adverse radiological impacts on human health from normal ANL and SNS operations.	Potential for adverse radiological impacts on human health from normal BNL and SNS operations.	This alternative would not contribute to radiological impacts on human health.
Minor increases in traffic due to the proposed SNS project and development of Parcel ED-1 may minimally reduce the level of service on roads.	Minimal cumulative impacts on transportation.			This alternative would not contribute to cumulative impacts involving transportation.

Table 3.5-1. Comparison of impacts among alternatives (continued).

PROPOSED ACTION				NO-ACTION ALTERNATIVE
ORNL Alternative	**LANL Alternative**	**ANL Alternative**	**BNL Alternative**	
13a. Cumulative Impacts (Construction and Operations) — continued				
Minimal cumulative impacts on electric power supply capabilities.	The power demand of the SNS, DAHRT facility, and continued LANL operations would exceed the delivery capacity of the electric power pool that serves the laboratory.	Adequate power is available, but new power lines would need to be installed.	Minimal cumulative impacts on electric power supply capabilities.	This alternative would not contribute to cumulative impacts on electric power supply capabilities.
Waste management facilities at ORNL, LANL, ANL, and BNL have sufficient capacity to handle the waste volume projected for the period 1998–2040, including the wastes from the proposed SNS. Additionally, standard DOE practice has been to dispose of hazardous waste at off-site DOE-approved, licensed facilities. Therefore, construction and operation would have a minimal contribution to cumulative impacts on waste management facilities.				This alternative would not contribute to cumulative impacts on waste management.

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CHAPTER 4: AFFECTED ENVIRONMENT

The affected environment includes the physical and natural environment around each of the four potential sites for the proposed Spallation Neutron Source (SNS) and the relationship of people with that environment. Descriptions of the affected environment provide a basis for understanding the potential direct, indirect, and cumulative impacts of construction and operation of the proposed SNS at each of the potential sites. In this chapter, the existing situation for environmental resources that the construction and operation of the proposed SNS could affect is described. The detail presented for each resource varies depending on the relevance of the resource to the construction and operation of the SNS.

4.1 OAK RIDGE NATIONAL LABORATORY

The Chestnut Ridge site is the preferred site for the proposed SNS and is located approximately 1.75 miles (2.8 km) northeast from the center of the Oak Ridge National Laboratory (ORNL). Site access is via Chestnut Ridge Road, across from the 7000 Area at ORNL (Figure 4.1-1). The Chestnut Ridge site extends on a long, wide, and gently sloping ridge top with a broad saddle area at its eastern end. This area planned for the target station would require a minimum of excavation. The linac, transport line, and ring tunnels would be notched into the south side of the ridge using cut-and-fill techniques, providing economical construction and effective shielding strategies. The entire site is currently undeveloped.

4.1.1 GEOLOGY AND SOILS

A detailed discussion of the geology of the Oak Ridge Reservation (ORR) is provided by Hatcher et. al. (1992). Elements of that report pertinent to the SNS site at Chestnut Ridge are presented below.

The ORR is located in the southwestern portion of the Valley and Ridge Physiographic Province that extends more than 500 miles (800 km) from Alabama northeastward into Virginia. The southwestern portion of the Valley and Ridge Province is about 25 to 50 miles (40 to 80 km) wide. The trend of the valleys and ridges which characterize this province reflects the regional orientation of underlying, deformed bedrock that was intensely folded and faulted by compressional forces from the southeast during the late Paleozoic Appalachian Orogeny. Features that distinguish this province are: (1) parallel ridges and valleys typically oriented from northeast to southwest, (2) topography influenced by alternating weak and strong strata exposed to erosion through a relatively great amount of folding and faulting, (3) a few major transverse streams with subsequent streams forming a trellis-like drainage pattern, (4) many ridges with similar summit levels suggesting former erosion surfaces, and (5) many water and wind gaps through ridges. The scarp (northwest-facing) slopes of these ridges are relatively short, steep, and smooth. The dip slopes (southeast facing) are longer, shallower, and dissected by drainages. Elevation ranges from 738 to 1,345 ft (225 to 410 m) above sea level. Drainage patterns have a dendritic-shape in headwater areas and a trellis shape farther downstream.

Several major ridges, formed from resistant strata, dominate the topography of ORR. Moving from southeast to northwest, prominent ridges are named Copper Ridge, Haw Ridge

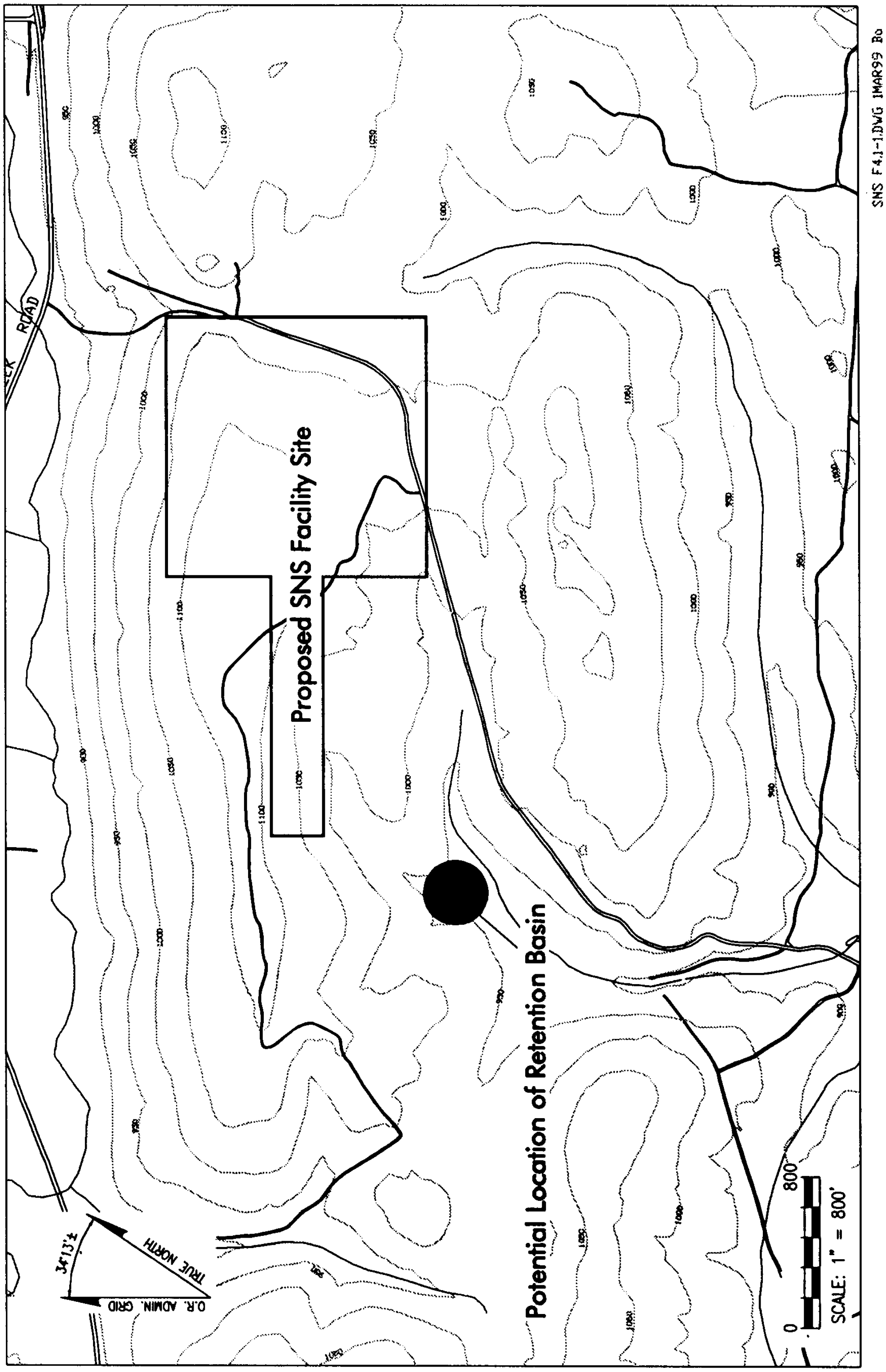


Figure 4.1-1. Proposed SNS site at ORNL.

(south of the ORNL main plant), Chestnut Ridge (separating the ORNL and Y-12 Plant sites), and Pine Ridge (between the Y-12 Plant and the City of Oak Ridge).

4.1.1.1 Stratigraphy

Rock units of the stratigraphic section in the ORR range in age from Early Cambrian to Silurian (Figure 4.1.1.1-1) [Hatcher 1992]. The stratigraphic units compose a complex assemblage of lithologies. The total thickness of the stratigraphic section in the ORR is about 1.6 miles (2.5 km), and each major stratigraphic unit possesses unique mechanical characteristics that respond differently to the strain imparted on these rocks through time.

In general, the Cambro-Ordovician age Knox Group and part of the overlying Chickamauga Group form the competent units within the major thrust sheets in the Oak Ridge area. The Knox Group underlies and forms both Chestnut Ridge (preferred site of the proposed SNS facility) and Copper Ridge and dips southward underneath Bethel Valley (Figure 4.1.1.1-2) [Hatcher 1992]. The Knox Group is composed of a series of medium to thickly bedded, massive, grey, green, and pink dolomite. On the ORR the Knox Group is divided into five separate units: the Copper Ridge Dolomite, the Chepultepec Dolomite, the Longview Dolomite, the Kingsport Formation, and the Mascot Dolomite. Total thickness of the Knox Group ranges between 1,970 and 2,950 ft (600 and 900 m) with the Copper Ridge Dolomite making up roughly one-third of the total. The Chestnut Ridge area encompasses all formation of the Knox Group, but the proposed SNS site boundary overlies the stratigraphic contact between the Copper Ridge and Chepultepec formations at the crest of Chestnut Ridge (Figure 4.1.1.1-3).

The Upper Cambrian Copper Ridge Dolomite is composed of a massively bedded cherty dolomite. It is characterized by medium to coarsely crystalline saccharoidal dolomite and is a common ridge formation in the Valley and Ridge. Sandstone beds in the upper part of the formation are common, and the contact with the Chepultepec Dolomite is mapped at the base of a prominent sandy zone. This formation forms the principal strong unit to support the folding and low-angle thrust faulting that occurs throughout the Valley and Ridge Province in East Tennessee.

Most of the Lower Ordovician Chepultepec consists of light-gray, fine-grained, medium-bedded dolomite. Chert in this formation is less abundant than in the Copper Ridge Dolomite and is characterized by the presence of white oolitic chert beds, dolomitic chert, and a prominent zone of quartz- and dolomite-cemented sandstone at the base.

4.1.1.2 Structure

Strata at the proposed SNS site are oriented (strikes along a northeast-southwest direction with dips 40 to 50° to the southeast) by the compressional tectonics that created the Valley and Ridge Province. These tectonic forces are responsible for two major northeast/southwest trending thrust faults, which dip to the southeast and define the thrust sheets: White Oak Mountain and Copper Creek Fault. Chestnut Ridge and Bethel Valley are underlain by the White Oak Mountain thrust sheet, which is soled by the White Oak Mountain fault (refer to Figure 4.1.1.1-2). Haw Ridge, Melton Valley, and Copper Ridge are underlain by the Copper

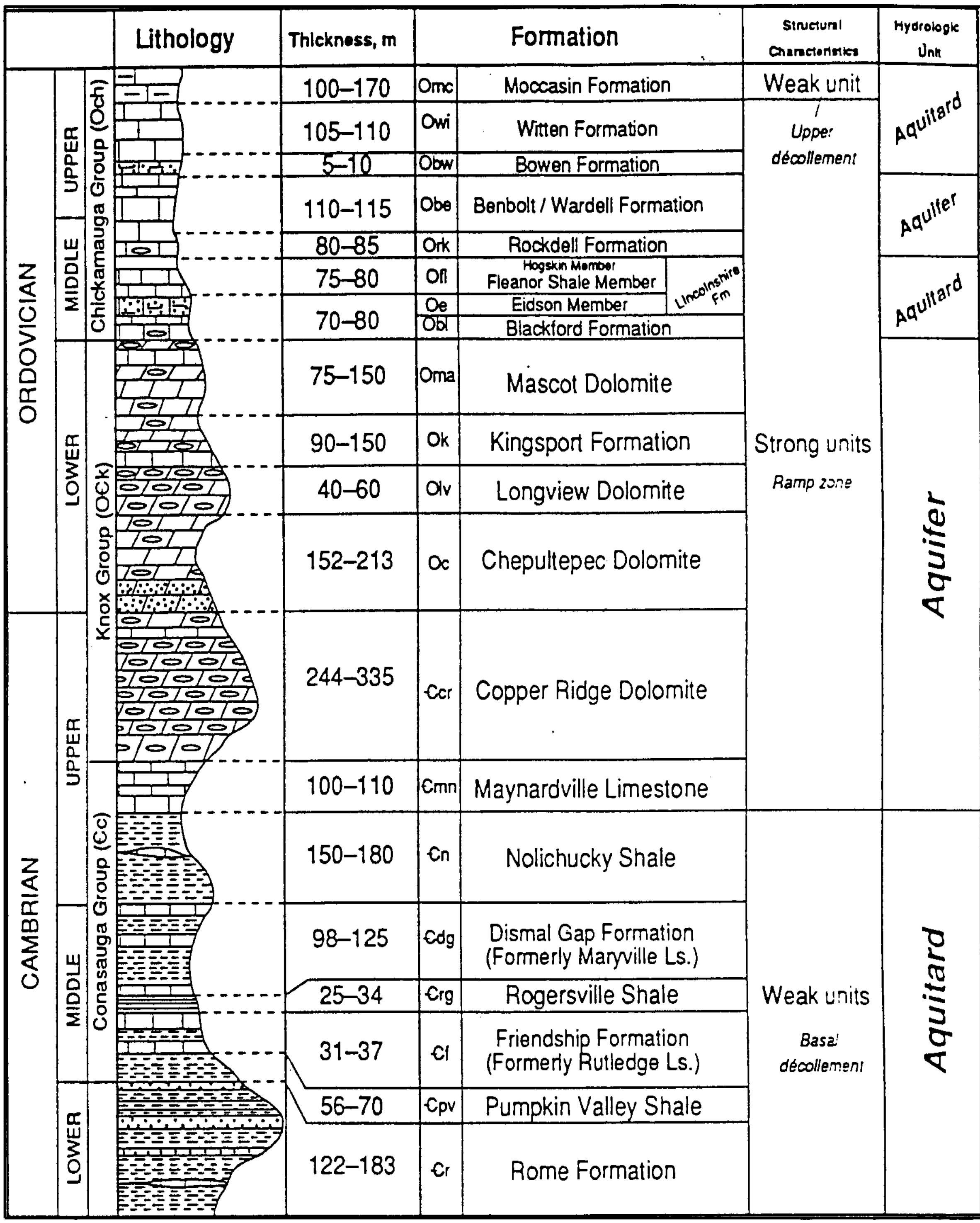


Figure 4.1.1.1-1. ORR Stratigraphy section.

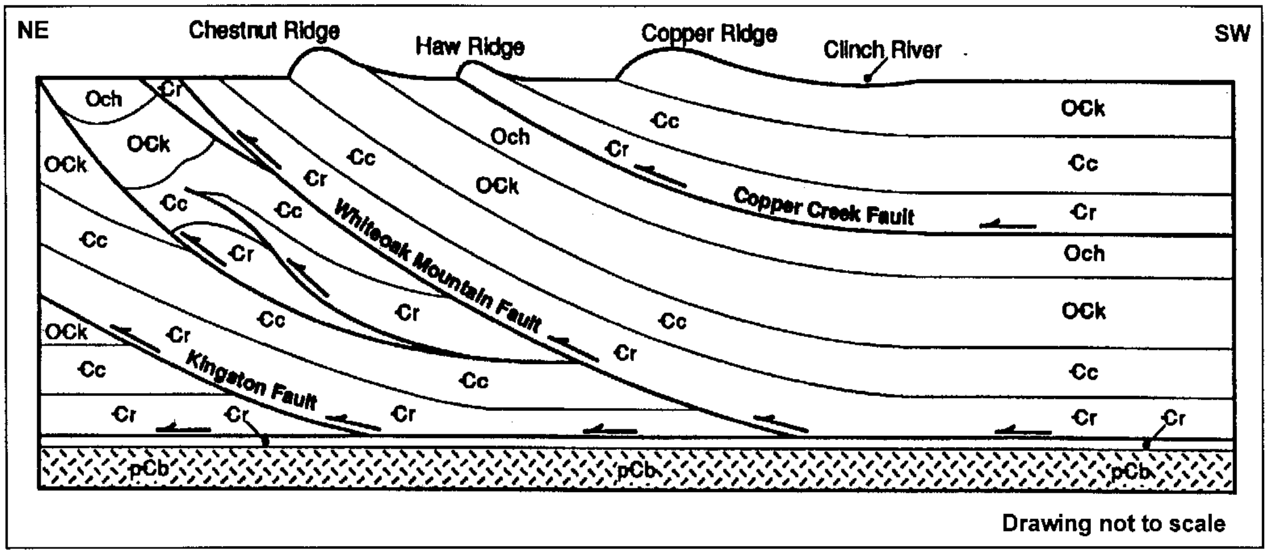


Figure 4.1.1.1-2. Geologic cross section.

Creek thrust sheet, which is soled by the Copper Creek thrust fault. Both thrusts are regional thrust faults that demonstrate at least several kilometers of translation. The faults formed during the Permian-Pennsylvanian Age Alleghenian Orogeny and have not been historically active.

Because of the large-scale faulting, all stratigraphic units in the ORR are fractured to varying degrees. Fractures are abundant on rock outcrops, in saprolite, and at shallow depths in fresh bedrock (Moore 1989). Fewer open fractures occur at deeper levels, and many are filled or partly filled with secondary minerals. Average fracture densities of 200 per meter have been measured in the saprolite of the Maynardville Limestone and Nolichucky Shale compared with five fractures per meter in fresh rock at depth. Most fractures are from a few centimeters to a meter in length. The areal extent of fractures may be only a few square meters for thin to very thin beds, but the areal extent of bedding-plane fractures may be greater by several orders of magnitude.

4.1.1.3 Soils

The following is a general discussion of the soils underlying the proposed SNS site at ORNL. More detailed information about soils across the ORR can be found in the *Status Report on the Geology of the Oak Ridge Reservation* (Hatcher et al. 1992). Five formations of the Knox Group are commonly identified by their location with respect to formations above and below and by the type of chert they contain. Soil series are designated by the first three digits of a five-digit number: the first number identifies the underlying geologic formation; the second number represents residuum, colluvium, or alluvium; and the third number indicates soil classification. Soil of the Copper Ridge Dolomite and the Chepultepec Dolomite are present under the proposed SNS facility.

Series 400 occurs on convex landforms facing south and west in the residuum of the Copper Ridge Dolomite and contains a high silt content with variable amounts of chert. Series 401 is

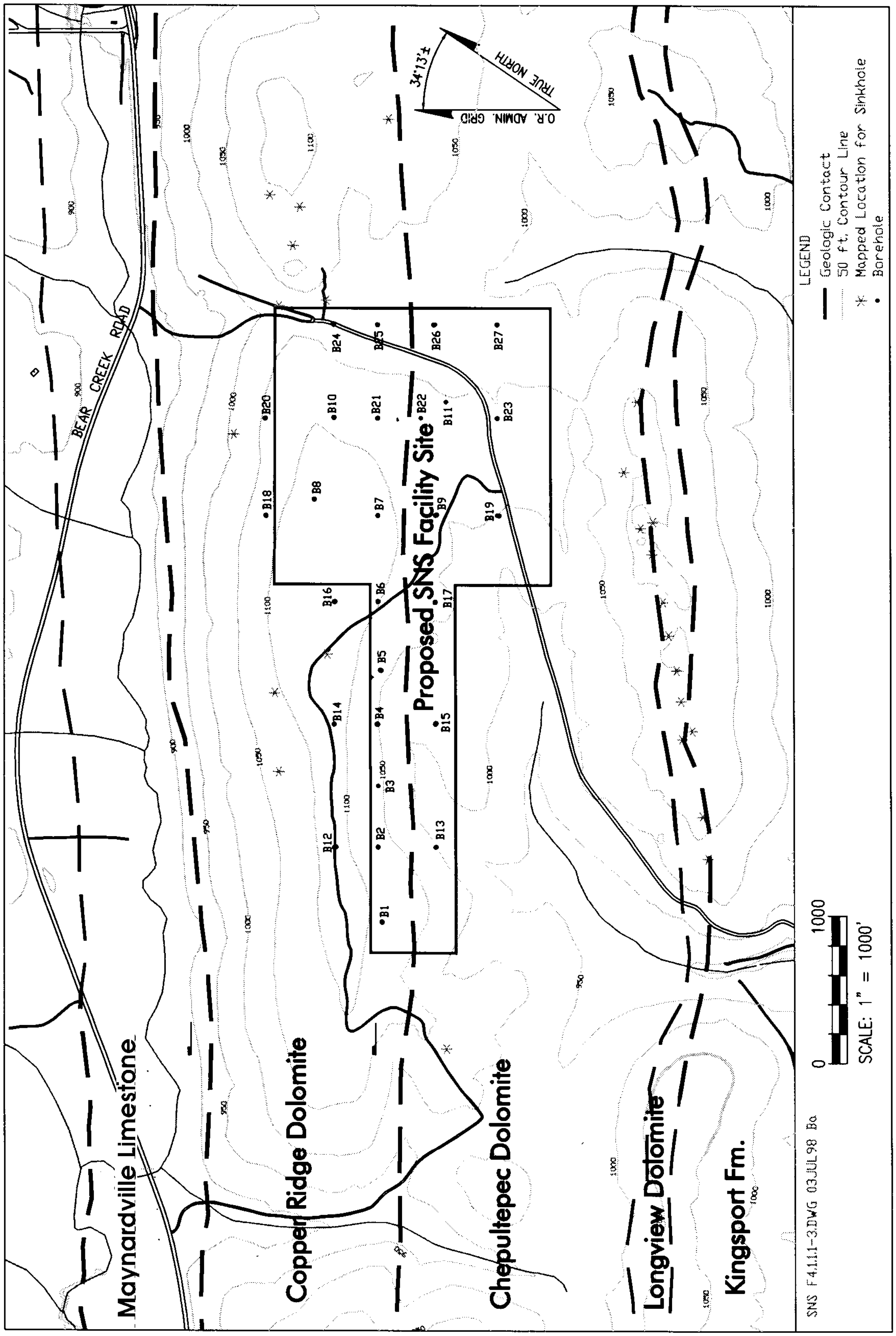


Figure 4.1.1.1-3 Geologic contacts at the SNS site at ORNL.

found in protected, shaded, and cool north slope areas. They have a thicker A horizon and a less distinct E horizon. Series 409 forms at the boundary of the Copper Ridge Dolomite and the Maynardville Limestone. They are found on the lower slope of the western side of Chestnut Ridge. Rock outcrops are common, and depth to bedrock is usually between 3.3 and 4.9 ft (1.0 and 1.5 m).

Series 402 forms in thick saprolite on upland summits and convex side slopes. The A and E horizons have higher chert content. Series 408 was observed only in Walker Branch watershed.

Prime farmland may be considered the best physical and environmental conditions for the production of food crops, livestock, feed, or forage. Prime farmland designation within the City of Oak Ridge boundary and ORR is waived, and other uses are permitted. None of the area affected by the proposed SNS could be valued as prime or unique farmlands, although prior to 1942 the area was used for subsistence farming. The proposed SNS site lies on an irregular sloping ridge line covered in secondary forest.

4.1.1.4 Site Stability

In April and May of 1997, Law Engineering (LAW 1997) installed several soil borings and a single rotary drill hole at the proposed SNS site on Chestnut Ridge to test subsurface conditions. Testing consisted of four borings (Boreholes B-1, B-5, B-8, and B-11); [refer to Figure 4.1.1.1-3] that obtained undisturbed samples at various horizons and continuous measurement of the penetration rate (as an indicator of soil strength, density, consolidation, etc.). The borings were taken to depths of approximately 100 ft (33 m) but possibly encountered bedrock at one location. A rotary drill hole was subsequently installed to determine actual depth to solid bedrock; details are forthcoming in a final report. Initial conclusions are that a highly irregular and weathered bedrock surface exists at the site and that large slabs and fragments of chert may occur within the soil mass. Additional borings and geophysical surveys would be conducted in the future to provide a more complete understanding of the subsurface.

Selected soil samples were analyzed for standard engineering characteristics such as grain size, specific gravity, moisture content, and Atterberg limits. The soils tested ranged from clayey sandy silt with gravel-sized chert (Unified Soil Classification System-“GC”) (USACOE 1967) to highly plastic clayey silt (“MH”). Two soil samples yielded unconfined compressive strengths of 3.61 and 2.13 kg/ft^2 (8 and 4.7 lb/ft^2). These soils are typical of the ORR and are not susceptible to liquefaction or mass movement.

Seismicity of the southeastern United States was reviewed for the Advanced Neutron Source (ANS) site assessment that was sited approximately 1.9 miles (3 km) south of the proposed SNS site (Blasing et al. 1992). The following summarizes those findings. Historical seismicity in the southeastern United States has been traditionally correlated with surficial or shallow geologic features as expressed by physiographic and tectonic provinces. Some large earthquakes in the southeastern United States are apparently associated with basement structures, and others have not been correlated with any specific geologic structures. Little is known about the precise relationships between earthquakes and basement structure because the historical record of seismicity is too short and the location and nature of basement structures is not well know. Figure 4.1.1.4-1 displays the location of major earthquakes in relation to known or suspected basement structures.

Five tectonic provinces have experienced significant historical strong-motion earthquakes relevant to the ORR. These provinces are the Appalachian Basin, Piedmont Plateau, Interior Low Plateau, the Mississippi Embayment, and the Atlantic Coastal Plain. The strongest earthquake(s) (#1, 2, 3, 4, 5; year-1812) in the south occurred along the New Madrid Fault in the Reelfoot Rift zone. This fault zone offsets Holocene sediments of the Mississippi Embayment as well as basement rocks. The strongest earthquake within the Atlantic Coastal Plain had its epicenter at Charleston, South Carolina (#5; year-1886), near the rifted continental margin. Rift structures associated with the early opening (Triassic) of the Atlantic Ocean Basin are buried beneath the Atlantic Coastal Plain in Georgia and South Carolina, exposed at the surface in the Piedmont of North Carolina and Virginia, and exposed in the Appalachian Basin from Maryland to Connecticut. It has been suggested that South Carolina earthquakes may occur along reactivated Triassic Basin faults. The nearest Triassic Basin is about 200 miles (320 km) from the ORR. The epicenter of the Giles County, Virginia, earthquake (#7; year-1897) was located on the late Precambrian/early Cambrian basement rift zone beneath Paleozoic Appalachian Basin structures. The Anna Ohio earthquake represents the strongest earthquake in the Interior Low Plateaus Province and had its epicenter (#10; year-1937) near the junction of two Precambrian rift zones. The strongest earthquake of the Piedmont Province (#9; year-1913) was located near Spartanburg, South

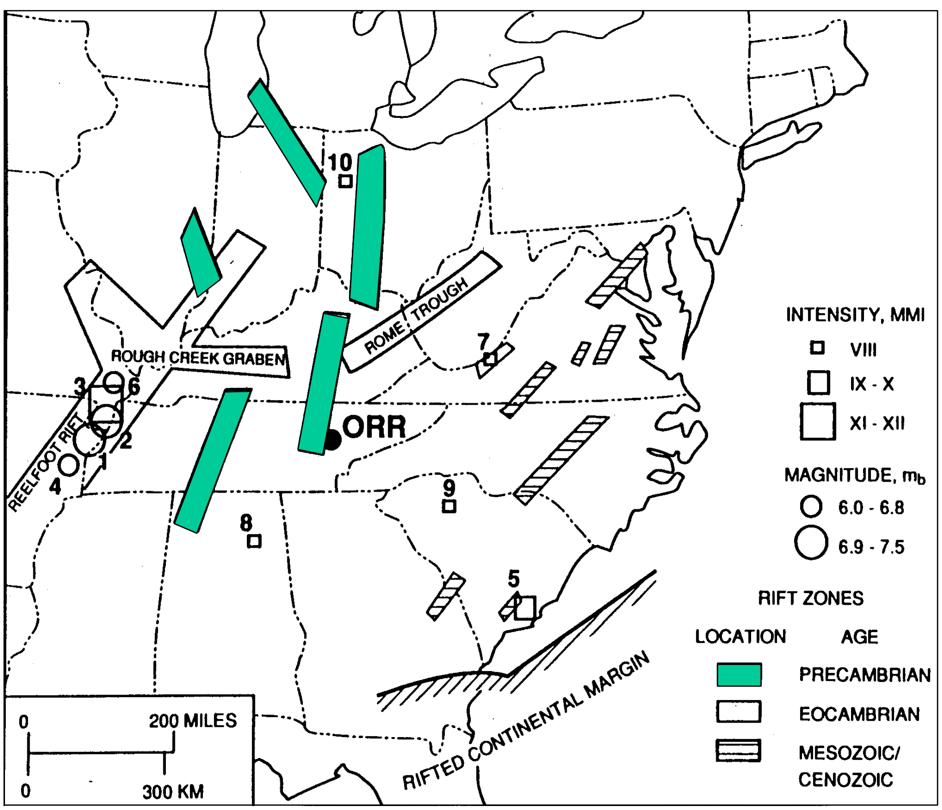


Figure 4.1.1.4-1. Southeast region basement structures and major earthquakes.

Carolina, and the strongest earthquake within 60 miles (100 km) of the ORR had an epicenter near Maryville-Alcoa, Tennessee.

The nearest capable faults (with the capacity of seismic movement) are in the New Madrid Fault zone, approximately 480 km (300 mi) northwest of ORR. An exhaustive literature search in the preparation of the Tennessee Valley Authority (TVA) Safety Analysis Review (Blasing et al. 1992) revealed no evidence of capable faults in the Appalachian Basin where the ORR is located. The U.S. Nuclear Regulatory Commission (NRC) (Blasing et al. 1992) affirmed TVA assessment for the Clinch River Breeder Reactor site with the ORR. Furthermore, the depth of earthquakes within the Appalachian Basin is generally greater than 10 km (6.2 mi) for instrumentally recorded earthquakes. Neither earthquake nor outcrop data support the hypothesis that Paleozoic faults exposed at the surface have been reactivated during modern time (Holocene). However, earthquake energies could be transmitted from adjacent physiographic provinces where recent motion events have been observed. Based on historical observations modified for the dampening effect of distance, Table 4.1.1.4-1 presents expected earthquake intensities for the ORR.

MODIFIED MERCALLI INTENSITY SCALE OF EARTHQUAKE MOTION

I. Not felt except by a few under exceptionally favorable circumstances.
II. Felt by a few persons at rest, especially on upper floors of buildings.
III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Vibration like passing of truck.
IV. Felt indoors by many; outdoors by few during the day. Dishes, windows, door disturbed; walls make creaking sound. Sensation like heavy truck striking building.
V. Felt by nearly everyone, many awakened. Some objects broken; cracked plaster in a few places. Disturbances of trees, poles, and other tall objects sometimes noticed.
VI. Felt by all, many scared and run outside. Some heavy furniture moved. Damages slight.
VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate damage in well built ordinary structures; considerable in poorly built or badly designed structures.
VIII. Damage slight in specially designed structures; considerable in ordinary substantial building with partial collapse; great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, and walls. Sand and mud ejected in small amounts. Changes in well water levels.
IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings. Buildings shifted off foundations. Underground pipes broken.
X. Some well-built structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Landslides considerable from river banks and steep slopes.
XI. Few, if any, structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines out of service. Earth slumps and land slips in soft ground.
XII. Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air.

4.1.2 WATER RESOURCES

The following section discusses the water resources at ORNL.

Table 4.1.1.4-1. Maximum expected earthquakes and their peak ground accelerations at ORR.

Province	Maximum Historical Earthquake MMI[a]	Distance to ORR mi (km)	Maximum MMI[b] at ORR
Appalachian Basin	VIII	on-site	VIII
Atlantic Coastal Plain	X	200 (320)	VII
Interior Low Plateaus	VIII	30 (50)	VII
Reelfoot Rift	XI-XII	250 (400)	VII
Piedmont	VII-VIII	125 (200)	V-VI

[a] Blasing et al. 1992.
[b] Modified Mercalli Intensity (MMI) scale.

4.1.2.1 Surface Water

Surface water at the proposed Chestnut Ridge SNS site consists of a small perennial stream (first order) that acts as headwater to White Oak Creek. This unnamed tributary flows southeast from below the proposed footprint on Chestnut Ridge into the ORNL main plant area. (Figure 4.1.2.1-1). In the lower reaches, the stream has created a floodplain 16 to 33 ft (5 to 10 m) wide with a stream channel up to 6.5 ft (2 m) wide, with overall water depths of about 6 in. (15 cm). Up slope, the tributary forms a deep “V” slope with a channel 3.3 to 6.5 ft (1 to 2 m) wide and with water depths of 2 to 4 in. (5 to 10 cm) during wet-weather base flow. Figure 4.1.2.1-2 displays the combined flow of this stream and two other small tributaries at the weir located well below the proposed SNS site at the foot of Chestnut Ridge (Feb. 97 through Jan. 98). These flows (Salmons 1998b) represent a snapshot of the flow in White Oak Creek from a single recorded measurement for each month shown.

Flow diminishes to zero at the elevation of the proposed SNS site. Two additional drainages northeast and southwest of the site dissect the scarp face of Chestnut Ridge and flow northwesterly into Bear Creek. While these drainages may receive runoff from the footprint area, the site boundary does not overlay the actual stream channels.

No known users exist for water from these headwater tributaries. Also, the proposed site is not within a floodplain, nor is widespread flooding likely for a site location several hundred feet above the valley floor.

Water quality of the watershed below the proposed SNS site is frequently monitored and used as a reference site for comparison with the ORNL main plant area. Six sampling events (Salmons 1998a) took place in 1996-1997 at the White Oak Creek Headwater Station (WCK 6.8). For those six sampling events, volatile organic compounds (VOCs) and heavy metal contaminants were not detected. Background concentrations of dissolved metals were observed (i.e., Al, Ba, Ca, Fe, Mg, Mn, P, Na, and Zn).

Six sampling events for radiological monitoring (Salmons 1998a) took place in 1996-1997 at the White Oak Creek Headwater Station (WCK 6.8). Radionuclide levels reflect atmospheric contributions and are far below any level of concern (Table 4.1.2.1-1). Water quality of this stream reflects the nonimpacted character of the watershed.

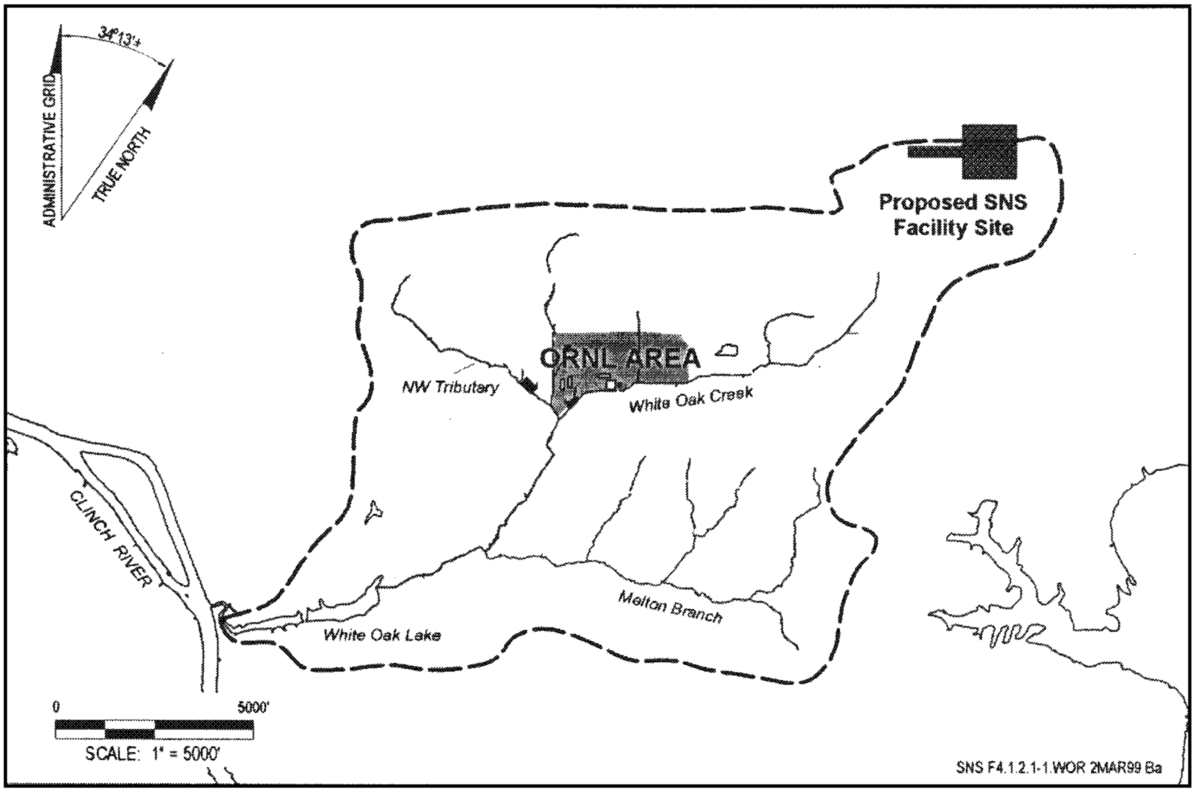


Figure 4.1.2.1-1. White Oak Creek drainage at ORR.

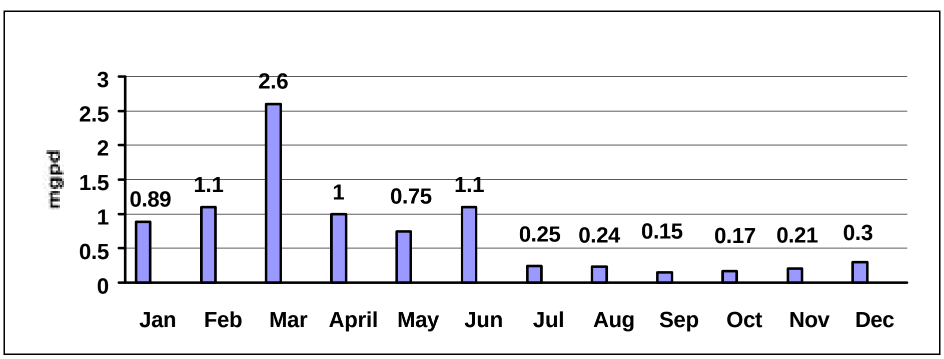


Figure 4.1.2.1-2. White Oak Creek headwater flow at ORR.

Table 4.1.2.1-1. Radionuclide activities (Bq/L) at the White Oak Creek Headwaters Monitoring Station.

Radionuclide	Frequency of Detection	Maximum Activity	Average Activity	Minimum Activity
Gross Alpha	2/9	0.044	0.0019	-0.036
Gross Beta	6/9	0.094	0.057	0.016
Be-7	0/1	0.22	0.22	0.22
Co-60	0/9	0.070	0.034	-0.050
Cs-137	0/9	0.050	0.0035	-0.053
H-3	2/9	300.0	41.0	0.0010
TC-99	1/6	0.20	0.055	-0.030
Sr-89,90	1/10	0.099	-0.0039	-0.082
Total Uranium	1/6	0.028	0.013	-0.0020

4.1.2.2 Groundwater

Groundwater at the proposed Chestnut Ridge site is observed at a depth of greater than 60 ft (18 m). Temporary water levels were recorded in open borings by Law Engineering at the site at 67 and 94 ft (20 and 29 m) (B-8 and B-1, respectively). Also, two groundwater monitoring wells (GW-165 and GW-166) located about 3,000 ft (914 m) east of the proposed site (Oak Ridge Administrative Coordinates N27800, E44500) have water levels at depths of greater than 75 ft (23 m). It should be noted that groundwater levels vary significantly depending upon height above the valley floor and seasonal and climatic conditions. No specific groundwater monitoring at the proposed SNS site is available.

Limited site-specific data about the subsurface of the SNS site are currently available. If the Chestnut Ridge alternative is selected, a geophysical, geotechnical, and hydrogeological characterization of subsurface and groundwater conditions will be completed. The following discussion is intended to supply an understanding of the proposed site as deduced from the conceptual regional model.

Two broad hydrologic units are identified in the ORR, each having fundamentally different hydrologic characteristics. The Knox Group and the Maynardville Limestone of the Conasauga Group constitute the Knox aquifer, in which flow is dominated by solution conduits formed along fractures and bedding planes. The remaining geologic units constitute the ORR aquitards, in which flow is dominated by fractures. Subsurface flow in both types of aquifers is recharged mainly on ridges and is discharged into lakes, streams, springs, and seeps.

The hydrology of the ORR has been described by Moore (1989). The subsurface flow system can be divided into the storm flow zone, the vadose zone, and the groundwater zone. Water budget models indicate that 90 percent of the active subsurface flow occurs through the top 3.3 to 6.5 ft (1 to 2 m) of the stormflow zone. Infiltration tests indicate that this zone is as much as 1,000 times more permeable than the underlying vadose zone. During rain events, the stormflow zone partially or completely saturates and transmits water laterally to the surface-water system. A vadose zone exists throughout the ORR except where the water table is at land surface. The thickness of the zone is greatest beneath ridges and thins towards valley floors. Beneath ridges underlain by the Knox aquifer (for example, Chestnut Ridge), the vadose zone is often as much as 164 ft (50 m) thick. Most recharge through the vadose zone is episodic and occurs along discrete permeable features that may become saturated during rain events.

The groundwater zone occurs typically near the transition from regolith to bedrock. This zone can be divided into three intervals: the water table interval, the intermediate interval, and the deep interval. The water table surface lies near the contact between the regolith and weathered bedrock. A large flux has formed regolith at a shallower level by dissolution of the rock cement. Fresh bedrock at deeper levels indicates a smaller water flux. Seasonal declines in water table elevation can nearly drain this interval.

Groundwater movement within the bedrock is dominated by flow through fractures that can be separated into two categories: the larger, well-connected, water-producing intervals and the smaller intervals that make up the matrix. Distinctly different transmissivity values represent two populations of aquifer properties [for example, flowing fractures (mean T=0.23 m^2/d) and matrix contributions (mean T=0.0011 m^2/d)]. The deeper groundwater zone occurs below any water-producing interval and generally has the same characteristics as matrix intervals within the shallow groundwater zone (SAIC 1994).

The Knox aquifer is a carbonate unit with karst features in which the majority of groundwater flow is controlled by a few cavity systems. In the Knox aquifer, and to a lessor extent in other carbonate rocks of ORR, fractures are enlarged by solution to create well-developed and extensive cavity systems. A survey of the proposed SNS site has mapped the surface expression of locations for possible sinkholes related to karst development (Figure 4.1.1.1-3). Many of these sinkholes occur within the Longview Dolomite southeast of the proposed site, but others are scattered within the general area of the SNS footprint.

In bedrock throughout the ORR, groundwater flow occurs through networks of open, connected fractures and conduits. To understand the significance of karst development within the Knox aquifer, a study of 802 wells in various formations showed that only 97 wells (12 percent) intercepted a cavity. From the population of wells that intercepted cavities, 53 out of 97 (55 percent) encountered only one cavity, while the Knox wells encountered two or more cavities 76 percent of the time. There is also a correlation between formations and the cavity size. The average cavity height at ORNL in the 97 occurrences is 1.8 ft (0.59 m). The largest cavities are generally found in the Knox Group with a mean height of 3.3 ft (1.0 m). In addition, cavities occur at deeper depths in the Knox Group than in other units. Mean depth below ground surface of the cavities in the Knox Group [112 ft (34 m)] is significantly greater than in the Rome Formation [39.3 ft (12 m)], Conasauga Group [27.2 ft (8.3 m)], or the Chickamauga Group [32.2 ft (9.8 m)].

Two wells on the southeast side of Bear Creek Valley are reported to produce greater than 950 gpm (3,596 lpm) of water, and about a dozen large springs discharge water near the base of ridges underlain by the aquifer. A tracer test in the Knox aquifer showed a fluid velocity of 650 to 950 ft/d (200 to 300 m/d) between a swallow hole and a resurgent spring farther downstream. Most wells in the Knox aquifer, however, yield small quantities of water and are not capable of similar flows from those permeable zones.

No groundwater monitoring wells are located in the vicinity of the proposed SNS site to characterize the water quality parameters.

4.1.3 CLIMATE AND AIR QUALITY

The ORR is part of the southeast climatological region of the United States and may be broadly classified as humid continental. The region is characterized by a moderate continental forest climate with mild, cool winters and warm, humid summers. The Blue Ridge Mountains to the east and the Cumberland Plateau to the west have a protective and moderating influence on the area's climate. These features divert severe storms and tornadoes; consequently, high-velocity windstorms are rare. Similarly, the mountains divert hot, southerly winds that develop along the south Atlantic Coast. Slow-moving high-pressure cells that may remain stationary for days suppress rain in the fall and provide mild weather.

Precipitation in this portion of the Tennessee Valley is seasonally distributed (Figure 4.1.3-1). Winter storms are generally of low intensity and long duration. Brief, heavy rains associated with thunderstorms are common in the summer. Peaks in precipitation usually occur in winter and early spring and in mid-late summer. The 40-year mean annual precipitation is 53.9 in. (137 cm), and the mean annual snowfall is 10.4 in. (26 cm). Year-round mean temperatures are about 58 F (14.4 °C) with a January mean of about 38 °F (3.5 °C) and a July mean of about 77 °F (25 °C). Extreme temperatures can dip as low as -24 °F (-31 °C) and peak as high as 100°F (37.8 °C).

The prevailing winds in this area follow the general topography of the surrounding ridges: up-valley winds come from the southwest during the daytime, and down-valley winds come from the northeast during the nighttime (Figure 4.1.3-2). The average wind speed recorded for 1996 was 3.13 mph (5 km/h), with a maximum recorded gust of 50.3 mph (81 km/h) and a predominant wind direction to the southwest (NCDC 1996).

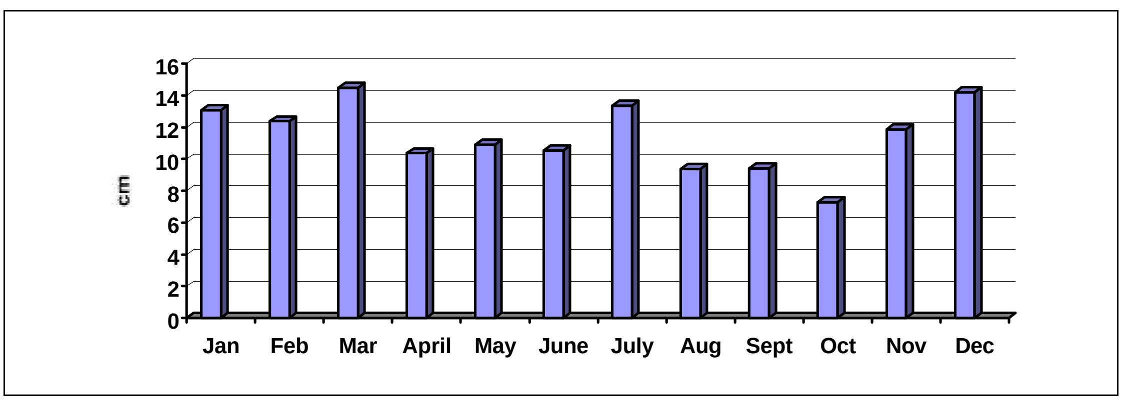


Figure 4.1.3-1. Average monthly precipitation at ORR.

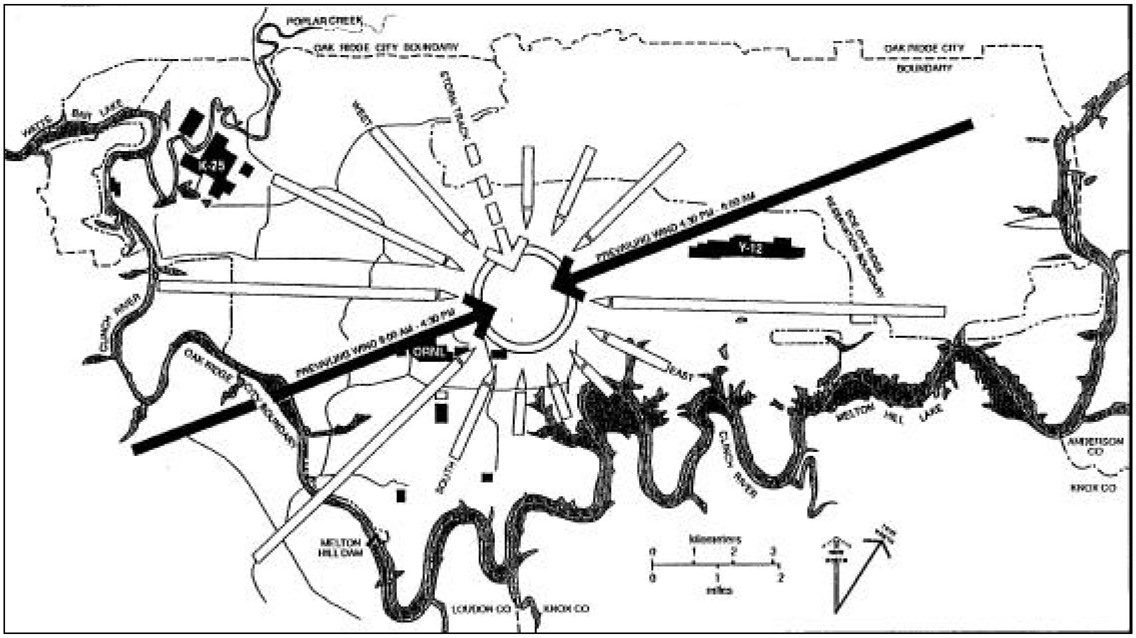


Figure 4.1.3-2. Day and nighttime wind patterns at ORR.

4.1.3.1 Severe Weather

Severe weather in the Oak Ridge area is primarily related to convective thunderstorms with associated hail and lightening. On the average, this area experiences 51.3 thunderstorm events per year. The maximum sustained wind velocity observed at the National Oceanic and Atmospheric Administration (NOAA) meteorological station was recorded January 1959 at 59 mph (95 km/h). An average of 33.6 days is observed with heavy fog restricting visibility to less than 0.25 miles (0.4 km). Historically, snowfalls greater than 1 in. (2.5 cm) have been recorded on only 3.6 days.

East of the Rocky Mountains, East Tennessee has one of the lowest incidences for severe weather involving a tornado (Figure 4.1.3.1-1). Nonetheless, occurrences of such storms are a possibility, as demonstrated by the storm of February 21, 1993. Climatic conditions of this storm spawned a tornado with winds estimated to be in excess of 100 mph (161 km/h). The storm path cut through ORR near the Y-12 Plant. It caused relatively light damage, much in part due to its course and relatively small size. Effects of a tornado on certain key facilities on the ORR have been examined from an emergency-planning standpoint. Numerous approaches to calculating tornado frequencies and recurrent intervals exist. A common approach was initially proposed by H.D.S. Thom in 1963. Based upon historical tornado sightings over a large square (one degree), a point probability can be calculated. The chance of a point, like the proposed SNS location, being struck by a tornado of *any* magnitude in a one-year period is approximately 0.0004. Conversely, the recurrence interval for a tornado striking that point is 1/0.0004 or about once every 2,500 years (Knazovich et al. 1993).

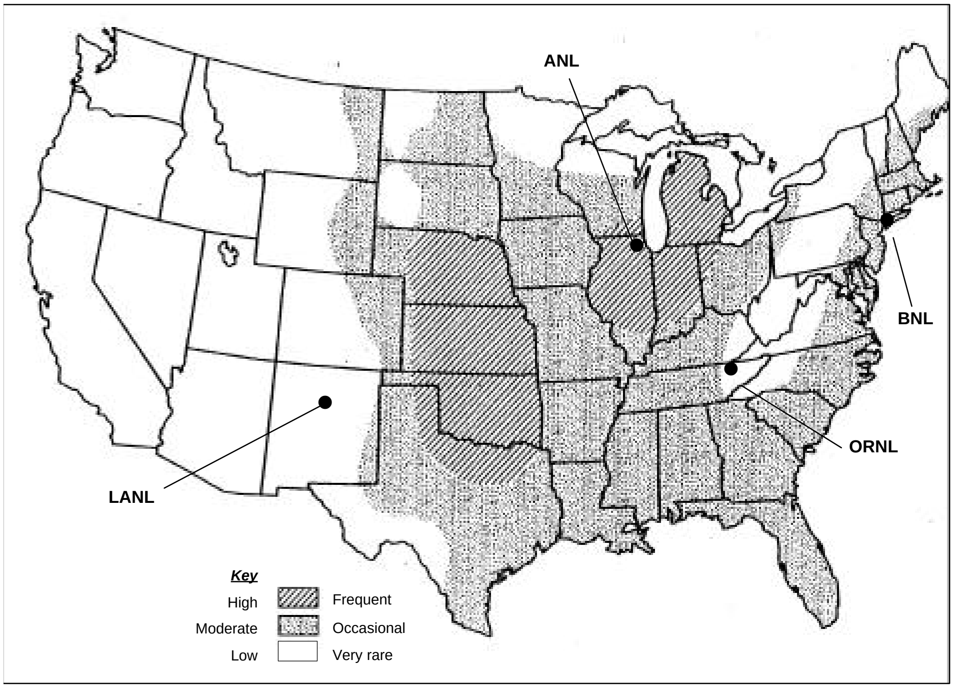


Figure 4.1.3.1-1. Tornado frequency in the United States.

Other studies by Fujita (1979, 1980), McDonald (1979), and Beavers et al. (1985) (all cited in Knazovich et al. 1993) were performed for the ORR. Based on these studies, the probability of a tornado with wind speeds in excess of 100 mph (161 km/h) occurring at Oak Ridge is approximately 5 x 10^{-5}, or a recurrence interval of about once every 20,000 years. The estimate of a tornado with higher wind speeds striking Oak Ridge is even lower. The probability of a significant tornado (F2 or higher) striking the Oak Ridge area is on the order of 3 x 10^{-5} to 1 x 10^{-7}.

4.1.3.2 Atmospheric Dispersion

Seven meteorological towers provide data on meteorological conditions and on the transport and diffusion qualities of the atmosphere on the ORR. The system consists of two towers at the Y-12 Plant [328 and 216 ft (100 and 66 m) high], three towers at the ORNL main plant area [one 328 ft (100 m) and two 108 ft (33 m) high)], and two towers at the East Tennessee Technology Park (ETTP) site [216 and 108 ft (66 and 33 m) high]. Data are collected at different levels to determine the vertical structure of the atmosphere and the possible effects of vertical variations on releases from facilities. At all towers, data are collected at 33 ft (10 m) and at the top levels. At the 328-ft (100-m) towers, data are also collected from an intermediate 108-ft (33-m) level. At each level, temperature, humidity, wind speed, and direction are measured. Select stations measure barometric pressure, precipitation, and solar radiation.

THE FUJITA SCALE

F-Scale Number	Intensity Phrase/ Wind Speed	Type of Damage Done
F0	Gale tornado: 40-72 mph	Some damage done to chimneys; breaks branches off trees.
F1	Moderate tornado: 73-112 mph	Peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads; attached garages may be destroyed.
F2	Significant tornado: 113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; large trees snapped.
F3	Severe tornado: 158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	Debasing tornado: 207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off; cars thrown.
F5	Incredible tornado: 261-318 mph	Strong frame houses lifted off foundations and carried considerable distances; automobile-sized missiles fly through the air; trees debarked; concrete structures badly damaged.

As mentioned previously, prevailing winds are channeled from the southwest or northeast by the ridges flanking the proposed site, providing limited cross-ridge flow. These conditions dominate over the entire reservation with the exception of the ETTP site, which is located in a relatively open area that has a more varied flow. On ORR, low-speed winds predominate at the surface level. Data from tower levels indicate an increase in wind speed at progressively higher elevations. The atmosphere over the reservation is dominated by stable conditions on most nights and in the early morning hours. These conditions, coupled with low wind speeds and channeling effects of the valleys, result in poor dilution of material emitted from facilities. Air stagnation is relatively common in eastern Tennessee. An average of about two air stagnation episodes for periods greater than 24 hours occurs annually, covering an average of eight days per year. August, September, and October are the most likely months for air stagnation episodes.

4.1.3.3 Air Quality

The State of Tennessee has adopted the National Ambient Air Quality Standards (NAAQS), and the Tennessee Department of Environment and Conservation (TDEC) has also adopted regulations to guide the evaluation of hazardous air pollutants and toxics to specify permissible short- and long-term concentrations. Oak Ridge is in an Air Quality Control Region, classified as an “attainment” area for the six NAAQS criteria pollutants.

Existing ambient air quality in the vicinity of ORR is best quantified in terms of recent ambient monitoring data collected by the TDEC at nearby locations. Table 4.1.3.3-1 summarizes these data and is taken from *AIRS Quick Look Report* (TDEC 1998) for 1997. The ORR is located in a Class II prevention-of-significant-deterioration (PSD) area. The nearest Class I PSD area is the Great Smoky Mountains National Park, approximately 35 miles (56 km)

Table 4.1.3.3-1. Summary of 1997 monitoring data in the vicinity of the ORR.

Pollutant Averaging Time	Nearest Monitor Location	Maximum 1st	Maximum 2nd	Maximum 3rd	Maximum 4th	NAAQS TAAQS	Number of Exceedances
PM-10	Knox Co.						
24-hour		69.0	67.0	61.0	60.0	150.0 μg/m^3	0
Annual		33.0				50.0 μg/m^3	0
TSP	Knox Co.						
24-hour		107.0	87.0	77.0	77.0	150.0 Sec. 260.0 Pri. μg/m^3	0
Ozone	Anderson Co.						
1-hour		0.109	0.107	0.106	0.105	0.12 ppm	0
NO_x	Loudon Co.						
Annual		0.015	—	—	—	0.05 ppm	0
SO_2	Anderson Co.						
3-hour		0.152	0.125	—	—	0.5 ppm	0
24-hour		0.032	0.025	—	—	0.14 ppm	0
Annual		0.005	—	—	—	0.03 ppm	0
CO	Knox Co.						
1-hour		10.3	9.6	—	—	35.0 ppm	0
8-hour		4.9	4.8	—	—	9.0 ppm	0
Lead	Roane Co.						
Quarterly		0.13	0.11	0.07	—	1.5 μg/m^3	0

Source: TDEC 1998. TAAQS - Tennessee Ambient Air Quality Standards.

southeast of the ORR. Class I PSDs include certain national parks and wilderness areas and permit the least amount of air quality deterioration for baseline concentrations of particulate matter, sulfur dioxide, and nitrogen dioxide. All areas not designated as Class I PSDs are supplied with a Class II determination.

4.1.4 NOISE

The SNS site is proposed for a wooded section of the ORR that is roughly 0.75 miles (1.2 km) from the nearest public-use highway (Bethel Valley Road) and about 1 mile (0.6 km) from the nearest concentration of on-site workers (ORNL). A site-specific survey has not been conducted, but ambient noise levels in a rural setting such as this are typically in the 35-45 dB range. Because of its remote location, the proposed site would be protected by distance from sources of noise and removed from any sensitive populations. The proposed SNS site would be situated about 3 miles (4.8 km) from residential population centers within the City of Oak Ridge and dispersed populations within Knox County.

4.1.5 ECOLOGICAL RESOURCES

This section provides a general description of the ecological resources for the proposed SNS site and the surrounding area. The discussions are based on information readily available from other sources. Site-specific surveys were done for protected species and wetlands. All other information was obtained from existing publications. For the most part, the impacts from construction and operation of the proposed SNS would be minor. Therefore, much of the information presented here is summary in nature. Greater detail can be obtained from the references compiled for this section.

4.1.5.1 Terrestrial Resources

ORR is an area of primarily natural vegetation surrounded by dramatically different land uses.

Since 1942, when the land was purchased for the Manhattan Project, the 34,516-acre (13,980 ha) reservation has been undisturbed except for project development of the U.S. Department of Energy (DOE) and its predecessors and for forest management. The original forests on the ORR were extensively cleared, and the land was cultivated or partially cleared and used for rough pasture during settlement. Except for the very steep slopes, most of the forest had been cut for timber, though not necessarily cleared and put into cultivation. Cultivation on the ORR ended in 1942, and cultivated fields have developed into forest, either through natural selection or planting of pines. Many of these old abandoned fields support mixed hardwood forests. Between 1948 and 1954, many of the abandoned fields that were not developing into forest were planted with loblolly, shortleaf, and white pine trees. Most of these plantations have been maintained with little or no invasion of hardwoods. Most pine stands that currently exist are on lower slopes; relatively level, wide ridge tops; and well-drained bottomlands (LMES 1994; LMES 1995; LMES 1996).

Based on information from the Forest Compartment Maps for the ORR, over half of the proposed site is covered with a mixed hardwood forest, composed of red oak, white oak, chestnut oak, poplar, and hickory. Approximately 20 percent of this area is covered with loblolly pines, the majority of which were planted in the 1940s and 1950s. Approximately 20 percent of the proposed site is labeled as "Beetle Kill cut over" (clear cutting for control of the pine bark beetle). The remaining 10 percent of the vegetative cover is old field scrub.

Only general information on wildlife in the vicinity of the proposed SNS site is available. Wildlife in this area is typical for forests in East Tennessee. Numerous small mammals occupy the hardwood/mixed-hardwood habitat, including flying squirrels, southeastern shrews, eastern moles, white-footed mice, and eastern chipmunks. Birds commonly found in forest areas include the yellow-shafted flicker, red-bellied woodpecker, hairy woodpecker, downy woodpecker, blue jay, Kentucky warbler, pine warbler, yellow-breasted chat, ovenbird, Carolina chickadee, tufted titmouse, and scarlet tanager. Hawks, including red-shouldered, red-tailed, and broad-winged, are commonly found on the ORR, as are wild turkeys. Amphibians and reptiles found in the forest habitat include the dusky salamander, American toad, eastern box turtle, ground skink, worm snake, black racer, rat snake, black king snake, milk snake, and copperhead (LMES 1994; LMES 1995; LMES 1996).

Pine plantations are essentially barren of both small and large mammals due primarily to the dense canopy that shade out most undergrowth. The pine warbler and white-throated sparrow are birds commonly found, but in general few bird species prefer this type of habitat. Reptiles and amphibians make little use of this habitat.

Right-of-ways for power line, gas pipeline, and water pipeline run through or adjacent to the proposed site. In addition, there are several dirt roads running through the site.

4.1.5.2 Wetlands

A report from a field survey conducted in September 1997, describes the wetlands on and adjacent to the proposed SNS site (Rosensteel et al. 1997). Eight wetland areas were identified. Seven of the wetlands (WOM14, WOM15, WOM16, WOM17, WOM18, WONT1-1, WONT2-1) are in the White Oak Creek watershed, and one (BCST2-1) is in the riparian zone of a first-order stream in the Bear Creek watershed. The wetlands are classified as palustrine forested, broad-leaved deciduous (PFO1), palustrine scrub-shrub, broad-leaved deciduous (PSS1), and palustrine emergent, persistent (PEM1). It is most likely that the hydrologic regimes of these wetlands are saturated and temporarily flooded. One of the wetlands that is spring-fed may be semi-permanently or permanently flooded. Wetland locations are shown in Figure 4.1.5.2-1.

The boundaries of all of the wetlands, except for WOM17, WOM18, and BCST2-1, were delineated and located by a civil survey. Therefore, the area sizes given for the delineated wetlands are accurate, while those for WOM17, WOM18, and BCST2-1 are estimated. The total area of wetlands in the survey area is 3.62 acres (1.46 ha), the majority of which [3.27 acres (1.32 ha)] are in the White Oak Creek watershed.

A 0.03-acres (0.01-ha) emergent wetland (WONT2-1) was identified along a tributary of White Oak Creek. An infrequently used, grass-covered roadbed crosses the tributary near its confluence with White Oak Creek. The emergent wetland includes a low spot in the road where it crosses the stream and a small alluvial area at the mouth of the stream. Surface runoff and seasonal stream flow collect in and flow through the wetland area. Species in the wetland include smartweed (*Polygonum* sp.), false nettle (*Boehmeria cylindrica*), microstegium (*Microstegium vimineum*, an invasive exotic grass species), and sedges (*Carex* spp.).

A 0.05-acres (0.02-ha) emergent wetland swale (WOM15) is immediately adjacent and parallel to Chestnut Ridge Road. Discharge from two springs flows through the swale and empties into White Oak Creek just downstream of the Chestnut Ridge Road culvert. Shrubs, including alder (*Alnus serrulata*) and elderberry (*Sambucus canadensis*), grow along one side of the swale. The swale is vegetated with numerous wetland species including watercress (*Nasturtium officiniale*), great lobelia (*Lobelia siphilitica*), cardinal flower (*Lobelia cardinalis*), turtle head (*Chelone glabra*), smartweed (*Polygonum* sp., and sedges (*Carex* spp.).

A 0.015-acres (0.006-ha) emergent wetland (WOM14) was identified in a manmade, isolated depression in an open area. This depression is near the wetland swale (WOM15), but separated from it by a vegetated berm. The depression does not have a surface outlet to the swale or to White Oak Creek. There was no water in the depression on the day of the wetland survey or on followup visits in the summer of 1998, but it is possible that it holds precipitation and surface runoff for an undetermined period of time during the winter and spring. The soil has hydric characteristics. Species in this man-induced emergent wetland include fescue (*Festuca arundinaceae*), false nettle (*Boehmeria cylindrica*), smartweed, Frank's sedge (*Carex frankii*), and other sedges.

A 2.36-acres (0.96-ha) forested wetland (WOM16) is located in a seep and spring area in

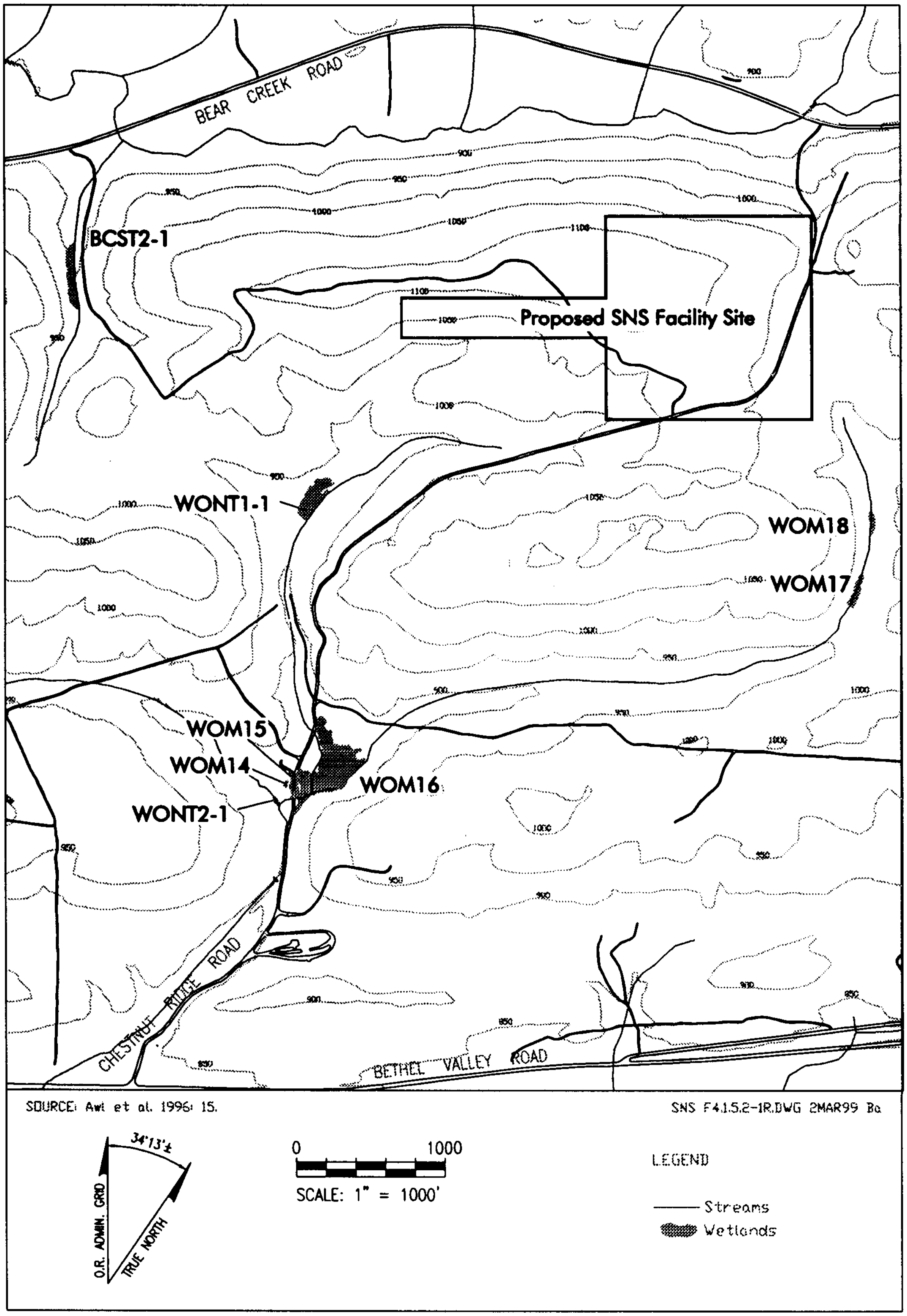


Figure 4.1.5.2-1. Wetland areas within and adjacent to the proposed SNS site at ORNL.

the floodplain of White Oak Creek, immediately adjacent to the east side of Chestnut Ridge Road. This wetland includes forested areas on both sides of White Oak Creek, a portion of a transmission line right-of-way, and a swale adjacent to Chestnut Ridge Road. Except at its upper end, this swale is separated from the rest of the wetland area by a 2 to 3 ft high upland berm. The wetland includes floodplain area on both sides of White Oak Creek. Dominant or common plant species in this wetland include sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), spicebush (*Lindera benzoin*), sedges (*Carex* spp), watercress, microstegium, false nettle, cardinal flower, bugleweed (*Lycopus virginicus*), smartweed, and hog peanut (*Amphicarpa bracteata*). The primary hydrologic source is localized (seeps and springs) and diffuse groundwater discharge. Although this wetland is primarily an undisturbed forested wetland, the section in the transmission line right-of-way is more appropriately classified as a scrub-shrub/emergent wetland that is periodically disturbed by mowing. *Carex leptalea* and *Bartonia paniculatum*, two species that are uncommon in East Tennessee, occur in the forested part of wetland WOM16. This wetland area had initially been designated an Environmental Research Park Reference Area but is now within Environmental Research Park Natural Area 55 (Awl et al. 1996).

A small area of forested wetland (WOM17); [0.15 acres (0.06 ha)] and a small, emergent wetland (WOM18) [<0.03 acres (<0.012 ha)] were identified in the upper reach of White Oak Creek. WOM17 is a 0.15-acres (0.06-ha) wetland in a seep area that appears to contribute a significant portion of the summer and early fall base flow of a section of upper White Oak Creek. The stream channel immediately upstream and downstream of this wetland area

Wetland Classification

Wetlands identified within the vicinity of the proposed SNS site at ORNL were classified with a hierarchical system developed in 1979 by Cowardin et al. (as cited in Rosensteel et al. 1997). Wetlands are described by system, class, and subclass. Additional modifiers are used for water regime, chemistry, soils and disturbances.

The systems are marine, estuarine, riverine, lacustrine, and palustrine. The marine and estuarine systems are oceanic and coastal and do not occur on the ORR. The lacustrine and riverine systems encompass freshwater lakes and streams. The palustrine system includes nontidal wetlands dominated by trees, shrubs, or emergent vegetation. These wetlands are traditionally called marshes, swamps, or ponds.

The palustrine system includes five classes that are vegetated and that are considered as wetlands under the U.S. Army Corps of Engineers (1987) definition: (1) aquatic bed, (2) moss-lichen, (3) emergent (dominated by herbaceous plants), (4) scrub-shrub (dominated by shrubs and sapling trees), and (5) forested. Subclasses of the vegetation classes indicate differences in vegetative form. Water regime modifiers include: (A) temporarily flooded, (B) saturated, (C) seasonally flooded (F), semipermanently flooded, and (H) permanently flooded. (As cited in Rosensteel et al. 1997.)

was dry on the day of the survey. The soil was saturated, and there was flowing water in shallow surface channels on the day of the survey. The dominant vegetation species in wetland WOM17 include sweetgum, red maple, ironwood, smartweed (*Polygonum punctatum*), cardinal flower, microstegium, false nettle, and poison ivy (*Toxicodendron radicans*). WOM18 is a narrow fringe (0.6 to 0.9 m wide) of emergent wetlands on the edge of the stream channel. This section of stream contained flowing water. Dominant species in WOM18 include microstegium, cardinal flower, smartweed, bugleweed, and sensitive fem (*Onoclea sensibilis*).

A 0.63-acres (0.26-ha) forested wetland (WONT1-1) is located in the riparian zone of White Oak Creek north tributary 1. This tributary is located in a forested drainage on the west side of Chestnut Ridge Road north of the transmission line right-of-way and is in Environmental Research Park Natural Area 55. Further downstream the tributary crosses the power line, flows through a culvert under Chestnut Ridge Road, and empties into White Oak Creek in the WOM16 wetland. The wetland is located along the middle reach of the stream. The primary water source for this wetland is groundwater in the form of perennial seeps and a seasonal high water table. Overbank flooding may be an occasional, but not a sustaining, source of water. Dominant species include sycamore, red maple, sweetgum (*Liquidambar styraciflua*), green ash, bugleweed, cardinal flower, and cinnamon fem (*Osmunda cinnamomea*). At a perennial seep, which spreads out over a wide area, the dominant species include smartweed, watercress, bugleweed, cutgrass (*Leersia oryzoides*), leathery rush (*Juncus coriaceous*), avens (*Geum* sp), and tickseed sunflower (*Bidens* sp).

In the riparian zone of Bear Creek south tributary 2 (BCST2), there are three small areas of forested wetlands and emergent wetlands at streamside seeps. These three areas are close

Wetlands as defined by the U.S. Army Corps of Engineers (USACOE): Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. The USACOE uses three characteristics of wetlands when making wetland determinations:

Vegetation indicators – The vegetation community must be hydrophytic. At least 50 percent of the dominant plant species in each stratum must be classified as obligate wetland (OBL), facultative wetland (FACW, FACW-, FACW+), or facultative (FAC, FAC-, FAC+) [Reed 1988].

Soil indicator - Existence of soils that are hydric, having characteristics that indicate occurrence of anaerobic conditions resulting from depleted soil oxygen due to prolonged saturation, flooding, or ponding.

Hydrology indicators - Wetland hydrology exists when the presence of water at or above the soil surface for a sufficient period of the year significantly influences the plant types and soils that occur in the area.

Unless an area has been altered or is in a rare natural situation, wetland indicators of all three characteristics must be present for an area to be characterized as a wetland by the USACOE.

together along the stream and were combined into one wetland area (BCST2-1) for purposes of mapping and description. The approximate size of the wetland area is 0.35 acres (0.14 ha). It is downslope of, but not within, the site boundary. Dominant species include green ash, red maple, spicebush, microstegium, poison ivy, woodreed (*Cinna arundinacea*), and Virginia knotweed (*Tovara virginiana*).

4.1.5.3 Aquatic Resources

The proposed site lies within the White Oak Creek watershed (refer to Figure 4.1.5.2-1). White Oak Creek is a second-order stream with a watershed area of approximately 0.85 mi² (2.2 km²), bordered by a young-to-mature forest and disturbance vegetation. The stream contains substantial aquatic vegetation, primarily watercress and peppermint. A rich and diverse assemblage of benthic invertebrates and a stable fish community occur in this area. At White Oak Creek kilometer 6.8, upstream of discharges from ORNL but downstream of the proposed SNS site, small numbers of the central stoneroller (*Campostoma anomalum*), blacknose dace (*Rhinichthys atratulus*), creek chub (*Semotilus atromaculatus*), and banded sculpin (*Cottus carolinae*) have been collected. Historically, operations at ORNL have had an adverse ecological effect on White Oak Creek and it tributaries, First Creek and Fifth Creek. The mean number of different kinds of taxa per sample (species richness) of benthic macroinvertebrates (bottom-dwelling invertebrates capable of being seen with the naked eye) is less downstream of ORNL than upstream. The number of pollution-intolerant benthic macroinvertebrate taxa is also less downstream of ORNL than upstream (LMER 1996/1997; ORNL, OR Y-12 Plant, and ETTP 1997).

4.1.5.4 Threatened and Endangered Species

DOE is in the process of consulting with the U.S. Fish and Wildlife Service (USFWS) and TDEC regarding whether or not construction and operation of the proposed SNS at ORNL would jeopardize the habitat of any threatened or endangered species and regarding appropriate mitigation measures. The USFWS responded with a list of federally listed or proposed endangered or threatened species that they believe may occur on the proposed SNS site. The TDEC has yet to respond. Appendix D presents the letters of consultation.

Surveys of the proposed SNS site for the presence or evidence of state and federally listed plant and animal species were conducted in 1997 (Rosensteel et al. 1997). No suitable habitat was identified for listed species of fish that have been previously documented on the ORR or for other listed fish known to occur in the region.

Threatened and Endangered Species: Animals, birds, fish, plants, or other living organisms in jeopardy of extinction by human-produced or natural changes in their environment are considered threatened or endangered. Requirements for declaring species threatened or endangered are contained in the *Endangered Species Act of 1973*.

This Act protects animal and plant species currently in danger of extinction (endangered) and those that may become endangered in the foreseeable future (threatened). The Act provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend, both through Federal action and by encouraging the establishment of state programs. Section 7 of this Act requires federal agencies to ensure that all federally associated activities within the United States do not harm the continued existence of threatened or endangered species or designated areas (critical habitats) important in conserving those species.

No suitable habitat was identified on or adjacent to the proposed site for any federally listed wildlife species. Suitable habitat was found for species listed as threatened, in need of management by the State of Tennessee, or as federal species of concern.

Previous studies have provided an indication of protected species that may occur on this site (Mitchell et al. 1996). Table 4.1.5.4-1 provides a list of species potentially occurring on the proposed site, their preferred habitat, and their status. Suitable habitat was located for nine species listed by the State of Tennessee as in need of management, one species listed as state threatened, and one federally listed species of concern. Figure 4.1.5.4-1 illustrates the locations of potential habitat for each of these species. Appendix E contains additional details of each of these listed species.

The proposed SNS site contains the following vegetation types and landscape elements associated with the occurrence of protected plants on the ORR: deciduous forests, mixed deciduous and pine forests, overmature/ successional pine plantations, wetlands and stream bottoms, limestone outcrops, and springs and seeps. The proposed site encroaches on a National Environmental Research Park (NERP)-designated Natural Area, NA52 (Awl et al. 1996).

The locations of designated natural areas and other environmentally sensitive areas on and near the proposed SNS site are shown in Figure 4.1.5.4-2. Several areas on and near the site have been ranked by the Nature Conservancy according to their significance in terms of biodiversity. These areas are shown in Volume II, Appendix B, page B-43.

NERP Natural Areas have been established on the ORR to protect federally or state-listed species that occur on the reservation. Each natural area consists of a core area, the actual location of the protected plant, and a buffer area for habitat protection. Aquatic Natural Areas are used for study and reference areas as part of the Biological Monitoring and Abatement Program (BMAP), required by the National Pollutant Discharge Elimination System (NPDES) permit for ORNL, or environmental remediation efforts. Many of the Aquatic Natural Areas represent nonimpacted streams or reaches of streams that are comparable in terms of size and potential fauna to streams or reaches that are monitored for impacts.

Ten protected plant species were recognized as potentially occurring within the proposed SNS site (Table 4.1.5.4-2). Pink lady's slipper and American ginseng were found at three locations (Figure 4.1.5.4-3) during the 1996 site surveys. An additional species verified to be located on the proposed site during previous surveys, Howe's Sedge (*Carex howei*), was removed from protection status by the State of Tennessee in 1997. Of the remaining species potentially occurring on this site, two are classified as having high potential for occurrence, while the remaining six are classified as having low potential for occurrence.

4.1.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The region of influence (ROI) for the SNS at the proposed ORR site includes Anderson, Knox, Loudon, and Roane Counties, as shown in Figure 4.1.6-1. Approximately 90 percent of ORR employees reside in this region. The region includes the cities of Clinton, Oak Ridge,

Table 4.1.5.4-1. List of species potentially occurring on the ORNL site.

Species	Habitat on the proposed SNS and Status	Preferred Habitat
Sharp-shinned hawk (*Accipter striatus*)	Power line corridors In need of management	Mixture of woods and open country
Cooper's hawk (*Accipiter cooperii*)	Powerline corridors In need of management	Mixed woods with openings
Cerulean Warbler (*Dendroica cerulea*)	Mature hardwood forest on ridgetop Federal Species of Concern	Mature hardwood forests
Grasshopper Sparrow (*Ammodramus savannarum*)	Powerline corridors In need of management	Grassy fields and farmlands
Yellow-bellied sapsucker (*Sphyrapicus varius*)	Possible in most areas except pine stands In need of management	Open deciduous woods
Rafinesque's big-eared bat (*Plecotus rafinesquii*)	Abandoned building along C-17 Road In need of management	Unoccupied man-made structures and caves
Southeastern shrew (*Sorex longirostris*)	Pine plantations and tributaries In need of management	Pine woods and stream banks
Northern Pine Snake (*Pituophis m. melanoleucus*)	Ridgetops and powerline corridors State Threatened	Pine woods, dry ridges, and old fields
Eastern Slender Glass Lizard (*Ophisaurus attenuatus longicaudus*)	Ridgetops and powerline corridors In need of management	Dry upland areas, brushy cut-over woodlands
Mole salamander (*Ambystoma talpoideum*)	Depression with temporary pools In need of management	Moist low-lying woodland areas with ponds
Four-toed salamander (*Hemidactylium scutatum*)	Tributaries of White Oak Creek In need of management	Hardwood forest wetlands

Knoxville, Loudon, Lenoir City, Harriman, and Kingston.

This section provides a description of the following socioeconomic and demographic characteristics:

- Demographics
- Housing
- Infrastructure
- Local economy
- Environmental justice

4.1.6.1 Demographic Characteristics

Population trends and projections for each of the counties in the ROI are presented in Table 4.1.6.1-1. Of the four counties, Knox has the largest population, with 70 percent of the 1995 regional population of 517,604. Anderson County accounted for 14 percent of the regional population, Roane County for 9 percent, and Loudon County accounted for the remaining 7 percent. The region represents approximately 10 percent of the state's population. The Tennessee Department of Economic and Community Development has indicated that the population in the region will likely decline to 512,399 by year 2000 and then increase slightly by year 2005. Roane County is the exception to this trend, as it is projected to grow 28 percent.

Population data for the cities in the region are presented in Table 4.1.6.1-2. Between 1980 and 1995, the populations of the four-county region and the state both grew at about one percent per year. Projections in Table 4.1.6.1-1 show that regional and state populations are expected to grow by less than half of one percent annually through the year 2005.

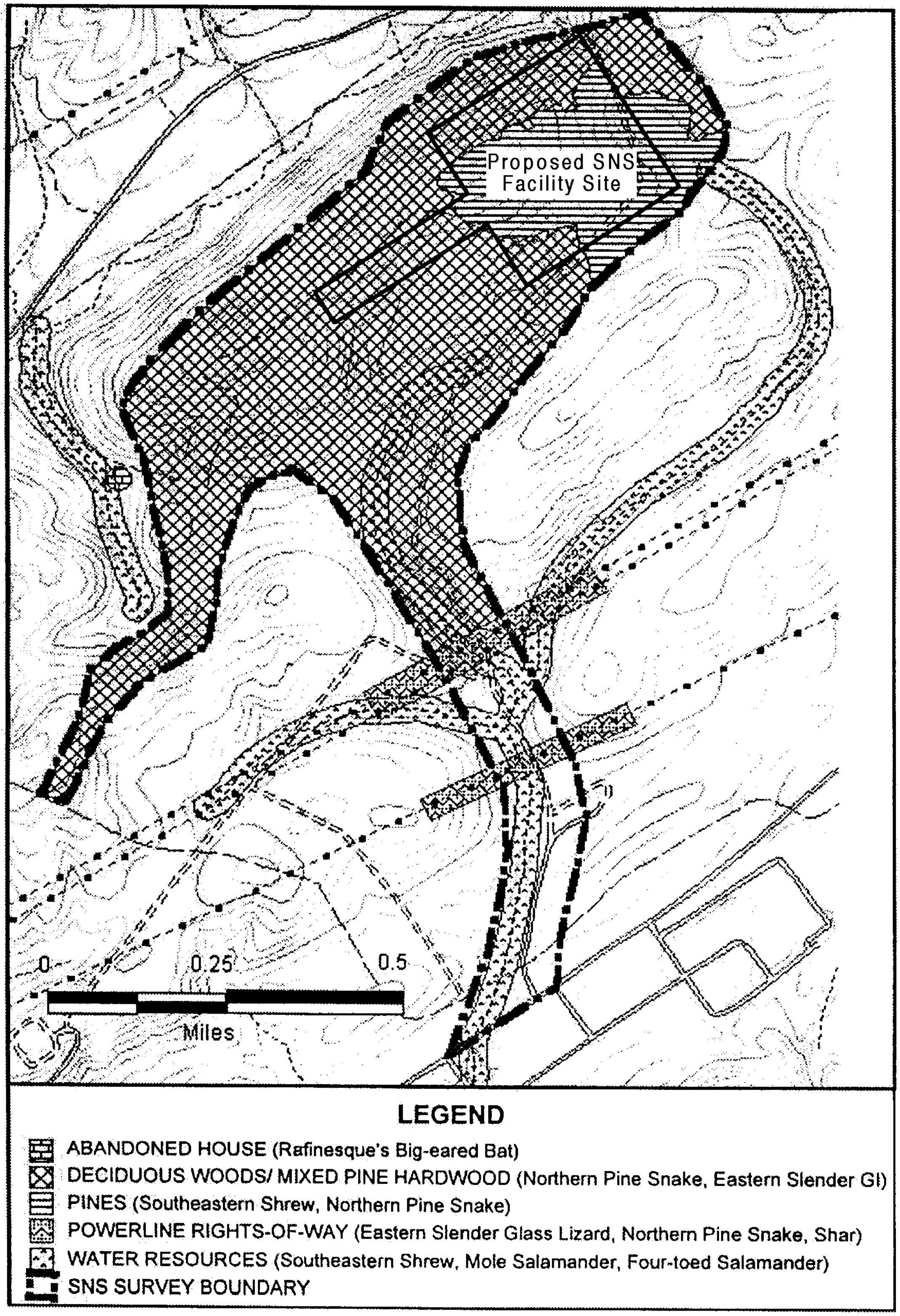


Figure 4.1.5.4-1. Potential habitat areas for threatened and endangered animal species within the ORNL site.

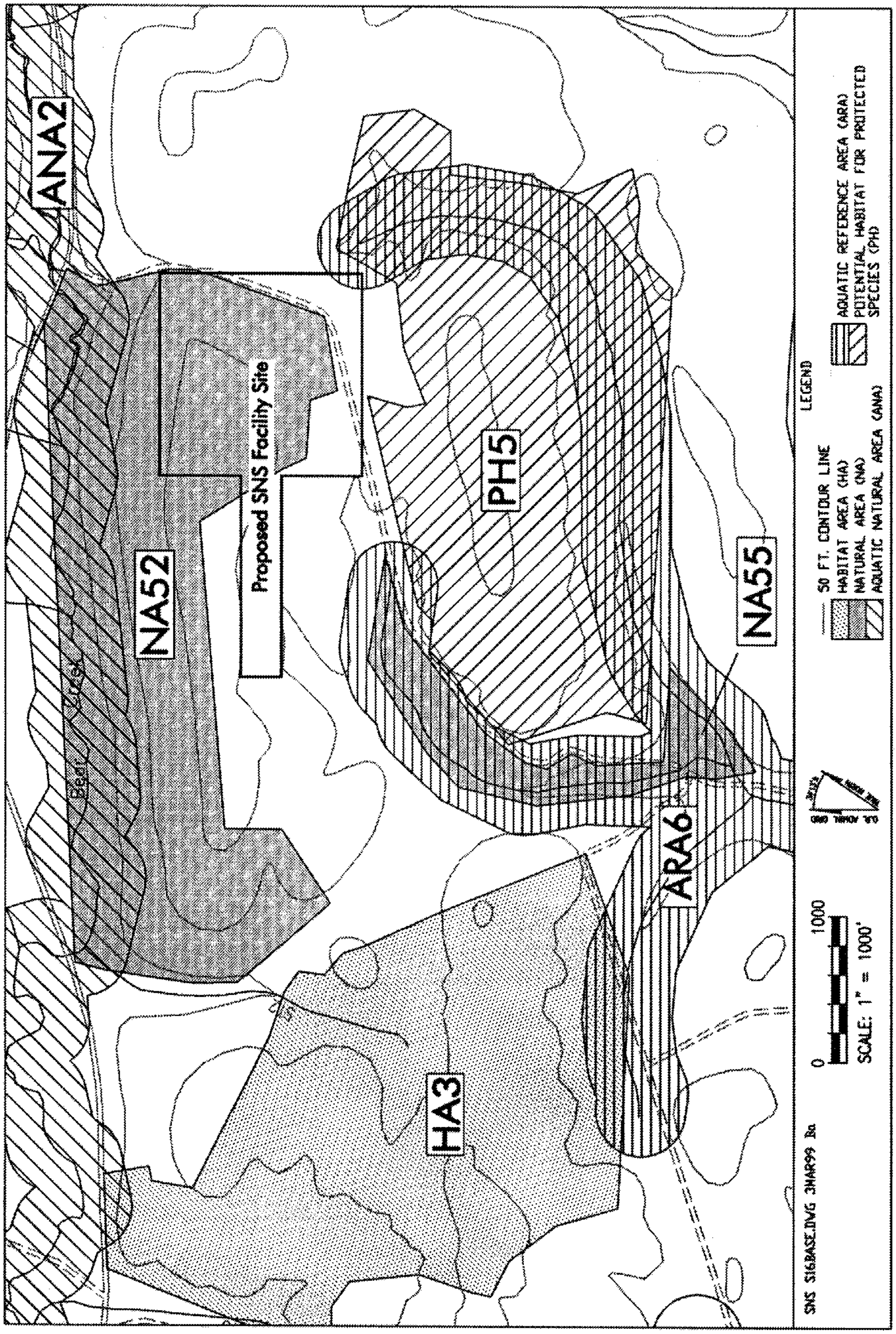


Figure 4.1.5.4-2. Natural and other environmentally sensitive areas in the vicinity of the proposed SNS site on the ORR.

Table 4.1.5.4-2. Threatened and endangered plant species potentially occurring within the proposed SNS site at ORNL.

Species	Common name	Habitat on ORR	Status[a]	Verification Time Frame	Potential for Occurrence within the Proposed SNS Site
Cypripedium acaule	Pink lady's slipper	Dry to rich woods	E-CE	Apr.-July	Verified on-site
Delphinum exaltatum	Tall larkspur	Barrens and woods	(C2), E	Aug.-Sept.	High
Fothergilla major	Mountain witch-alder	Woods	T	Apr.-May	Low
Hydrastis canadensis	Golden seal	Rich woods	S-CE	April-July	Low
Juglans cinerea	Butternut	Slope near stream	(C2), T	no time frame	Low
Lilium canadense	Canada lily	Moist woods	T	June-July	High
Liparis loeselii	Fen orchis	Forested wetland	E	May-July	Low
Panax quinquifolius	Ginseng	Rich woods	S-CE	May-Oct.	Verified on-site
Platanthera flava var. herbiola	Tuberculed rein-orchid	Forested wetland	T	May-Aug.	Low
Platanthera peramoena	Purple fringeless orchid	Wet meadow	T	July-Aug.	Low

[a] Status based on 1997 TN State List:
- (C2) Special Concern, was listed under the formerly used C2 candidate designation. More information needed to determine status.
- E Endangered in Tennessee.
- T Threatened in Tennessee.
- S Special Concern in Tennessee.
- CE Status due to commercial exploitation.

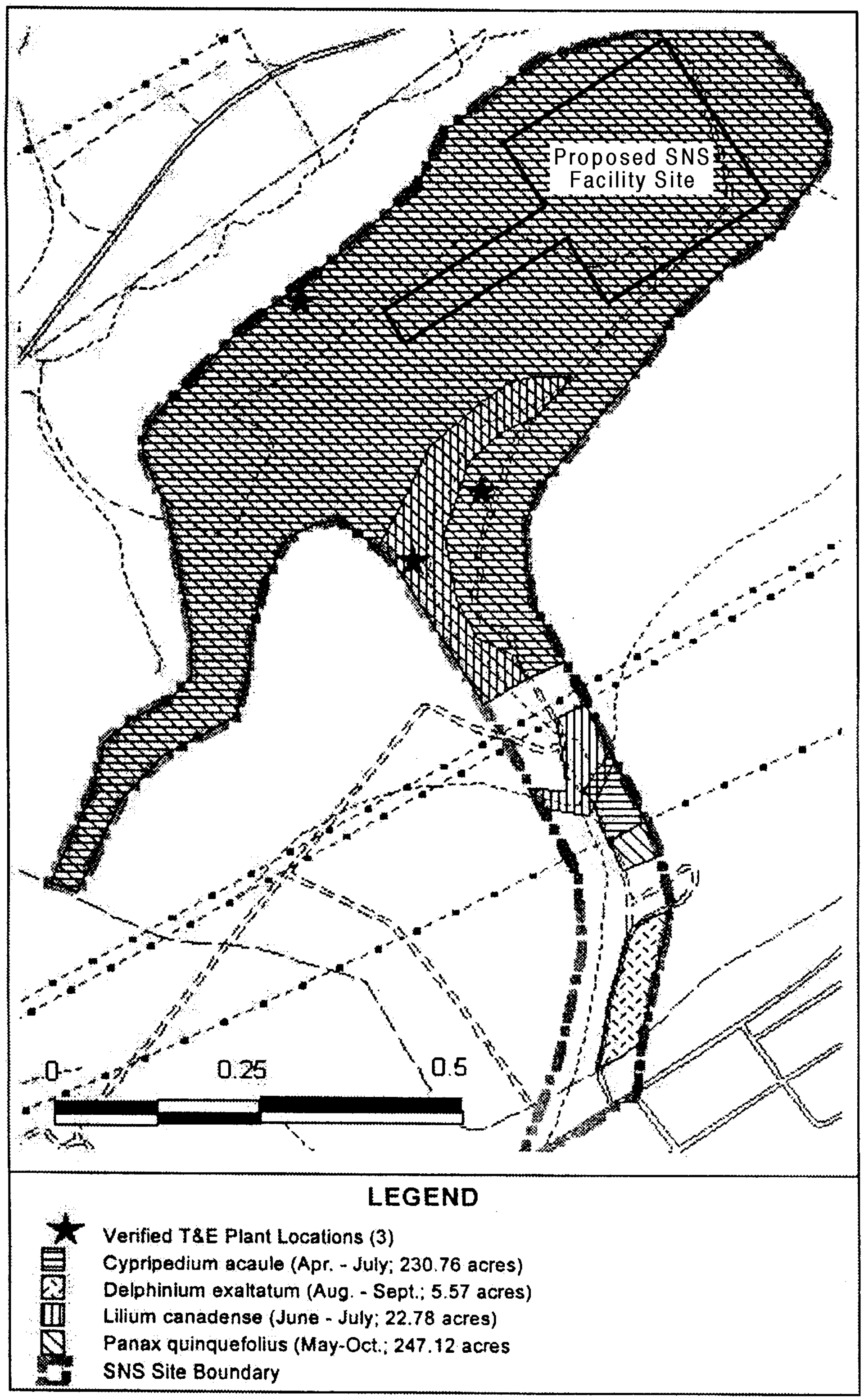


Figure 4.1.5.4-3. Threatened and endangered plant locations and potential habitat areas within the ORNL SNS site.

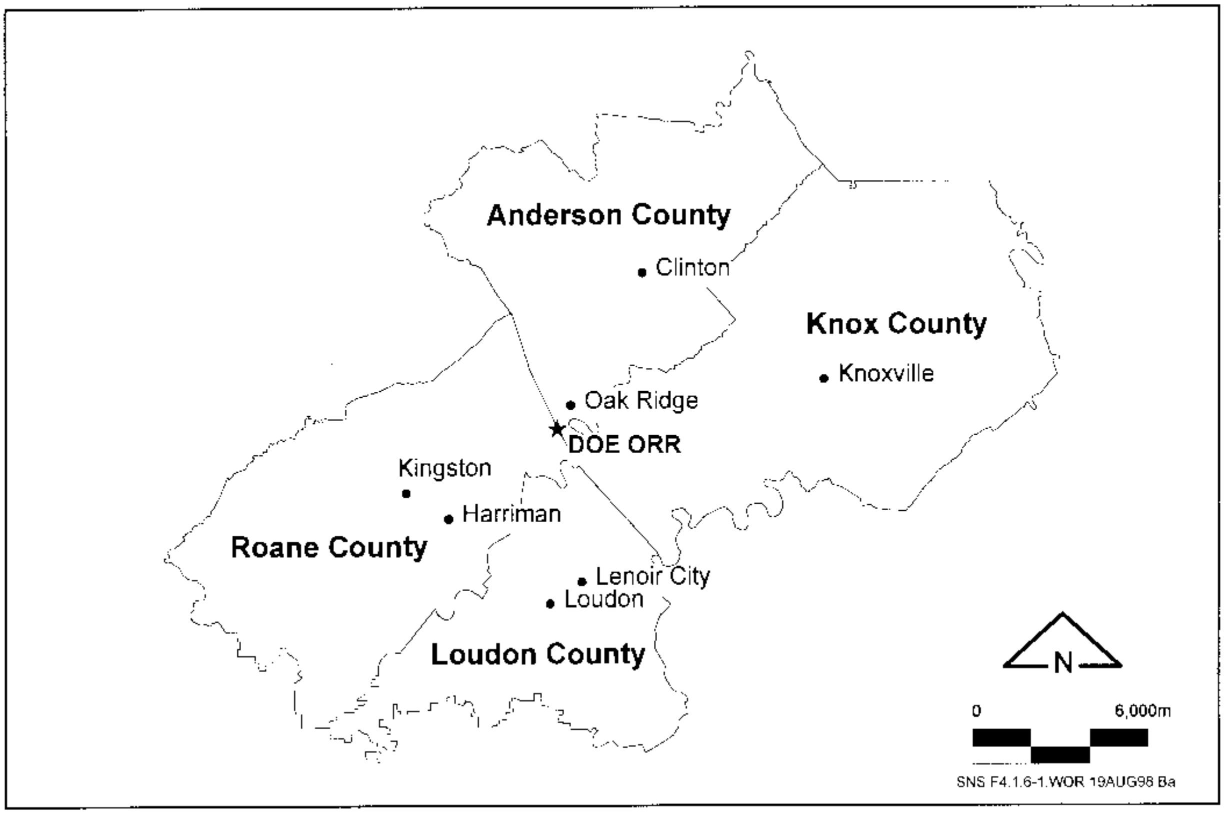


Figure 4.1.6-1. Map showing the socioeconomic ROI at ORR.

Table 4.1.6.1-1. Regional population trends and projections at ORNL.

County	1980	1990	1995	2000	2005
Anderson	67,346	68,250	71,663	68,181	66,347
Knox	319,694	335,749	361,407	353,721	360,833
Loudon	28,553	31,255	35,927	34,149	36,458
Roane	48,425	47,277	48,607	56,348	61,984
Region	464,018	482,531	517,604	512,399	525,622
State	4,591,023	4,877,185	5,235,358	5,178,587	5,305,137

Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996; TEDC 1994-1997.

Table 4.1.6.1-2. Population for incorporated areas within the ORR region.

Communities	1990	1996	Percent growth
Clinton	8,972	9,320	3.9
Oak Ridge	27,310	27,742	1.6
Knoxville	169,761	167,535	-1.3
Loudon	4,288	4,544	6.0
Lenoir City	6,147	8,890	44.6
Harriman	7,119	7,006	-1.6
Kingston	4,552	4,935	8.4

Source: U.S. Bureau of Census 1990; Tennessee Department of Economic and Community Development 1998.

Population by race and ethnicity for the region is presented in Table 4.1.6.1-3. The 1990 census data reflect racial and ethnic compositions in the four counties. There is little variation among the four counties, and Caucasians make up more than 90 percent of the combined population. African-Americans compose seven percent of the population.

4.1.6.2 Housing

Regional housing characteristics are presented in Table 4.1.6.2-1. In 1990, vacancy rates in the region ranged between a low of six percent in Loudon County to a high of nine percent in Roane County. Among all occupied housing units in the region, approximately two-thirds were owner occupied.

Housing vacancy rates for selected regional cities and towns are similar to county rates. In 1990, the county vacancy rate for all units was seven percent, while the combined vacancy rate for the seven selected communities (refer to Table 4.1.6.2-1) was eight percent. There were a total of 14,600 vacant units throughout the four-county region.

Median home value was similar in Roane, Loudon, and Anderson Counties, ranging between $48,700 to $55,100. Knox County median home values were higher at $69,900. Rents ranged from $280 to $351 across the ROI.

4.1.6.3 Infrastructure

The Infrastructure section characterizes the region's community services with indicators such as education, health care, and public safety.

4.1.6.3.1 Education

Tennessee is divided into 140 school districts, eight of which are within the four-county ROI. Information regarding school districts within the region is presented in Table 4.1.6.3.1-1.

The school districts in the region receive funding from local, state, and federal sources, but the percentage received from each source varies. Local funding varies from a low of 32.4 percent in Loudon County to a high of 55 percent in Knox County. State funding varies between 37.4 percent in Knox County to 60.1 percent in Loudon County, and federal funding ranges between a low of 6.7 percent in Oak Ridge and a high of 13.1 percent in Anderson County.

Table 4.1.6.1-3. 1990 population by race and ethnicity for the ORR region.

All Persons, Race/ Ethnicity	Anderson		Knox		Loudon		Roane		Total	
	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]
All Persons	68,250	100	335,749	100	31,255	100	47,277	100	482,531	100
Caucasian	64,745	95	301,788	90	30,762	98	45,422	96	442,717	92
African-American	2,681	4	29,299	9	362	1	1,534	3	33,876	7
American Indian[b]	195	<1	996	<1	46	<1	87	<1	1,324	<1
Asian/ Pacific Islander	540	<1	3,136	<1	55	<1	177	<1	3,908	1
Hispanic of any race[c]	582	1	1,935	1	107	<1	273	1	2,897	1
Other races	89	<1	530	<1	30	<1	57	<1	706	<1

[a] Percentages may not total to 100 due to rounding.
[b] Numbers for Aleuts and Eskimos were placed in the "other" category, given their small number.
[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from each of the race categories.
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.1.6.2-1. Housing summary for the ORR region, 1990, by county.

	Anderson County		Knox County		Loudon County		Roane County	
	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]
Total Housing Units	29,323	100	143,582	100	12,995	100	20,334	100
Occupied	27,384	93	133,639	93	12,155	93	18,453	91
Vacant	1,939	7	9,943	7	840	6	1,881	9
Median Home Value	$55,100	NA	$63,900	NA	$51,000	NA	$48,700	NA
Gross Rent	$342	NA	$351	NA	$280	NA	$287	NA

NA - Not applicable.
[a] May not total 100 due to rounding
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.1.6.3.1-1. Public school statistics in the ORR region, 1997-1998 school year.

School System	Number of Schools	Student Enrollment	Teachers	Teacher/ Student Ratio	Per-Student Expenditures
Anderson County	16	6,935	475	1:14.6	$4,508
Clinton	3	1.006	69	1:14.6	$5,269
Oak Ridge	8	4,752	342	1:13.9	$6,517
Knox County	86	51,982	3,293	1:15.8	$4,799
Loudon County	10	4,584	250	1:18.3	$4,012
Lenoir City	3	1,850	109	1:17.0	$4,530
Roane County	14	5,918	366	1:16.2	$4,387
Harriman	5	1,527	100	1:15.3	$4,951

Source: Tennessee Department of Education 1998.

4.1.6.3.2 Health Care

There are eight hospitals currently serving the region. Table 4.1.6.3.2-1 presents data on hospital capacity and usage. Average statistics for the hospitals indicate that there are approximately 2,400 acute-care hospital beds in the region, about 45 percent of which are available on any given day. This capacity is considered adequate to serve the health needs of the local population.

4.1.6.3.3 Police and Fire Protection

Table 4.1.6.3.3-1 gives the number of full time law enforcement officers for the incorporated areas within the ORNL region. The Knoxville Police Department has 383 officers with an approved fiscal year (FY) 1998 budget of $26.4 million. In addition, the Oak Ridge Police Department has 49 officers and an approved FY 1996 budget of $2.3 million. The Knoxville Fire Department has 13 fire stations, staffed by 118 Fire Department personnel. Fire protection for ORNL is provided on site by the ORNL Fire Department. The ORNL Fire Department has 30 firefighters and operates one rescue vehicle, two pumper engines, and 2 ambulances. The ORNL Fire Department has mutual agreements with the Y-12 Fire Department, the East Tennessee Technology Park Fire Department and the Oak Ridge Fire Department (Rosenbalm, 1999).

4.1.6.4 Local Economy

This subsection provides information on the economy of the region, including employment, education, income, and fiscal characteristics.

4.1.6.4.1 Employment

Regional employment data for 1997 are summarized in Table 4.1.6.4.1-1. Since 1991, unemployment has decreased in the four counties within the region, and the largest reductions in unemployment occurred in Knox County (from 4.6 percent in 1991 to 2.6 percent in 1997) and Loudon County (from 7.2 percent in 1991 to 4.2 percent in 1997). The 1997 unemployment rate for the ROI was 4.3 percent.

Table 4.1.6.4.1-2 presents employment by industry for the region. Government, manufacturing, retail trade, and services are the principal economic sectors in the region.

Table 4.1.6.3.2-1. Hospital capacity and usage in the ORR region.

Hospital	Number of Hospitals	Number of Beds[a]	Annual Bed-Days Used[b] (%)
Anderson	1	281	62
Knox	5	1,948	53
Loudon	1	62	28
Roane	1	85	53

[a] The number of acute-care beds.
[b] Based on the number of people discharged and the average length of stay divided by total beds available annually.
Sources: The American Hospital Directory, Inc. 1998; Tennessee Department of Health 1996.

Table 4.1.6.3.3-1 Full-time law enforcement officers for incorporated areas within the ORNL region (1996).

Community	Officers
Anderson County	124
Knox County	321
Loudon County	42
Roane County	49
Clinton	16
Oak Ridge	49
Knoxville	383
Lenoir City	14
Harriman	13
Kingston	8

Source: U.S. Department of Justice, 1997.

Table 4.1.6.4.1-1. ORR regional employment data, 1997.

County	Civilian Labor Force	Employed	Unemployed	Unemployment Rate
Anderson	36,800	35,270	1,530	4.2
Knox	197,420	192,280	5,140	2.6
Loudon	19,330	18,510	820	4.2
Roane	26,640	25,050	1,590	6.0
Region	280,190	271,110	9,080	3.2

Source: Tennessee Department of Employment Security 1998.

Table 4.1.6.4.1-2. Employment by industry for the Oak Ridge region of influence, by county and for the State of Tennessee (1995).

Economic Character	Anderson County	Knox County	Loudon County	Roane County	Region of Influence	State of Tennessee
Employment by Industry (1995)						
Farm	616	1,534	1,309	635	4,094	98,298
Agriculture Services	256	2,050	255	149	2,710	27,225
Mining	132	528	18	20	698	7,228
Construction	5,351	15,187	878	937	22,353	176,116
Manufacturing	11,307	25,207	3,173	5,774	45,461	553,865
Transportation and Public Utility	1,843	11,080	777	640	14,340	160,068
Wholesale Trade	596	15,924	280	433	17,233	151,126
Retail Trade	(D)	46,304	2,148	(D)	48,452	535,549
Finance, Insurance, and Real Estate	1,777	14,245	632	513	17,167	180,867
Services	(D)	75,131	3,621	(D)	78,752	848,610
Government	5,364	37,063	1,690	3,970	48,087	401,059

(D) - Data withheld to avoid disclosure when there are less than four businesses in an industry classification.
Source: U.S. Bureau of Census 1990.

Services employment is the largest employment sector in Anderson, Knox, and Roane counties. In Loudon County, the largest employment sector is manufacturing. While retail trade employs the second highest number in Knox, Loudon, and Roane Counties, retail trade employment in Anderson County is relatively low, and manufacturing and construction are the second and third highest employment sectors.

4.1.6.4.2 Income

In 1995, total regional income was approximately $11.5 billion, and six percent of this ($680,000,000) was paid to the ORR workforce (14,500 individuals, including contractors) residing in the region. Per capita income data for the region and the state are presented in Table 4.1.6.4.2-1. Over the period 1991-1995, per capita incomes in each ROI county grew by an approximate average of 22 percent to nearly $21,000. This rate of growth substantially exceeded the state-wide increase in income of only 18 percent. The number of persons in the region with income below the poverty level was 15 percent in 1990.

4.1.6.4.3 Fiscal Characteristics

Municipal and county general fund revenues in the ROI are presented in Table 4.1.6.4.3-1. The general fund supports the ongoing operations of local governments as well as community services such as police protection and parks and recreation.

The State of Tennessee does not have state or local personal income tax. Under Tennessee constitutional law, property taxes are assessed as follows:

- Residential Property equals 25 percent of appraised value.

Table 4.1.6.4.2-1. Measures of per capita income for the ORR region.

Area	Per Capita Income 1991 ($)	Per Capita Income 1995 ($)	Percent Increase
Anderson County	18,004	21,621	20
Knox County	18,911	23,107	22
Loudon County	15,671	19,606	25
Roane County	15,530	18,749	21
State of Tennessee	16,962	21,060	24

Sources: U.S. Bureau of Economic Analysis 1985-1995; TEDC 1994-1997.

Table 4.1.6.4.3-1. Municipal and county general fund revenues in the ORR region, FY 1997.

	Anderson County		Knox County		Loudon County		Roane County	
Revenue by Source	$(1000)	%[a]	$(1000)	%[a]	$(1000)	%[a]	$(1000)	%[a]
Local Taxes[a]	12,732	40	232,145	56	4,147	68	22,970	45
Licenses and Permits	34	<1	1,633	<1	178	3	102	<1
Fines and Forfeitures	56	<1	3,086	1	157	3	302	1
Charges for Service	2,640	8	21,811	5	43	1	1,167	2
Intergovernmental[b]	14,483	45	145,582	35	638	11	22,826	45
Interest	1,285	4	10,982	3	—[c]	NA	1,183	2
Miscellaneous Income	680	2	483	<1	911	14	2,474	5
Total	31,910	100	415,722	100	6,074	100	51,024	100

N/A - Not available.
Percentages may not total 100 due to rounding.
[a] Local taxes include real and personal property taxes, hotel/motel taxes, and local sales taxes.
[b] Intergovernmental includes state transfers and federal funds.
[c] Interest revenue not identified separately for Loudon County.
Source: Comprehensive Annual Financial Reports 1997a.

- Commercial/Industrial Property equals 40 percent of appraised value.
- Personal Property equals 30 percent of appraised value.

The largest revenue sources for the counties' general fund has traditionally been local taxes (which includes taxes on property, real estate, hotel/motel receipts, and sales) and inter-governmental transfers from the federal or state government. Over 80 percent of the 1997 general fund revenue came from these combined sources.

4.1.6.5 Environmental Justice

Figures 4.1.6.5-1 and 4.1.6.5-2 illustrate distributions for minority and low-income populations residing within 50 miles (80 km) of ORR. The definitions of minority and low-income populations and the methodology for assessing potential environmental justice effects are given in Section. 5.2.6.5.

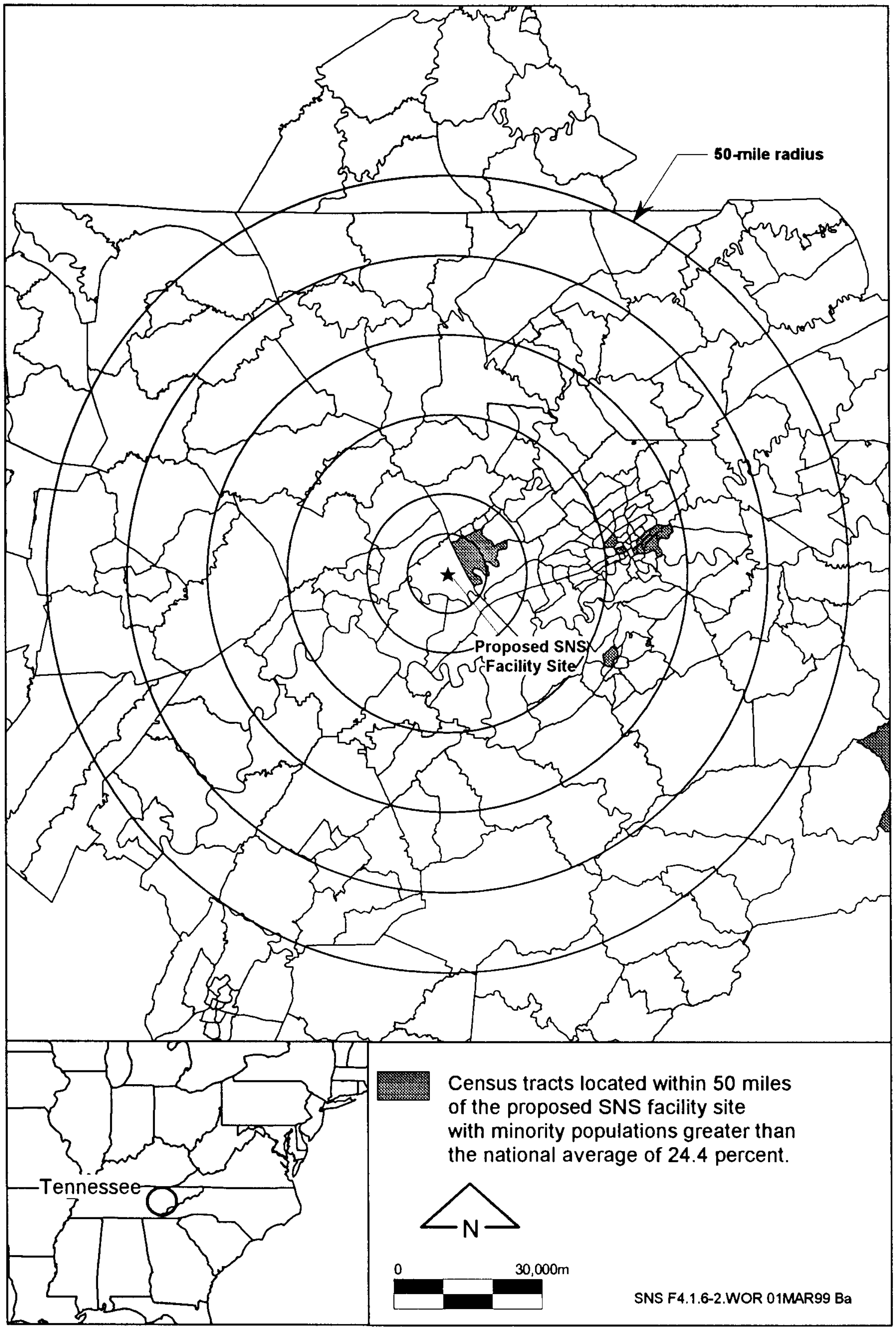


Figure 4.1.6.5-1. Distributions of minority populations at the ORR.

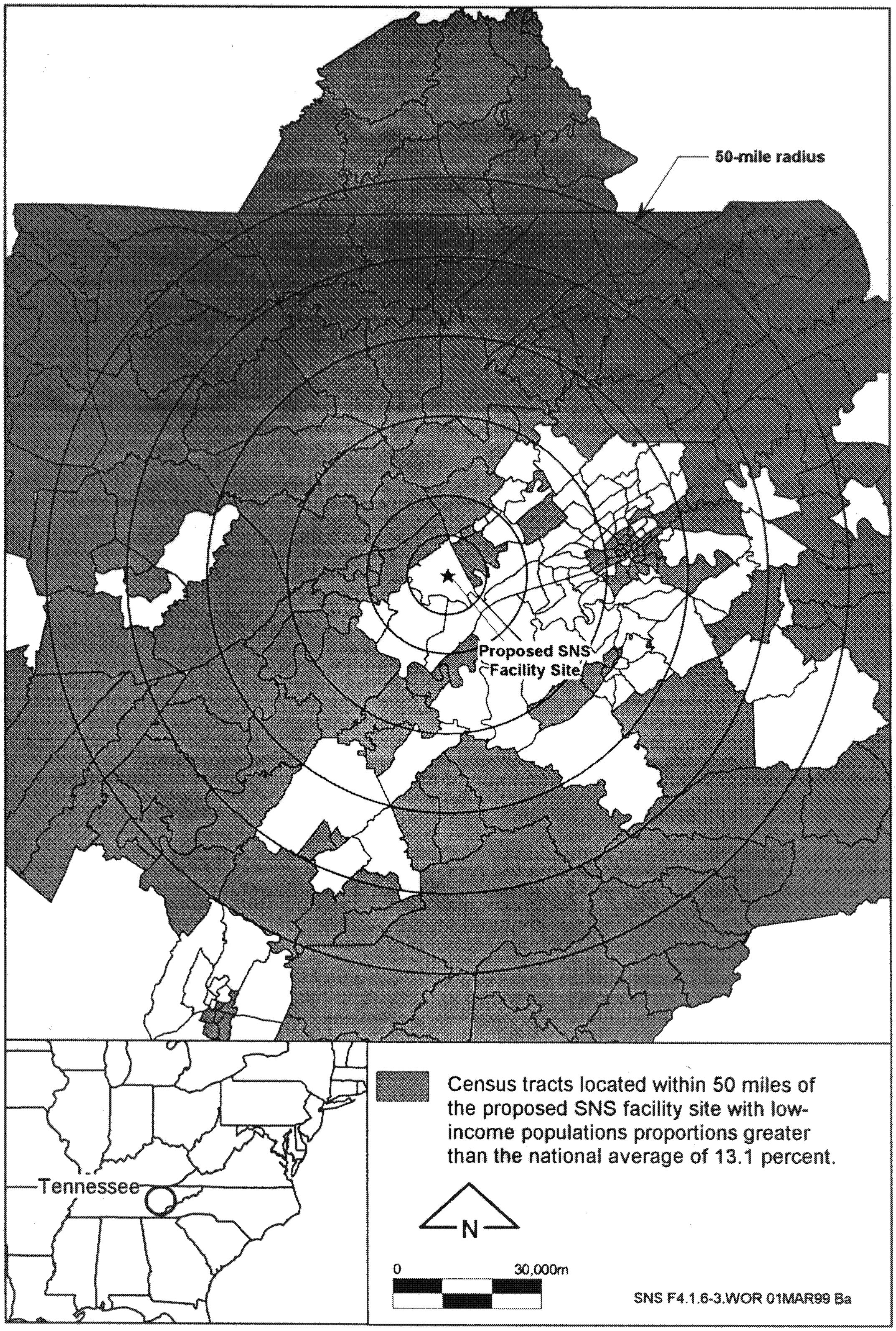


Figure 4.1.6.5-2. Distribution of low-income populations at the ORR.

Approximately 880,000 people live within a 50-mi (80-km) radius of the proposed ORR site. Minorities compose 6.1 percent of this population. In 1990, minorities composed 24.1 percent of the population nationally and 17 percent of the population in Tennessee. There are no federally recognized Native American groups within 50 miles (80 km) of the proposed site. The percentage of persons below the poverty level is 16.2 percent, which compares with the 1990 national average of 13.1 percent and a statewide figure of 30 percent (U.S. Census 1990).

4.1.7 CULTURAL RESOURCES

Cultural resources are any prehistoric or historic sites, buildings, structures, objects, or districts considered to be important to a culture, subculture, or community for scientific, traditional, or religious purposes, or for any other reason. They constitute the human legacy associated with a particular place.

The first known cultural resources study in the Lower Clinch River Basin was an archaeological survey reported by Cyrus Thomas in 1894. Since this report was published, approximately 29 archaeological and historical studies have been conducted in this area, and more than 20 studies were on the ORR (DOE 1996c: 4-29). Nearly 90 percent of the ORR has been surveyed for cultural resources at the reconnaissance level, but less than 5 percent of it has been intensively surveyed (DOE 1996c: 2-29).

Cultural resource surveys of the ORR have identified more than 45 prehistoric archaeological sites. None of these sites are actually listed on the National Register of Historic Places (NRHP), but 13 are considered to be eligible for listing. The remaining sites have not been evaluated for potential NRHP eligibility (DOE 1996c: 4-29).

More than 240 historic resources have been identified through surveys of the ORR. These resources consist of Historic Period (A.D. 1600-Present) cemeteries, structures, and archaeological remains. Thirty-one cemeteries, all established prior to 1942, are located on the reservation. Historic structures include log cabins, barns, churches, grave houses, spring houses, storage sheds, smokehouses, log cribs, privies, henhouse, and garages that predate U.S. government acquisition of the reservation from private land owners in 1942. In addition, the historic structures include many of the buildings and equipment items associated with the Manhattan Project (A.D. 1942-1945) and Cold War Period (A.D. 1946-1989) activities on the reservation. These structures include three security checking stations and the Graphite Reactor at ORNL (DOE 1996c: 4-29 to 4-30). Most of the historic archaeological remains consist of structure foundations; trash scatters and subsurface features, usually associated with foundations and standing structures; and roads. Thirty-eight of these historic resources are considered to be potentially eligible for listing on the NRHP.

Seven of the historic sites on the ORR are listed on the NRHP. These are the Oak Ridge Turnpike Checking Station, Bear Creek Road Checking Station, Bethel Valley Road Checking Station, Graphic Reactor, New Bethel Church, George Jones Memorial Church (Wheat Community), and Freels Bend Cabin. The Graphite Reactor at ORNL is a National Historic Landmark. An additional 38 historic sites on the ORR are considered to be potentially eligible for listing on the NRHP.

Surveys conducted prior to 1997 located a number of cultural resources in the vicinity of the proposed SNS site. Additional prehistoric and historic remains were identified during a cultural resources survey conducted by DuVall & Associates, Inc., from July 26 to August 5, 1997 (Pace 1997). This survey included extensive background research, a pedestrian survey of the proposed SNS site and adjacent areas, and systematic shovel testing of landforms with less than 15 percent slope.

The SNS design team has not established the areas where construction or improvement of utility corridors would be necessary to support the proposed SNS at ORNL. In addition, the complete route for one of the two access roads (southwest access road) to the proposed SNS site has not been determined. As a result, such areas could not be surveyed for cultural resources by DuVall & Associates, Inc., in 1997. Because considerable information is available on the cultural resources of the ORR, particularly the historic resources, the eventual establishment of these areas would proceed in such a manner as to avoid any known cultural resource locations. If the proposed SNS site at ORNL were chosen for construction, the established utility corridors and road improvement zones would be surveyed for cultural resources prior to the initiation of construction-related activities in these areas.

The cultural resources in the vicinity of the proposed SNS site are described in this section of the final Environmental Impact Statement (FEIS). However, the precise locations of these resources are not indicated in the descriptions. To protect these sites, DOE and Lockheed Martin Energy Research Corporation do not reveal the locations of cultural resources in documents available to the general public. Because several of the original reports cited in this section show the locations of cultural resources on the ORR, they are not included in the DOE public reading rooms established as part of the SNS EIS process.

4.1.7.1 Prehistoric Resources

No prehistoric archaeological sites were identified on the proposed SNS site at ORNL. However, three isolated occurrences of prehistoric artifacts were encountered at three other locations that may be subject to activities under the proposed action. Locus FN-1 is in the bed of a current dirt service road leading into the proposed SNS site and is very close to a proposed switchyard. Locus FN-1A is very close to the extreme southwest corner of the proposed SNS site and is near the proposed location of a retention basin. Locus FN-7 is located a substantial distance south of the proposed SNS site in an area slated for road improvements.

An Early Archaic Period *Big Sandy* projectile point/knife (ca. 8000-7000 B.C.) was found at Locus FN-1. One chert flake of indeterminate age was found at each of the other loci. Each locus may contain a low-density scatter of chert waste from the shaping or sharpening of prehistoric stone tools. Because no artifact-bearing subsurface deposits were encountered during shovel testing, these isolated occurrences are considered insufficient to define a significant cultural resource, and their loci of occurrence are not considered to be eligible for listing on the NRHP (Pace 1997: 21).

Site 40RE488 is a multicomponent archaeological site located a substantial distance south of the proposed SNS site in an area slated for road improvements under the proposed action. As defined by shovel tests, 40RE488 measures about 230 to 262 ft (70 to 80 m) north/south by

67 ft (20 m) east/west and may extend further to the west beyond the test limits. The east edge of this site is only about 26 ft (8 m) from the bed of the existing road that would be improved. Shovel tests revealed past disturbance of the site by grading, filling, scalping of topsoil, and downslope redeposition of soils. The artifacts recovered during the shovel testing indicated at least one prehistoric component at the site (ORNL-2: 21-24).

No prehistoric artifacts were recovered on the ground surface at 40RE488. The 13 prehistoric artifacts recovered at the site came from the plow zone and disturbed (spolic) layers in 5 of 10 shovel test units. These artifacts consisted of seven chert flakes, or flake fragments, and six pieces of chert debris. The date and cultural context of this prehistoric component could not be determined from these remains (Pace 1997: 24).

The prehistoric component at 40RE488 can be characterized as a low-density lithic scatter of unknown date and cultural affiliation. Given the occurrence of all prehistoric artifacts in the plow zone or other disturbed soil zones, the presence of well-preserved archaeological context with subsurface features and midden deposits is unlikely. As a result, the surveyed portion of this component is not considered to be a significant archaeological resource with potential for listing on the NRHP (Pace 1997: 27).

4.1.7.2 Historic Resources

No Historic Period cultural resources listed on or eligible for listing on the NRHP have been identified on the proposed SNS site at ORNL. In addition to the prehistoric component, a Historic Period archaeological component has also been identified at 40RE488. As previously noted in Section 4.1.7.1, this site is located substantially south of the proposed SNS site in an area subject to road improvements under the proposed action.

Thirteen historic artifacts were recovered from the same five shovel test units that yielded the prehistoric artifacts at 40RE488. These artifacts were 3 wire nails, 2 wire brads, 3 cut nail fragments, 3 miscellaneous metal fragments, and 2 pieces of container glass. While the cut nails could indicate a 19th century occupation of the site, the other artifacts suggest an occupation dating from the turn of the century to 1942 (Pace 1997: 24).

Fielder et al. identified a farm outbuilding (standing log crib) at 40RE488, which was designated as Historic Inventory #15A in his survey (Fielder et al. 1977: 47). This structure is no longer present at the site (DuVall 1994, as cited in Pace 1997: 16). In addition, historical records indicate that another structure no longer standing but presumably associated, was located to the north of the log crib in 1935. Both structures were in a 190-acre (77-ha) tract of land purchased by the U.S. government from Luther and Edith Duncan in 1942 (Fielder et al. 1977: 47). These findings suggest that the historic component at 40RE488 is part of a late 19th to early 20th century farmstead. Given significant past soil disturbance of indeterminate origin at this site and its spatial divorcement from the larger farmstead setting, this Historic Period component is not considered potentially eligible for listing on the NRHP (Pace 1997: 24-27).

4.1.7.3 Traditional Cultural Properties

A Traditional Cultural Property (TCP) is a significant place or object associated with the historical and cultural practices or beliefs of a living community. It is rooted in the community's history and is important for maintaining the continuing cultural identity of the community. A TCP may include a prehistoric or historic archaeological site, natural resource, traditional use area, shrine, sacred place, trail, spring, river, traditional hunting area, cemetery or burial, or rock art. In addition, it may include a rural community or urban neighborhood with a unique cultural tradition and identity. The term is not limited to ethnic minority groups. All Americans have properties to which they ascribe traditional cultural value.

Portions of the Tennessee, Clinch, Hiwassee, and Little Tennessee River valleys were occupied by the Overhill Cherokee during the 18th century. Most of the Cherokee people were relocated to the Oklahoma Territory via the infamous Trail of Tears in 1838. However, some of the Cherokee remained in western North Carolina and others have returned from Oklahoma over the years (DOE 1996c: 4-30). Currently, the Eastern Band of the Cherokee occupies the Qualla Reservation in Cherokee, North Carolina, and maintains an interest in the traditional Overhill Cherokee lands in East Tennessee.

DOE Oak Ridge Operations (DOE-ORO) Office has consulted with the Eastern Band of the Cherokee concerning the presence of TCPs on the ORR. No TCPs of special sensitivity or concern to the Cherokee are known to exist on the proposed SNS site or at other locations on the ORR.

4.1.7.4 Consultation with the State Historic Preservation Officer

Section 106 of the National Historic Preservation Act (NHPA) requires a review of proposed federal actions to determine whether or not they would impact properties listed on or eligible for listing on the NRHP. DOE-ORO has consulted with the State Historic Preservation Officer (SHPO) in Tennessee concerning the occurrence of such properties within the area of potential impact of the proposed SNS at ORNL. Based on cultural resources survey information provided by DOE, the SHPO has determined that no such properties occur within this area. The consultation letter received from the SHPO at the Tennessee Historical Commission is provided in Appendix D.

4.1.8 LAND USE

Described in this section are land uses for the vicinity of the ORR; within the boundaries of the reservation, which include ORNL; and on the proposed SNS site. The descriptions cover past, current, and future uses of the land in these areas. In addition, they include descriptions of environmentally sensitive land areas that have been set aside for public use, environmental protection, or research. These areas include parks, natural areas, environmental education centers, and public recreation areas. The section concludes with a discussion of visual resources.

4.1.8.1 Past Land Use

The land surrounding the ORR was predominantly forested wilderness prior to the 18th century. During the late 18th and early 19th centuries the area was settled by emigrants, who were primarily from North Carolina and

Virginia. During this settlement period, three major uses of the land were established: forestry, agriculture, and residential. Commercial, mining, transportation, waterways, and industrial land uses gradually developed.

The land that composes the ORR was purchased from private landowners by the federal government in 1942. At that time, the predominant land uses were forestry, agriculture, and residential. However, government activities during World War II changed the overall pattern of land use on the reservation. The establishment of the X-10 Plant (ORNL), Y-12 Plant, K-25 Site (ETTP), and various support facilities added industrial land use to the reservation. With the exception of some agriculture-related research activities in later years, agricultural use of the land nearly disappeared. Because much of the reservation was allowed to revert to an increasingly natural state after its purchase by the government, the amount of land covered in forest expanded. Residential land use ended over most of the reservation. However, residential and commercial land uses increased rapidly in the north corner of the reservation. The current land use pattern on the reservation and at ORNL gradually evolved between 1942 and the present day.

The proposed SNS site remained largely undeveloped after its purchase by the federal government and was not a focus of waste disposal activities. As a result, no contaminated sites were created at this location.

The U.S. Environmental Protection Agency (EPA) placed the reservation on the National Priorities List in December 1989. This list specifies contaminated sites that are subject to regulation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and are a high priority for cleanup. In 1996, DOE initiated detailed investigations of reservation land areas that were never used for activities involving hazardous materials. This process was aimed at releasing their use from regulation under existing cleanup laws. The proposed SNS site location is within an area of land scheduled for release approval by the Federal Facilities Agreement partners (DOE, EPA Region IV, and TDEC) in FY 1998 (Kendall 1998).

4.1.8.2 Current Land Use

The current uses of land in the vicinity of the ORR are forestry, agriculture, residential, commercial, industrial, mining, transportation, waterways, and several other uses. The largest use is commercial forestry, followed in order by agriculture, other uses, residential, waterways, and transportation. The remaining uses are quite small, each accounting for less than 7,410 acres (3,000 ha) of land. The predominant land use in most urban areas is residential (MMES 1994: 1-27).

The closest urban center to the reservation is the City of Oak Ridge. In fact, with the exception of a very small area of land in the northwest corner of the reservation, the city limits include the entire reservation. The total incorporated area of the city is 57,541 acres (23,296 ha). More than 60 percent of the land in the city is designated for forestry, agricultural, industrial, and research use. This high percentage is a function of having 34,516 acres (13,970 ha) of DOE land within the city limits. Less than 10 percent of the land in Oak Ridge is used for residential purposes, and most of this land is located in the northeast section of the city. The University of Tennessee owns 2,250 acres

(911 ha) of land in Oak Ridge. This land is used for research, public education, and recreation. TVA owns 2,395 acres (969 ha) of land within the city for industrial and recreational purposes (MMES 1994: 1-27; DOE-ORO 1996: 3-1).

The reservation contains 34,516 acres (13,794 ha) of land, and approximately 64 percent of this land is undeveloped. Despite being within the City of Oak Ridge, the use of ORR land is controlled entirely by DOE. DOE classifies land use on the reservation according to five primary categories: Institutional/ Research, Industrial, Mixed Industrial, Institutional/Environmental Laboratory, and Mixed Research/Future Initiatives. The Institutional/Research category applies to land occupied by the central research facilities at ORNL. Land in the Industrial category includes the Y-12 Plant and is used for defense support, manufacturing, and storage. The Mixed/ Industrial category includes the ETTP and is used for environmental management and reindustrialization of DOE land by private sector businesses. The Oak Ridge Institute for Science and Education, operated by Oak Ridge Associated Universities, provides training and research support to DOE and uses the land within the boundaries of the Institutional/ Environmental Laboratory category. The Mixed Research/Future Initiatives category applies to land currently used or available for use in field research and land reserved for future DOE initiatives, including new research facilities. Figure 4.1.8.2-1 shows the distributions of these land use categories across the reservation and the relative amounts of land within each category (LMER and LMES 1998: 7).

A large number of reservation-wide land uses overlay the primary land use categories and are officially designated as mixed uses. The largest mixed use is biological and ecological research in the Oak Ridge NERP. This mixed use overlays most of the land in the Mixed Research/Future Initiatives category (Figure 4.1.8.2-1). The other mixed uses are environmental research and demonstration areas, safety training facilities and associated safety buffers, transportation, utilities, public use areas, ecological resource management, land application of biosolids, education, waste management, environmental monitoring, wetlands mitigation, environmental restoration, protection of cultural resources, emergency response planning zones, and conservation of unique ecological resources. The latter use includes state natural areas, the Oak Ridge Wildlife Management Area, Nature Conservancy biodiversity ranked areas, Nature Conservancy landscape complexes, NERP endangered species habitats, NERP endangered species potential habitats, wetlands, and the Oak Ridge National Environmental Research Park Biosphere Reserve (LMER and LMES 1998: 7-8).

The proposed SNS site and adjoining land would be located within a portion of the Mixed Research/Future Initiatives category that is within the NERP (refer to Figure 4.1.8.2-1), which means that the land is either being used for environmental field research or is available for such use. Currently, the proposed site is not being used for environmental research. However, long-term environmental monitoring and research efforts are under way at locations in its vicinity.

Several of these efforts are being conducted in the headwaters of White Oak Creek, which drain the proposed SNS site area. Additional environmental monitoring and research projects are ongoing in the Walker Branch Watershed to

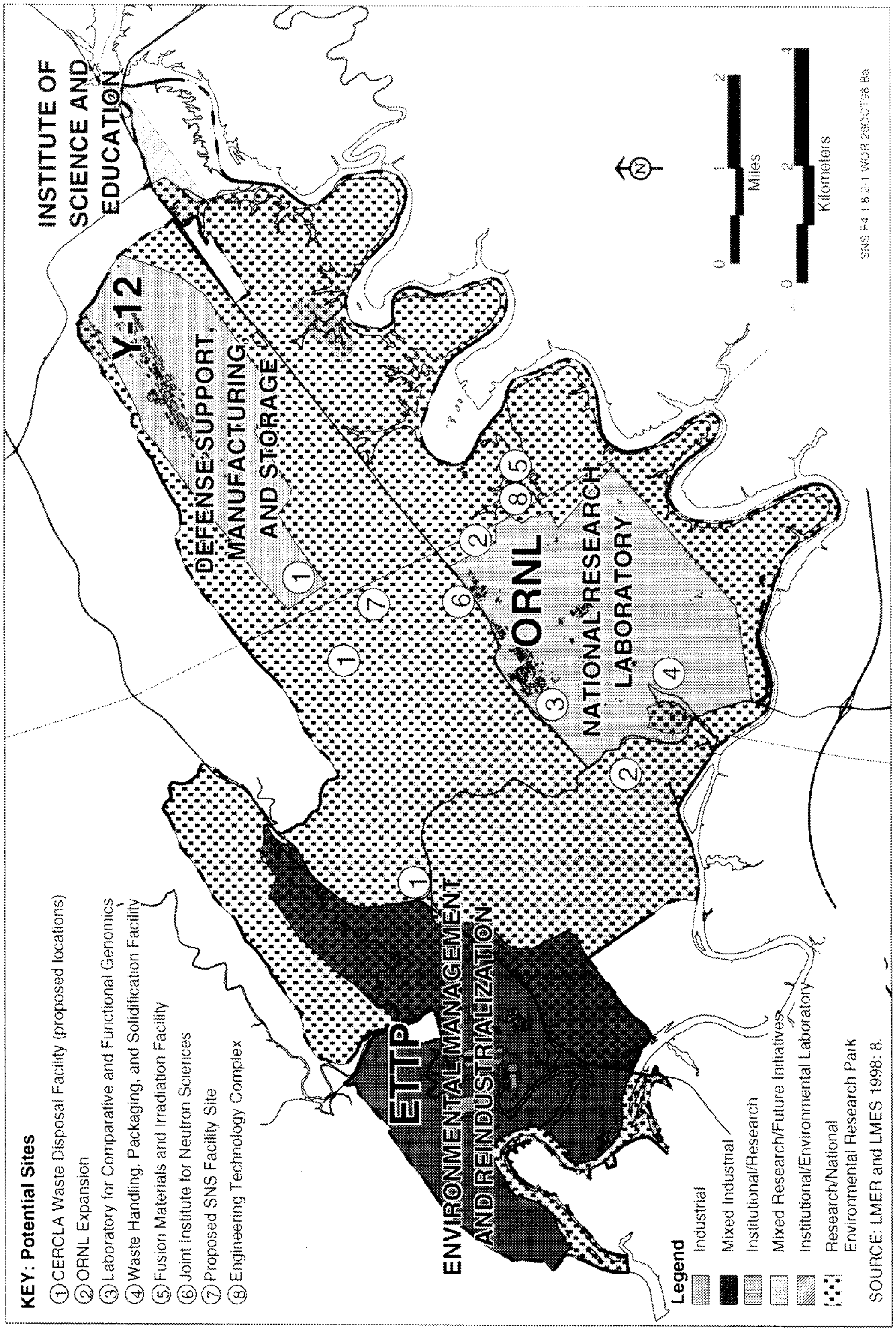


Figure 4.1.8.2-1. Map of current and potential future land uses on the ORR.

the east of the proposed SNS site. The use of these land areas and the waters that flow through them for environmental monitoring and research is described in the succeeding sections.

Headwaters of White Oak Creek

Downstream portions of the White Oak Creek Watershed receive effluent discharges from ORNL. These discharges are regulated at the federal level under the Clean Water Act and by state regulations issued by TDEC. Operating under authorization from the EPA, TDEC has issued a NPDES permit to regulate the ORNL discharges to White Oak Creek.

The NPDES permit for ORNL mandates the implementation of a Biological Monitoring and Abatement Program (BMAP) on White Oak Creek and its tributaries. The objective of the BMAP is to evaluate the effects of the discharges on the aquatic integrity of the White Oak Creek Watershed and to demonstrate that the permitted effluent limitations protect classified stream uses (ORNL, OR Y-12, and ETTP 1997: 4-48). The program involves studying the bioaccumulation of contaminants in fish and performing detailed ecological surveys of fish and benthic macroinvertebrate communities. Observed changes in the key indicators of stream integrity are compared with effluent discharge conditions and are charted through time to provide a historical perspective on stream conditions and dynamics (ORNL, OR Y-12, and ETTP 1997: 4-51 to 4-52).

The headwater tributaries of White Oak Creek near the proposed SNS site drain largely undeveloped land that has been reverting towards a natural state since its purchase by the U.S. government in 1942. No effluent discharges occur in this area. For this reason, the White Oak Creek Headwaters Monitoring Station, located approximately 3,400 ft (1,036 m) southwest of the proposed site, and several other stations immediately downstream have been used to gather baseline reference data for the ORNL BMAP, general NPDES permit compliance, and support of downstream environmental restoration efforts. The headwaters of White Oak Creek are also used as a baseline reference site for current environmental monitoring activities in McCoy Branch, which drains the south side of Chestnut Ridge approximately 3 miles (5 km) east of the proposed SNS site. This research is being conducted under the Environmental Restoration Integrated Water Quality Program (Huff 1998: 1; Peterson 1998: 1; Smith 1998: 1-2).

Use of the White Oak Creek headwaters as a reference site began in 1984, when baseline data were used to support environmental research involving Bear Creek (Smith 1998: 2). These headwaters were used to support the ORNL BMAP efforts that began in 1985, and have continued until the present day (ORNL, OR Y-12, ETTP 1997: 4-51). As a result, the headwaters of White Oak Creek have become one of the oldest and most well recorded reference sites on the reservation.

The headwaters of White Oak Creek are used to support other research projects, apart from their function as a reference site. The Environmental Sciences Division (ESD) at ORNL is currently using the headwaters as a source of algae and invertebrates for two environmental research projects funded by DOE. One of these projects is “Autotrophic Biofilms for Removing Contaminants from Industrial Wastewater.” This project is investigating the potential use of autotrophic biofilms to sorb contaminants and clean industrial wastewater. The other project, "Ecological Effects of UV-B Radiation," is studying the ecological effects of current and increasing levels of ultraviolet B (UV-B) radiation, which is caused by destruction of the earth's ozone layer (Hill 1998a: 1; Hill 1998b: 1).

Walker Branch Watershed

The Walker Branch Watershed is a major research area located approximately 0.75 miles (1.2 km) east of the proposed site. The central research area consists of approximately 247 acres (100 ha) of land covered with temperate deciduous forest and drained by two perennial streams. It is completely surrounded by a very large buffer zone, which was delineated to protect the research efforts in the area. This zone was formally established in 1990 after an evaluation process and approvals by the Reservation Management Organization (RMO) and the Oak Ridge Operations (ORO) Land Use Committee (Parr 1998b: 3-10; Parr 1998c: 1). The Walker Branch Watershed and its buffer zone are shown in Figure 4.1.8.2-2.

The Walker Branch Watershed has been the focus of ecological research by ORNL-ESD and NOAA, Atmospheric Turbulence and Diffusion Division (ATDD) since 1967. Their projects in this area have contributed to a greater understanding of how forest watersheds function, and they have provided insights into the solution of energy-related problems associated with air pollution, contaminant transport, and forest nutrient dynamics. The Walker Branch Watershed is one of the few sites

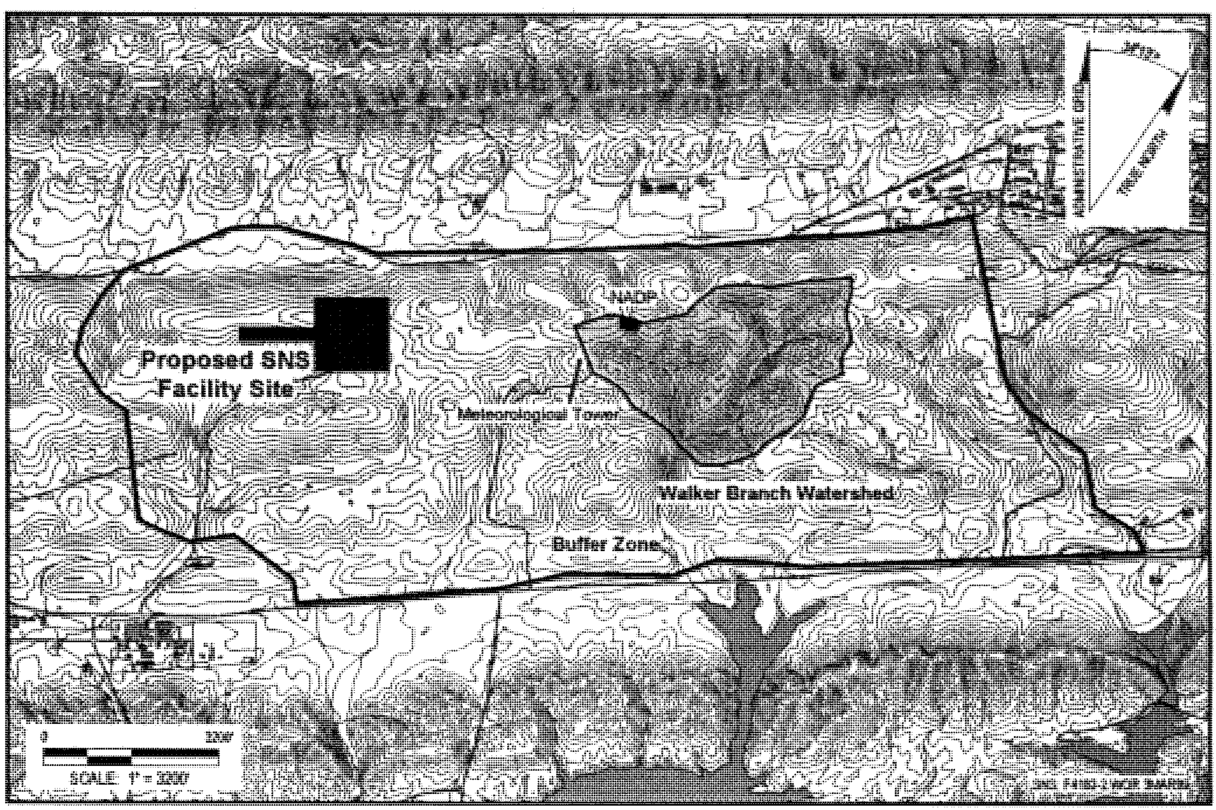


Figure 4.1.8.2-2. Walker Branch Watershed research areas and buffer zone on the ORR.

in the world characterized by long-term, intensive environmental studies (ORNL 1997d: 1 and 4).

The NOAA/ATDD is conducting the Temperate Deciduous Forest Continuous Monitoring Program (TDFCMP) in the Walker Branch Watershed. This program is measuring the continuous exchange of carbon dioxide (CO_2), water vapor, and energy between the deciduous forest in the Walker Branch Watershed and the atmosphere. The aim of the program is to continuously monitor these exchanges over a long period of time. This monitoring is needed because few direct, long-term measurements of CO_2 exchange over a whole ecosystem have been done. Their purpose is to examine the uptake, use, and loss of carbon by components of the plant community within the intact Walker Branch Watershed ecosystem. Most published reports on carbon exchange over temperate forests are derived from limited (two to three week) studies conducted during the summer growing season. When the Walker Branch Watershed study began on October 24, 1994, a research team at Harvard University had conducted the only other long-term measurements of CO_2 over forest canopies in the United States. Ultimately, the Walker Branch Watershed study is expected to result in a better understanding of local, regional, and global carbon budgets and the effects of elevated atmospheric CO_2 on temperate forests worldwide (ORNL 1997d: 2 and 8; NOAA 1998: 1).

The TDFCMP is measuring very small changes in CO_2 exchange between the atmosphere and the Walker Branch Watershed forest ecosystem. These changes are measured around a local background CO_2 level of 668 mg/m^3 (668,000 μg/m^3) of air. The measured changes are being associated with physical, chemical, and biological activity in the forest biomass and soils.

The monitoring instruments for the TDFCMP are located near the west periphery of the Walker Branch Watershed, on and near the base of a 144-ft (44-m) meteorological tower, and within the National Atmospheric Deposition Program Wet/Dry Deposition Monitoring Site (ORNL 1997d: 2 and 8). These locations are approximately 0.75 miles (1.2 km) east of the proposed SNS site. The prevailing winds blow from the direction of the proposed site to the east-northeast towards the Walker Branch Watershed during the daytime hours (refer to Section 4.1.3).

The ESD at ORNL is currently using Walker Branch Watershed land for nine major ecological research projects. Each of these projects is identified and briefly described in Table 4.1.8.2-1. A more detailed description of each project is provided in Appendix F.

4.1.8.3 Future Land Use

The current pattern of land use in the vicinity of the ORR is likely to continue into the foreseeable future. Urban development within the City of Oak Ridge will continue as the city gradually acquires control of reservation land for residential, commercial, and industrial purposes.

The missions of DOE have priority for the future use of land on the ORR. The zoning of reservation land for future use is shown in Figure 4.1.8.2-1. This zoning is the same as the current land use pattern, which reflects DOE plans to use the land in ways compatible with the current pattern of use.

Table 4.1.8.2-1. Current ORNL-ESD ecological research in the Walker Branch Watershed.

Project No.	Project	Description	Duration
C-1	Throughfall Displacement Experiment	Experimentation at the forest stand level to understand how forest ecosystems respond to changes in regional rainfall and how this relates to a warming global climate.	Long-Term (>10 years)
C-2	Long-Term Ecological Measurements of Ecosystem Response	Long-term project to monitor forest biomass and species composition, water inputs and outputs, and soil chemistry. These measurements are being made to quantify the response of the forest ecosystem to changes in climate and atmospheric deposition that are expected to occur. They support DOE's local, regional, and global research and provide baseline measurements for environmental restoration activities. The current measurement record spans 30 years.	Long-Term (>10 years)
C-3	Terrestrial Feedbacks to Regional Hydrologic Budgets	Continuous, multiyear measurement of climate variables, soil water conditions, and tree/forest evapotranspiration to enhance understanding of how closed canopy, deciduous forest stands contribute to local and regional hydrologic budgets. Project data will be used by the GEWEX Continental-Scale International Project (GCIP) to test climatic models. The Walker Branch Watershed is one of five primary project sites in the Ohio-Tennessee Watershed.	Completion by FY 2005
C-4	Nitrogen Uptake, Retention, and Cycling in Stream Ecosystems: An Intersite ^{15}N Tracer Experiment	A conservative radioisotope of nitrogen is being used as a tracer to study water use; nutrient uptake; stream metabolism; and nitrogen uptake, retention, and recycling in a stream ecosystem. Data from the Walker Branch Watershed study will be used with data from eight other sites to test hypotheses about the relationships between nitrogen uptake, cycling, and turnover and the hydrology, chemistry, and metabolism of streams.	Completion in FY 1999
C-5	Development of Gene Probes for Nitrate Reduction in Environmental Media: A Tool to Evaluate Nitrogen Retention in Watersheds	Development and field testing of molecular detection and quantification methods to evaluate nitrogen retention in watersheds.	Completion in FY 1999
C-6	Experimental and Theoretical Studies on the Seasonal, Annual, and Interannual Exchange of Water Vapor and Energy Exchange by a Temperate Forest Ecosystem in the Mississippi River Basin	Using micrometeorological, physiological, and hydrological methods to quantify the seasonal and interannual rates of water vapor and energy exchange over a temperate, broad-leaved forest and ecosystem in the Mississippi River Basin. This study illustrates the impact of periodic biotic events, ecological factors, and environmental factors on intra-and interannual variations in water vapor exchange at three scales: tree, canopy, and watershed.	Completion in FY 2000

Table 4.1.8.2-1. Current ORNL-ESD ecological research in the Walker Branch Watershed - Continued.

Project No.	Project	Description	Duration
C-7	Theoretical Studies of the Annual Exchange of CO_2 and Energy by a Temperate Forest Ecosystem	A detailed model of deciduous forest ecosystem physiology and physics is being used to simulate response of the forest in the Walker Branch Watershed to air temperature, rainfall, wind speed, solar irradiance, humidity, and atmospheric CO_2. The model will be tested against actual measurements in the Walker Branch Watershed. The aim of model development and testing is to predict land ecosystem responses to increasing atmospheric CO_2 concentrations and any associated climate change. This capability is important because land ecosystem responses to global environmental change may be significant to the global carbon cycle and climate.	Completion in FY 1999
C-8	Use of Multiscale Biophysical Models for Ecological Assessment: Applications in the Southeast	Data on primary productivity, soil carbon, and nitrogen dynamics in the Walker Branch Watershed are being used to test ecological models that evaluate variability in four fundamental factors of ecosystem condition.	Completion in FY 1999
C-9	Global Carbon Cycle Studies–Forest Carbon Dynamics: Field Experiments and Model Validation	Investigating the storage and properties of forest soil organic matter along an elevation/climate gradient in the Southern Appalachian Mountains. The Walker Branch Watershed is one of six sites where measurements relevant to this study are taken.	Long-Term (>10 years)

Source: Shriner 1998:2-6.

A number of major, mission-related projects are now planned for the ORR. These include the proposed SNS Project; expansion of ORNL; Laboratory for Comparative and Functional Genomics; Waste Handling, Packaging, and Solidification Facility; Joint Institute for Neutron Science (JINS); Engineering Technology Complex; Fusion Materials Irradiation Facility; and CERCLA Waste Disposal Facility. Future land use on the ORR would also include large-scale environmental process research, continuing reindustrialization and commercial development in the Mixed/Industrial use area, and continued environmental research activities in the NERP. Additional uses for the NERP are discussed in the *ORNL Land and Facilities Use Plan* (LMER and LMES 1998: 11).

As indicated in Figure 4.1.8.2-1, many of these projects would be sited in the general vicinity of ORNL and on land zoned as Institutional/Research and Mixed Research/ Future Initiatives. The land in the Institutional/Research zone is already heavily developed, and this zoning reflects plans for its continued development. The Mixed Research/Future Initiatives zone is largely undeveloped land that is zoned for a balanced mixture of future environmental field research in the NERP with new facility development (Parr 1998a: 2). The preferred site for the proposed SNS is located entirely within the Mixed Research/Future Initiatives zone.

Headwaters of White Oak Creek

The environmental compliance monitoring programs at ORNL plan to continue using the headwaters of White Oak Creek as a baseline reference site for the BMAP, NPDES permit compliance, and other research projects, as long as the physical, chemical, and ecological conditions of the stream reflect baseline conditions. These plans include continued use of the headwaters area as a unique reference site and source of organisms for research. Its use to collect data pertinent to environmental restoration programs downstream is expected to continue. Ideally, from the ORNL research perspective, the current environmental conditions that support these land uses need to persist indefinitely.

Walker Branch Watershed

The buffer zone for the Walker Branch Watershed was designed to function as a land use zoning overlay on the major land use zones in this area of the ORR. Its purpose is to exclude from its boundaries any future activities that could adversely impact environmental monitoring and experiments in the Walker Branch Watershed. The proposed location of the SNS at ORNL is entirely within this buffer zone.

Seven types of proposed activities within the buffer zone must be reviewed by the RMO and approved by the ORO Land Use Committee. They are:

- Application or disposal of any chemicals or materials that might enter groundwater streams.
- Alteration of surface topography.
- Actions that result in the generation of dust or gases that are released into the atmosphere.
- Drilling of wells.
- Application of pesticides or herbicides.
- Application of limestone, asphalt, or other materials in maintenance of infrastructure.

- Changes in the nature of activities conducted within the research area.

However, the establishment of the buffer zone and the designation of restricted activities within it are not considered to be irrevocable actions. Both actions are subject to future reconsideration by the ORO Land Use Committee, if priorities dictate a different course of action (Parr 1998b: 3-10).

The TDFCMP in the Walker Branch Watershed was established as a long-term research effort. To meet the overall objectives of the program, the established monitoring activities would need to continue for many years into the future. NOAA/ATDD plans to continue all of its monitoring activities in the Walker Branch Watershed for an indefinitely long period of time.

Eight of the nine current ORNL-ESD ecological research projects in the Walker Branch Watershed would extend into the future in some form. Three are long-term monitoring projects that are planned to continue for many years into the future. Two projects would continue into FY 2000 and 2005. Another three projects are scheduled to end in FY 1999; one project involves a subject slated for future long-term research, and the other two projects are expected to result in related follow-on work. According to the current proposed SNS project schedule, the ongoing and anticipated work on all eight projects would occur while the SNS is being constructed and operated. These projects and current plans concerning them are indicated in Table 4.1.8.3-1.

The ORNL-ESD has plans for a number of additional ecological research projects in the Walker Branch Watershed, and these projects fall into two categories. The first is research for which proposals are currently pending. These projects are identified and described in Table 4.1.8.3-2, and more detailed information on them may be found in Appendix F. The second category covers ecological research activities that are part of ORNL-ESD strategic planning goals and objectives. Proposals for this research have not been written, and no funding has been committed. Future work on all of these projects and initiatives would overlap the timeline for construction and operation of the proposed SNS.

The ORNL-ESD Strategic Plan identifies Large-Scale Environmental Process Research as a priority area in the future of the division. This priority is based in large part on the historical record of research and the understanding of the ecological processes regulating ecosystem structure and function on the NERP, which includes the Walker Branch Watershed. The NERP is the cornerstone for large field experiment campaigns in this area for decades to come. Future strategic initiatives would include:

- Large-scale manipulation of interacting factors affecting climate change, such as temperature, precipitation, CO_2, and nutrient status.
- A major initiative to gain a better understanding of the physical, biological, and chemical environment of the below-ground ecosystem.
- Terrestrial and aquatic climate warming manipulations.
- Nitrogen dynamics of a deciduous forest.
- Soil carbon management and use in forest ecosystems.

The baseline of research and monitoring activities on the Walker Branch Watershed is intended to contribute to a new national,

Table 4.1.8.3-1. Planned continuation of current ORNL-ESD ecological research projects in the Walker Branch Watershed.

Project No.	Project	Plans
C-1	Throughfall Displacement Experiment	Long-term project (>10 years)
C-2	Long-Term Ecological Measurements of Ecosystem Response	Long-term project (>10 years)
C-3	Terrestrial Feedbacks to Regional Hydrologic Budgets	Follow-on work possible beyond FY 2005 completion
C-4	Nitrogen Uptake, Retention, and Cycling in Stream Ecosystems: An Intersite ^{15}N Tracer Experiment	Nitrogen dynamics is a priority for future long-term research beyond FY 1999 completion
C-6	Experimental and Theoretical Studies on the Seasonal, Annual, and Interannual Exchange of Water Vapor and Energy Exchange by a Temperate Forest Ecosystem in the Mississippi River Basin	Continue project into FY 2000
C-7	Theoretical Studies of the Annual Exchange of CO_2 and Energy by a Temperate Forest Ecosystem	Anticipate proposal to continue project beyond FY 1999 completion
C-8	Use of Multiscale Biophysical Models for Ecological Assessment: Applications in the Southeast	Follow-on work possible beyond FY 1999 completion
C-9	Global Carbon Cycle Studies--Forest Carbon Dynamics: Field Experiments and Model Validation	Long-term project (>10 years)

Source: Shriner 1998: 2-6.

Table 4.1.8.3-2. Future ORNL-ESD research projects in the Walker Branch Watershed (proposals pending).

Project No.	Project	Description	Duration
F-1	Ecosystem Effects of Climate Change: Experimental Alteration of the Spatio-Temporal Pattern of Net Primary Productivity in a Deciduous Forest Ecosystem	This project would experimentally simulate the large-scale effects of atmospheric changes on the NPP of an eastern deciduous forest and its streams. It would focus on the ecosystem impacts of spatial and temporal variability in NPP that would result from the manipulation. The proposed experiment is a multidisciplinary collaboration with the University of Tennessee, which is submitting a separate proposal to address ecological responses.	Long-term (up to 10 years)
F-2	Ecosystem Effects of Climate Change: Responses to Experimental Alteration of the Spatio-Temporal Pattern of Net Primary Productivity in a Deciduous Forest	This study would evaluate the responses to altered NPP at several levels of the food chain in the terrestrial and aquatic portions of the ecosystem. Plant responses at the canopy, subcanopy, and herbaceous levels would be quantified using a variety of methods, including satellite imagery. Animal responses would be evaluated using forest floor, canopy, and stream invertebrates, as well as small mammal populations. This would be a companion effort to the previously described project and would be dependent upon it.	Long-term (up to 10 years)
F-3	Retention and Fate of Atmospheric Nitrogen Deposition in Forests: Tracer ^{15}N Addition Experiments in Forests of Contrasting Nitrogen Status	The retention and fate of atmospheric nitrogen deposition to forests would be studied by conducting ^{15}N addition experiments in two forests of contrasting nitrogen status. The Walker Branch Watershed forest would be used as a nitrogen deficient forest in contrast to the nitrogen-saturated Noland Divide forest in the Great Smoky Mountains National Park.	Project completion by FY 2001. A priority subject for long-term research in the Walker Branch Watershed.
F-4	The Effect of Field-Scale Climate Manipulation on the Dynamics of Dissolved Organic Matter in Soil: Implications for Soil Carbon Pools	Comparisons of paired control- and climate-manipulation regimes would be used to assess differences in the chemical nature and concentrations of DOM in soil and shallow groundwater, determine decomposition rates of DOM, measure differences in the flow of DOM from soil through stormwater, and evaluate the interactive effects of altered CO_2, precipitation, and temperature on the fate and transport of DOM in soil.	Project completion in FY 2001. A priority subject for long-term research in the Walker Branch Watershed.

DOM - Dissolved organic matter.
NPP - Net primary productivity.
Source: Shriner 1998: 6-8.

interagency program for long-term ecosystem monitoring. The Oak Ridge NERP would serve as an index site in the monitoring network.

Common Ground Process and End Uses of ORR Land

DOE-ORO has actively sought public perspectives on future ORR land use through a process called Common Ground and through the End Use Working Group. The Common Ground process has resulted in public recommendations for future use of all reservation land. The End Use Working Group has determined end use recommendations for areas of land with contaminated sites. The results of their determination have been presented to DOE in the form of final community land use guidelines and recommendations for the end use of contaminated land in specific watersheds (ORR End Use Working Group 1998).

The proposed SNS site at ORNL is located in an area DOE has zoned for a combination of environmental research and development of new facilities. As part of the Common Ground process, the Nature Conservancy was retained to assess the biological significance of land areas on the reservation. This assessment was done using ORNL data to rank the biodiversity of land areas. Most of the land on the proposed SNS site was not given a high biodiversity significance ranking (BSR). However, a BSR 3 (High Significance) was assigned to a strip of land in the middle of the "hammerhead" on the SNS footprint. A BSR 3 was also assigned to two very small areas of land within the west corner of the hammerhead (refer to the figure in Appendix B, page B-43). Furthermore, the proposed SNS site lies within a preliminarily defined landscape complex, which is a broad area encompassing several BSR areas (Figure 4.1.8.3-1). Consequently, the Common Ground process has recommended a future land use category, Conservation Area Uses, for the land on and adjacent to the proposed SNS site (Figure 4.1.8.3-2). This category includes environmental protection, research sites, forestry, agricultural research, and passive recreation (LMES 1995: 20-21 and 33).

The End Use Working Group has developed community guidelines for land use on the ORR (ORR End Use Working Group 1998). These guidelines recommend the siting of additional DOE facilities on brownfield sites instead of greenfield sites. Brownfield sites consist of previously developed land or contaminated land that has been remediated to accommodate certain uses. Greenfield sites consist of uncontaminated and previously undeveloped land. The proposed SNS site and areas adjacent to it are greenfields.

4.1.8.4 Parks, Preserves, and Recreational Resources

The University of Tennessee Arboretum is located approximately 0.25 miles (0.4 km) northeast of the ORR. This facility contains 250 acres (101 ha) of land and functions as a living botanical education center for the general public. Several trails with botanical themes run throughout the arboretum and are open to the public for hiking. The University of Tennessee operates a forest experiment station on 2,000 acres (810 ha) of land adjacent to the arboretum (LMES 1996: 2-49). This area is not open to the public.

Large portions of the ORR are devoted to nature preservation and biological research. About 21,980 acres (8,899 ha) of undeveloped and geographically fragmented areas of reservation

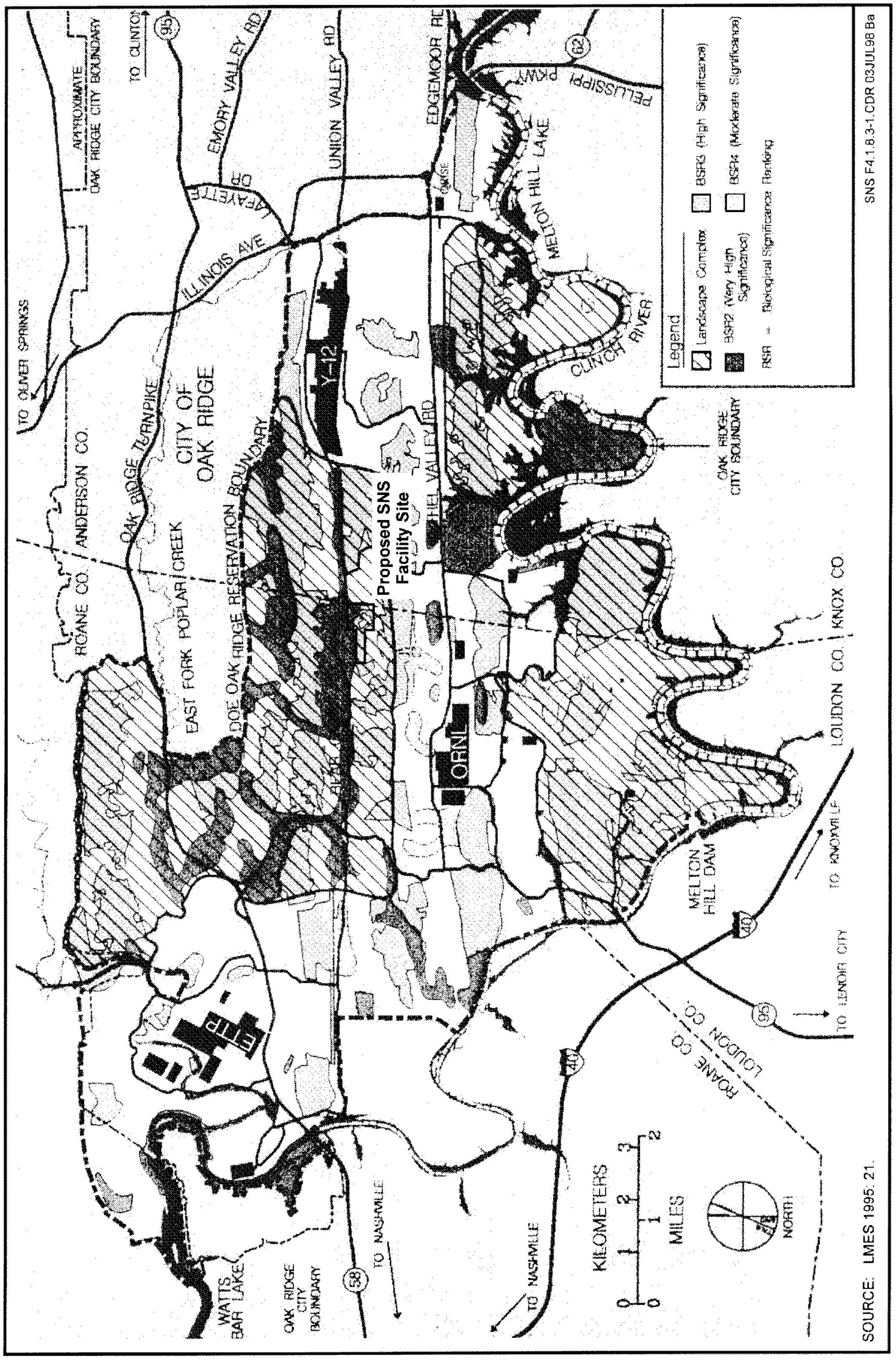


Figure 4.1.8.3-1. Map of preliminary conservation sites on the ORR.

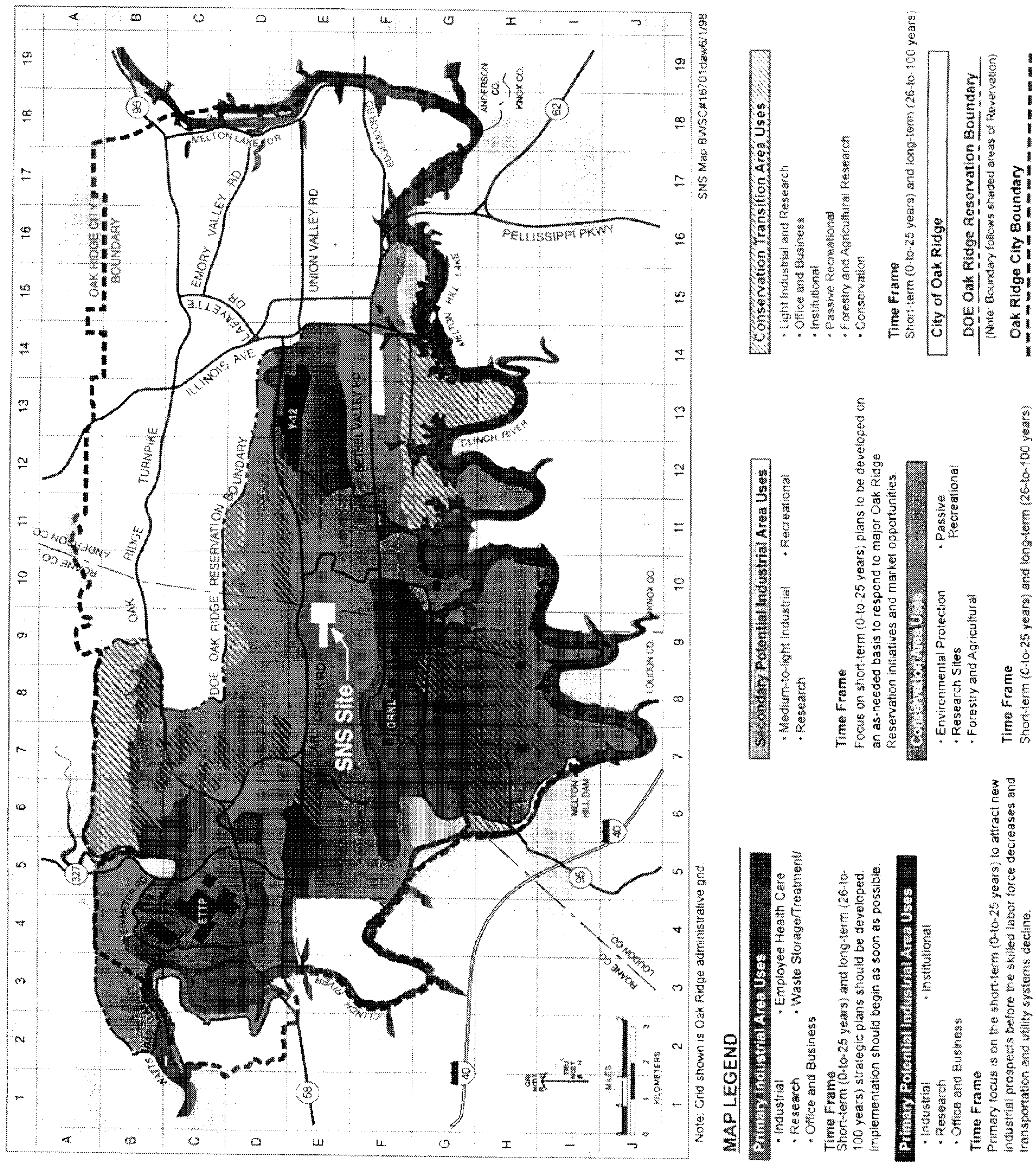


Figure 4.1.8.3-2. Map of ORR Common Ground future land use recommendations.

land comprise the Oak Ridge NERP (ORNL, OR Y-12, and ETTP 1997: 1-8). The NERP is used by the U.S. scientific community as an outdoor environmental science laboratory to study the current and future environmental consequences of the DOE mission in Oak Ridge (LMES 1995: 7). Numerous areas within the NERP are designated for the protection of rare species. A number of reference areas have been established to serve as examples of regional plant communities and unique biotic features (Pounds et al. 1993).

The Clark Center Recreational Park occupies 90 acres (36 ha) of land within the east corner of the reservation. It is open to the public for swimming, picnicking, fishing, pleasure boating, and athletic activities such as softball.

Several public recreation areas are located along Melton Hill Lake, which is outside the ORR but adjacent to a large portion of the reservation's southeast boundary. This body of water is a TVA reservoir that was formed by impounding the Clinch River with Melton Hill Dam. The body of water on the downstream side of this dam is Watts Bar Lake, which is adjacent to the southwest boundary of the reservation.

Melton Hill Dam is located approximately 2.7 miles (4.3 km) southwest of the central ORNL plant, but land used for laboratory activities extends south to the shore of the lake. A large TVA public recreation area is located at the dam on the opposite shore from ORNL land. This area is used for pleasure boating, fishing, swimming, and picnicking. Other TVA recreational areas with similar uses are located along Melton Hill Lake upstream from the dam and ORNL, including 1,051 acres (425 ha) of recreational lands within the city limits of Oak Ridge (MMES 1994: 1-27). A TVA boat ramp is located on the ORNL side of Watts Bar Lake, approximately 1.5 miles (2.4 km) downstream from Melton Hill Dam. Watts Bar Lake is used for pleasure boating, fishing, and swimming.

A portion of the reservation is operated as the Oak Ridge Wildlife Management Area through a cooperative agreement between DOE and the Tennessee Wildlife Resources Agency (DOE-ORO 1996: 3-1). In 1984, this agreement was initiated to reduce traffic accidents involving deer by opening the reservation to hunting by the public (Saylor et al. 1990: 8-2). The proposed SNS site at ORNL is located entirely within a currently designated hunting zone (MMES 1994: 2-119).

4.1.8.5 Visual Resources

The steep, linear ridges, intervening valleys, and lakes in the vicinity of ORNL create beautiful natural scenery. However, many parcels of rural land are used for agricultural and residential purposes. As a result, the visual field at many locations includes various combinations of houses, barns, roads, and utility features. In heavily developed areas of Oak Ridge, views are predominated by these features, along with numerous commercial structures, industrial plants, and public service buildings.

The ORR was primarily in agricultural use when it was purchased by the federal government in 1942. Since that time, much of it has been allowed to return to its natural state. Consequently, natural scenery abounds on the reservation. However, many views of the landscape in developed areas of the reservation, such as those in the vicinity of ORNL, are a mixture of natural features with buildings, roads, and utility features. On the reservation, there are no well-established and frequently visited visual resources, such as overlooks, that include the proposed SNS site.

The proposed SNS site would be located on top of Chestnut Ridge and approximately 1 mile (1.6 km) northeast of the central ORNL plant. Its location is visible from Bear Creek Road to the north and Chestnut Ridge Road to the east. Viewed from these locations, the proposed site appears to be completely forested. Standing at points within the interior of the proposed site, the trees shroud panoramic views of the surrounding landscape. Signs of human activity are apparent in the form of a few dirt utility roads and evidence of recent surveying and core drilling activity. From points on the east periphery of the proposed site, Chestnut Ridge Road and a utility corridor are visible.

4.1.9 RADIOLOGICAL AND CHEMICAL ENVIRONMENT

This section describes the radiological and chemical environment at ORNL.

4.1.9.1 Radiological Environment

Facilities that contribute the majority of radioactive emissions from the ORR include the Y-12 Plant; ORNL facilities, specifically the 2026 Radioactive Materials Analytical Laboratory, 3020 Development Facility, 3039 Central Off-Gas and Scrubber System, High Flux Isotope Reactor, and Radiochemical Engineering Development Center; and the Toxic Substance Control Act (TSCA) Incinerator at ETTP.

Four off-site facilities were identified as potential contributors to radiation exposure of the public around the ORR. These facilities include a waste-processing facility located on Bear Creek Road, a depleted uranium processing facility located on Illinois Avenue, a decontamination facility located on Flint Road in Oak Ridge, and a waste processing facility located on Gallaher Road in Kingston. Airborne emissions from these facilities (based on information supplied by the facilities) should not cause any individual to receive an annual effective dose equivalent (EDE) greater than 3.8 mrem. When combined with impacts caused by emissions, no individual should receive an EDE in excess of EPA or DOE limits. No information was obtained about waterborne releases, if any, from these facilities.

4.1.9.1.1 Air

DOE maintains a perimeter air monitoring network to perform surveillance of airborne radionuclides at the reservation perimeter and to collect reference data from remote locations. This network consists of eight stations spread throughout the ORR and one regional (off-site reference) station that samples levels of alpha-, beta-, and gamma-emitting radionuclides; tritium; beryllium; and total radioactive strontium. A comparison of the perimeter station data with the regional station data indicates that the ORR operations do not significantly affect local air quality (ORNL, OR Y-12, and ETTP 1997).

Station 37 in this network is centrally located within the ORR in Bear Creek Valley. It is the closest station to the proposed SNS site and monitors the overlap of the Y-12 Plant, ORNL, and the ETTP site emissions. Table 4.1.9.1.1-1 provides radiochemical results for Station 37 and the two off-site reference stations (Station 51—Norris Dam, Station 52—Ft. Loudon Dam). No significant difference can be discerned between airborne radionuclide

Table 4.1.9.1.1-1. Comparison of radionuclide levels (Ci/ml) between air monitoring stations at ORR and reference locations.[a]

Monitor Station	Be-7	Co-60	Cs-137	H-3	U-234	U-235	U-238	Gross Alpha	Gross Beta
Station 37	1.6E-13	8.3E-17	1.3E-17	9.3E-12	2.0E-17	7.2E-19	2.1E-17	2.8E-15	5.7E-15
Station 51	1.6E-13	2.4E-17	2.2E-17	9.2E-12	8.5E-18	3.8E-19	7.2E-18	2.7E-15	5.2E-15
Station 52	1.5E-13	5.0E-17	1.1E-17	6.6E-12	9.4E-18	1.4E-18	9.3E-18	1.8E-15	4.2E-15

[a] ORNL, OR Y-12, ETTP 1997.
Values: 1.6 E-13 = 1.6 X 10^{-13} Ci/ml.

activities on the reservation or off-site. (Note: Station 51 is no longer used).

Each ORR facility has a comprehensive air pollution control and monitoring program to ensure that airborne discharges meet regulatory requirements and do not adversely affect ambient air quality. During 1996, the effects of radionuclides released to the atmosphere from ORR operations were evaluated by calculating the EDE to maximally exposed off-site individuals and to the entire population residing within 50 miles (80 km) of the center of the ORR. A total of 47 emission points, each of which includes one or more individual sources, on the ORR were modeled during 1996. This total includes seven points at the Y-12 Plant, 27 points at ORNL, and 13 points at ETTP.

The EDE received by the hypothetical maximally exposed individual for the ORR was calculated to be about 0.45 mrem, which is below the National Emissions Standards for Hazardous Air Pollutants (NESHAP) standard of 10 mrem and well below the 300 mrem that the average individual receives from natural sources of radiation. The maximally exposed individual is located about 0.7 miles (1.13 km) north-northeast of the Y-12 Plant release point, about 5.8 miles (9.3 km) northeast of the 3039 stack at ORNL, and about 8.11 mile (13 km) east-northeast of the K-1435 (TSCA Incinerator) stack at ETTP. The calculated collective EDE to the entire population within 50 miles (80 km) of the ORR (about 879,546 persons) was about 9.9 person-rem, which is approximately 0.004 percent of the 264,000 person-rem that this population could have received from natural sources of radiation.

4.1.9.1.2 Water

Radionuclides discharged to surface waters from the ORR enter the Tennessee River system by way of the Clinch River and various feeder streams. Discharges from the Y-12 Plant enter Clinch River by way of Bear Creek and East Fork Poplar Creek, both of which enter Poplar Creek before it enters the Clinch River, and by direct discharge from Rogers Quarry into Melton Hill Lake. Discharges from ORNL enter the Clinch River by way of White Oak Creek and White Oak Lake. Discharges from ETTP enter the Clinch River by way of Poplar Creek.

Based on three years of data, Bear Creek downstream from the Y-12 Plant Burial Grounds has the highest levels of gross alpha activity, total uranium, and uranium isotopes. The highest levels of gross beta, total radioactive strontium, and tritium have been at Melton Branch downstream from ORNL, White Oak Creek at White Oak Dam, and White Oak Creek downstream from ORNL.

The potential radiological impacts of these discharges to persons who drink water, eat fish, swim, boat, and use the shoreline at various locations along the Clinch and Tennessee Rivers are evaluated annually. When all pathways are considered, the maximum EDE resulting from waterborne radionuclide discharges could have been about 1.5 mrem: 1.2 mrem from use of off-site waters, plus 0.3 mrem from drinking Kingston water. The collective EDE to the 50-mi (80-km) population was estimated to be about 2.0 person-rem. These are small percentages of individual and collective doses attributable to natural background radiation, 0.5 percent and 0.0008 percent, respectively.

4.1.9.1.3 Soil

Soil samples were collected from eight perimeter stations and the remote station at Norris Dam. Sampling results indicate the presence of uranium isotopes and gross alpha activity. Individual uranium isotopes were detected at less than 1 pCi/g compared to a nondetect at the Norris Dam reference locations. Gross alpha levels averaged 2.4 pCi/g at the eight locations compared to 2.3 pCi/g at Norris Dam. No readings were significantly above background levels.

4.1.9.1.4 Ambient Gamma Radiation

The ORNL continuously monitors external gamma radiation from six ambient air stations in and around the ORR. The furthest station is located at Norris Dam, 26 miles (41.9 km) northeast of the ORR. Six ambient air stations monitor external gamma radiation. The median external radiation value for the ORR in 1996 was estimated to be 67 mR/yr compared to 81mR/yr for cities across the United States.

4.1.9.2 Chemical Environment

This section describes the levels of nonradiological contaminants in air and water at ORNL. Soil is not routinely monitored for nonradiological contaminants at ORNL.

4.1.9.2.1 Air

The Y-12 Plant releases nonradiological contaminants into the atmosphere as a result of plant processes, maintenance, waste management operations, and steam production. More than 90 percent of the Y-12 Plant's emissions are attributable to the operation of the Y-12 Steam Plant. The steam plant is monitored for SO_x, NO_x, carbon monoxide, particulates, and VOCs. Other common pollutants from the Y-12 Plant include refrigerants (freon) and miscellaneous chemicals (methanol, HCl).

For ORNL, the steam plant and two small oil-fired boilers contribute the majority of nonradiological air pollutants, contributing 98 percent of allowable emissions. In 1996, no noncompliance infractions occurred.

The major sources of criteria air pollutants at ETTP consist of the three remaining steam-generating units at the K-1501 Steam Plant and the TSCA Incinerator. Signature pollutants of steam plants include sulfur dioxide, nitrogen oxides, carbon monoxide, particulates, and VOCs. The TSCA Incinerator is monitored for lead, beryllium, mercury, fluorine, chlorine, sulfur dioxide, and particulates.

4.1.9.2.2 Water

To assess the water quality of the surrounding surface water resources, surface water samples are collected from 22 locations around the ORR. Out of 79 parameters analyzed at each of the 22 sites, chromium at White Oak Dam, arsenic at the Melton Hill Reservoir at the Oak Ridge Marina, zinc at White Oak Creek upstream from ORNL, and mercury at the water supply intake for Knox County are the only parameters that exceeded a reference value in 1996.

In 1996, more than 200 surface water samples were collected from three areas bordering the Y-12 Plant. Results indicate that only mercury and zinc were detected at values exceeding criteria maxima. The source of zinc is believed to be a zinc additive in the once-through cooling water. The sample location that produced these results is located in East Fork Poplar Creek near the junction of Scarboro and Bear Creek Roads.

In 1996, over 10,000 surface water samples were collected from the ORNL property at various process discharge points, as required by the ORNL NPDES Permit. Of the samples collected, only a small number were noncompliant with NPDES permit limits. Parameters exceeding permit limits included fecal coliform, iron, and total suspended solids. ORNL has a fairly extensive mercury monitoring program. In 1996, 78 samples were collected from 13 locations. The highest value reported was 0.55 µg/L near the Outfall 207 in White Oak Creek. Average concentrations ranged from 0.13 to 0.36 µg/L.

Discharge monitoring from ETTP in 1996 indicates one excursion for total petroleum hydrocarbons and three for unpermitted discharges. Aside from those four noncompliance episodes, all discharges into receiving waters were within NPDES permit limits.

4.1.9.2.3 Soil

Soil is not routinely monitored for nonradiological contaminants at ORR.

4.1.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The Support Facilities and Infrastructure section characterizes the local vehicular transportation routes around the proposed SNS site. The existing utilities that are available to provide needed services to support the operation of the proposed SNS are also described.

4.1.10.1 Transportation

The proposed SNS facility would be located between ORNL and the Y-12 Plant near the City of Oak Ridge, Tennessee. Figure 4.1.10.1-1 gives the location of the proposed SNS facility site and the transportation routes around the site.

Major transportation routes to the ORR are via two interstate highways, I-40 and I-75, and U.S. highways 11, 25W, and 70. State highways that service the area include 58, 61, 62, 95, and 162 (Pellissippi Parkway). These highways lead to Bear Creek Road and Bethel Valley Road, which border the site to the north and south, respectively. Primary access to the proposed SNS facility would be from Chestnut Ridge Road via Bethel Valley Road. Chestnut Ridge Road is constructed of gravel and laterite material and is unable to accommodate heavy vehicle loads. Traffic flow on Chestnut Ridge Road is light.

The Phase I Environmental Report for the ANS at ORNL (Blasing et al. 1992) contains a

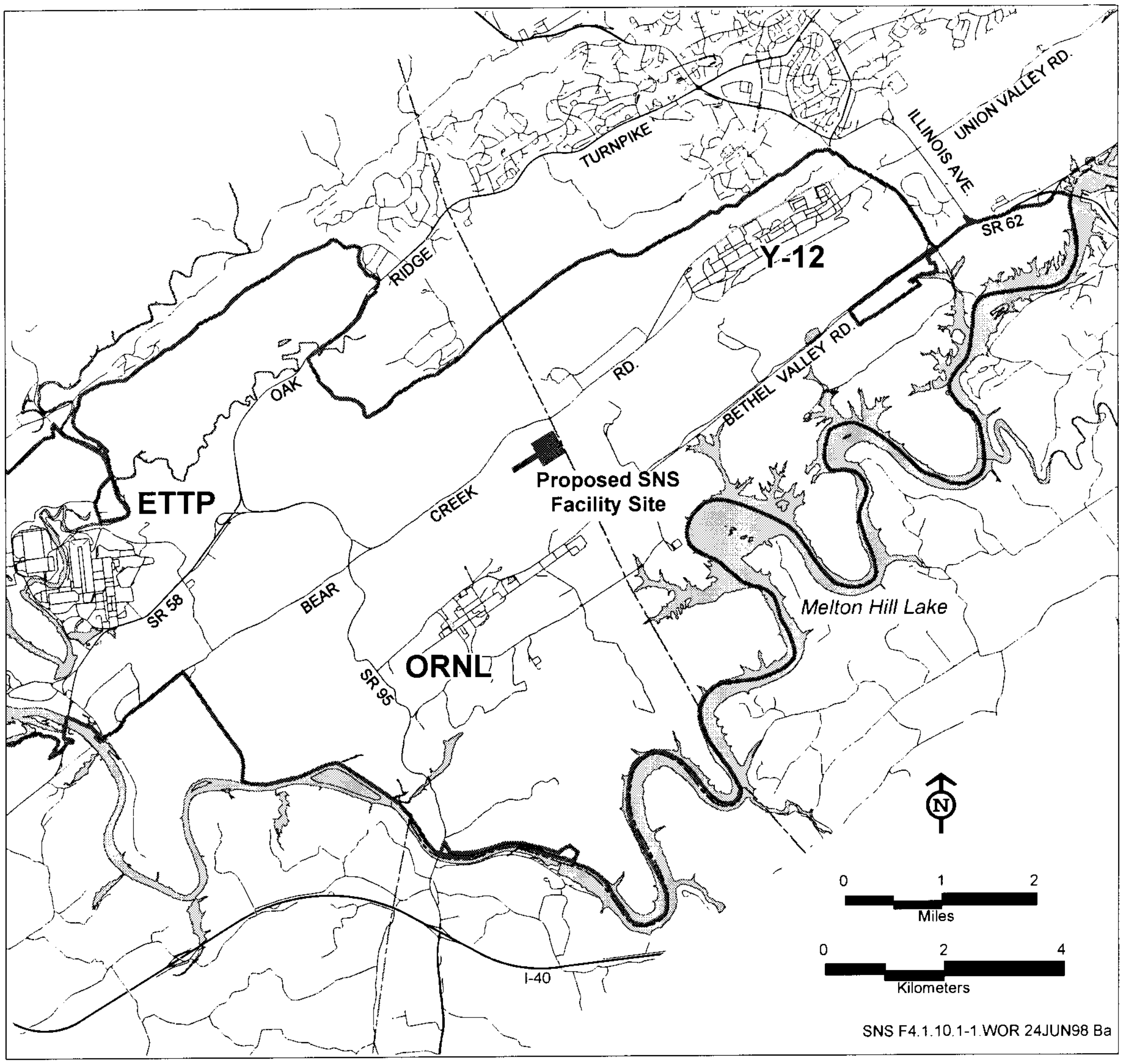


Figure 4.1.10.1-1. Transportation routes at the ORR and surrounding areas.

detailed traffic analysis of the effects of construction and operation of the ANS. This analysis is the basis for the SNS analysis at Oak Ridge because of the proximity of the respective sites considered. The major public access roads examined for the ANS traffic analysis are the same as the SNS analysis (State Road 62, State Road 95, and Bethel Valley Road) making the data and analysis directly applicable. These roadways and associated traffic flows are provided in Table 4.1.10.1-1.

4.1.10.2 Utilities

This section provides a description of the utility infrastructure at ORNL. The following is based upon existing documentation and discussions with select ORNL staff.

4.1.10.2.1 Electrical Service

ORNL purchases its electricity from TVA. Power is brought to the site via two 161-kV transmission lines, currently owned by DOE,

Table 4.1.10.1-1. Existing average daily traffic flows (vehicles/day) and LOS at ORR.

Road Segment	Average Daily Flow
Bethel Valley Road (east) (from Melton Valley Rd. eastward to SR-62)	7,400
Bethel Valley Road (west) (from Melton Valley Rd. westward to SR-95)	4,200
State Route 95 (north) (from Bethel Valley Rd. northward to SR-58)	6,600
State Route 95 (south) (from Bethel Valley Rd. southward to I-40)	6,600
State Route 62 (south) (from Bethel Valley Rd. southward to the Pellissippi Parkway toward Knoxville)	29,940

Source: Blasing et al. 1992.

which terminate into a main substation approximately 6,000 ft (1,800 m) west of the proposed site. At the substation, power is stepped down to 13.8 kV before distribution to the laboratory via overhead and underground lines. The existing 161-kV transmission lines cross Chestnut Ridge approximately 3,000 ft (914 m) west of the proposed site and have been determined to be adequate for future electrical energy demands (Schubert 1997). Currently, there are no electrical power lines or facilities on-site.

4.1.10.2.2 Steam

ORNL produces steam for its operations from the steam plant located on the far west end of the laboratory. The plant consists of five boilers, with a sixth boiler currently being installed. Four of the boilers are coal fired, each with a 50,000-lb/hr capacity. The fifth and sixth boilers are natural gas fired, each with a 100,000-lb/hr capacity. Approximately 90 percent of the steam is used for building heating systems; the other 10 percent is used for evaporators and process steam. ORNL's maximum steam consumption is approximately 70,000 lb/hr in the summer. Currently, there are no steam lines or facilities on-site.

4.1.10.2.3 Natural Gas

East Tennessee Natural Gas Company (ETNG) supplies natural gas to ORR. A 22-in. main enters ORR from Knox County, crosses the Clinch River, and proceeds to a valve station located along Bethel Valley Road. Smaller pipelines [6 to 14 in. (15.2 to 35.6 cm)] supply gas to various facilities around the laboratory. ETNG mainline pressures range from 450 to 600 psi but are reduced to 65 and 125 psig for distribution to ETTP and the Y-12 Plant, respectively, and 100 psig for distribution to ORNL. The annual natural gas demand for ORNL ranges from 110,000 to 150,000 million ft^3/yr (33,528 to 45,720 million m^3/yr). Currently, there are no natural gas lines or facilities on-site. The distribution header is located approximately 1 mile (1.6 km) from the proposed SNS site.

4.1.10.2.4 Water Service

DOE withdraws water from the Clinch River at a point south of the eastern end of the Y-12 Plant. The water is filtered and chlorinated at a water treatment plant located north of the Y-12 Plant and distributed to the City of Oak Ridge, the Y-12 Plant, and ORNL. This treatment facility provides potable water through two storage reservoirs with a combined capacity of 7 million gal (26.5 million L). Water is distributed from the treatment facility to ORNL via a 24-in. (61-cm) water main. An existing 24-in. (61-cm) line currently exists adjacent to the southern and eastern edge of the proposed SNS facility. At ORNL, two 3-million-gal (11.4-million-L) storage reservoirs hold the water before it is distributed through ORNL's water distribution system.

4.1.10.2.5 Sanitary Waste Treatment

ETTP and ORNL operate and maintain individual sanitary wastewater treatment plants (SWTPs), while the Y-12 Plant uses sewage treatment services at the City of Oak Ridge. The SWTP at ORNL is located on the western end of the laboratory. The SWTP's current capacity is 300,000 gpd (1.1 million lpd), while the average daily flow to the SWTP is less than 200,000 gpd (757,080 lpd). Within the last four years, the SWTP received upgrades including new chlorination and ozone systems and a relining of all major underground sewer lines to eliminate groundwater infiltration. The closest sewer line to the proposed SNS facility is approximately 1 mile (1.6 km) south of the site.

4.2 LOS ALAMOS NATIONAL LABORATORY

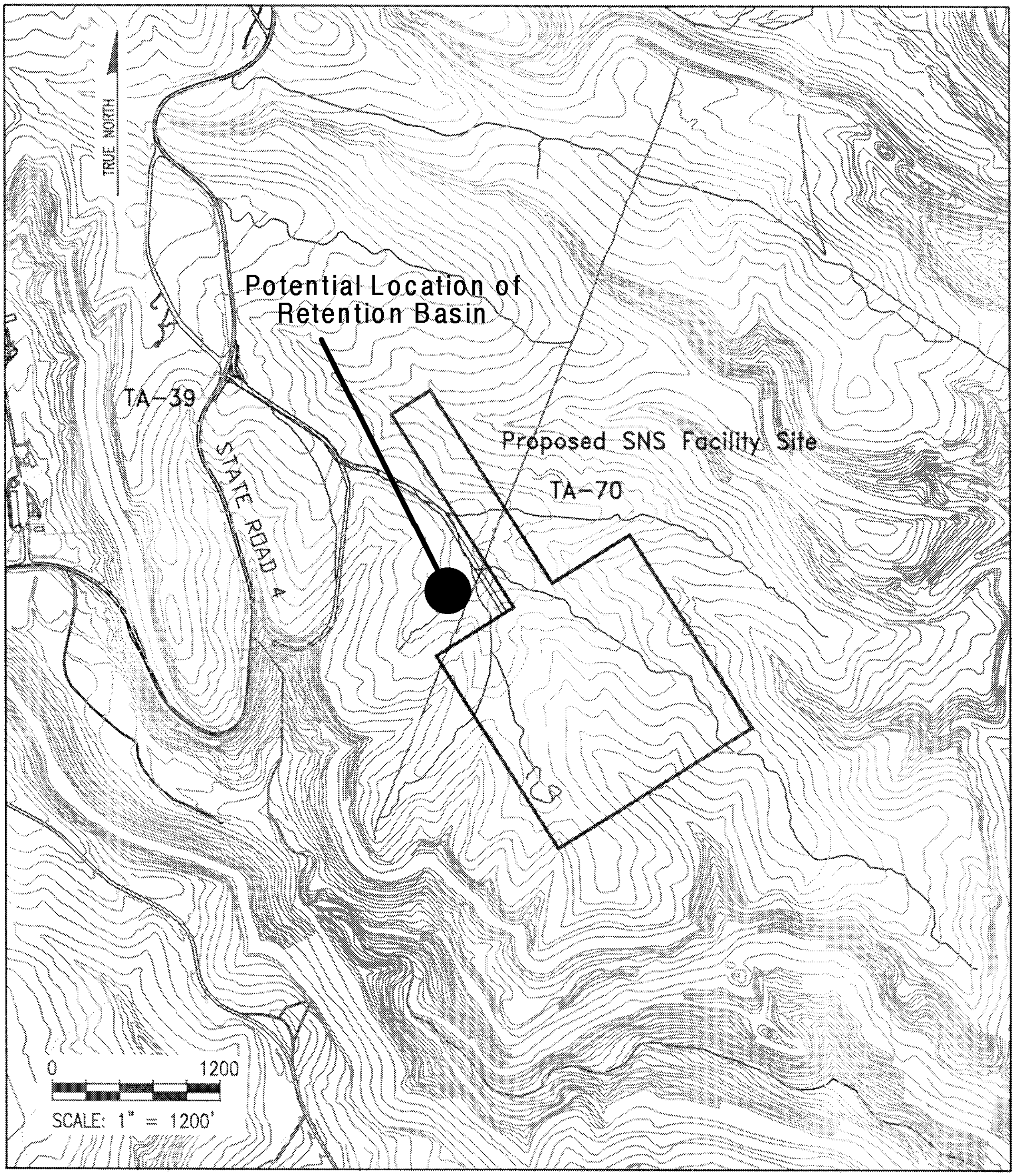
The proposed site for the SNS facility is located on the Pajarito Plateau on the east-central edge of the Jemez Mountains. The plateau is formed by an apron of volcanic sedimentary rocks and is dissected into a number of narrow mesas by southeast-trending canyons. Most of these canyons support intermittently flowing streams. The stream drainages ultimately descend into White Rock Canyon and converge with the Rio Grande near the eastern boundary of Los Alamos National Laboratory (LANL). The Rio Grande is the only permanently flowing river near the project area.

No major surface water bodies are located within 0.25 miles (0.44 km) of the proposed SNS facility. However, Ancho Canyon Spring, a smaller surface water body, is located approximately 0.5 miles (0.88 km) from the proposed site.

The proposed site is within a portion of the LANL reservation called Technical Area (TA)-70 (Figure 4.2-1), which is located on a mesa flanked by Ancho Canyon 0.27 miles (0.47 km) to the southwest and a small unnamed canyon an equal distance to the northeast. To the southeast, the Rio Grande flows through nearby White Rock Canyon, at a distance of approximately 1.2 miles (1.9 km) from the proposed facility site. The proposed site is located 0.22 miles (0.35 km) to the east of State Road 4, a two-lane paved road (Figure 4.2-1). Elevations within the area evaluated range from 6,410 ft (1,954 m) to 6,490 ft (1,978 m).

4.2.1 GEOLOGY AND SOILS

LANL is located in north central New Mexico on the Pajarito Plateau between the Jemez Mountains on the west and the Rio Grande on the east. The topography of the area is characterized by mesas and bluffs with deeply incised canyons. The major geologic feature of the area is the Rio Grande rift that extends from northern Mexico across central New Mexico and terminates in south central Colorado. The Rio Grande rift is a series of grabens or down-thrown blocks resulting from tensional tectonics some 32 million years ago. The present-day



SOURCE: LANL 1997c: 8.

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Figure 4.2-1. Proposed SNS site at LANL.

form of the rift is displayed by a series of basins filled with sediments eroded from adjacent highlands interspersed with lava flows. The rift basin in the vicinity of Los Alamos and Santa Fe is referred to as the Española Basin.

The Valles Caldera is the dominant physical feature adjoining the Los Alamos area. The caldera formed when the center of the volcanic uplift collapsed after a large volume of magma ejected along a series of ring-shaped fractures that now defines the present-day structure. Faulting associated with the rifting provided conduits for volcanic activity, such as the basaltic lavas that are interbedded with the basin-filling sediments (Figure 4.2.1-1). The deep faulting helped localize the expression of some major trends in volcanic activity. The volcanic vents in and near the Jemez Mountains lie at the intersection of a northeast trend of volcanic centers and the western edge of the Española Basin. Deposits from the Jemez Mountain vents covered the basin-filling sediments and the adjacent uplands over an area of more than 800 mi² (2,100 km²). Pyroclastic eruptions occurring about 1.5 to 1.0 million years ago resulted in significant accumulations of ash fall that is called the Bandelier Tuff.

4.2.1.1 Stratigraphy

The tuffs accumulated on the Pajarito Plateau include a mixture of ash falls, ash fall pumice, and rhyolite tuff and range from welded to nonwelded tuffs. On the Pajarito Plateau the Bandelier Tuff is divided into the Otowi and Tshirege members (Figure 4.2.1.1-1). This tuff is more than 300 m (1,000 ft) thick in the western part of the plateau near the Jemez Mountains and thins to about 80 m (260 ft) at the eastern edge of the plateau above the Rio Grande.

Surface geology at the site proposed for the SNS facility is characteristic of the lower elevation mesa tops on the Pajarito Plateau. The site slopes less than 20° from the northwest to the southeast towards White Rock Canyon and the Rio Grande. The surface of the mesa top is composed of bare tuff bedrock with scattered areas of soil. Surface bedrock at this site is on the Tshirege member, but its thickness at TA-70 has not been determined.

4.2.1.2 Structure

The geologic structure of LANL is dominated by three fault zones—the Pajarito, Rendija Canyon, and Guaje Mountain faults. These faults are clearly expressed by surface offsets at some locations and are inferred from geologic evidence at others. Figure 4.2.1.2-1 shows the results of recent mapping of faults, including the young faulting that is significant to LANL in general (Wong et al. 1995). The Pajarito fault is thought to mark the currently active western boundary of the Española Basin. Prior to the Jemez Mountains volcanism, the basin boundary may have been farther west and under the present Valles Caldera. The Rendija Canyon and Guaje Mountain faults are geologically young and are capable of producing future earthquakes.

There are no known faults within a 2.8-mi (4.5-km) radius of the TA-70 site. The primary fault zones mapped within the LANL reservation occur well to the west of the TA-70 site, and no faults have been identified along the eastern boundary of LANL (although LANL is currently updating a prior study to better define the extent and paleomovements of regional faults). Using the current knowledge base, the three faults listed in Table 4.2.1.2-1 are the primary controls on the estimates of seismic

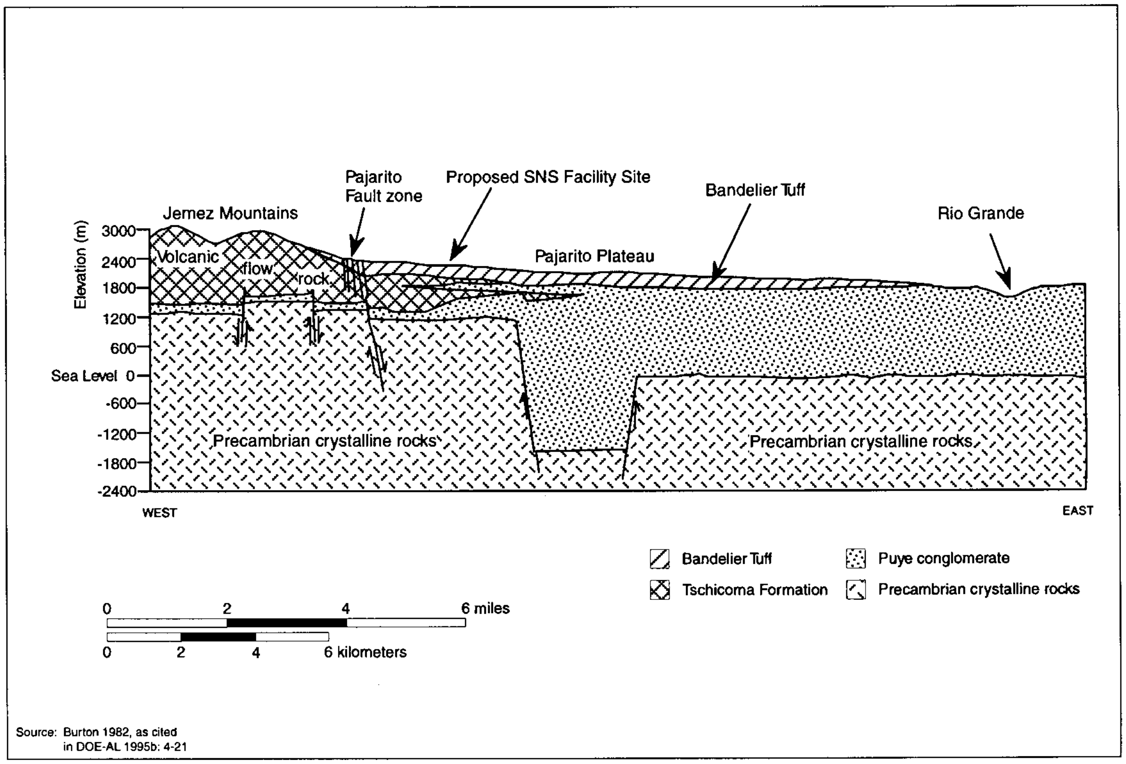

Figure 4.2.1-1. Geologic cross section of the LANL region.

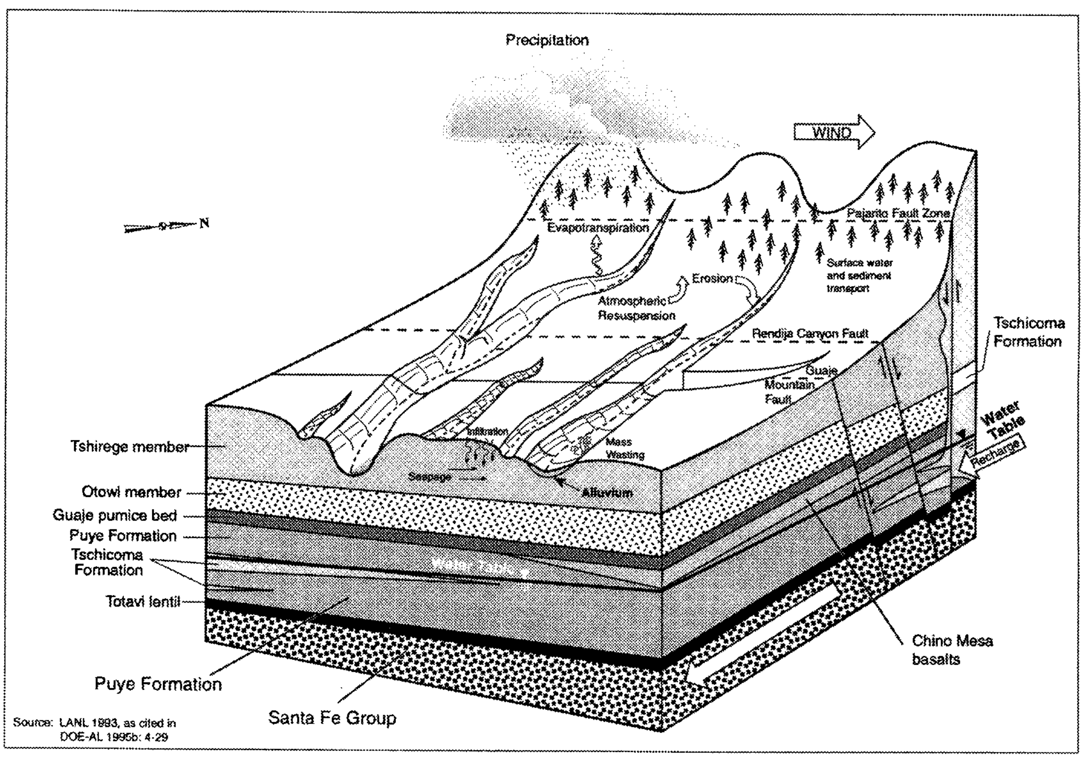

Figure 4.2.1.1-1. Conceptual model of the LANL area showing the relationships of major geologic features on the Pajarito Plateau.

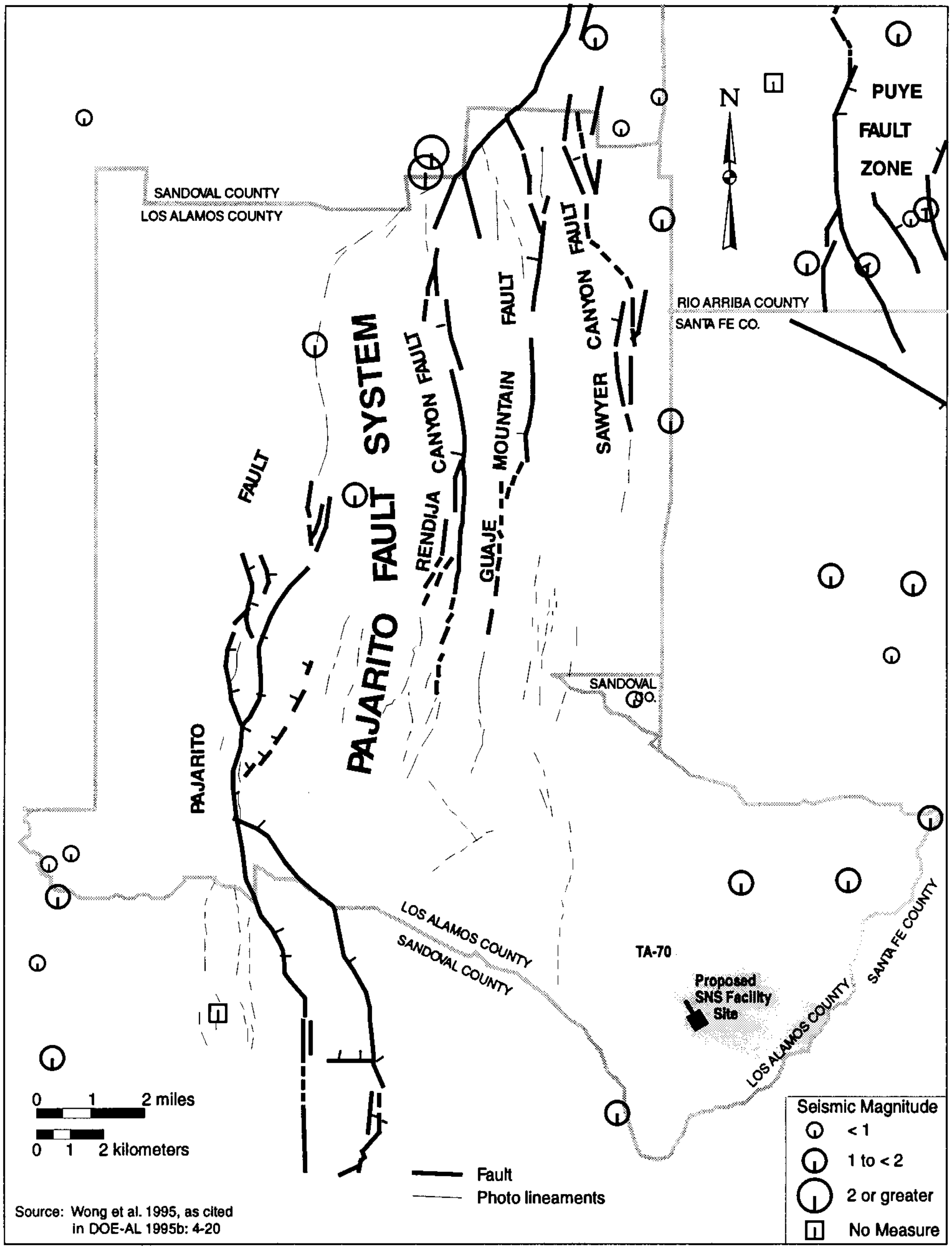

Figure 4.2.1.2-1. Recent geologic mapping of faults, lineaments, and earthquakes at LANL.

Table 4.2.1.2-1 Major faults at LANL.[a]

Name	Approximate Length [mi/(km)]	Type[b]	Most Recent Movement	Maximum Earthquake (Mw)[c]
Pajarito	29 (47.0 km)	Normal, East Side Down	multiple in past 100,000 to 200,000 years	7
Rendija Canyon	6 (9.7 km)	Normal, West Side Down	8,000 to 9,000 years ago	6.5
Guaje Mountain	8 (12.9.0 km)	Normal, West Side Down	4,000 to 6,000 years ago	6.5

[a] Source: Wong et al. 1995.
[b] Normal Fault **-** steep to moderately steep fault for which the movement is downward for the rock above the fault zone.
[c] Mw denotes the moment magnitude scale, which is physically based and calibrated to the Richter local magnitude scale at the lower values.

hazards at the proposed SNS location because of their size, proximity, and evidence of geologically young movement.

4.2.1.3 Soils

Several distinct soil types have developed on the Pajarito Plateau as the result of interaction among the bedrock, surface morphology, and local climate. Alluvium derived from the plateau, the Jemez Mountains, and windblown deposits contributes to soils in the canyons and also on some of the mesa tops. Layers of pumice from past eruptions in the Jemez Mountains and windblown sediment from beyond the Pajarito Plateau are also significant components of many soils on the plateau.

Soils on the mesas can vary widely in thickness and are typically thinnest near the edges of the mesas where bedrock is often exposed. Large areas of soil are not common at the proposed SNS site. The majority of the site consists of exposed bedrock with soils accumulated in low spots or along bedrock outcrops. Surface deposits on the mesa top include locally derived soils and in places a thin cover of fine-grained eolian sediment. The soil that does occur on the proposed site has been identified as a Hackroy sandy loam. The Hackroy is typically a light brownish, sandy loam over tuffaceous bedrock greater than 15.7 in. (40 cm) deep. The canyon slopes and bottoms adjacent to the site contain a variety of loose soils, cobble, and large boulders from mass wasting of the canyon edges. There are no agricultural activities present at LANL, nor are there any prime or unique farmlands (DOE 1996d).

Samples to assess the soil quality were collected from 12 on-site and 10 perimeter areas around the laboratory, analyzed for radiological and nonradiological constituents, and compared to regional site locations. Radionuclides in soils collected from regional background areas are due to natural and/or to worldwide fallout. In general, most radionuclide concentrations in on-site and perimeter areas were within regional statistical reference levels (i.e., the upper limit background concentration from data averaged from 1974 to 1994) and were far below LANL screening action levels. Trend analyses show that most radionuclides in soils from on-site and perimeter areas have been decreasing over time.

These trends were especially apparent for tritium and uranium in soils from on-site areas. Soils were also analyzed for trace and heavy metals, and most metals were within regional statistical reference levels and were well below LANL screening action levels.

4.2.1.4 Stability

The ground is stable at the TA-70 site, and liquefaction and mass movement are not considered to be an issue. Subsidence is unlikely due to the presence of firm rock beneath LANL. The potential for liquefaction is also minimal. Liquefaction occurs when saturated and unconsolidated sediments lose their cohesive nature and become fluid due to vibratory motions of seismic events. Conditions favorable to liquefaction do not exist at LANL. Site stability could be affected by erosional retreat of cliffs forming the mesa rims and shaking from seismic ground motions. However, geologic studies of the stability of rocks near the rim of nearby Pajarito Mesa conclude that placing a facility similar to the proposed SNS more than 200 ft (60 m) from the mesa rim would be adequate to ensure the integrity of such facilities for periods exceeding 10,000 years (DOE-AL 1995b).

The occurrence of volcanism is relatively recent on Pajarito Plateau. The youngest volcano deposit is the El Cajete Pumice derived from the El Cajete crater in the southern part of the Valles caldera. Age-dating techniques have suggested a wide range of possible ages; however, it is thought to have occurred between 45,000 and 73,000 years ago, probably around 60,000 before present (Wong et al. 1995). While this is relatively recent in geologic time, volcanism is not considered likely within the 10,000-year standard for this type of facility.

Earthquakes in the region are not always well correlated with faults that are expressed at the surface. Refer to Figure 4.2.1.2-1, which shows the epicenter for reported earthquakes near LANL from 1873 through 1992 (Wong et al. 1995). A few of these epicenters are situated near the Pajarito and Rendija Canyon faults. While the exact epicenter locations have a degree of uncertainty, geologic and seismic evidence indicates that faulting in the region is an ongoing process.

Maximum earthquake amplitudes could cause damage to structures not designed to resist such force, but it is important to note that the maximum earthquake on any fault is predicted to be a rare event. A historical catalog has been compiled of earthquakes of estimated Richter magnitude that have occurred in the LANL area from 1873 to 1991 (Wong et al. 1995). A review of the catalog indicates that only six earthquakes having an estimated magnitude of five or greater have taken place in the LANL region. The seismic hazard results indicate that the Pajarito Fault system represents the greatest potential seismic risk, and, although large uncertainties exist, an earthquake with a magnitude greater than six is estimated to occur once every 4,000 years. An earthquake with a magnitude of seven is estimated to occur once every 10,000 years.

It is possible to relate Richter magnitudes to ground acceleration values, but the relationships should be considered approximate because of numerous factors affecting the correlation (distance to epicenter, orientation in relation to fault strike, depth to solid rock, etc.). The seismic hazards study estimated ground acceleration and return period for each of eight TAs (TA-2, TA-3, TA-16, TA-18, TA-21, TA-41, TA-46, TA-55) throughout the LANL reservation. Ground acceleration values for the various TAs ranged as follows (Table 4.2.1.4-1).

4.2.2 WATER RESOURCES

The following section discusses the water resources, surface water, flood potential, and groundwater at LANL.

4.2.2.1 Surface Water

The Rio Grande is the major source of surface water in north-central New Mexico. Surface water drainage and groundwater discharge from the Pajarito Plateau usually arrives at the Rio Grande. However, various climatic conditions may prevent the perennial flow from always reaching the Rio Grande, and at certain times the stream may recharge to the ground. The Rio Grande drainage basin at Otowi has an area of 14,300 mi² (37,037 km²) in southern Colorado and northern New Mexico. The flow at Otowi has ranged from a recorded low of 60 ft³/s (1.7 m³/s) in 1902 to a high of 24,400 ft³/s (69 m³/s) in 1920. The river transports about one million tons of suspended sediments past Otowi annually (LANL 1993a, as cited in DOE-AL 1995a).

No major surface water bodies are located within 0.25 miles (0.44 km) of the proposed SNS facility. However, Ancho Canyon Spring, a smaller surface water body, is located approximately 0.5 miles (0.88 km) from the proposed site. The TA-70 site lies on a mesa bordered by Ancho Canyon to the south, an unnamed canyon to the north, and the White Rock Canyon and the Rio Grande to the east. The drainage in Ancho Canyon and the unnamed canyon are classified as intermittent riverine wetlands by the USFWS National Wetlands Inventory. Major canyons (Figure 4.2.2.1-1) that contain localized reaches of perennial streams inside LANL include Pajarito, Water, Ancho, and Chaquehui canyons. Los Alamos, Water, and Pajarito canyons/streams originate upstream of LANL facilities. Perennial streams in the lower portions of Ancho and Chaquehui Canyons usually extend to the Rio Grande without being depleted by recharge to the ground; however, various climatic conditions may prevent the perennial flow from always reaching the Rio Grande, and at certain times the perennial streams may recharge to the ground. In lower Water Canyon, the perennial stream is very short and does not extend to the Rio Grande. In Pajarito Canyon, Homestead Spring feeds a perennial stream only a few hundred yards long, followed by intermittent flows for varying distances, depending upon climatic conditions. Springs between 7,900- and 8,900-ft (2,408- and 2,713-m) elevations on the eastern slope of the Jemez Mountains supply base flow throughout the year to the upper reaches of Cañon de Valle, Los Alamos, Pajarito, and Water Canyons. These springs discharge water perched in the Bandelier Tuff at rates from 0.0045 to 0.30 ft³/s (0.0001 to 0.0085 m³/s). The volume of flow from the springs is insufficient to maintain surface flow within more than the western third of the canyons before total evaporation, transpiration, and/or infiltration into the underlying alluvium.

Table 4.2.1.4-1. Predicted peak ground acceleration (PGA) and recurrence period.

Return Period (yrs)	500	1,000	2,000	10,000
PGA	0.14 - 0.15	0.21 - 0.22	0.29 - 0.31	0.55 - 0.57

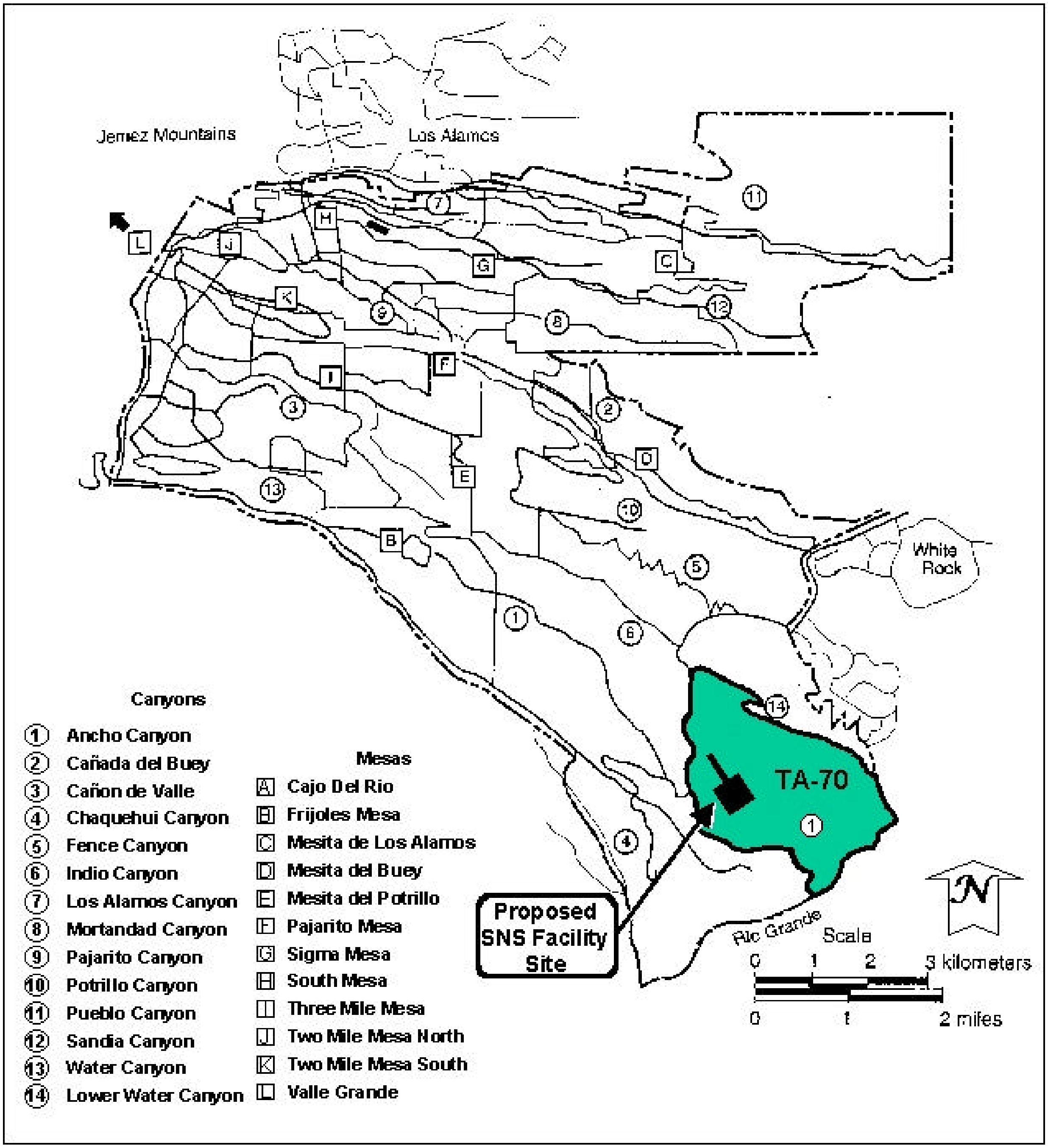

Figure 4.2.2.1-1. Major canyons and mesas at LANL.

Surface waters from regional and Pajarito Plateau stations are monitored to evaluate the environmental effects of LANL operations (no surface water is present at the proposed SNS site). The current network of annual sampling stations for surface water (both runoff and perennial flow) includes a set of regional (or background) stations and a group of stations near or within the LANL boundary. The regional stations are used to evaluate the background quantities of radionuclides derived from natural rock-forming minerals and from fallout affecting the region. The LANL stations monitor overall water quality effects of past or potential contaminant sources such as industrial or NPDES.

Concentrations of radionuclides in surface water samples may be compared to the DOE-Derived Concentration Guides (DCGs) for public dose, which are in general two orders of magnitude more conservative (lower) than similar New Mexico Water Quality Control Commission (NMWQCC) stream standards. The results of radiochemical analyses for surface water samples for 1996 are all below DCGs for public dose, and the majority are near or below the detection limits of the analytical method. Two stations sampled in 1996 were in proximity to TA-70, which allowed water quality to be characterized adjacent to or downstream from the site. Table 4.2.2.1-1 shows the results for the runoff station at Ancho Canyon near Bandelier National Monument and the surface water station Ancho Canyon at Rio Grande. None of the analyses exceeded or approached the DCG level or National Primary Drinking Water Standards (used in the absence of DCGs).

Table 4.2.2.1-1. Radiochemical analyses for runoff and surface water sampling stations within the LANL area of influence of TA-70.

Station	Tritium (pCi/L)	Sr-90 (pCi/L)	Cs-137 (pCi/L)	Total Uranium (g/L)	Pu-238 (pCi/L)
Ancho at Rio Grande	-122	1.0	-0.1	0.3	0.010
	±134	±0.4	±0.3	±0.0	±0.010
Ancho near Bandelier	-41	1.2	1.0	1.53	0.002
	±73	±0.4	±0.9	±0.15	±0.005
Water Quality Criteria	20,000[a]	8[a]	120[b]	30[b]	1.6[b]

Station	Pu-239,249 (pCi/L)	Am-241 (pCi/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Gross Gamma (pCi/L)
Ancho at Rio Grande	-0.007	-0.017	-0.4	2.9	-148
	±-0.007	±-0.017	±-0.0.1	±0.4	±50
Ancho near Bandelier	0.039	-0.014	1.4	14.7	-118
	±0.013	±0.020	±0.3	±1.8	±50
Water Quality Criteria	1.2[b]	1.2[b]	15[a]	NA	NA

±0.4 Measurement uncertainty associated with instrument quantification. If the uncertainty approaches the measurement value, then the more likely that the value is not a positive detection. Negative values represent measurements below the detection limit, which are useful for incorporation into long-term averages.

[a] Maximum Contaminant Level National Primary Drinking Water Regulations [40 CFR 141].

[b] U.S. DOE DCGs for drinking water (DOE Order 5400.5).

NA – Not available.

4.2.2.2 Flood Potential

Runoff from heavy thunderstorms and rapid snowmelt reaches the Rio Grande several times a year from some drainages that transect LANL. Water Canyon to the north of the TA-70 site has a drainage area greater than 10 mi^2, (26 km^2), while Ancho Canyon to the south has an area of less than 5 mi^2 (13 km^2). Theoretical maximum flood peaks range from 24 ft^3/s (0.7 m^3/s) for a two-year recurrence to 686 ft^3/s (19 m^3/s) for a 50-year recurrence. The overall flood risk to LANL and facilities at TA-70 is small because of the position of this site on a mesa top.

4.2.2.3 Groundwater

Groundwater within the LANL reservation occurs in three modes: (1) within the alluvium deposited on the canyon floors, (2) perched water within the unsaturated zone, and (3) within the main saturated regional aquifer. The main aquifer in the LANL area is the only aquifer in the area capable of serving as a municipal water supply. It is currently designated as a Class 2 aquifer but meets all the criteria for classification as a sole-source aquifer. LANL, the nearby communities of Los Alamos and White Rock, and Bandelier National Monument are entirely dependent on groundwater for their water supply, which is primarily obtained from well fields. About 4 mgpd (15.1 million lpd) are used by these communities.

The potentiometric surface of the main aquifer rises westward from its point of discharge into the Rio Grande. Here, the main aquifer surface lies within the Santa Fe Group but rises stratigraphically into the Puye Formation beneath the central and western part of the Pajarito Plateau. Figure 4.2.2.3-1 shows the elevation of the main aquifer across the LANL reservation. Depth to groundwater, 840 ft (256 m) at TA-70, is inferred by taking the difference between the surface elevation [6,445 ft (1,964 m)] of the proposed site and the groundwater contour elevation [approximately 5,605 ft (1,708 m), as referenced in the DEIS and the Site-Wide EIS] beneath the site.

Groundwater quality monitoring at LANL is divided into three principal modes cited above. Groundwater quality data are limited for the proposed SNS site at TA-70. Neither observation wells nor springs are available for monitoring of the shallow or intermediate groundwater systems in this area of the reservation. The nearest deep well to penetrate the main aquifer is located over 3.1 mile (5 km) from the site and would not be representative of the area. Ancho Spring in Ancho Canyon is sourced by the main aquifer and is adjacent to the proposed SNS site (Table 4.2.2.3-1). Concentrations of radionuclides and trace metals are shown in the Ancho Spring results. No organic compounds were detected in the samples. As compared to drinking water criteria and DOE-DCGs, groundwater in the vicinity of TA-70 is not affected by LANL.

The long-term trends of the water quality in the main aquifer beneath LANL have shown little impact resulting from operations (LANL 1997d). For 1996, radiochemical results for most water samples from wells or springs in the main aquifer were near or below the analytical detection limits. The few detects of radionuclides were not reproducible and were considered analytical anomalies (with the exception of dissolved uranium that is a common constituent of groundwater in the area). With just a few exceptions, values for chemical

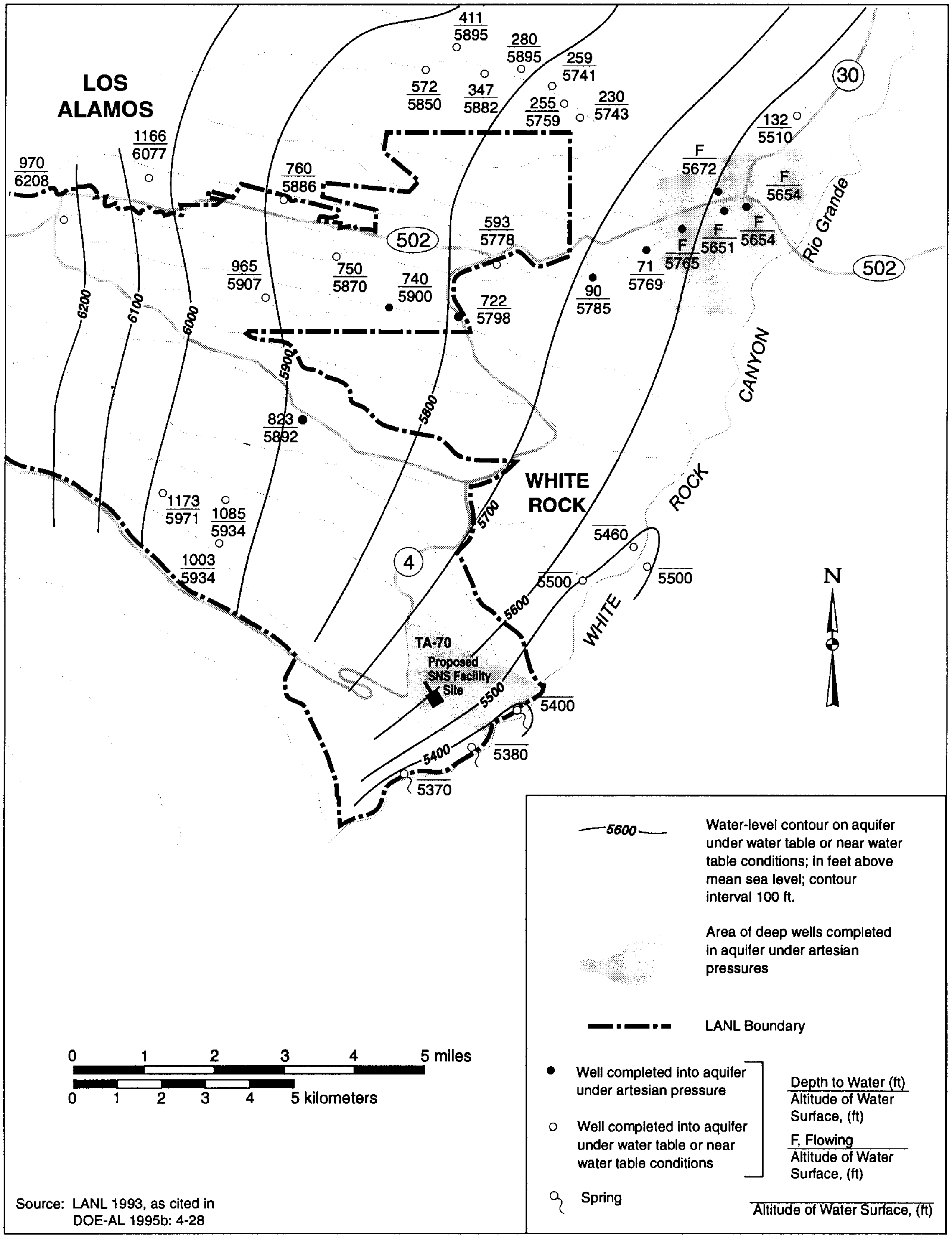

Figure 4.2.2.3-1. Groundwater surface of the main aquifer in the LANL area.

Table 4.2.2.3-1. Main aquifer water quality near the SNS site at LANL.

Radiochemical (pCi/L)	H-3	Sr-90	Cs-137	U_{total} (μg/L)	Gross Alpha	Gross Beta	Gross Gamma
Ancho Spring	-119 (134)	0.8 (0.3)	0.48 (2.5)	0.29 (0.03)	-0.34 (0.08)	2.15 (0.3)	-137 (50)
DCG-DW[a]	80,000	40	120	30	1.2	40	—
EPA-DW[b]	20,000	8	—	20	15	—	—

Chemical Quality (mg/L)	SO_4	F	NO_3-N	TDS[c]	Conductive (μS/cm)
Ancho Spring	4.4	0.35	0.43	120	133
EPA-DW	500	4	10	—	—

Recoverable Trace Metals (μg/L)	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	Tl
Ancho Spring	2	26	<3	<2	3	<.2	<10	<3	<3	3	<3
EPA-DW	50	2000	4	5	100	2	100	15	6	50	2

[a]DCG-DW - Derived Concentration Guide Drinking Water
[b]EPA-DW - EPA Drinking Water
[c]TDS - total dissolved solids

parameters measured in the water supply wells were within drinking water standards. The exceptions were not considered significant given the large number of samples, diversity of sample types, and varied well construction materials incorporated into the sampling program.

4.2.3 CLIMATE AND AIR QUALITY

The following is a brief description of Los Alamos climatology provided by LANL. For a more detailed discussion, Bowen (as cited in LANL 1997g) published a comprehensive climatology of the Los Alamos area based on observations at several meteorological observation stations within the LANL boundary and a summary document with more recent observations. The climate description presented here summarizes some of the Bowen analyses and discusses some recent observations of wind patterns in Los Alamos Canyon.

Los Alamos has a temperate mountain climate with four distinct seasons. Spring tends to be windy and dry. Summer begins with warm, often dry conditions in June, followed by a two-month rainy season. Summer is the rainy season (accounting for 37 percent of the annual precipitation) with afternoon convective-type thunderstorms and associated hail and lightening (Figure 4.2.3-1). In the autumn there is a return to drier, cooler, and calmer weather. Winters are generally mild, but occasional winter storms dump large snows and cause frigid temperatures.

The climate of Los Alamos is strongly influenced by the range of elevations, which creates large temperature and precipitation differences (Figure 4.2.3-2). In July, the warmest month of the year, the temperature ranges from an average daily high of 81 °F (27.2 °C) to an average daily low of 55 °F

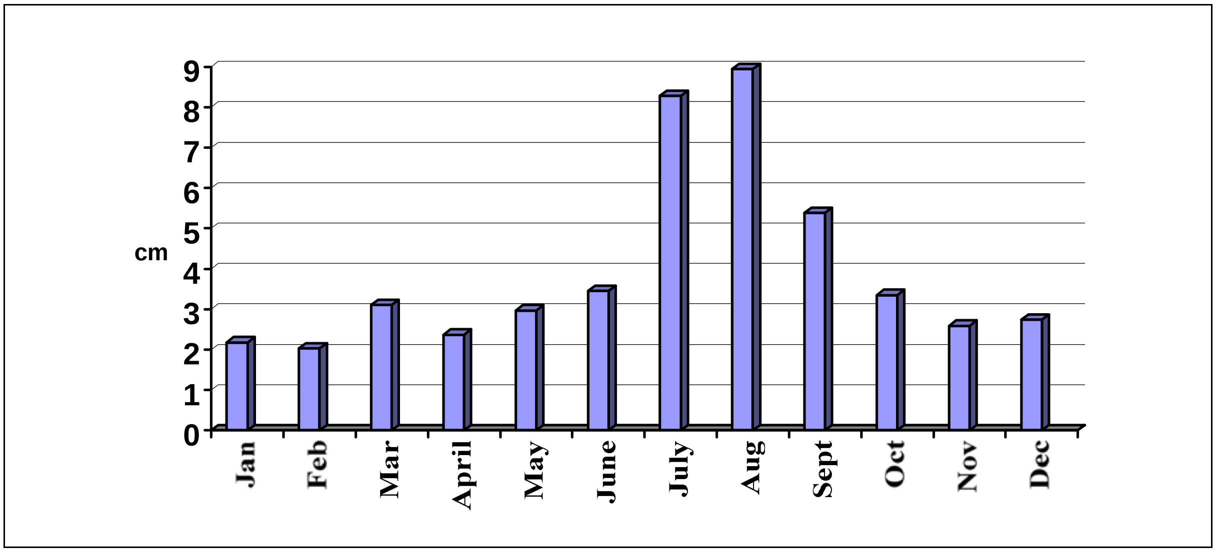

Figure 4.2.3-1. Average monthly precipitation at LANL.

(12.8 °C). The extreme daily high temperature in the record is 95 °F (35 °C). In January, the coldest month, the temperature ranges from an average daily high of 40 °F (4.2 °C) to a low of 17 °F (-8.3 °C). The extreme daily low temperature in the record is -18 °F (-27.8 °C). The large daily range in temperature is exaggerated by the site's relatively dry, clear atmosphere, which allows strong solar heating during the daytime and rapid radiant cooling at night.

The average annual precipitation (rainfall plus the water-equivalent of frozen precipitation) is 18.7 in. (47.6 cm). However, the annual total fluctuates considerably from year to year; the standard deviation of these fluctuations is 4.9 in. (12.2 cm). The lowest recorded annual precipitation is 6.8 in. (17.3 cm), and the highest is 30.3 in. (77.1 cm). The maximum precipitation recorded for a 24-hr period is 3.5 in. (8.8 cm). The maximum 15-min precipitation in the record is 0.9 in. (2.3 cm). Over the entire year, it appears that evapotranspiration totals approximately 90 percent of the annual precipitation.

Because of the eastward slope of the terrain, there is a large east-to-west gradient in precipitation across the plateau. White Rock often receives 5.1 in. (13 cm) less annual precipitation than the official observing station, and the eastern flanks of the Jemez often receive 5.1 in. (13 cm) more.

This summertime precipitation is often referred to as the "monsoon" season, but "rainy season" is probably a more accurate characterization of the July-August period. Winter precipitation occurs mostly as snow; freezing rain is rare. The snow is generally dry. On average, 20 units of snow is equivalent to one unit of water. Annual snowfall averages 59 in. (150 cm) but is quite variable. The standard deviation of fluctuations in the annual value is 28 in. (71 cm). The highest recorded snowfall for one season (1986-87) is 153 in. (389 cm), and the highest recorded snowfall for a 24-hour period (January 15, 1987) is 22 in. (56 cm). In a typical winter season, snowfalls equal to or exceeding 1 in. (2.5 cm) occur on 14 days, while snowfalls equal to or exceeding 4 in. (10.2 cm) occur on four days. The extreme single-storm snowfall in the record is 4 ft (122 cm).

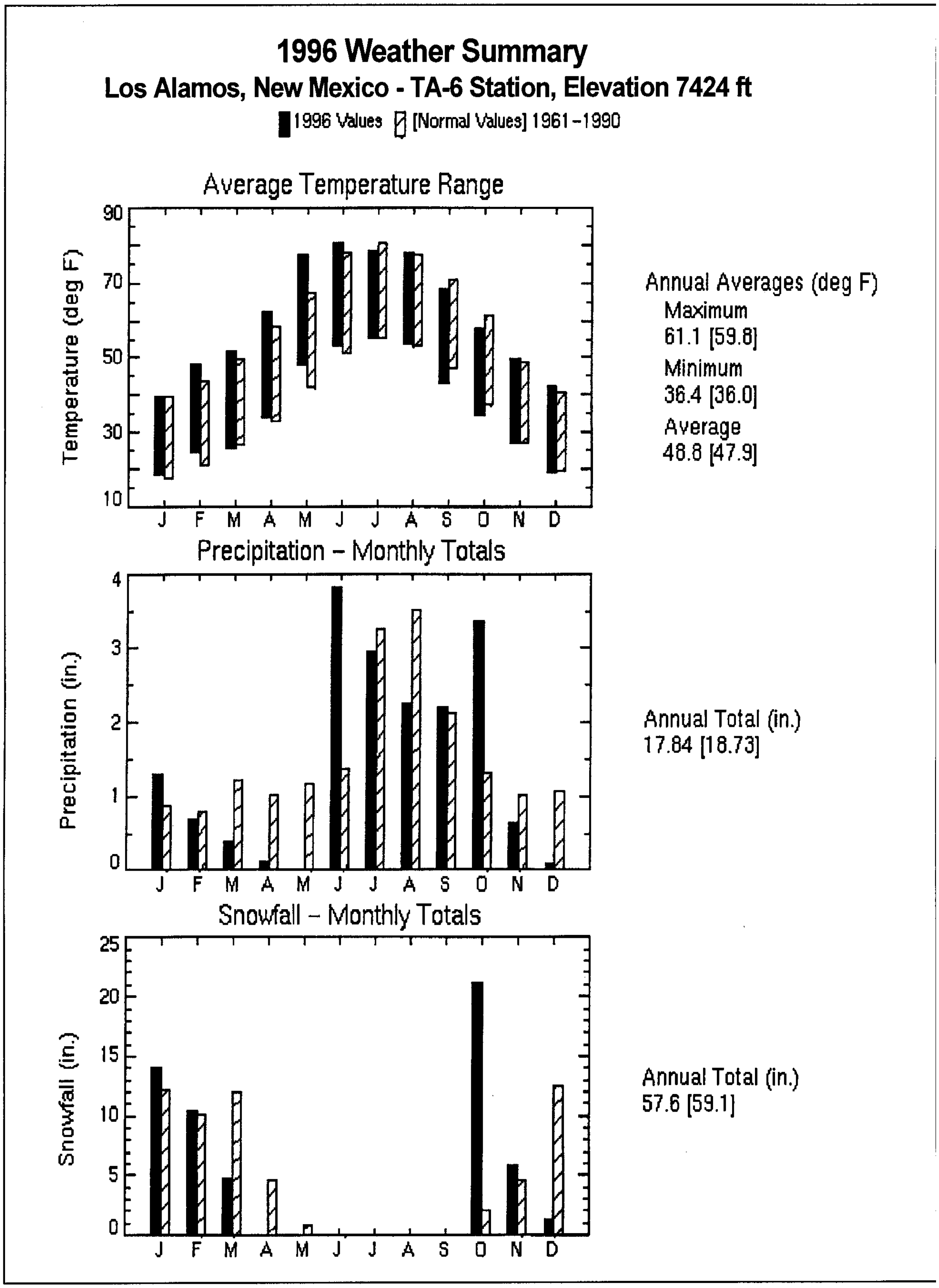

Figure 4.2.3-2. LANL 1996 weather summary chart.

4.2.3.1 Severe Weather

About 36 percent of the annual precipitation falls from convective storms during July and August. Most of these convective storms are of the single-cell type; local conditions do not support the development of supercells and the severe weather associated with them. Consequently, tornadoes are a very rare occurrence in New Mexico (refer to Figure 4.1.3.1-1), and no tornadoes are known to have touched ground in the Los Alamos area. However, funnel clouds have been observed in Los Alamos and Santa Fe counties. High winds are associated with frontal passages, thunderstorms, and mid-latitude storm systems. The highest wind gust on record is 77 mph (124 km/h).

Large-scale flooding is not common in New Mexico. However, flash floods in areas such as arroyos, canyons, and low spots do occur. Severe widespread flooding has never been observed in Los Alamos, but heavy downpour combined with saturated soil conditions caused flash flooding in Los Alamos on August 4, 1991.

Lightening is very frequent in Los Alamos. In an average year, Los Alamos experiences 61 thunderstorm days, about twice the national average. Only in the southeastern part of the United States is this frequency exceeded. In addition to lightning, hail often accompanies these summertime convective storms. Hailstones of 0.25 in. (0.6 cm) are common, but stones of 1 in. (2.54 cm) have been reported. Hail has caused significant damage to property and vegetation, and localized accumulations of 3 in. (7.6 cm) have been observed.

Fog in the Los Alamos area is a very rare occurrence. On average it occurs less than five times a year.

4.2.3.2 Atmospheric Dispersion

Los Alamos winds are generally light, having an annual average (at the TA-6 station) of 5.5 mph (9 km/h). However, the period from mid-March to early June is apt to be windy. During this windy period, sustained wind speeds exceeding 8.8 mph (14 km/h) occur 20 percent of the time during the daytime, and the daily maximum wind gust exceeds 31 mph (50 km/h) about 20 percent of the time.

Winds over the plateau show considerable spatial structure and temporal variability. The relatively dry climate promotes strong solar heating during the daytime and radiant cooling by night. Because the topography is very complex, the heating and cooling rates are uneven over the area. When the large-scale pressure gradient is weak, thermally generated local flows develop and respond to the heating/cooling cycle. During sunny, light-wind days, an up-slope flow often develops over the plateau in the morning hours. This flow is more pronounced along the western edge of the plateau, where it is 650 to 1,650 ft (200 to 500 m) deep. By noon, southerly flow usually prevails over the entire plateau. Daytime wind roses are presented in Figure 4.2.3.2-1.

The prevailing nighttime flow over the western portion of the site is west-southwesterly to northwesterly. These nighttime westerlies result from cold air drainage off the Jemez Mountains and the Pajarito Plateau; the drainage layer is typically 165 ft (50 m) deep in the vicinity of TA-6. At stations farther from the mountains, the nighttime direction is more variable but

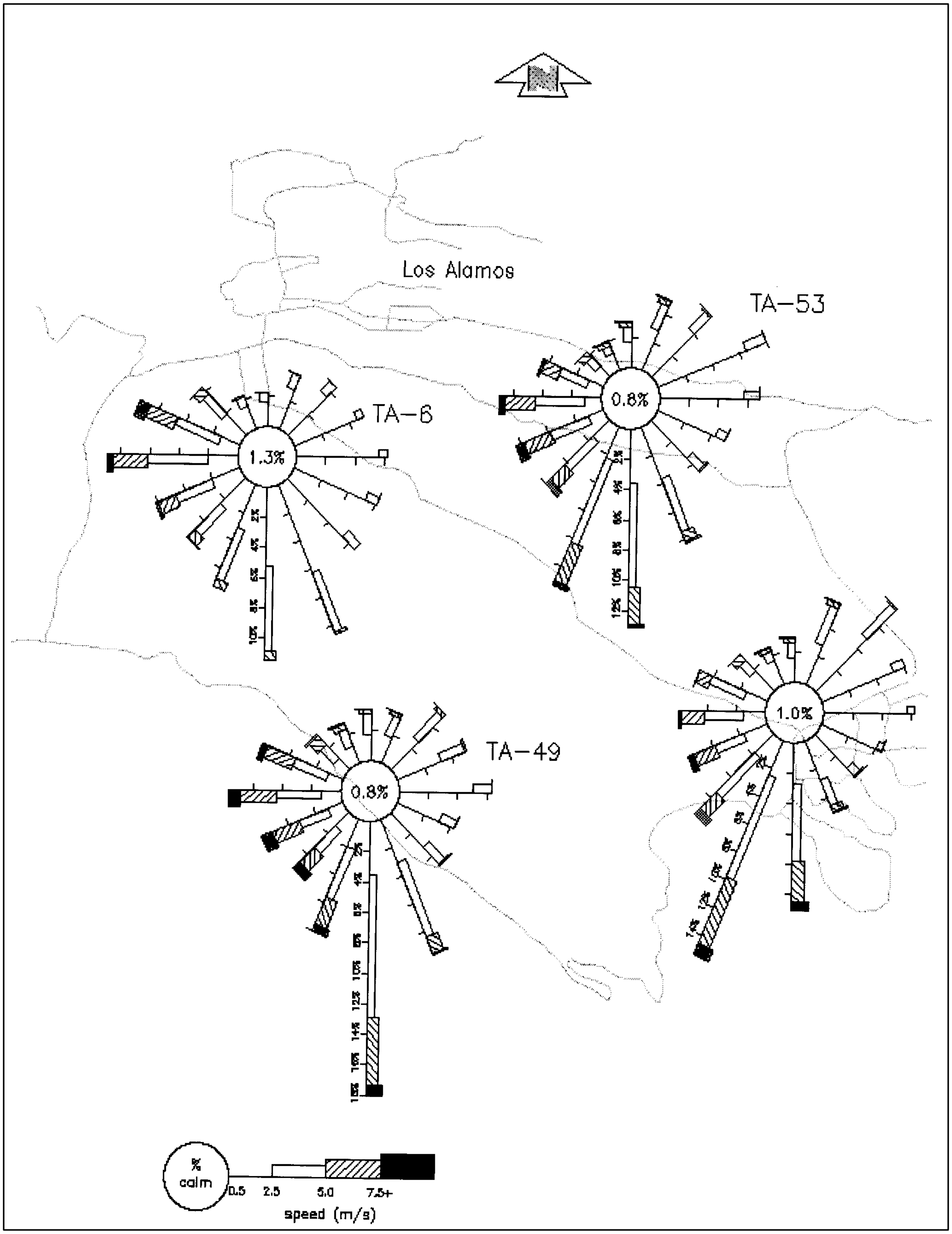

Figure 4.2.3.2-1. Daytime wind direction and speed at LANL.

usually has a relatively strong westerly component. Just above the drainage layer, the prevailing nighttime flow is southwesterly. A nighttime wind rose is presented in Figure 4.2.3.2-2.

Observations made at TA-41 in Los Alamos canyon show that atmospheric flow in canyons is quite different from flow over the plateau. During the nighttime, cold air drainage flow is observed about 75 percent of the time. This gravity flow is steady and continues for an hour or two after sunrise when it abruptly ceases and is followed by an unsteady up-canyon flow for a couple of hours. The up-canyon flow usually gives way to the development of what appears to be a rotor that fills the canyon when the wind over the plateau has a strong cross-canyon component. When the rotor occurs, southwesterly (or southeasterly) flow over the plateau results in northwesterly (or northeasterly) flow at the canyon bottom. Down-canyon flow begins again around sunset, but the onset time appears to be more variable than cessation time in the morning. Rotors have been observed at night, but they are very rare.

Although the dry atmosphere promotes rapid nighttime cooling near the ground, this cooling is somewhat counterbalanced by the flux of heat from above, generated by turbulence in the drainage flow. Therefore, the strong surface-based temperature inversions often observed in valleys are not observed on the Pajarito Plateau. Inversions of 5.4 °F (3 °C) over 328 ft (100 m) are typical, and these are generally destroyed in less than two hours after sunrise.

Turbulence intensity, when expressed as the standard deviation of fluctuations in the horizontal wind direction, has a median value of 22° during the day. Other conditions being equal, this value is larger than would be observed over flatter, smoother sites. At night, when the atmosphere is stable, the median value of the standard deviation of wind direction fluctuations drops to 15°.

Atmospheric dispersion potential is often related to a stability parameter that ranges from A to F (good to poor mixing potential). When this parameter is based on sigma phi measured at the TA-6 station, the frequency of occurrence of different stability parameter values is A: 10.6 percent, B: 8.0 percent, C: 15.9 percent, D: 38.6 percent, E: 13.9, and F: 13.1 percent. Statistics vary from station to station.

4.2.3.3 Air Quality

LANL is subject to a number of federal and state air quality programs: NESHAP, NAAQS, New Source Performance Standards, Stratospheric Ozone Protection, and Operating Permit Program. While no nonattainment areas under the Federal Clean Air Act are designated near LANL, the Bandelier National Monument and associated wilderness areas are categorized as Class I PSD areas.

Existing ambient air quality in the vicinity of LANL is best quantified in terms of recent ambient monitoring data collected by the New Mexico Environment Department Air Quality Bureau (NMEDAQB) at nearby locations. Table 4.2.3.3-1 summarizes these data and is taken from *New Mexico Air Quality 1994-1996* (NMEDAQB 1997).

Criteria pollutants released from LANL operations are primarily from combustion sources such as boilers, emergency generators,

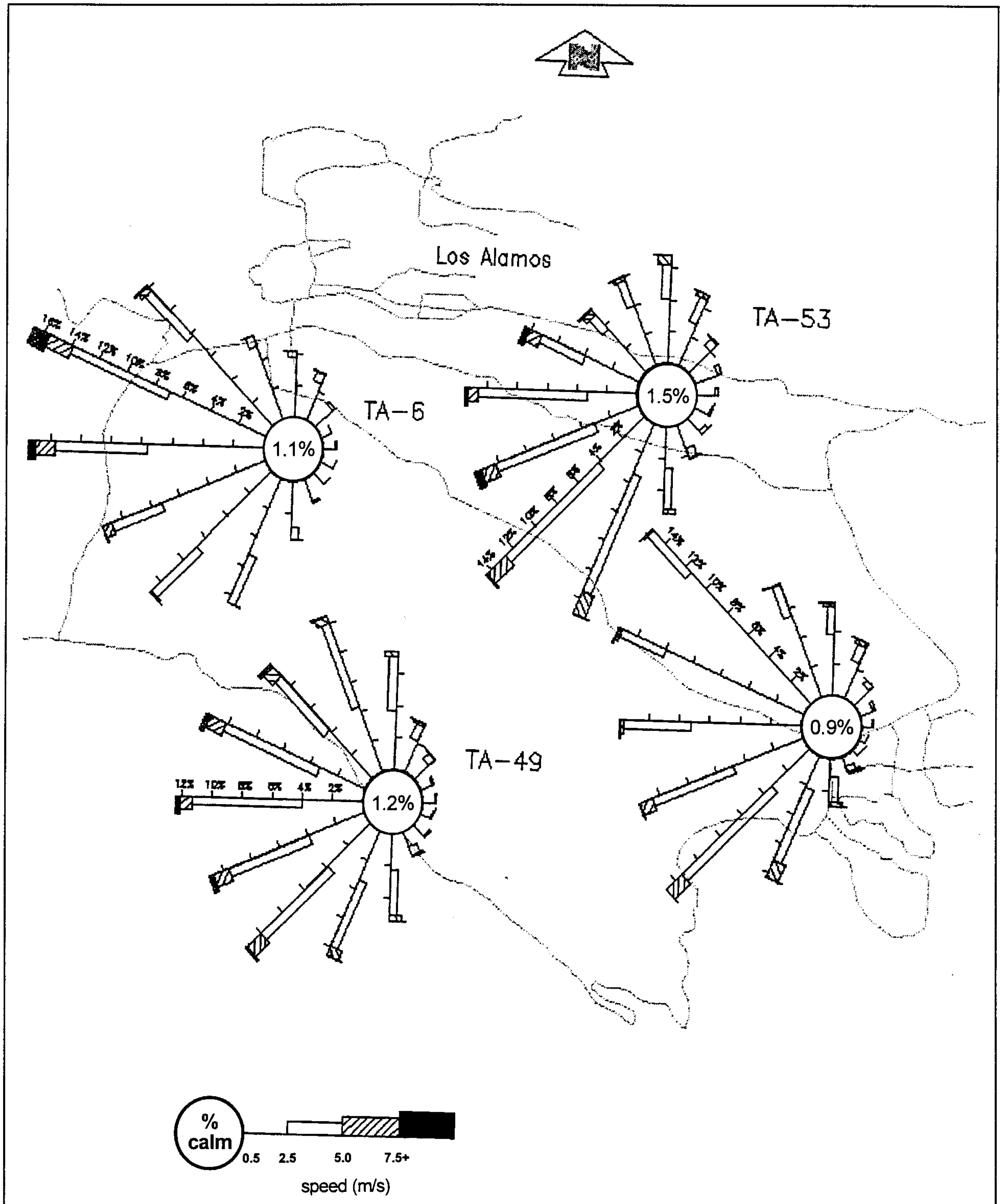

Figure 4.2.3.2-2. Nighttime wind direction and speed at LANL.

Table 4.2.3.3-1. Summary of 1996 monitoring data in the vicinity of LANL.

Pollutant Averaging Time	Nearest Monitor Location	Maximum 1st	Maximum 2nd	NAAQS NMAAQS	Number of Exceedances
PM-10	Bandelier (1994)				
24-hour		29.0	19.0	150.0 μg/m^3	0
Annual		9.0		50.0 μg/m^3	0
Ozone	Bandelier (1994)				
1-hour		0.090	0.074	0.12 ppm	0
NO_x	Bandelier (1994)				
Annual		0.003		0.05 ppm	0
24-hour		0.006	0.004	0.10 ppm	0
SO_2	Bloomfield				
3-hour		0.041	0.027	0.5 ppm	0
24-hour		0.010	0.010	0.10 ppm	0
Annual		0.0028	-	0.02 ppm	0
CO	Santa Fe				
1-hour		7.2	6.1	13.1 ppm	0
8-hour		2.3	2.2	8.7 ppm	0

Source: NMEDAQB 1997. NMAAQ – New Mexico Air Quality Standards.

and motor vehicles. Toxic air pollutants from LANL are released primarily from laboratory, maintenance, and waste management operations. Emissions from industrial sources are calculated annually because these sources are responsible for over 90 percent of all the nonradiological air pollutant emissions at the laboratory. Unlike a production facility with well-defined processes and schedules, LANL is a research and development facility with great fluctuations in both types of chemicals emitted and their emission rates. Because past reviews demonstrate that LANL's toxic air pollutant emissions are below the state's permitting threshold limits, LANL is not required to monitor toxic air pollutant emissions. As such, these emissions are not calculated annually; instead, each new or modified research source is addressed in the new source review process. Ambient monitoring for nonradioactive air pollutants was limited to particulate matter sampling as discussed herein.

The 1996 estimated emissions are shown in Table 4.2.3.3-2. These are typical industrial-type sources. LANL nonradiological emissions from research operations are small when compared with the listed sources. The three power plants, the largest sources of nonradioactive emissions, are used to supply steam for heating. The steam plant at TA-3 also produces electricity when sufficient power from outside sources is not available; approximately one-third of the emissions from this steam plant results from electricity production. The plants are primarily operated on natural gas but can use fuel oil as a backup.

PM_{10} samples (particles less than 10 μm in aerodynamic diameter) were collected for two events during 1996: the Dome Fire from April 26 through May 2 and a controlled burn on laboratory property in November. The Dome Fire samples were collected at the TA-49 air monitoring compound near the entrance to

Table 4.2.3.3-2. Emissions by source, 1996 (tons).

Source	PM	CO	NOx	SOx	VOC
TA-3 Power Plant	1.5	11.7	47.5	0.17	0.40
TA-16 Power Plant	1.9	5.5	22.6	0.08	0.19
TA-21 Power Plant	0.47	1.2	4.7	0.02	0.10
Asphalt Plant	0.14	0.07	0.05	0.001	0.03
Total	3.01	18.47	74.85	0.271	0.73

Bandelier National Monument. The controlled burn samples were collected downwind from the fire in the northwest part of Pajarito Acres. During the Dome Fire, the PM_{10} concentrations averaged 17 $\mu g/m^3$, with the highest one-day concentration of 32 $\mu g/m^3$, both of which are well below the federal standard of 150 $\mu g/m^3$. These concentrations are typical values for the dry windy conditions present during the Dome Fire.

The laboratory conducts explosive testing by detonating explosives at firing sites operated by the Dynamic Testing Division. The laboratory maintains monthly shot records that include the type of explosives used as well as other material expended at each mound. The explosives detonations conducted at the laboratory during 1996 released quantities of beryllium, aluminum, tantalum, copper, and molybdenum. The laboratory also burns scrap and waste explosives because of treatment requirements and safety concerns. In 1996, the laboratory burned 3,482 lb of high explosives.

4.2.4 NOISE

The SNS site is proposed for an isolated area of the LANL reservation 0.6 to 1.2 miles (1 to 2 km) from the nearest public-use highway (State Road 4) and roughly 3 miles (5 km) from the nearest community of White Rock. A site-specific survey has not been conducted, but ambient noise levels in a rural setting such as this are typically in the 35- to 45-dB range. Because of its remote location, the proposed site would be protected from distant sources of noise and would be removed from any sensitive populations. The proposed site is situated about 10 miles (16 km) from the primary residential population of the City of Los Alamos.

4.2.5 ECOLOGICAL RESOURCES

This section provides a general description of the ecological resources for the proposed SNS site and the surrounding area. The discussions are based on information readily available from other sources. Site-specific surveys were done for protected species and wetlands. All other information was obtained from existing publications. For the most part, the impacts from construction and operation of the proposed SNS would be minor. Therefore, much of the information presented here is summary in nature. Greater detail can be obtained from the references compiled.

4.2.5.1 Terrestrial Resources

Three major vegetative community types have been identified within the boundaries of LANL: juniper savannas at the lowest elevations in White Rock Canyon, piñon-juniper woodlands at intermediate elevations on the mesas, and ponderosa pine forests at higher elevations on the mesas.

The juniper savanna community is found along the Rio Grande on the eastern border of the Pajarito plateau and extends upward on the south-facing sides of the canyons at 5,600 to 6,200 ft (1,700 to 1,900 m). Principal species in this community include one-seeded juniper (*Juniperus monosperma*), skunk bush sumac (*Rhus trilobata*), and sagebrush (*Artemisia spp*). The piñon-juniper community, generally found in the 6,200- to 6,900-ft (1,900- to 2,100-m) elevation range, includes large portions of the mesa tops and north-facing slopes at the lower elevations. This woodland consists of stands of piñon pine (*Pinus edulis*) and one-seeded juniper, both dominant, and includes grasses such as blue grama (*Bouteloua gracilis*) and galleta (*Hilaria jamesii*) (Travis 1992, as cited in DOE-AL 1995b).

The ponderosa pine community is found in the western portion of the plateau and on mesa tops in the 6,900- to 7,500-ft (2,100- to 2,300-m) elevation range. This community is characterized by ponderosa pine (*Pinus Ponderosa*) as the primary overstory vegetation. It also contains Douglas fir (*Pseudotsuga menziesii*), Gambel oak (*Quercus gambelii*), mountain muhly (*Muhlenbergia montana*), and little bluestem grass (*Andropogon scoparius*) (Travis 1992, as cited in DOE-AL 1995b).

Mixed-conifer forests also occur on the north-facing slopes of some canyons. Riparian zones occur in many of the drainages and along the Rio Grande.

The vegetation in the proposed SNS facility area is dominated by piñon-juniper woodlands with scattered juniper savannas. Additionally, much of the land in and bordering the adjacent canyons is bare rock. Overstory plant species include piñon and one-seed juniper. Scattered grasses, primarily blue grama, shrubs, and forbs are found in the understories. In areas where bedrock is near the soil surface, the most common shrubs include wavy-leaf oak (*Quercus undulata*), hedgehog prickly pear (*Opuntia erinacea*), and sticky rabbitbrush (*Chrysothamnus viscidiflorus*). In areas with deeper soils, big sagebrush (*Artemisia tridentata*) is common. Forbs on both deep and shallow soils include greenthread (*Thelesperma trifidum*), golden aster (*Chrysopsis villosa*), thelypody (*Thelypodium wrightii*), and trailing fleabane (*Erigeron flagellaris*).

Complete lists of species found to be occurring in the proposed SNS facility area are located in Foxx 1996. Rocky Mountain elk (*Cervus elaphus nelsoni*) use piñon-juniper woodlands for wintering habitat and some year-round use. Mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), grey fox (*Urocyon cinereoargenteus*), rock squirrel (*Spermophilus variegatus*), and desert cottontail (*Sylvilagus auduboni*) are common mammals. Common bird species include common raven (*Corvus corax*), scrub jay (*Aphelocoma coerulescens*), piñon jay (*Gymnorhinus cyanocephalus*), plain titmouse (*Parus inornatus*), and ash-throated flycatcher (*Myiarchus cinerascens*).

4.2.5.2 Wetlands

A 1996 field survey by LANL personnel identified an estimated 50 acres (20 ha) of wetlands, based on the presence of wetland vegetation (hydrophytes), within the LANL boundaries. More than 95 percent of the wetlands are located in the Sandia, Mortandad, Pajarito, and Water Canyon watersheds.

There are no wetlands in TA-70. In the vicinity of the proposed SNS site, the drainages in Ancho Canyon, 0.27 miles (0.47 km) to the southwest, and in an unnamed canyon, 0.27 miles (0.47 km) to the northeast, are classified as intermittent riverine wetlands by the USFWS National Wetlands Inventory. These are dry and sandy drainages (arroyos) that occasionally contain water after snow melt or heavy rainstorm events. Riparian vegetation is supported in some portions of these arroyos (Foxx 1996).

4.2.5.3 Aquatic Resources

Aquatic habitats in LANL are limited to the Rio Grande and several springs and intermittent streams in the canyons. The streams and springs at LANL do not support fish; however, many other aquatic species thrive in these waters (Foxx 1996).

4.2.5.4 Threatened and Endangered Species

DOE is in the process of consulting with the USFWS regarding whether or not construction and operation of the proposed SNS at LANL would jeopardize the habitat of any threatened and endangered species and regarding appropriate mitigation measures. USFWS responded with a list of federally endangered, threatened, and candidate species and species of concern potentially occurring in Los Alamos County, New Mexico. Appendix D presents the letters of consultation.

DOE has not begun consultation with the New Mexico Department of Game and Fish. DOE recently completed the Site Draft EIS for continued operation of LANL (DOE-AL 1998). Included in Appendix D is a listing from the site-wide draft EIS of federal- and state-protected species occurring in the region of LANL.

Potential threatened or endangered species at LANL are listed in Table 4.2.5.4-1. The habitat within the proposed SNS facility site is not suitable for Mexican spotted owl (*Strix occidentalis lucida*), black-footed ferret (*Mustela nigripes*), and southwestern willow flycatcher (*Empidonax traillii extimus*). Therefore, these species were dismissed from consideration. The proposed SNS facility site area includes foraging habitat for American peregrine falcon (*Falco peregrinus anatum*) and foraging and roosting habitat for bald eagle (*Haliaeetus leucocephalus*). The American peregrine falcon is a summer resident and migrant on the Pajarito Plateau. Peregrines do not nest with LANL boundaries but do nest on surrounding land in the Jemez Mountains. Both adult and immature birds have been observed foraging on LANL. The preferred prey of peregrine falcons includes doves, pigeons, and waterfowl, all captured in flight (DOE-AL 1998). The nearest identified peregrine falcon nesting habitat is in White Rock Canyon, approximately 1.2 miles (1.9 km) from the site. Wintering bald eagles forage and roost within White Rock Canyon and connecting canyons, including Ancho Canyon. Additionally, bald eagles, whooping cranes (*Grus americana*), American peregrine falcon (*Falco peregrinus anatum*), and Arctic peregrine falcon (*Falco peregrinus tundrius*) may use White Rock Canyon as a migration route. Additional information on protected species at LANL is located in Appendix E.

Table 4.2.5.4-1. Threatened or endangered species potentially occurring on LANL.

Species	Scientific Name	Habitat Associations
American peregrine falcon (federally endangered)	*Falco peregrinus anatum*	Nests on cliff faces. Forages in all habitat types within LANL.
Whooping crane (federally endangered)	*Grus americana*	Migrates along Rio Grande in White Rock Canyon.
Southwestern willow flycatcher (federally endangered)	*Empidonax traillii extimus*	Inhabits riparian areas with established willow stands.
Black-footed ferret (federally endangered)	*Mustela nigripes*	Inhabits established prairie dog towns.
Arctic peregrine falcon (federally endangered)	*Falco peregrinus tundrius*	Potentially migrates along the Rio Grande in White Rock Canyon.
Bald eagle (federally threatened)	*Haliaeetus leucocephalus*	Inhabits riparian areas along permanent water ways such as lakes and rivers.
Mexican spotted owl (federally threatened)	*Strix occidentalis lucida*	Inhabits multistoried mixed conifer and ponderosa pine forests.

4.2.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The ROI for the SNS at the proposed LANL site includes Los Alamos, Rio Arriba, and Santa Fe Counties, as shown in Figure 4.2.6-1. Approximately 90 percent of LANL employees reside in this region. The region includes the cities of Santa Fe and Española, the incorporated communities of Los Alamos and White Rock, and several small villages and unincorporated communities. The Native American Pueblos of San Ildefonso, Santa Clara, San Juan, Nambe, Pojoaque, Tesuque, and part of the Jicarilla Apache Indian Reservation are included in this tri-county region.

This section provides a description of the following socioeconomic and demographic characteristics:

- Demographics
- Housing
- Infrastructure
- Local economy
- Environmental justice

4.2.6.1 Demographic Characteristics

Population trends and projections for each of the counties in the ROI are presented in Table 4.2.6.1-1. Of the three counties, Santa Fe has the largest population, with 68 percent of the 1995 regional population of 171,977. Rio Arriba County accounted for 21 percent of the regional population, and Los Alamos County accounted for the remaining 11 percent. Population projections prepared by the New Mexico Bureau of Business and Economic Research anticipate that the combined population of the three counties will increase by 47,000 between 1995 and 2010 (about two percent per year).

Population data for the cities, communities, and pueblos in the tri-county region are presented in Table 4.2.6.1-2. Population trends in the region reflect the development of LANL as well as the growth of the tourist economy in the Santa Fe area.

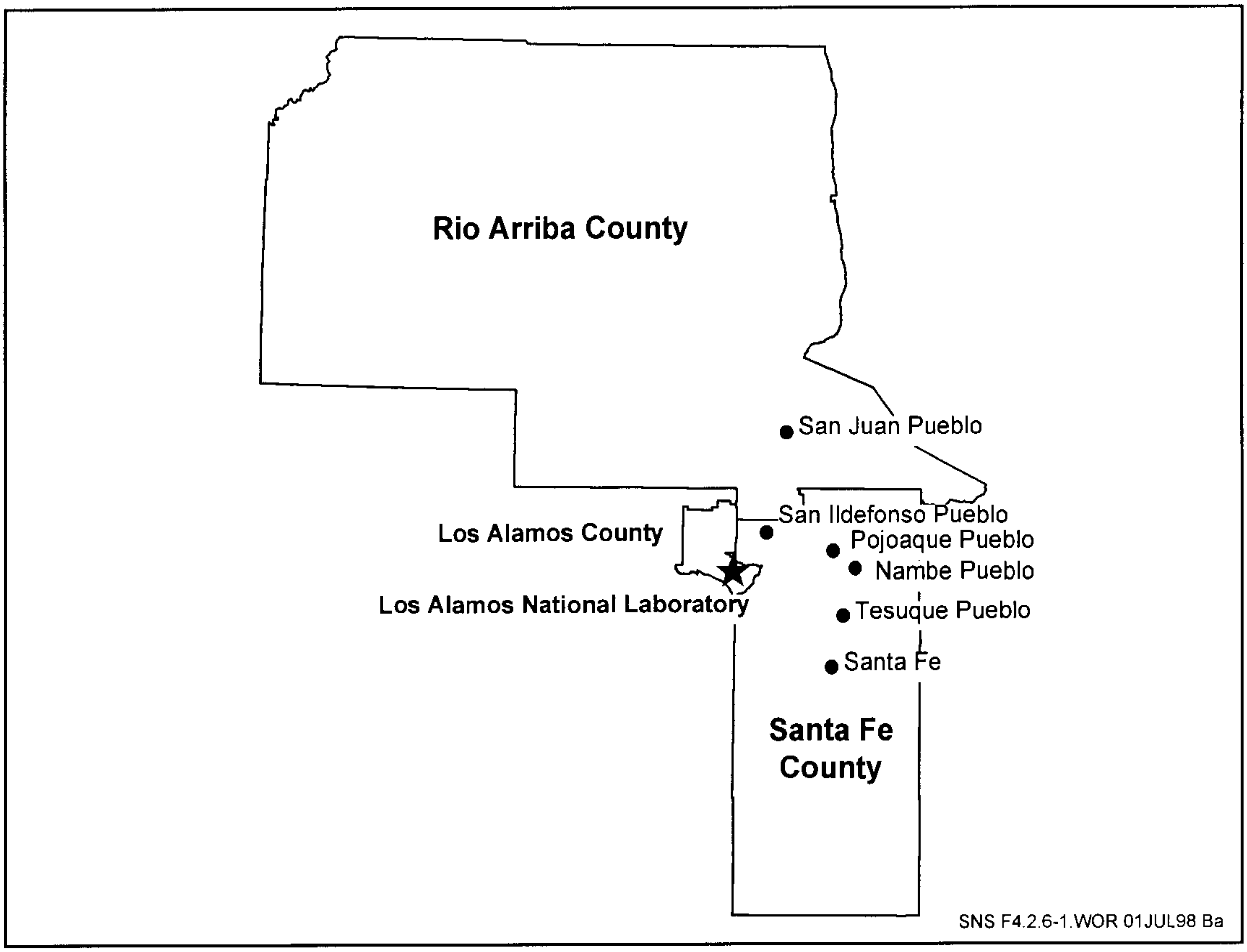

Figure 4.2.6-1. Map of socioeconomic region-of-influence for LANL.

Table 4.2.6.1-1. Regional population trends and projections.

County	1980	1990	1995	2000	2005	2010
Los Alamos	17,599	18,115	18,604	19,317	19,729	20,123
Rio Arriba	29,282	34,365	36,959	38,531	39,765	41,201
Santa Fe	75,519	98,928	116,414	128,985	142,792	157,925
Region	122,400	151,408	171,977	186,833	202,486	219,249
State	1,302,894	1,515,069	1,686,299	1,821,078	1,956,725	2,090,678

Sources: DOE-AL 1998; U.S. Bureau of the Census 1990; New Mexico BBER 1997.

Table 4.2.6.1-2. Population for incorporated and unincorporated areas within the LANL tri-county region.

Communities	1990	Most Recent
Santa Fe	56,537	66,522 (1996)
Española	8,389	9,008 (1996)
Los Alamos[a]	11,420	18,365 (1994)
Pueblos		
San Ildefonso[b]	424	580 (1998)
San Juan[b]	1,200	1,500 (1998)
Nambe[b]	NA	623 (1998)
Pojaque[b]	1,037	NA
Tesuque[b]	500	450 (1998)

[a] Includes the community of White Rock.
[b] Personal communication with tribal spokesperson, April 9, 1998.
NA - Not available.
Source: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Population by race and ethnicity for the tri-county region is presented in Table 4.2.6.1-3. Census data from 1990 reflect different racial and ethnic compositions in three counties. Los Alamos County is predominantly Caucasian (85 percent); Rio Arriba County is predominantly Hispanic of any race (73 percent); and Santa Fe County is predominantly Hispanic of any race (50 percent). Native Americans compose 14 percent of the population in Rio Arriba County, 2 percent in Santa Fe County, and 0.6 percent in Los Alamos County.

4.2.6.2 Housing

Regional housing characteristics are presented in Table 4.2.6.2-1. In 1990, vacancy rates in the region ranged between a low of five percent in Los Alamos County to a high of 20 percent in Rio Arriba County. Approximately 70 percent of all occupied units were "owner occupied," and 30 percent were rented.

4.2.6.3 Infrastructure

The Infrastructure section characterizes the region's community services with indicators such as education, healthcare, and public safety.

4.2.6.3.1 Education

New Mexico is divided into 89 school districts, four of which are predominantly within the tri-county ROI. Information regarding school districts within the tri-county region is presented in Table 4.2.6.3.1-1.

The Los Alamos School District receives 36 percent of its funding from the federal government, over 56 percent from the state, and 6.5 percent from local sources such as the property tax levy and surplus school space rental. The total school budget for FY 1997 is projected to be $24.5 million. Capacities differ at each school now in use, but as a whole,

Table 4.2.6.1-3. 1990 LANL population by race and ethnicity for the region.[a]

All Persons, Race/ Ethnicity	Los Alamos County		Rio Arriba County		Santa Fe County		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All Persons	18,115	100.0	34,365	100.0	98,928	100.0	151,408	100.0
Caucasian	15,467	85.0	4,375	13.0	46,450	47.0	66,292	44.0
African-American	88	0.5	117	0.3	505	0.5	710	0.5
American Indian[b]	112	0.6	4,830	14.0	2,284	2.0	7,226	5.0
Asian/ Pacific Islander	421	2.0	40	0.1	439	0.4	900	0.6
Hispanic of any race[c]	2,008	11.0	24,955	73.0	48,939	50.0	75,902	50.0
Other races	19	0.1	48	0.1	311	0.3	378	0.3

[a] Percentages may not total to 100 due to rounding.
[b] Numbers for Aleuts and Eskimos were placed in the "other" category, given their small number.
[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from each of the race categories.
Sources: DOE-AL 1998; U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.2.6.2-1. Housing summary for the LANL region, 1990.[a]

	Los Alamos County		Rio Arriba County		Santa Fe County	
	Number	Percent	Number	Percent	Number	Percent
Total Housing Units	7,565	100	14,357	100	41,464	100
Occupied	7,213	95	11,461	80	37,840	91
Vacant	352	5	2,896	20	3,624	9
Median Home Value	$125,100	N/A	$57,900	N/A	$103,300	N/A
Median Contract Rent	$403	N/A	$189	N/A	$422	N/A

N/A - Not applicable.
[a] May not total 100 due to rounding.
Sources: DOE-AL 1998; U.S. Bureau of Census 1990.

Table 4.2.6.3.1-1. Public school statistics in the LANL region, 1996-97 school year.

District	Student Enrollment[a]	Teachers[b]	Teacher/Student Ratio	Per-Student Operational Expenditures[c]
Los Alamos	3,879	264	1:15	$6,640
Santa Fe	16,490	917	1:18	$3,665
Española	6,445	369	1:17	$3,986
Pojoaque	2,140	116	1:18	$4,011
State Average	330,522	21,066	1:17	$4,009

[a] Includes public, nonpublic, and home-school students.
[b] Full-time equivalent figures.
[c] 1995-1996 data.
Sources: DOE-AL 1998; New Mexico Department of Education 1997.

schools currently in use could accommodate approximately 1,560 more students in the coming years.

4.2.6.3.2 Health Care

The three hospitals serving the tri-county region are Los Alamos Medical Center, Española Hospital, and St. Vincent Hospital in Santa Fe. St. Vincent Hospital is the second-busiest in the state and houses the only trauma center in the area. Table 4.2.6.3.2-1 presents data on hospital capacity and usage. The percentage of annual bed-days used indicates sufficient capacity to accommodate additional patients.

4.2.6.3.3 Police and Fire Protection

Table 4.2.6.3.3-1 gives the number of full-time law enforcement officers for the incorporated communities in the LANL region. The Los Alamos County Police Department has 42 full-time police officers and an approved FY 1997 budget of $3.7 million. The police department responds to approximately 1,700 service calls monthly and is involved in various community programs. The ratio of commissioned police officers in Los Alamos County was 2.33 officers per 1,000 of population in January 1997. This ratio is a higher level of police manpower than in Santa Fe. In addition to serving Los Alamos and White Rock, the police department investigates criminal activity at LANL.

The Los Alamos County Fire Department is owned by DOE and is operated through contract by Los Alamos County (fire department personnel are county employees). The Fire Department provides fire suppression, medical/rescue, wildland fire suppression, and fire prevention services to both LANL and the Los Alamos County community.

4.2.6.4 Local Economy

This subsection provides information on the economy of the region, including employment, education, income, and fiscal characteristics.

4.2.6.4.1 Employment

Regional employment data for 1996 are summarized in Table 4.2.6.4.1-1. Both Los Alamos and Santa Fe counties had

Table 4.2.6.3.2-1. Hospital capacity and usage in the LANL tri-county region.

Hospital	Number of Beds	Annual Bed-Days Used[a] (%)
Los Alamos Medical Center	53	26
Española Hospital	81	32
St. Vincent Hospital	268	51

[a] Based on the number of people discharged and the average length of stay divided by total beds available annually.
Source: DOE-AL 1998.

Table 4.2.6.3.3-1 Full-time law enforcement officers for incorporated areas within the LANL region (1996).

Community	Officers
Los Alamos County	42
Rio Arriba County	27
Santa Fe County	68
Española	24
Santa Fe	106

Source: Department of Justice, 1997.

Table 4.2.6.4.1-1. LANL regional employment data, 1996.

County	Civilian Labor Force	Employed	Unemployed	Unemployment Rate (%)
Los Alamos	10,544	10,229	315	3.0
Rio Arriba	18,099	15,352	2,747	15.2
Santa Fe	61,181	58,301	3,880	4.7
Tri-county region	89,824	83,882	5,942	6.6
State of New Mexico	799,807	735,363	64,444	8.1

Source: New Mexico BBER 1997.

unemployment rates below the state average of 8.1 percent and the 5.6 percent average for the United States. By contrast, the unemployment rate in Rio Arriba County was 15.2 percent.

Almost two-thirds of regional 1995 employment was in the "government" and "services" sectors. Employment in those two sectors totaled more than 64,000 persons. Also significant was employment in "retail trade" (19,200), which accounted for 19 percent of the total.

Table 4.2.6.4.1-2 presents employment by industry for the ROI. Government and services are the principal economic sectors in the region. There were approximately 6,000 business

Table 4.2.6.4.1-2. Employment by industry for the Los Alamos region-of-influence, by county, and for the State of New Mexico, 1995.

Economic Characteristic	Los Alamos County	Rio Arriba County	Santa Fe County	Region of Influence	State of New Mexico
			Employment by Industry (1995)		
Farm	0	993	352	1,345	20,465
Agriculture Services	53	(D)	713	766	12,203
Mining	34	(D)	414	478	21,539
Construction	314	743	5,211	6,268	59,763
Manufacturing	166	547	3,009	3,722	52,058
Transportation and Public	78	456	1,443	1,977	36,269
Wholesale Trade	120	168	1,581	1,869	31,468
Retail Trade	1,449	1,904	15,852	19,205	163,452
Finance, Insurance, and Real Estate	589	438	5,718	6,745	53,915
Services	6,136	4,120	25,597	35,853	263,654
Government	9,860	2,933	15,549	28,342	188,626

(D) - Data withheld to avoid disclosure when there are less than four businesses in an industry classification.
Source: Regional Economic Information for Los Alamos, Rio Arriba, Santa Fe Counties and State of New Mexico (U.S. Bureau of Census 1990).

establishments, government agencies, and government enterprises in the tri-county region in 1994. Nearly 29 percent of these were service businesses that employed less than 33 percent of the employed workforce in the area and paid 30 percent of the earnings reported in 1993. Approximately 21 percent were farms or ranches, which employed less than two percent of the employed workforce and provided 0.3 percent of the 1993 earnings. Retail trade establishments composed another 21 percent of the business, and government operations employed slightly more that 17 percent of the employed workforce and paid 12 percent of the 1993 reported earnings. Government agencies and enterprises, including federal, state, county, city, school district, and tribal governments, composed 36 percent of these establishments, employed nearly 29 percent of the employed workforce, and paid nearly 40 percent of the total earnings reported in 1993.

4.2.6.4.2 Income

In 1995, total regional income was approximately $3.78 billion, and 13 percent of this ($473 million) was paid to the LANL workforce residing in the tri-county region. Wages and salaries in the region increased 47 percent between 1989 and 1994. Income data for the tri-county region are presented in Table 4.2.6.4.2-1. Median family incomes in the region vary considerably, from $21,144 in Rio Arriba County to $60,798 in Los Alamos County. In 1989, Los Alamos County had the highest family and per capita incomes in New Mexico and the highest median family income of all U.S. counties. The percentage of persons below the poverty level was approximately two percent in Los Alamos County, 13 percent in Santa Fe County, and 28 percent in Rio Arriba County (Santa Fe Planning Department 1998).

Table 4.2.6.4.2-1. Measures of LANL regional income.

Area	Median Family Income	Per Capita Income	
	1989 ($)	1989 ($)	1994 ($)
Los Alamos County	60,798	24,473	29,762
Rio Arriba County	21,144	8,590	11,731
Santa Fe County	34,073	16,679	22,531
State of New Mexico	27,623	11,246	16,346

Source*:* DOE-AL 1998; New Mexico BBER 1997.

4.2.6.4.3 Fiscal Characteristics

Municipal and county general fund revenues in the tri-county ROI are presented in Table 4.2.6.4.3-1. The general funds support the ongoing operations of local governments as well as community services such as police protection and parks and recreation. In Los Alamos County, the fire department is funded through a separate fund derived from DOE contract payments.

New Mexico communities are heavily dependent on gross receipts tax revenues, which are sensitive to changes in employment, income, procurement and construction contracting. In recent years, gross receipts tax revenues from retail and services have either declined or increased modestly in the region. Property taxes, another source of general fund revenues, are limited by New Mexico statute to a 5 percent annual increase on any single property.

4.2.6.5 Environmental Justice

Figures 4.2.6.5-1 and 4.2.6.5-2 illustrate distributions for minority and low-income populations residing within 50 miles (80 km) of LANL. The definitions of minority and low-income populations and the methodology for assessing potential environmental justice effects are given in Section 5.3.6.5.

Approximately 270,000 people live within a 50-mi (80-km) radius of the proposed LANL site. Minorities comprise 48.1 percent of this population. In 1990, minorities composed 24.4 percent of the national population and 24 percent of the population in New Mexico. There are several federally recognized Native American groups within 50 miles (80 km) of the site. The percent of persons below the poverty level is 13 percent, which compares with the 1990 national average of 13.1 percent and a statewide figure of 31 percent (U.S. Census 1990).

4.2.7 CULTURAL RESOURCES

The cultural resources in the Los Alamos area and on LANL land have been extensively studied and documented. Approximately 75 percent of LANL has been surveyed for cultural resources, although the coverage of some individual surveys has been less than 100 percent. However, about 60 percent of LANL has received 100 percent survey coverage (DOE 1993, as cited in DOE-AL 1998: 4-157). The cumulative results of these surveys and site excavations are recorded on the LANL Cultural Resources Database.

The LANL Cultural Resources Database indicates that 1,295 prehistoric sites have been identified on laboratory land. These prehistoric

Table 4.2.6.4.3-1. Municipal and county general fund revenues in the LANL tri-county region, FY 1995.[a]

Revenue by Source	Los Alamos County		Rio Arriba County		City of Española		Santa Fe County		City of Santa Fe	
	($)	Percent	($)	Percent	($)	Percent	($)	Percent	($)	Percent
Property Tax	3,001,910	14	2,504,037	22	262,707	5	9,819,861	34	964,507	2
Gross Receipts Tax	10,361,829	50	663,626	6	3,930,810	72	4,233,441	15	46,986,752	79
Lodgers Tax	921,854	4	205,451	2	671,746	13	1,325,943	4	3,244,930	5
Others	921,854	4	205,451	2	671,746	13	1,325,943	4	3,244,930	5
Fees, Fines, Charges, Forfeits, Licenses, and Permits	2,427,527	12	132,857	1	373,620	7	1,458,675	5	3,853,266	7
Oil and Gas Taxes	NA	NA	3,319,900	30	NA	NA	NA	NA	NA	NA
Miscellaneous Income	4,033,998	19	1,306,555	12	153,686	3	1,428,134	5	1,185,088	2
Restricted Funds	NA	NA	3,091,129	28	NA	NA	10,822,381	37	NA	NA
Total Revenues	20,919,195	100	11,223,555	100	5,450,354	100	29,088,435	100	59,870,838	100

NA - Not available.
[a] Percentages may not total 100 due to rounding.
Source: DOE-AL 1998.

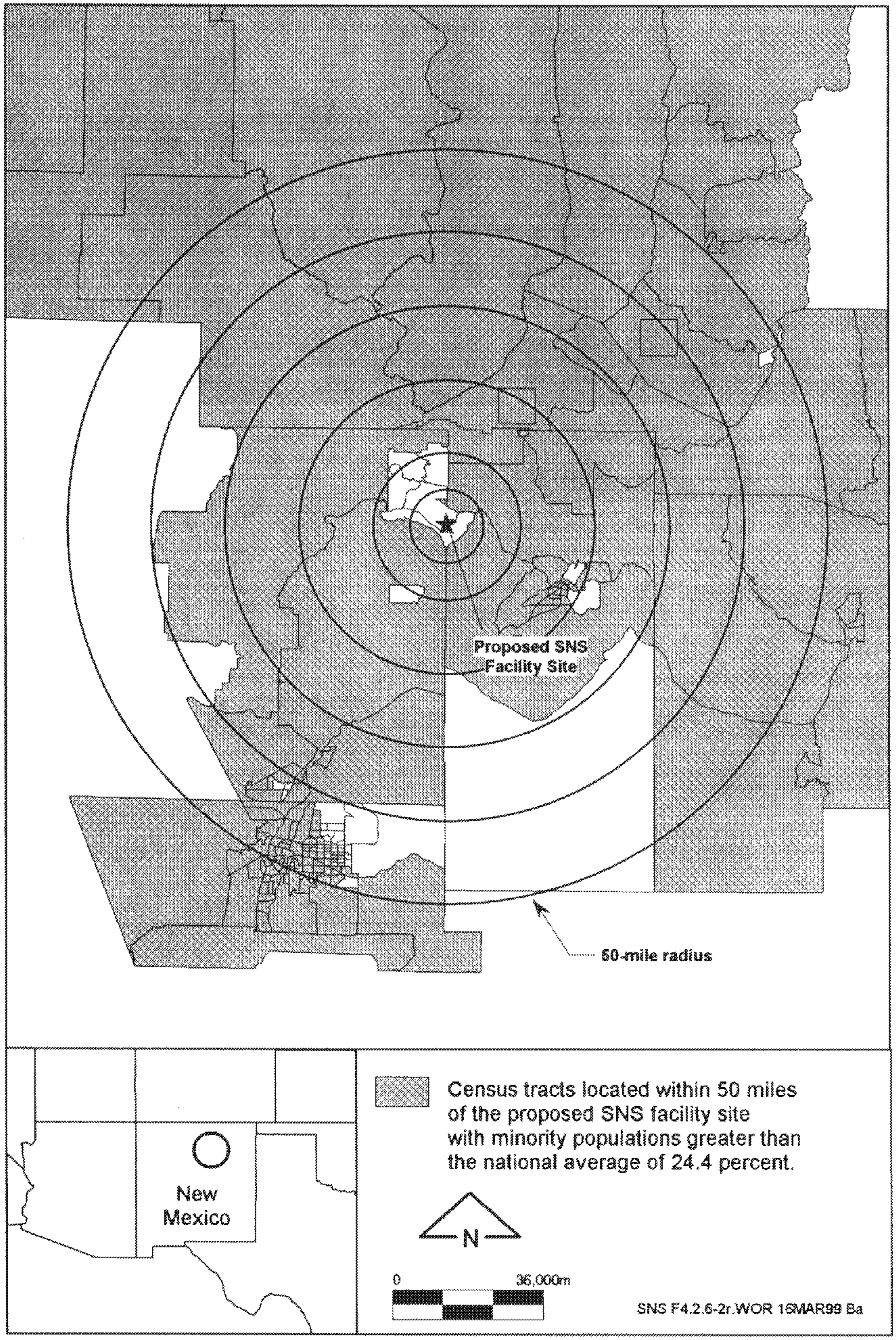

Figure 4.2.6.5-1. Distribution of minority populations at LANL.

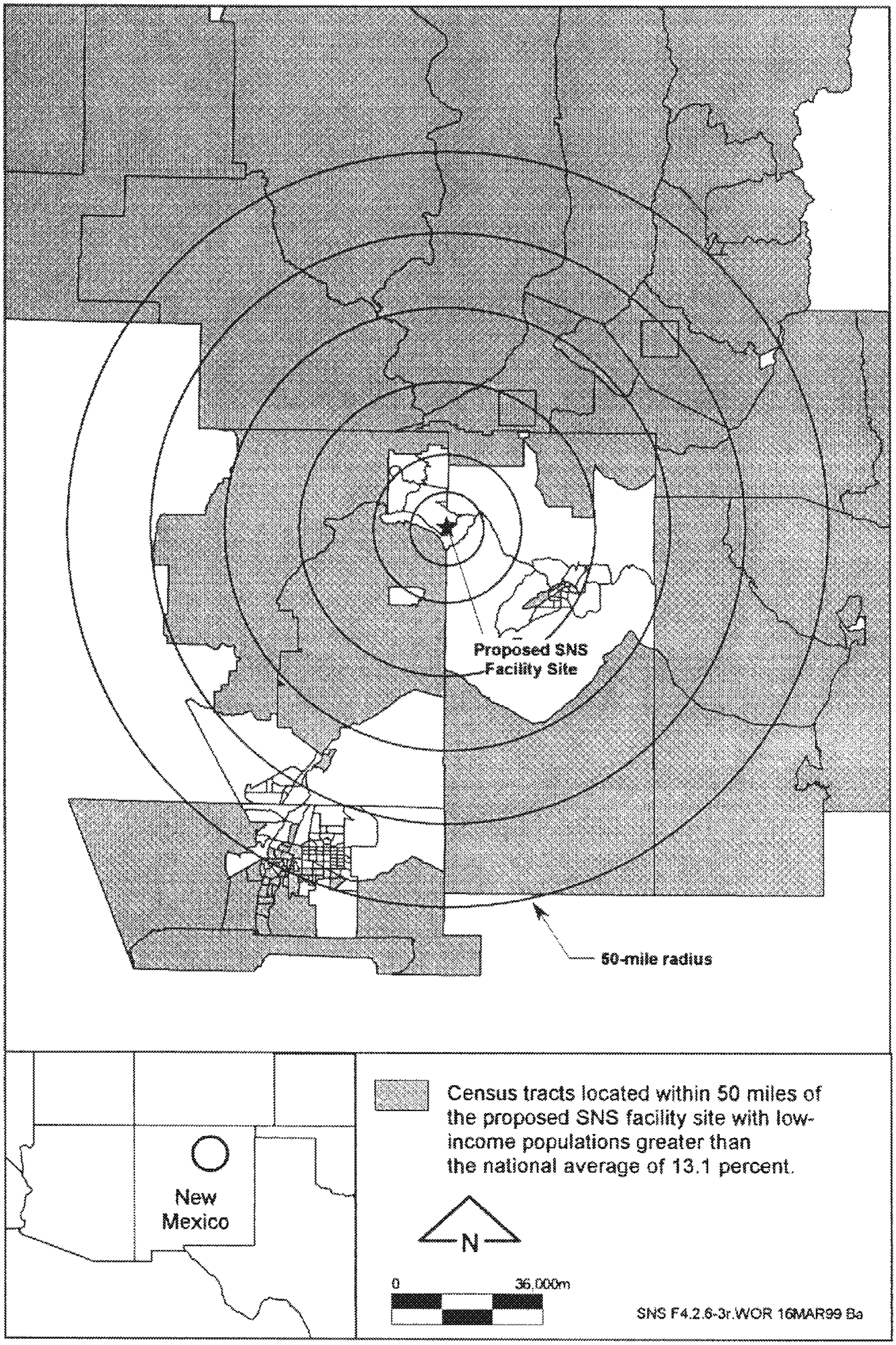

Figure 4.2.6.5-2. Distribution of low-income populations at LANL.

sites include archaeological sites such as simple pueblos, complex pueblos, small cave pueblos, highly eroded pueblos, rock shelters, artifact scatters, lithic scatters, and rock rings. Other sites in the database include trails and steps, rock art, water control features, and game traps. Of the total number of prehistoric sites in the database, 1,192 have been assessed for NRHP eligibility. Out of this number, 770 are eligible for listing on the NRHP, 322 are potentially eligible, and 100 sites are ineligible. The other 103 prehistoric sites have not been assessed for NRHP eligibility, but they are assumed to be potentially eligible until such assessments can be made (DOE-AL 1998: 4-158).

The Laboratory has not been systematically and comprehensively surveyed for historic cultural resources. However, the surveys performed to date have identified 214 historic sites. Approximately 2,105 more historic sites have been identified through a combination of archival research and field observations. Sites identified include historic archaeological sites, homesteads, commercial ranches, and guest ranches established prior to 1943. In addition, they include the original Los Alamos town site and numerous other buildings and facilities associated with the early development of nuclear weapons [World War II–Early Nuclear Weapons Development Period (A.D. 1943–1948)]. Most of the historic sites at LANL are buildings and facilities associated with Cold War Period (A.D.1946–1989) activities. Ninety-nine of the historic sites at LANL are eligible for listing on the NRHP, and two sites are listed on the State Register of Cultural Properties (DOE-AL 1998: 4-158 to 4-159).

A number of TCPs have been identified within the LANL boundaries and at nearby locations outside the laboratory boundaries. These TCPs include substance features, ceremonial and archaeological sites, natural features, plant gathering sites, and sites where artisans obtain raw materials.

A cultural resources survey of the proposed SNS site and an associated buffer zone was procured by LANL in 1997 to support preparation of this FEIS. However, only about 65 percent of this area was surveyed (LANL 1998); five prehistoric cultural resources were identified (refer to Section 4.2.7.1). Furthermore, the density of prehistoric sites per unit area of LANL land as a whole is high, and most of these sites are eligible for listing on the NRHP. Considering these factors, the chances of finding additional cultural resources within the unsurveyed 35 percent of the proposed SNS site and buffer zone would be reasonably high. If the proposed site at LANL is eventually chosen for construction of the SNS, the remaining 35 percent of the area of potential impact would be surveyed for cultural resources prior to the initiation of construction activities.

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at LANL. In addition, the locations of ancillary structures such as a retention basin, switchyard, and sanitary waste treatment systems have not been determined. As a result, such areas could not be surveyed for cultural resources. However, the eventual establishment of these areas would proceed in such a manner as to avoid known cultural resource locations. If the proposed SNS site at LANL were chosen for construction, these areas would be surveyed for cultural resources prior to the initiation of construction-related activities within them.

The locations of archaeological sites, historic sites, and TCPs are not provided as part of the cultural resource descriptions in this section of the FEIS. These omissions are consistent with DOE and the University of California efforts to protect cultural resources from vandalism by not revealing these locations in documents available to the general public. Because several of the original reports cited in this section show the locations of cultural resources at LANL, copies of them are not available in the DOE public reading rooms established as part of the SNS EIS process.

4.2.7.1 Prehistoric Resources

Five prehistoric archaeological sites have been identified on and adjacent to the proposed SNS site at LANL. All of these sites are located within the 65 percent of the proposed SNS site and an adjacent buffer zone that have been surveyed for cultural resources. Three of these sites date to the Coalition Period, and two sites date to the Classic Period (LANL 1998).

Most of the prehistoric sites within the LANL boundaries date to the Coalition Period (A.D. 1100 to 1325). The peoples of the Coalition Period in the LANL area were maize horticulturists. Their early sites are characterized by adobe and masonry rectangular structures, and the later sites have large, masonry-enclosed plaza room blocks with over 100 rooms. Some researchers attribute the increase in numbers of sites during this period to migration of peoples into the area, while others believe that the increase was a function of *in situ* population growth.

The Classic Period (A.D. 1325 to 1600) immediately followed the Coalition Period in the LANL area. The people of this period practiced intensive maize horticulture. The settlements on the Pajarito Plateau were aggregated into three population clusters with outlying one- to two-room field houses. The central cluster consisted of four temporally overlapping sites: Navawi, Otowi, Tsankawi, and Tsirege. The Otowi and Tsirege sites are on DOE land at LANL. The ruins on these sites are ancestral to the current Tewa speakers living at the nearby Pueblo of San Ildefonso.

Descriptive data covering the prehistoric archaeological sites identified on and adjacent to the proposed SNS site are provided in Table 4.2.7.1-1. These descriptions include the official site designation, the site type defined by function, the period when the site was occupied, the time range of the period, the size of the major remains at the sites, and the NRHP eligibility of the sites.

4.2.7.2 Historic Resources

No Historic Period cultural resources have been identified within the 65 percent survey area at the proposed SNS site.

4.2.7.3 Traditional Cultural Properties

A number of TCPs are known to be present on LANL land as a result of a study conducted in support of the recent site-wide EIS covering laboratory operations. Twenty-three American Indian tribes and two Hispanic communities were contacted during the study. The Hispanic communities and 19 tribes agreed to consult with DOE on the identification of TCPs in the LANL region. All groups indicated the presence of TCPs on or near LANL land. These resources can be broadly categorized as artisan material sites, natural features, ethnobotanical sites, subsistence features, ceremonial sites, and

Table 4.2.7.1-1. Prehistoric cultural resources on the proposed SNS site at LANL.

Designation	Type	Period (Components)	Dates	Size	NRHP Eligibility[3]
LA12676-B[1]	Field house	Coalition	A.D. 1100–1325	1–2 Rooms	E
LA12676-C[1]	Pueblo	Early Coalition	A.D. 1100–1213	8–10 Rooms	E
L-154[2]	Pueblo	Classic	A.D. 1325–1600	2–4 Rooms	E
LA6786[1]	Pueblo	Early Coalition		6–8 Rooms	E
LL-155[2]	Field house	Classic	A.D. 1325–1600	1 Room	E

[1]New Mexico Laboratory of Anthropology number.
[2]LANL field numbers.
[3]E - Eligible for listing on the NRHP under Criterion D. This criterion applies to sites that are significant because of their potential to contribute to archeological and historical research.
Source: LANL 1998.

archaeological sites (DOE-AL 1998: 4-160 to 4-161). Generally, the consulted groups consider all archaeological sites, rivers and water resources, human burials, shrines, trails, plants, animals, and minerals to be TCPs (DOE-AL 1998: 5-71). Although such resources are located throughout LANL and adjacent lands, the consulting groups did not identify specific TCP features or locations (DOE-AL 1998: 4-161).

The five prehistoric archaeological sites identified within the 65 percent survey area on the SNS site would be considered to be TCPs (see Section 4.2.7.1). The specific identities and locations of any other TCPs on and adjacent to the proposed SNS site are not known and cannot be reasonably estimated.

4.2.7.4 Consultation with the State Historic Preservation Officer

Section 106 of the NHPA requires a review of proposed federal actions to determine whether or not they would impact properties listed on or eligible for listing on the NRHP. DOE-AL has consulted with the SHPO in New Mexico concerning the occurrence of such properties within the area of potential impact of the proposed SNS at LANL. The consultation letter sent to the SHPO at the New Mexico Historic Preservation Division is provided in Appendix D.

4.2.8 LAND USE

Descriptions of land use in the vicinity of LANL, within the boundaries of LANL, and on the proposed SNS site are provided in this section. The descriptions cover past, current, and future uses of the land in these areas. In addition, they include descriptions of environmentally sensitive land areas that have been set aside for public use, environmental protection, or research. These areas include parks, natural areas, environmental education centers, and public recreation areas. The section concludes with a discussion of visual resources.

4.2.8.1 Past Land Use

LANL has been surrounded by large tracts of federal, county, and Native American tribal lands for many years. Generally, the federal and tribal lands have remained in their natural state and may be largely categorized as open space. However, some areas within these lands have been devoted to residential and limited commercial/industrial use. Historically, a very small percentage of the land in the vicinity of LANL has been under local government or private ownership. This small percentage includes the urban lands in Los Alamos and White Rock. Most of the privately owned land has been developed for residential, commercial, and industrial use (DOE-AL 1995b: 4-4; LANL 1998).

The land within the boundaries of LANL was largely open space wilderness prior to its use by the Manhattan Project in 1943. Over the next 55 years, the current pattern of land use at LANL gradually evolved. This evolution involved the increasing use of laboratory land for industrial purposes related to scientific research and the development of nuclear weapons. During this period, large portions of LANL remained as open space in its natural state.

The proposed SNS site, located in TA-70 at LANL, has always been largely an open space wilderness area covered with piñon-juniper woodlands. Piñon-juniper woodlands cover 12,770 acres (5,108 ha) of land at LANL (DOE-AL 1998: 4-103). The proposed SNS site and TA-70 have not been a focus of past industrial development, and no contamination of soil from past activities is known to be present at the site. In addition to TA-70 and the proposed SNS site, TA-69 and TA-71 are also undeveloped, as is most of TA-6 (DOE-AL 1998: 2-19 to 2-22). The total area of land in TA-70 is about 1,825 acres (739 ha). The total land area in the other three TAs is approximately 1,684 acres (682 ha). On a lab-wide basis, it is estimated that approximately 16,000 acres (6,478 ha) of land have never been developed, but about 14,000 acres (5,668 ha) are unsuitable for development because they consist of canyon bottoms and land with slopes in excess of 20 percent (Anderson 1998: 1-2).

4.2.8.2 Current Land Use

The land use pattern in the vicinity of LANL stems from predominant ownership and management of the land by governmental entities and Native American tribal authorities. A general depiction of land use areas in the vicinity of LANL is provided in Figure 4.2.8.2-1.

A portion of the northern laboratory boundary is adjoined by the community of Los Alamos, which is characterized by a combination of residential, commercial, public/quasi public, and open space land use. The rest of the northern boundary is adjacent to the Santa Fe National Forest. The national forest is managed by the U.S. Department of Agriculture (USDA) and contains a total land area of 1,567,181 acres (634,238 ha). This area consists primarily of open space in its natural state and specific natural areas preserved for research purposes by the USDA (DOE-AL 1995b: 4-4). Land use within the national forest is further categorized according to eight discrete forest management areas. These forest management areas are delineated and described in the *Santa Fe National Forest Plan* (USFS 1987, as cited in DOE-AL 1998).

The Tsankawi area of Bandelier National Monument, lands of the Pueblo of San Ildefonso, and the community of White Rock lie along the eastern boundary of LANL. The Tsankawi area, managed by the Department of the Interior (DOI), is nonwilderness open space covering 826 acres (334 ha) and characterized by the presence of prehistoric Native American

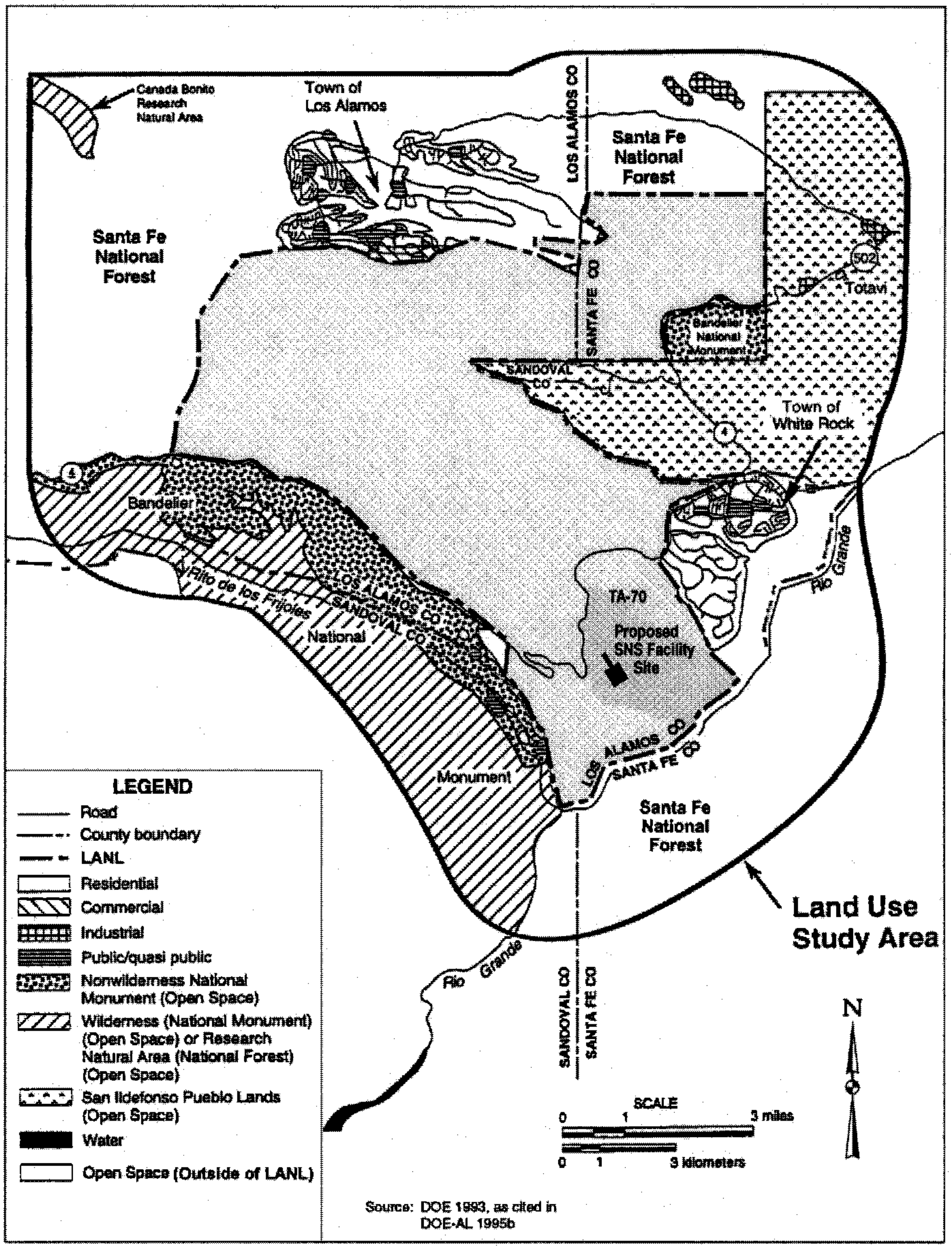

Figure 4.2.8.2-1. Map of current land use in the vicinity of LANL.

ruins. With the exception of a few small commercial, industrial, residential, and agricultural use areas, the Native American pueblo lands are largely open space. The urban land use pattern in the community of White Rock is similar to the one in Los Alamos (DOI 1995, as cited in DOE-AL 1998; DOE-AL 1995b: 4-4).

The southern and eastern boundaries of LANL are adjacent to an area of the Santa Fe National Forest and the primary area of Bandelier National Monument, respectively. The national forest tract is open space. The primary unit of the national monument is wilderness and nonwilderness open space containing prehistoric ruins (DOE-AL 1995b: 4-4). A small portion of this area is developed to meet the needs of visitors (DOI 1995, as cited in DOE-AL 1998: 4-13).

The laboratory occupies approximately 27,832 acres (11,268 ha) of land in Los Alamos and Santa Fe Counties. It is subdivided into 49 distinct technical areas, but only 30 of these are active (DOE 1996c: 4-246).

The laboratory uses a current land use characterization system consisting of 11 major categories: Environmental Research/Buffer, Physical Support and Infrastructure, Experimental Science, High Explosives Research & Development and Testing, Special Nuclear Materials Research & Development, Public and Corporate Interface, Administrative and Technical Services, Waste Management, Theoretical and Computational Science, Non-DOE Land: Potentially Physical Support and Infrastructure, and High Explosives Administrative and Technical Support Area (LANL 1995: 11). The areas of laboratory land within each category are shown in Figure 4.2.8.2-2.

The proposed SNS site is located within TA-70 at the southeast end of LANL (refer to Figure 4.2.8.2-2). All of TA-70 is in the Environmental Research/Buffer land use category (LANL 1995: 11). This area has remained largely undeveloped and could be classified as open space in more conventional land use terminology. It is surrounded on the north, east, and west by land in the same use category. The Rio Grande River and the Santa Fe National Forest are along its southern boundary.

The entire laboratory has been designated as a NERP, and all of the land on and adjacent to the proposed site is in the Environmental Research/Buffer land use category. The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects that would be potentially sensitive to SNS activities. (Withers 1998: 2).

4.2.8.3 Future Land Use

Future land use in the area surrounding LANL is managed according to comprehensive land use and development plans prepared for Los Alamos County, Santa Fe National Forest, and Bandelier National Monument. A formal land use plan has not been adopted for the Pueblo of San Ildefonso.

Fifty-four percent of the land in Los Alamos County, which includes the communities of Los Alamos and White Rock, has slopes of 20 percent or greater. Land with such slopes is not conducive to building. As a result, future urban development is expected to occur in compact, contiguous areas with less slope,

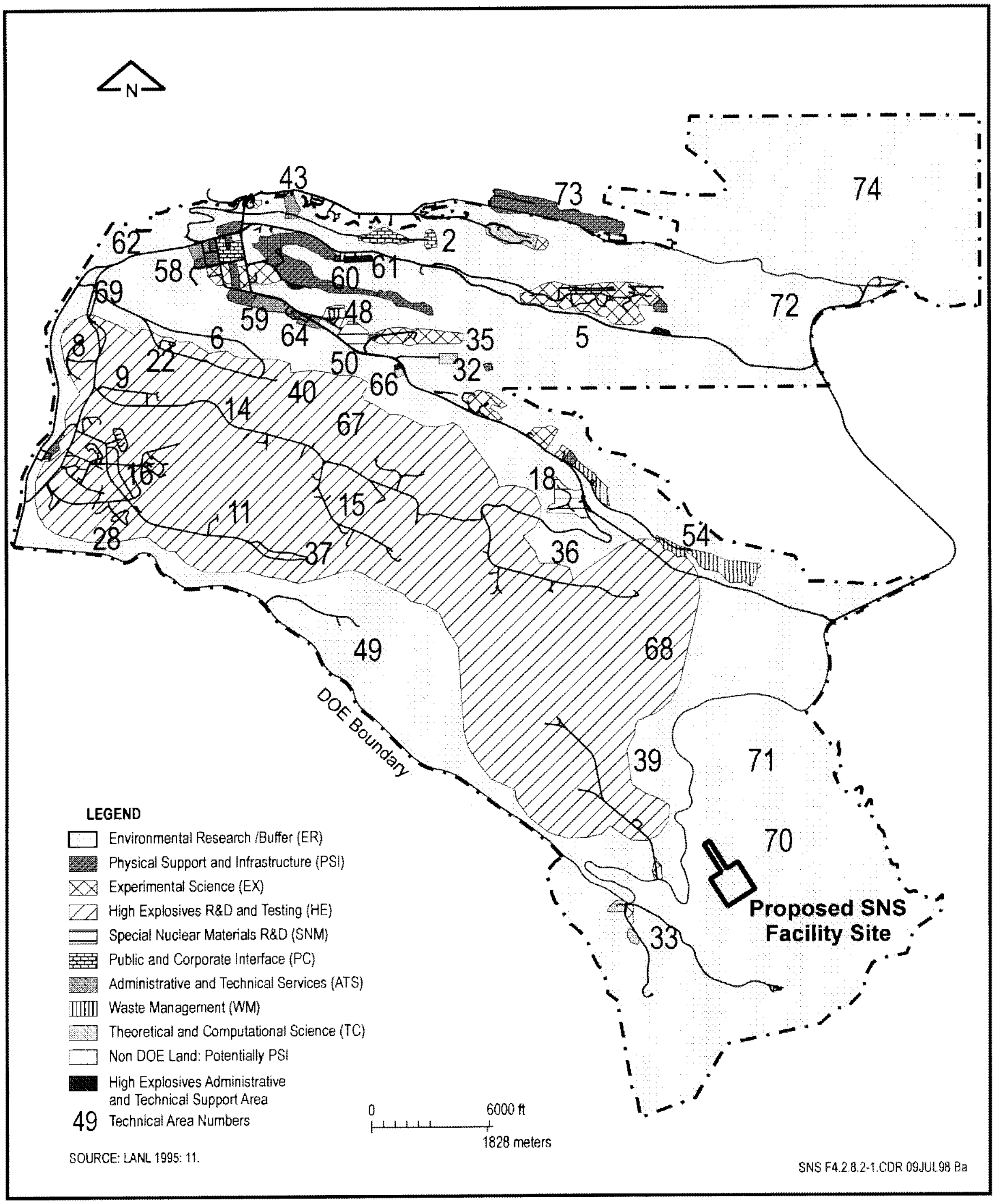

Figure 4.2.8.2-2. Map of current land use at LANL.

where public services can be most efficiently provided and where environmental impacts can be minimized. Much of this development would occur as infill or reuse of land. An outlying development is planned along the northern edge of the community of Los Alamos on land that will be transferred to the county by the U.S. General Services Administration. In cooperation with the Pueblo of San Ildefonso, another outlying development is planned on pueblo land north of the community of White Rock (Los Alamos County 1987, as cited in LANL 1997b).

Most of the land surrounding LANL is expected to remain as federal and tribal land. The use of the federal lands for a national forest and a national monument will continue for the foreseeable future, although specific land uses within each area may change with agency priorities. In the absence of a land use plan, projected land use on the Pueblo of San Ildefonso remains unknown.

The zoning of LANL land for future use involves the expansion of many current land uses into areas now used for other purposes. For example, large portions of the current Environmental Research/Buffer category are zoned for future use in Experimental Science and High Explosives Research & Development and Testing. Portions of the current Environmental Research/Buffer areas and High Explosives Research & Development and Testing areas are zoned as Waste Management in anticipation of expanding future laboratory waste management activities into these areas. The zoning of LANL land for future use is shown in Figure 4.2.8.3-1 (LANL 1995: 12).

A large portion of the current Environmental Research/Buffer land in TA-70 is zoned as Experimental Science for future use. The SNS is an experimental science facility, and the proposed SNS site is located within this zone. No environmental research that would be potentially sensitive to SNS activities is planned for the proposed site or areas in its vicinity (Withers 1998: 2). The Future Site Use Planning Integration Team was established in the mid-1990s at LANL. Its purpose was to integrate the planning of land use, facility development, environmental restoration, laboratory strategic planning, and stakeholder involvement in the current and future planning processes of the laboratory (LANL 1995: 10). However, this process has not resulted in independent stakeholder recommendations to DOE on future land use at the laboratory (Withers 1998: 1-2).

4.2.8.4 Parks, Preserves, and Recreational Resources

Several parks, natural areas, and recreation areas are located on the land surrounding LANL. Bandelier National Monument is a popular public attraction that offers natural beauty, prehistoric ruins, historic structures, abundant wildlife, picnic areas, playgrounds, campgrounds, and concession facilities. In addition, it contains 65 miles (105 km) of maintained hiking trails, ranging from easy to strenuous. In addition to timber growth and logging, the Santa Fe National Forest offers public recreation opportunities such as sightseeing, hiking, fishing, hunting, camping, and skiing. The Jemez Division of the national forest includes the Jemez Mountains and the Dome Wilderness Area, a designated habitat for federal and state protected species such as the Mexican spotted owl. Research natural areas, additional habitat for threatened and endangered species, and cultural resources are present in other areas

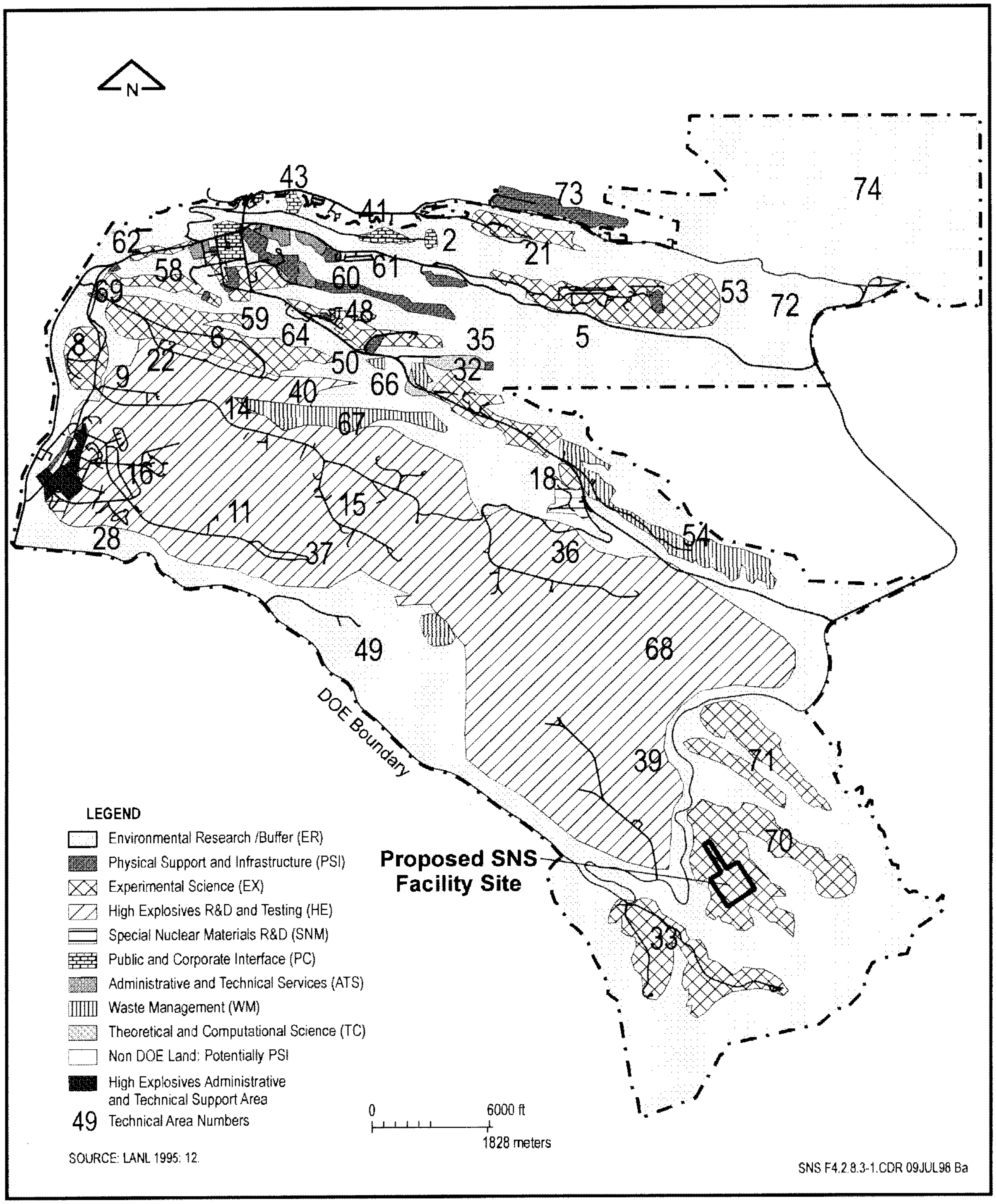

Figure 4.2.8.3-1. Land use zoning map of LANL.

of the national forest (USDA 1987, as cited in LANL 1997b; DOE-AL 1995b: 4-6).

The public is provided with limited access to certain areas of LANL for recreational purposes. An area north of Ancho Canyon between the Rio Grande River and State Road 4 is open to the public for activities such as hunting and hiking. In addition, portions of Mortandad and Pueblo Canyons are open to the public. An archaeological site (Otawi Tract) is located north of State Road 502 and is open to the public, subject to cultural resource management restrictions (DOE-AL 1995b: 4-6).

The U.S. Energy Research and Development Administration, the predecessor agency to DOE, designated all laboratory land as a NERP in 1977. This park is used by the national scientific community as an outdoor laboratory to study the effects of DOE activities on southwest woodland ecosystems (DOE 1985a: 3, 21, as cited in DOE 1996c: 4-246.)

The proposed SNS site is currently open for use by the general public. Several unpaved hiking trails are present in the site area (LANL 1998).

4.2.8.5 Visual Resources

The LANL region is well known for its spectacular views. The orientation and geographical features on the Pajarito Plateau provide dramatic views of landscapes ranging from arid grasslands to alpine and subalpine mountains (LANL 1998).

The mountains of the region are clearly visible from LANL. Looking southward from most locations at LANL, the Sandia Mountains near Albuquerque can be seen. Looking to the north and east, one can see the Upper Rio Grande Valley and the Sangre de Cristo Mountains. The Jemez Mountains are visible west of the Pajarito Plateau. The elevation of the mountains, along with the finger-like mesas and deep canyons that separate them, create a fascinating combination of landscape features at LANL (LANL 1998).

The proposed SNS site is located in a remote, undisturbed piñon-juniper woodland. Traveling from Bandelier National Monument to the community of White Rock, the site is visible from State Route 4. It is not visible from White Rock or popular use areas in Bandelier National Monument (LANL 1998).

4.2.9 RADIOLOGICAL AND CHEMICAL ENVIRONMENT

This section describes the radiological and chemical environment at LANL.

4.2.9.1 Radiological Environment

Currently LANL's largest contributors of radiation and radioactive materials to the environment are the Los Alamos Neutron Science Center (LANSCE), tritium operations, the Criticality Facility at TA-18, the Pulsed High Energy Radiation Machine Emitting X-rays Facility at TA-15, the dynamic testing facility at TA-36, and the low-level radioactive waste disposal at Material Disposal Area G.

4.2.9.1.1 Air

LANL air monitoring is designed to measure environmental levels of airborne radionuclides that may be released from laboratory operations. Radionuclide emissions from LANL point and nonpoint sources include several isotopes such as tritium, uranium, ^{90}Sr, and plutonium.

During 1996, LANL conducted ambient air sampling for airborne radioactivity at more than 50 stations (called AIRNET) including on-site, regional, pueblo, and perimeter [within 2.5 miles (4 km) from the site] locations. Collected samples were analyzed for uranium, plutonium, americium, and tritium. Natural atmospheric and fallout radioactivity levels fluctuate and affect measurements made by the laboratory's air sampling program. Regional airborne radioactivity is largely composed of fallout from past atmospheric weapons tests, natural radioactive constituents from the radioactive decay of thorium and uranium attached to dust particles, and from cosmic radiation. Regional levels of radioactivity in the atmosphere are useful for comparison against on-site measurements made at LANL (Table 4.2.9.1.1-1). Note that the measurements taken in Santa Fe (by EPA) are similar to those taken (by LANL) surrounding the LANL reservation.

More than 1,000 air samples were analyzed for gross alpha and beta contamination. Results indicate that gross alpha and beta concentrations were well below the National Council on Radiation Protection and Measurement's estimated national averages of 2 femtocuries (fCi)/m³ and 20 fCi/m³, respectively. In 1996, laboratory operations released 680 Ci of tritium. The perimeter sampling stations exhibited average tritium concentrations of 1.3 pCi/m³ that were higher than the regional and pueblo tritium concentrations. Elevated tritium concentrations were observed at a number of on-site locations. The highest maximum and annual mean concentrations were measured at TA-54 (waste disposal site), near shafts where tritium-contaminated waste is disposed.

Table 4.2.9.1.1-1. Average regional background comparison against LANL radioactivity levels.[a]

Radionuclide	Units	Santa Fe 1990–1995	LANL 1996	EPA Limits[b]
Gross Alpha	fCi/m³ (10^{-15}Ci)	NA	0.8	NA
Gross Beta	fCi/m³ (10^{-15}Ci)	10	10.2	NA
U-234	aCi/m³ (10^{-18}Ci)	14	35.6	7,700
U-235	aCi/m³ (10^{-18}Ci)	0.6	2.2	7,100
U-238	aCi/m³ (10^{-18}Ci)	13	24.7	8,300
Pu-238	aCi/m³ (10^{-18}Ci)	0.2	0.1	2,100
Pu-239-240	aCi/m³ (10^{-18}Ci)	0.3	0.7	2,000
H-3	pCi/m³ (10^{-12}Ci)	NA	0.3	1,500
Am-241	aCi/m³ (10^{-18}Ci)	NA	2.1	1,900

[a] Source*:* LANL 1997d.
[b] Each EPA limit equals 10 mrem/yr.
NA - Not available.

The 1996 EDE for the maximally exposed off-site individual was 1.93 mrem/yr, primarily from the LANSCE operations. The collective EDE attributable to laboratory operations to persons living within 50 miles (80 km) of the LANL was calculated to be 1.2 person-rem.

Gross alpha and gross beta analyses are used to evaluate general radiological air quality and identify potential trends. If gross activity is inconsistent with past observations, then analysis of specific radionuclides is performed. When pre-established investigation levels are exceeded, then a process is undertaken to validate the results and identify the source of the radioactivity. During 1996 further investigation was initiated by anomalous levels at TA-54, Area G; TA-16; TA-21; firing sites at TA-15; and Station #30. For a detailed discussion of those investigations, reference the annual report, *Environmental Surveillance and Compliance at Los Alamos during 1996* (LANL 1997d). None of the on-site or regional sampling and analyses suggested air quality impacts to TA-70.

4.2.9.1.2 Water

Surface waters from regional and Pajarito Plateau stations are monitored to evaluate the environmental effects of LANL operations. The current network of annual sampling stations for surface water (both runoff and perennial flow) includes a set of regional (or background) stations and a group of stations near or within the LANL boundary. None of the surface waters of the laboratory are a source of municipal, industrial, or irrigation water. In 1996, the results of radiochemical analyses indicated that all surface water concentrations were below the DOE DCGs for public dose. The majority of values were near or below the detection limits of the analytical methods except for samples from Mortandad Canyon at GS-1 (^{239}Pu, ^{240}Pu, and ^{241}Am). Most of the measurements at or above the detection limits were from locations with previously known contamination (Acid/Pueblo Canyon, Los Alamos Canyon, and Mortandad Canyon). Surface and runoff water results from Ancho Canyon (TA-70) indicate all radionuclides well below the DOE DCGs for public dose, with many reported values below analytical detection limits (Table 4.2.9.1.2-1).

Groundwater surveillance efforts at LANL are focused on the main aquifer underlying the region, the perched alluvial groundwater in the canyons, and the localized intermediate-depth perched groundwater systems. Sample results from the main aquifer indicate that most levels of ^{3}H, ^{90}Sr, uranium, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am, and gross beta were below the DOE DCGs. Some test wells exhibited slightly elevated values from ^{3}H, ^{90}Sr, and uranium. The long-term trends of the water quality in the main aquifer have shown little impact resulting from LANL operations (LANL 1997d).

Sample results from the alluvial groundwaters indicate that except for ^{90}Sr in Mortandad and Los Alamos Canyon, none of the radionuclide activities exceed the DOE DCGs applicable to drinking water.

4.2.9.1.3 Soil

The soil sampling program at LANL evaluates radionuclide, radioactivity, and heavy metals in soils collected on-site (12 sites), around the LANL perimeter (10 sites), and regional (background) locations (six sites). In order to assess radioactive contamination from air stack emissions and fugitive dust, the on-site locations are located close to or downwind from major facilities or operations at LANL. In 1996, most

Table 4.2.9.1.2-1. Radiochemical analyses for runoff and surface water sampling stations within the LANL area of influence of TA-70.

Station	Tritium (pCi/L)	Sr-90 (pCi/L)	Cs-137 (pCi/L)	Total Uranium (μg/L)	Pu-238 (pCi/L)
Ancho at Rio Grande	-122 ± 134	1.0 ± 0.4	-0.1 ± 0.3	0.3 ± 0.0	0.010 ± 0.010
Ancho near Bandelier	-41 ± 73	1.2 ± 0.4	1.0 ± 0.9	1.53 ± 0.15	0.002 ± 0.005
Water Quality Criteria	20,000[a]	8[a]	120[b]	30[b]	1.6[b]

Station	Pu-239–249 (pCi/L)	Am-241 (pCi/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Gross Gamma (pCi/L)
Ancho at Rio Grande	-0.007 ± -0.007	-0.017 ± -0.017	-0.4 ± - 0.01	2.9 ± 0.4	-148 ± 50
Ancho near Bandelier	0.039 ± 0.013	-0.014 ± 0.020	1.4 ± 0.3	14.7 ± 1.8	-118 ± 50
Water Quality Criteria	1.2[b]	1.2[b]	15[a]	NA	NA

Note: ± 0.4 Measurement uncertainty associated with instrument quantification. If the uncertainty approaches the measurement value, then the more likely the value is not a positive detection. Negative values represent measurements below the detection limit which are useful for incorporation into long-term averages.

[a] Maximum Contaminant Level National Primary Drinking Water Regulations (40 CFR 141).

[b] DOE DCGs for drinking water (DOE Order 5400.5).

NA – Not available.

radionuclide concentrations in soils were within background concentrations as compared to data collected over the last 21 years. Some total uranium, ^{239}Pu, and ^{240}Pu values in some perimeter and on-site stations were higher than background but well within LANL screening levels.

4.2.9.1.4 Ambient Gamma Radiation

The laboratory's largest contributor to the ambient gamma radiation in the environment is the Criticality Facility at TA-18. Criticality experiments produce neutrons and photons; contribute to the external penetrating radiation dose. During experiments that have the potential to produce a dose in excess of 1 mrem per operation, public access is restricted by closing Pajarito Road from White Rock to TA-51. The other potentially significant contributor to penetrating radiation exposures is the LANSCE at TA-53. During experimentation at LANSCE, short-lived positron emitters are released from the stacks and diffuse from the buildings. These emitters release photon radiation as they decay, producing a potential external radiation dose.

Most of the emitters decay very quickly, and within a few hundred meters from LANSCE the dose is negligible. However, the dose at East Gate (the laboratory boundary north-northeast of LANSCE) is elevated by these laboratory emissions. The laboratory's contribution to the penetrating radiation dose at East Gate is derived by modeling and environmental measurements. The EDE as measured at the East Gate in 1996 was approximately 168 mrem, while the background measurements at TA-49 were approximately 164 mrem.

4.2.9.2 Chemical Environment

This section describes nonradiological contaminants in air, water, and soil at LANL.

4.2.9.2.1 Air

Levels of particulates with aerodynamic diameters less than 10 μm (PM_{10}) were measured during two events in 1996: the Dome Fire from April 26 through May 2 and a controlled burn on LANL property in November. PM_{10} levels at TA-49 air monitoring compound downwind of the Dome Fire averaged 17 μg/m³, and the highest 1-day level was 32 μg/m³. PM_{10} levels before and after the controlled burn in November were 12 μg/m³ and 30 μg/m³ during the burn. These levels are well below the federal 24-hour standard of 150 μg/m³.

4.2.9.2.2 Water

Surface water samples from stations on the Rio Grande and Jemez Rivers are monitored as background locations, and samples from the Pajaroito plateau surrounding the site are monitored as indicator locations. Major chemical constituents in these samples from 1996 show some variability but are generally consistent with results from previous years. With the exception of some pH values of 8.5, monitored parameters were within applicable standards. Trace metals (lead, barium, silver, and mercury) were found in a number of surface water samples.

Groundwaters in the main aquifer, canyon alluvial aquifers, and the intermediate perched groundwater system are monitored for nonradiological contaminants. Most parameters in samples from drinking water supply wells were below applicable standards in 1996. The pH standard of 8.5 was exceeded at three locations (G-1, G-1A, and Otowi-1). At G-1, a silver concentration of 52 μg/L exceeded applicable state standards, and a thallium level of 6.0 μg/L exceeded the EPA action level. Samples from the alluvial canyon aquifers show elevated nitrate levels attributable to LANL operations. Trace metal concentrations were lower than in previous years. Levels of iron, lead, manganese, and zinc approached or exceeded the water quality standard in samples from the perched aquifer.

4.2.9.2.3 Soil

Soil samples from 1996 were analyzed for trace and heavy metals and were within background concentrations for the Los Alamos area. In fact, they were within the range of metal concentrations normally encountered in the continental United States (LANL 1997d).

4.2.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The Support Facilities and Infrastructure section characterizes the local vehicular transportation routes around the proposed SNS site. The existing utilities that are available to provide needed services to support the operation of the proposed SNS are also described.

4.2.10.1 Transportation

The regional highway system and major roads in the LANL area are illustrated in Figure 4.2.10.1-1. Regional transportation routes connecting LANL with Albuquerque and Santa Fe are I-25 to US 84/285 to NM 502. Connection with Española is via NM 30 to NM 502. The route connecting LANL with western communities (including Jemez Springs) is NM 4.

Only two major roads, NM 502 and NM 4, access Los Alamos County. Traffic volume on these two highway segments is primarily associated with LANL activities. Approximately 11,000 DOE and DOE contractor personnel support LANL operations. Approximately 63 percent of commuter traffic originates from Los Alamos County, while roughly 35 percent originates from east of Los Alamos County (the Rio Grande Valley and Santa Fe). Only one percent of LANL employees commute to LANL from the west along NM 4 (DOE-AL 1998).

NM 4 is a two-lane state highway that would be the primary access road for the proposed SNS at TA-70. Access to NM 4 from both Los Alamos County and counties from the east is via NM 502. From Los Alamos County to NM 4, NM 502 is a two- to four-lane state highway, while NM 502 from NM 30 to the intersection of NM 4 is a four-lane divided state highway with an uphill truck lane.

Traffic counts in 1994 indicated that the average daily traffic on these two segments was 16,286 and 12,041, respectively. The same 1994 traffic counts indicate that the average daily traffic on NM 4 between the intersection of NM 501 and NM 4 and the entrance to Bandelier National Monument [4 miles (6.4 km)] is 758 vehicles. The average daily traffic between the entrance to Bandelier National Monument and NM 502 [9 miles (14.5 km)] is 1,029 vehicles. The latter is the section of NM 4 that would access the proposed SNS site.

4.2.10.2 Utilities

Ownership and distribution of utility services are split between the DOE and Los Alamos County. DOE owns and distributes utility services to LANL facilities, and the county provides these services to the neighboring communities of White Rock and Los Alamos. DOE also owns and maintains several main lines for electrical, natural gas, and water distribution located throughout the town's residential areas. The County's Department of Public Utilities utilizes these lines at a number of locations while maintaining the final distribution systems.

4.2.10.2.1 Electrical Service

In 1985, DOE and Los Alamos County combined their generating and transmission resources to form the Electric Resource Pool (Pool). Pool resources currently provide 72 to 94 MW from a number of hydroelectric, coal, and natural gas power generators throughout the western United States. The Pool receives power from two 115-kV electric power transmission lines originating from near Albuquerque and near White Rock. These lines distribute electricity to LANL as well as White Rock, Los Alamos, and Bandelier National Monument. On-site electrical generation comes from the TA-3 steam/power plant, which is capable of

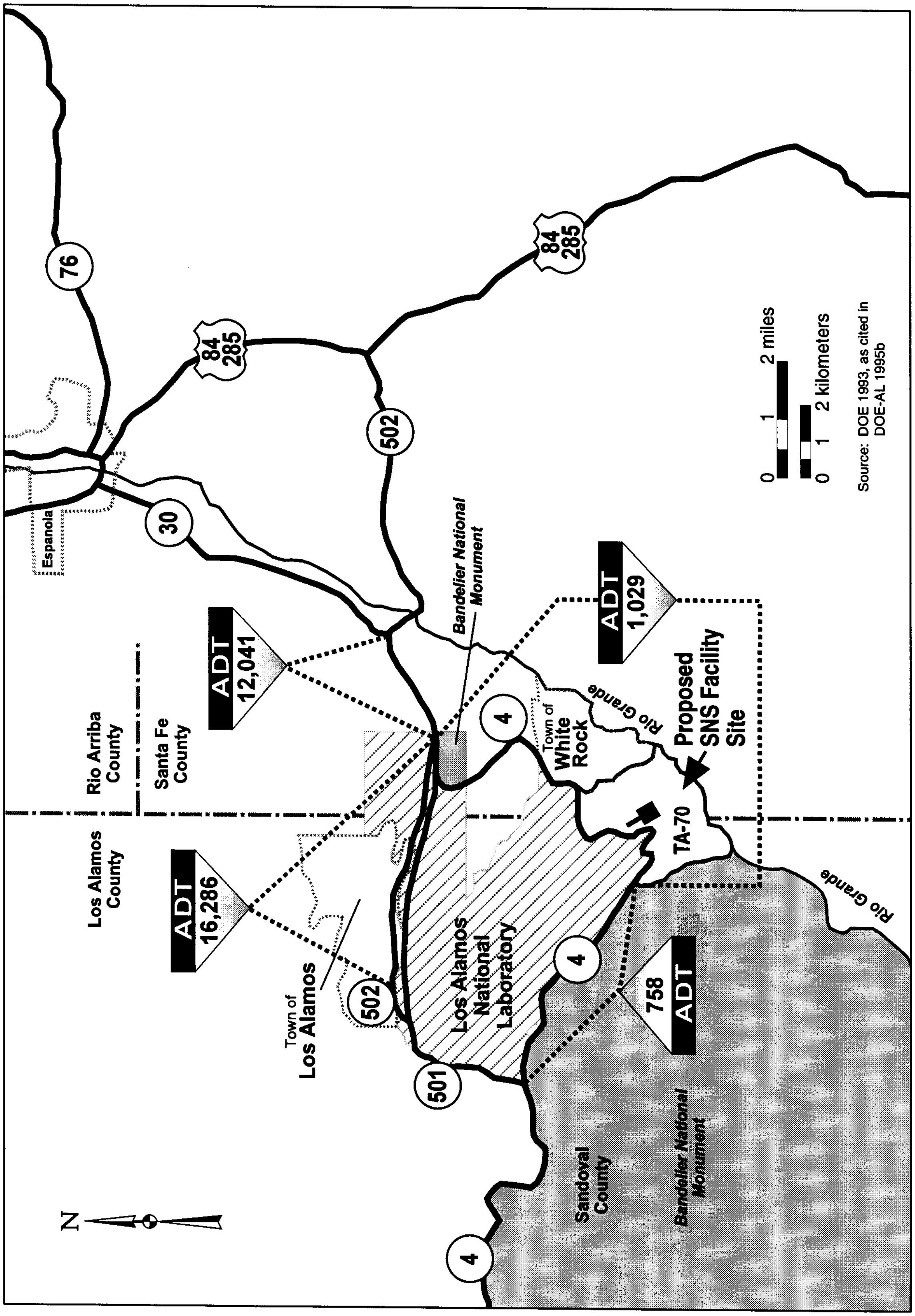

Figure 4.2.10.1-1. Transportation routes at LANL and surrounding areas

producing up to 14 MW. The TA-3 plant is used as a peaking facility when peak load demands exceed the capacity of the two 115-kV lines. The Pool peak electrical demand in 1995 was approximately 80 MW. LANL consumed roughly 66 MW (83 percent) of the total demand.

The majority of LANL's 120-mi (193-km) electrical distribution system is past or nearing the end of its useful design life. Most of LANL's 480/277-V and 208/120-V systems would fall below industry reliability standards if used to supply additional power. Roughly 19 miles (30.6 km) of 40-year-old underground cables and 13.8-kV switchgear will require replacement in the next 10 years.

4.2.10.2.2 Natural Gas

LANL purchases natural gas from the Natural Gas Clearing House through a DOE–Department of Defense Federal Defense Fuels Procurement. The majority of the on-site gas supply lines are located in the northern portion of the site. The southern portion of the site and the TA-70 area are devoid of any existing natural gas lines or distribution lines. In 1995, LANL consumed approximately 2.7 billion ft^3 of natural gas. Approximately 80 percent of the gas is used for heating (steam and hot air). The remainder is used for electrical generation. The electrical generation was used to fill the difference between peak loads and the electric distribution system capacity. Natural gas capacity is considered adequate in the region with reserves available to meet existing system needs and commitments (Withers 1998).

4.2.10.2.3 Water Service

DOE has rights to withdraw 5,541.3 acre-feet or about 1,806 million gal (6.8 billion L) of water per year from the main aquifer. In addition, DOE obtained the right to purchase 1,200 acre-feet [391 million gal (1.5 billion L)] of water per year from the San Juan–Chama Transmountain Diversion Project in 1976. Although the San Juan–Chama water rights exist, DOE has no delivery system in place and has no plans at this time to exercise this right. DOE's potable water production system consists of 14 deep wells, 153 miles (244.8 km) of main distribution lines, pump stations, storage tanks, and nine chlorination stations.

During FY 1994, of the 1,450 million gal (5.5 billion L) that DOE withdrew from the aquifer, LANL operations used approximately 487 million gal (1.8 billion L) or roughly 34 percent of the water drawn. Los Alamos County used approximately 958 million gal (3.6 billion L) [66 percent], and the National Park Service used approximately 5 million gal (19 million L).

4.2.10.2.4 Sanitary Waste Treatment

Sanitary liquid wastes are delivered by dedicated pipelines to the Sanitary Waste System Consolidation plant at TA-46, which processes sanitary waste streams from various site buildings. The plant has a design capacity of 600,000 gpd (2.3 million lpd) and in 1995 processed a maximum of about 400,000 gpd (1.5 million lpd). Some septic tank pumpings are delivered periodically to the plant for treatment.

4.3 ARGONNE NATIONAL LABORATORY

Argonne National Laboratory (ANL) occupies 1,500 acres (610 ha) of gently rolling land in the Des Plaines River Valley of DuPage County, Illinois, about 27 miles (43 km) southwest of downtown Chicago and 24 miles (39 km) west of Lake Michigan. Surrounding the ANL site is the Waterfall Glen Forest Preserve, a 2,040-acre (826-ha) greenbelt forest preserve of the DuPage County Forest Preserve District. This land was deeded to the DuPage County Forest Preserve District in 1973 for use as a public recreation area, nature preserve, and demonstration forest. Nearby highways are Interstate 55 to the north and Illinois Highway 83 to the east. The Des Plaines River is located about 0.4 mi (0.6 km) south of ANL. The Chicago Sanitary and Ship Canal is about 0.6 mi (1.0 km) south of the laboratory. The section of the Illinois and Michigan Canal that lies within the Illinois and Michigan Canal National Heritage Corridor is located about 0.8 mi (1.3 km) south of ANL. The Calumet-Sag Channel is located about the same distance to the southeast of the laboratory boundary. Figure 4.3-1 shows ANL and the proposed site for the SNS.

The terrain of ANL is gently rolling, partially wooded, former prairie and farmland. The principal stream on ANL is Sawmill Creek, running through the eastern portion of ANL, draining southward to the Des Plaines River, located approximately 1.3 miles (2.1 km) southeast of the center of the property. The forest preserve and the area between the river and ANL are undeveloped, whereas urban developments predominate other surrounding areas.

4.3.1 GEOLOGY AND SOILS

ANL sits on a slightly tilted plain that is lower to the east. Some relief exists as a result of stream erosion. Steep slopes are found only adjacent to the floodplain areas and near the southeastern edge of the reservation where the fall into the Des Plaines River Valley begins. The Des Plaines River Valley was carved by waters flowing out of the glacial Lake Michigan about 11,000 years ago.

4.3.1.1 Stratigraphy

The area surrounding ANL is located on a glacial till plateau that forms a complex arrangement of hills and depressions comprising the Valpariso Moraine (which has a northwest-southeast trend). The moraine consists of a prominent bedrock high that is covered by surficial deposits and two Pleistocene glacial units that are designated as the Wadsworth Till and the underlying Lemont Drift (Figure 4.3.1.1-1). The surficial deposits are wind-blown silts generally less than 5 feet (1.5 m) thick. The composition of the Till and Drift is highly variable both horizontally and vertically over short distances. The Till is dominated by a thick silty clay to clayey silt. Thin discontinuous granular zones, usually less than 5 to 10 ft (1.5 m to 3 m) thick, may occur within the Till. The Drift consists of sandy silt, silty sand, and clayey silt of various origins but also includes large volumes of glaciolacustrine and glaciofluvial materials. A rubble zone of dolomite fragments less than 3 feet (1 meter) to more than 10 ft (3 m) thick is present at the base of the Lemont at several locations penetrated by bedrock monitoring wells. The total thickness of deposits overlying the bedrock ranges from about 40 to 160 ft (12 to 49 m).

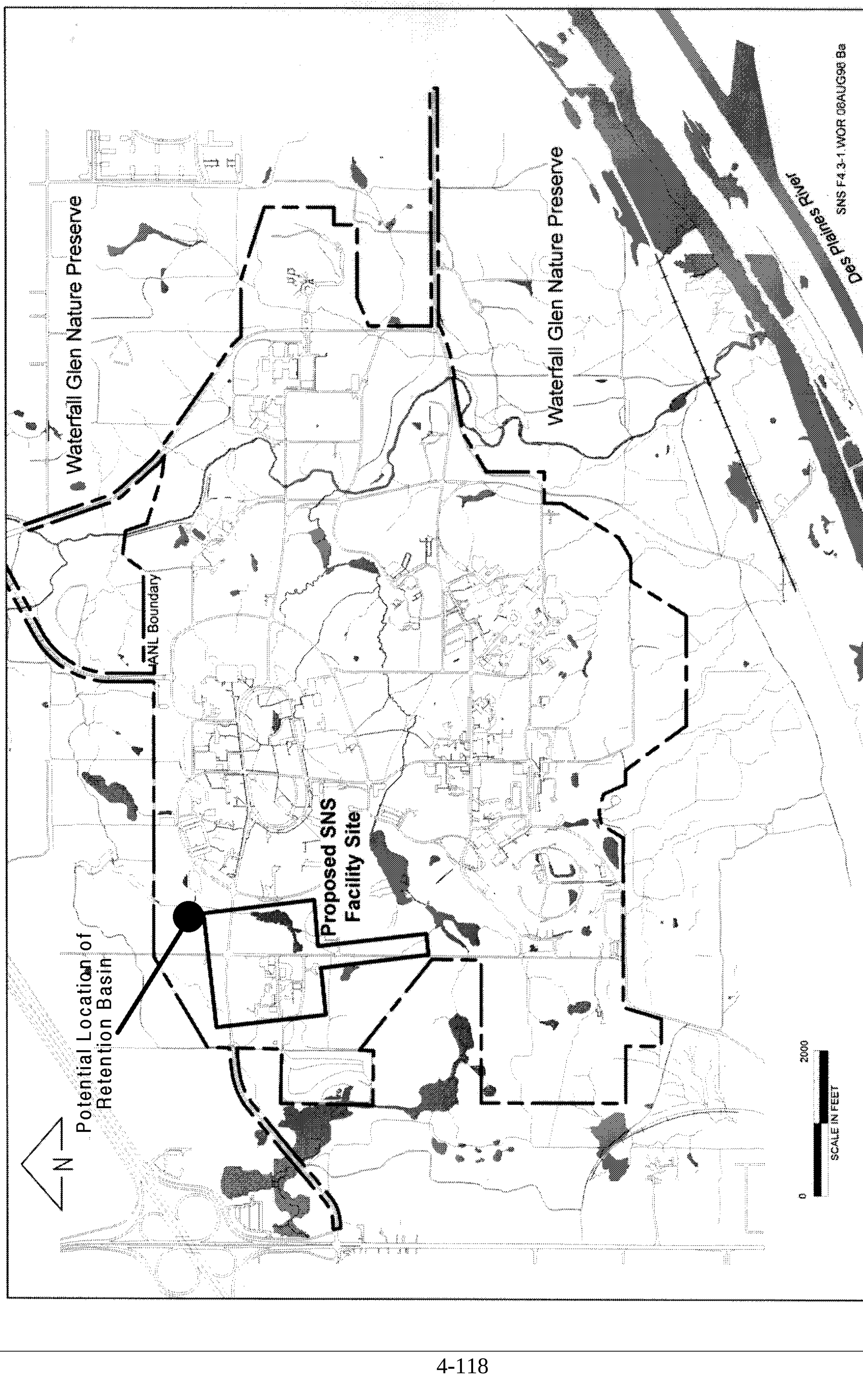

Figure 4.3-1. Proposed SNS site at ANL.

System	Series	Units	
Quarternary	Pleistocene	Surficial Deposits Wadsworth Till Lemon Drift	
Silurian	Niagaran	Racine Formation (dolomite) Sugar Run Formation (dolomite and shale) Joliet Formation (dolomite and shale)	
	Alexandrian	Kankakee Formation Elwood Formation Wilhelmit Formation (dolomitic)	
Ordovician	Cincinnatian	Maquoketa Shale Group	
	Champlainian	Galena and Platteville Groups (dolomitic)	
		Ancell Group	Glennwood Sandstone St. Peter Sandstone
Cambrian	Canadian	Knox Dolomite Megagroup	
		Ironton and Galesville Sandstones	
		Eau Claire Formation (shales and siltstones)	
		Elmhurst-Mt Simon Sandstone	
Precambrian		Precambrian Basement (granites, granodiorites, rhyolites)	

Figure 4.3.1.1-1. Stratigraphy for Northeast Illinois and ANL.

The bedrock surfaces underlying ANL are the Silurian-age Niagaran and Alexandrian Series dolomites. The dolomites are thin to massive bedded, fine-to-medium grained, and calcareous with some chert, and have fractures, joints, and bedding planes that are enlarged by solutioning.

It is divided into several formations and is 200 to 225 ft (60 to 70 m) thick at the ANL site. Older units from the Ordovician and Cambrian systems underlie the Silurian dolomites. The relatively impermeable Maquoketa Shale Group consists of about 165 ft (50 m) of compact, soft shale. Below these units is a sequence containing sandstone strata that have been used as regional aquifers. The Maquoketa Shale separates the upper dolomite aquifer from the underlying sandstone and dolomite aquifers and retards the hydraulic connection between them. The underlying Precambrian basement is composed of granites or granitic rocks.

4.3.1.2 Structure

Structurally, ANL is located on the Kankakee Arch, which defines the northern limits to the Illinois Basin. Strata in the area lay nearly horizontal. No tectonic features within 62 miles (100 km) of ANL are known to be seismically active within recent geologic time, and only two major structural features occur within the region occupied by ANL. The longest of these features is the Sandwich Fault, which extends some 80 miles (128 km) along a northwest-southeast strike roughly 20 miles (32 km) southwest of ANL (William et al. 1975). This fault displays several hundred meters of displacement with the down-thrown side to the north. Smaller structural features include inactive faults of Cambrian age, insignificant faults in the Chicago area, and the Des Plaines Disturbance. The Des Plaines Disturbance is a crypto-explosion structure now believed to be an astrobleme or meteorite impact formed in the Ordovician Period. This feature is situated about 20 miles (32 km) north of ANL and is covered by younger rocks and sediments.

4.3.1.3 Soils

The soils on the ANL property have derived from glacial till over the past 12,000 years. The predominant soils are of the Morley series, which are moderately well drained upland soils with slopes ranging from 2 percent to 20 percent. The surface layer is a dark grayish-brown silt loam, the subsoil is a brown silty clay, and the underlying material is a silty clay loam glacial till. Morley soils have a relatively low organic content in the surface layer, moderately slow subsoil permeability, and a large water capacity. These soils are well suited to growing crops, if good erosion control practices are used. The remaining soils along creeks, intermittent streams, bottom lands, and a few small upland areas are of the Sawmill, Ashkum, Peotone, and Beecher Series, which are generally poorly drained. They have a black to dark gray or brown silty clay loam surface layer, high organic-matter content, and a large water capacity.

The proposed SNS site consists of support-service buildings, open space, and undeveloped ecological plots. The area was prairie and farmland before federal acquisition of the site in 1947. Land use plans designate the area as office, research, and development. This land-use commitment of the site to development precludes the land from being prime or unique farmlands under the Farmland Protection Policy Act.

4.3.1.4 Stability

A few minor earthquakes have occurred in northern Illinois, but none have been positively associated with the particular tectonic features mentioned above. Most of the recent local seismic activity is believed to be caused by isostatic adjustments of the crust in response to glacial loading and unloading rather than tectonically induced stress. In general, the area surrounding ANL is seismically quiescent (Figure 4.3.1.4-1).

There are several areas of considerable seismic activity that could influence the proposed SNS site even though they are several hundred kilometers from ANL. These areas include the New Madrid fault zone (southwestern Missouri), the St. Louis area, the Wabash Valley Fault zone along the southern Illinois–Indiana border, and the Anna region of Ohio. According to estimates, ground motions induced by near and distant seismic sources in northern Illinois are expected to be minimal. However, peak accelerations in the ANL area may exceed 10 percent of gravity once in about 600 years (-250 to +450 year error). This amplitude is on the threshold of the major damage range.

4.3.2 WATER RESOURCES

Surface water, flood potential, and groundwater resource characteristics of the area are covered in this section.

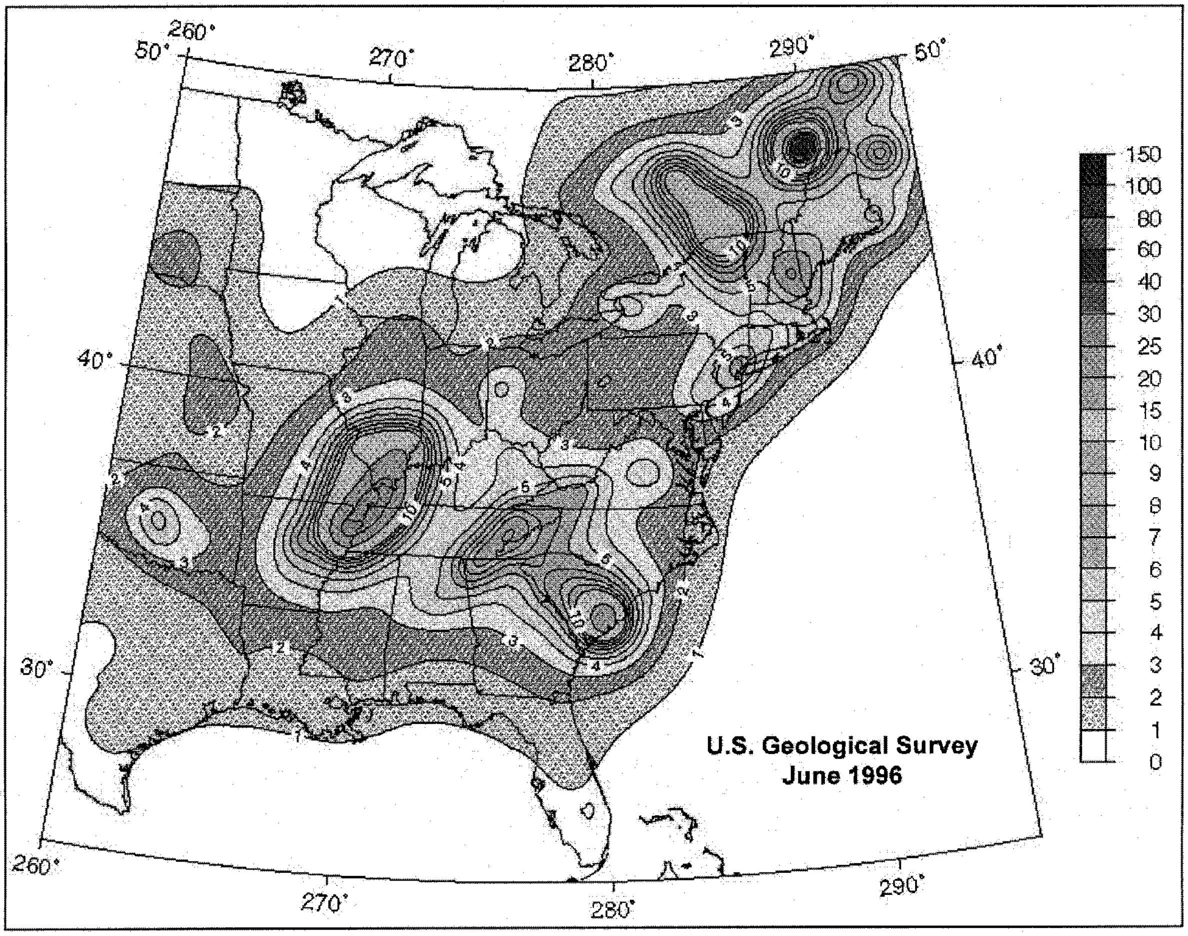

Figure 4.3.1.4-1. Peak acceleration (% gravity) with 10 percent probability of exceedance in 50 years.

4.3.2.1 Surface Water

Surface drainage at ANL is in a southerly direction toward the Des Plaines River approximately 2,000 ft (0.6 km) south. Within ANL, Sawmill Creek flows southerly through the eastern edge of the reservation and discharges into the Des Plaines River channel (Figure 4.3.2.1-1). Two intermittent branches of Freund Brook flow from west to east, draining the interior portion of the reservation and, ultimately, flow into Sawmill Creek. The larger, south branch of the creek originates in a marsh adjacent to the western boundary of the reservation. Also, an unnamed drainage flows from the northwest portion of the reservation northward into the Waterfall Glen Nature Preserve. Along the southern margin of ANL, the terrain slopes abruptly downward, forming forested bluffs. These bluffs are dissected by ravines containing intermittent streams that discharge site drainage into the Des Plaines River channel. Numerous small streams, various ponds, and cattail marshes are present throughout the reservation.

Until 10 years ago, Sawmill Creek carried effluent water from a sewage treatment plant

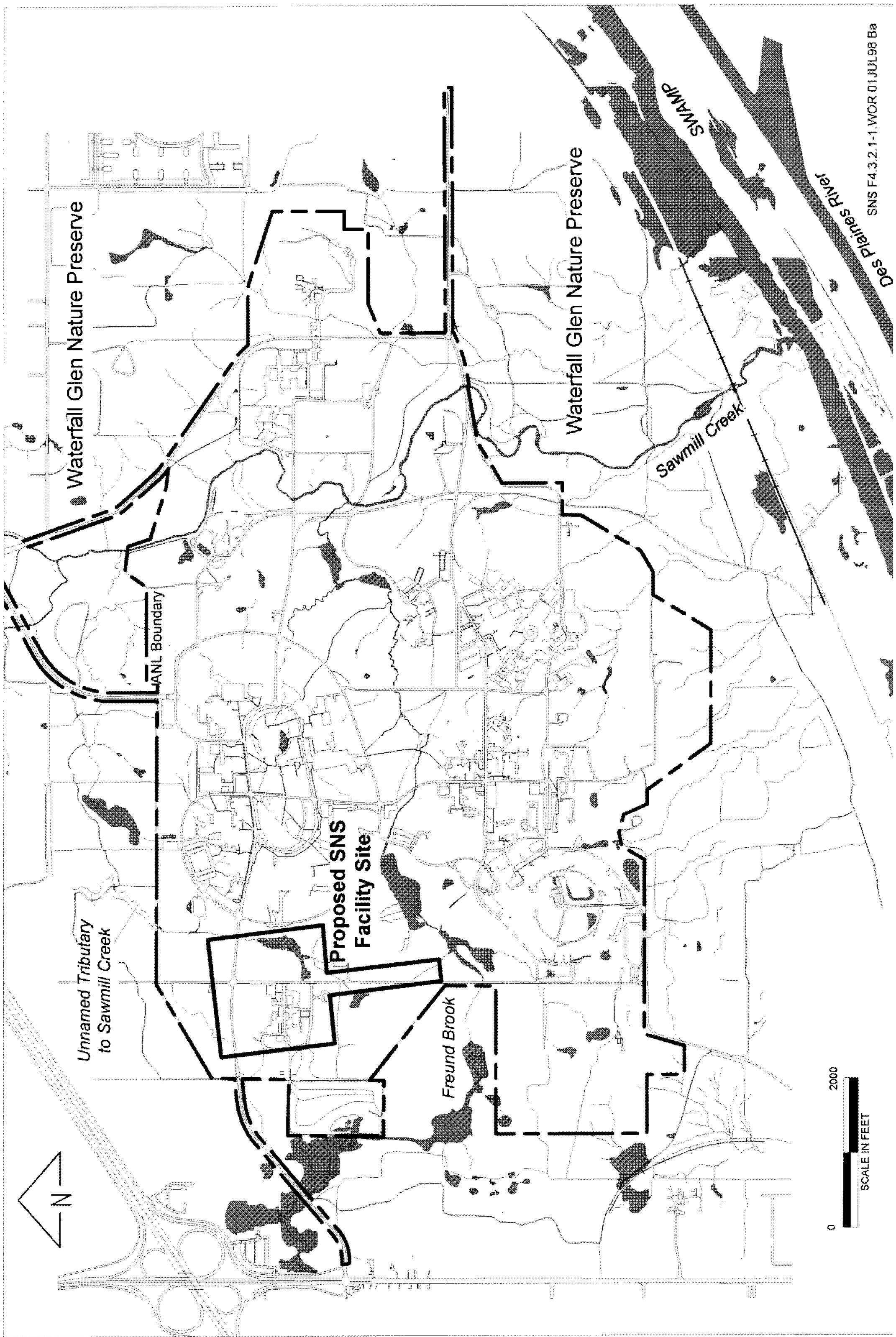

Figure 4.3.2.1- 1. Proposed SNS location and nearby drainages within ANL boundary.

(STP) located approximately 1 mile (1.6 km) north of ANL. Residential and commercial development in the area has resulted in the collection and channeling of runoff water into Sawmill Creek. Treated sanitary and laboratory wastewaters from ANL are combined and discharged into lower Sawmill Creek.

Sawmill Creek and the Des Plaines River near ANL receive very little recreational or industrial use. About 290,000 gpd (1.1 million lpd) of water from the Chicago Sanitary and Ship Canal, which runs parallel to the Des Plaines River, was previously used for cooling towers and other industrial purposes. Surface water from the area around ANL is not used as a source of drinking water with the first downstream location [about 150 miles (241 km)] of surface water being used by a community water supply system at Peoria on the Illinois River.

4.3.2.2 Flood Potential

Since the ANL reservation is situated at an elevation about 164 ft (50 m) above the Des Plaines River, it is not subject to major flooding. A number of small areas associated with the Sawmill Creek drainage and other small streams are subject to local flood conditions during heavy precipitation.

The preferred site for the proposed SNS (called the 800 Area) is situated in the northwestern portion of ANL. The footprint of the SNS would overlie two small floodplain areas. The eastern edge of the SNS footprint would overlie a portion of the 100-year floodplain and associated wetlands of an unnamed tributary of Sawmill Creek. The total area of this floodplain within the footprint would be approximately 5 acres (2 ha). This unnamed tributary originates in the 800 Area and connects to Sawmill Creek north of ANL. In addition, the southern tip of the SNS footprint would overlie a portion of the 100-year floodplain and associated wetlands of an unnamed tributary to Freund Brook. The area of floodplain within the footprint would be <1 acre (0.40 ha). This tributary originates within the footprint of the proposed SNS and flows southeast to Freund Brook. Its confluence with Freund Brook is outside the footprint of the proposed SNS. The relationship of these floodplain areas to the footprint of the proposed SNS is shown in Figure 4.3.2.2-1. Because of the many streams and marshes within the ANL boundaries, alternative sites considered for the proposed SNS would occupy similar or larger floodplains and wetlands areas.

4.3.2.3 Groundwater

Groundwater in the area surrounding ANL is segmented into three hydrogeological groups. From the surface they are (1) the glacial deposits of the Pleistocene age, (2) the shallow bedrock of the Silurian age, and (3) the deeper bedrock aquifers of the Ordovician age. The upper two groups are effectively separated from the deep bedrock system by an aquitard, and the vadose zone occurs within the Pleistocene glacial deposits.

Groundwater in the Wadsworth Till occurs mainly in the silty clay or sandy portions of the unit at a depth of 15 to 30 ft (4.6 to 9.1 m) below ground level in the 800 Area. Sands found in the Wadsworth Till formation are localized and do not represent a large scale regional formation. Thus, the major portion of the underlying geological formation at the ANL site consists of silty clay with extremely low permeability.

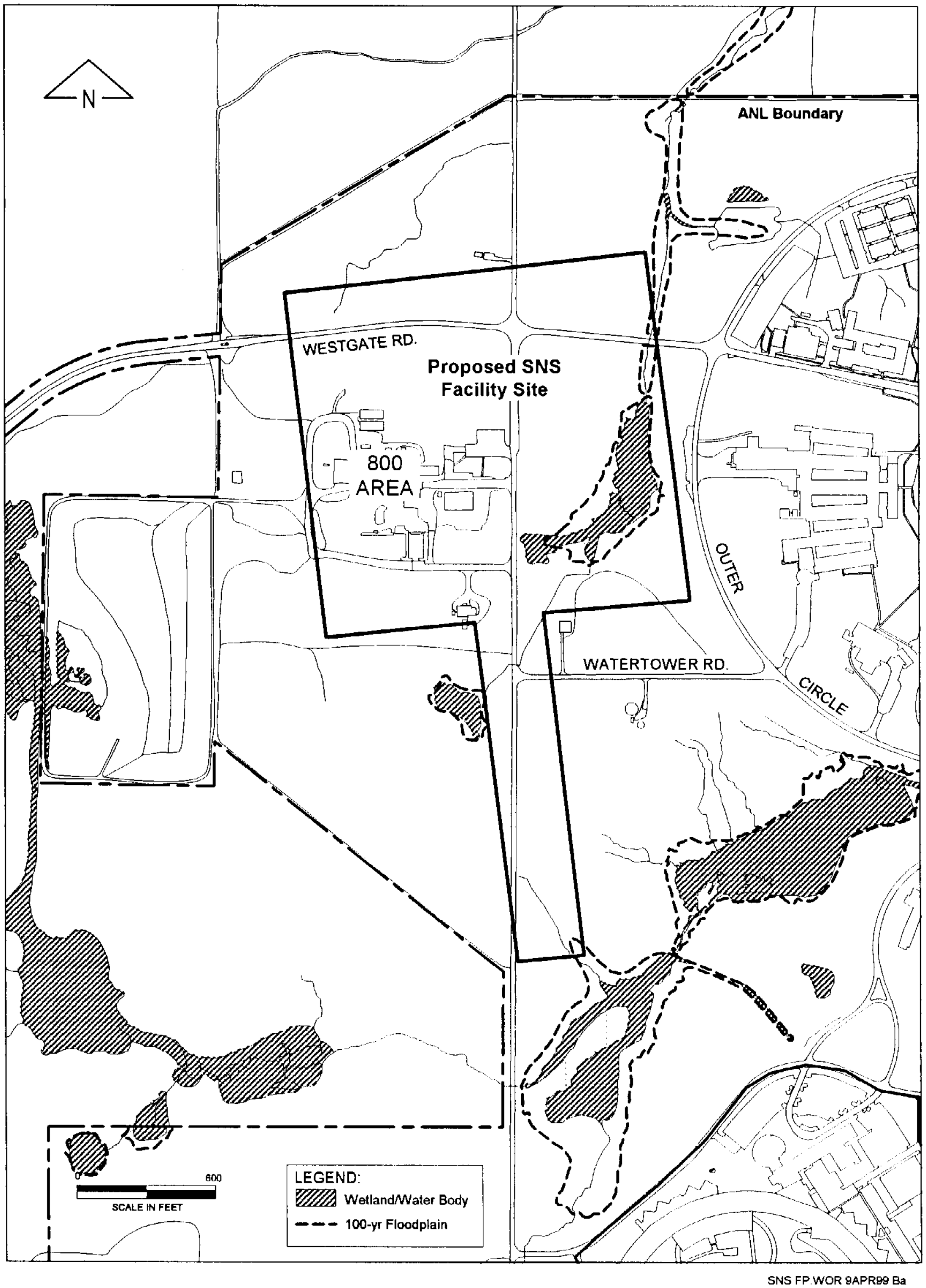

Figure 4.3.2.2-1. Floodplain areas on the proposed SNS site at ANL.

Accordingly, despite the localized, high-yield portions of sands, the overall low permeability of the silty clay should minimize the potential for offsite groundwater migration from the SNS site. Data on groundwater levels from 1988 to 1993 show seasonal fluctuations of up to several feet. The water table level and surface elevation are poorly correlated, possibly indicating the absence of significant horizontal groundwater flow. The extremely low permeability (1×10^{-7} cm/s) of the Till (SNL 1996) renders this formation unusable as a source of drinking water. The downward rate of water movement or recharge rate through the saturated zone of the Till is approximately 0.1 in./day (0.3 cm/day), or 3 ft/yr (90 cm/yr).

Little information is available on the Lemont Drift to evaluate the hydrogeological characteristics of this unit. The Drift has a clay content approximately one-half of the Wadsworth Till and is probably more permeable than the overlying unit.

The Silurian dolomite aquifer is the uppermost bedrock aquifer lying between the glacial sediments and the Maquoketa Shale. Water levels in this aquifer within the 800 Area lie at a depth of approximately 110 ft (33.5 m). Significant permeability in the dolomite occurs near the top of the unit from secondary structures such as bedding planes, joints, and fractures enhanced by solutioning. Recharge of the dolomite aquifer is primarily by precipitation that percolates downward through fractures and joints. The rate of recharge is about 4 in./yr (10 cm/yr) depending on annual precipitation. An estimated horizontal velocity in the dolomite was calculated using $K = 1.3 \times 10^{-4}$ ft/s (4×10^{-3} cm/s) with a very low gradient of 0.0005 and estimated fracture void of 10 percent. The velocity is estimated to be 20 ft/yr (1.7 cm/day).

Approximately 300 ft (90 m) below the Maquoketa Shale aquitard is a sandstone aquifer in the Ancell Group. Below the Ancell Group, older rocks contain two water-bearing sandstone units, the Galesville Sandstone and the Elmhurst-Mt. Simon Sandstone. The uppermost of the two sandstone units is the Galesville Sandstone, which is widely utilized as a source of groundwater in northern Illinois. The Elmhurst-Mt. Simon has supplied groundwater to the Chicago region in the past. The sandstone is recharged by precipitation in areas north and west of the Chicago metropolitan area where this aquifer is positioned near the surface.

Groundwater from the Silurian and Ordovician aquifers was used as ANL drinking water supplies until recently. Since 1997, water resources have been obtained from Lake Michigan (Stull 1998). Groundwater flow within the Niagaran dolomite is generally to the southeast; however, historical pumping in the eastern portion of the reservation from four ANL water supply wells has influenced the direction of flow. A large cone of depression in the dolomite potentiometric surface exists as a result of pumping an average 800,000 gpd (3 million lpd) from the supply wells since 1948. This cone extends into the western portions of ANL. Thus, movement of water within this aquifer has been generally toward the wells. The effect of the cessation in pumping will be evaluated as part of a site-wide hydrogeological assessment.

Groundwater quality representative of the 800 Area can be observed from two wells [Illinois Environmental Protection Agency (IEPA) designation G06S and G06D] about 400 ft (122 m) southwest of the proposed SNS location. G06S is screened in the shallow Till aquifer at a depth of 20 to 25 ft below ground surface and G06D is screened in the Silurian dolomite aquifer at a depth of 119 to 129 ft (36.3 to 39.3 m) below the ground surface. Each well is sampled quarterly for routine indicator parameters as well as inorganic constituents. The average concentrations from four sampling events in 1997 (ANL 1997) compared against Illinois Class I Groundwater Quality Standards (GWQS) are shown in Table 4.3.2.3-1. From the results, only manganese is elevated in respect to GWQS.

4.3.3 CLIMATE AND AIR QUALITY

The regional climate around ANL is characterized as continental with relatively cold winters and hot summers, and is slightly modified by Lake Michigan. January is the coldest month with an average of 21°F (–6°C); July is the warmest month with an average temperature of 70°F (21°C). The average annual precipitation at ANL is 31.5 in. (80 cm) and is primarily associated with thunderstorm activity in the spring and summer (Figure 4.3.3-1). Evapotranspiration in the area is estimated at 80 percent of the annual rainfall or about 25 in. (64 cm). The annual average accumulation of snow and sleet is 32.7 in. (83 cm) (DOE-CH 1997). Snow storms resulting in accumulations greater than 5.9 in. (>15 cm) occur only once or twice each year on average, and severe ice storms occur only once every 4 or 5 years (DOE-CH 1997).

4.3.3.1 Severe Weather

The area experiences about 40 thunderstorms annually (Angel 1998). Occasionally, these storms are accompanied by hail, damaging winds, or tornadoes. From 1957 to 1969 there were 371 tornadoes in the state of Illinois with more than 65 percent of tornadoes occurring during the spring months. DuPage County has been subjected to 19 tornadoes for the period from 1955 to 1995.

The theoretical probability of a 150-mph (492 km/h) tornado strike at ANL is estimated to be 3.0×10^{-5} each year, a recurrence interval of one tornado every 33,000 years (Coats and Murray 1985). ANL property has been struck by milder tornadoes, which have resulted in minor damage to power lines, roofs, and trees.

Obscured visibility in the form of fog is observed about 39 days per year in the metro Chicago area.

Table 4.3.2.3-1. Groundwater quality at ANL 800 Area.

	NH_4 (mg/L)	As (mg/L)	Cd (µg/L)	Cl^- (mg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)
G06S	<0.1	5.1	<0.1	77	28	<1.0	420
G06D	0.7	4.4	<0.1	186	2,350	<1.0	95
GWQS	10.0	50.0	5.0	200	5,000	7.5	150

	Hg (mg/L)	SO_4 (mg/L)	TDS (mg/L)	Cyanide (mg/L)	Phenol (µg/L)	TOC (mg/L)	TOX (µg/L)
G06S	<0.1	210	1,044	<0.010	<5	3.2	62
G06D	<0.1	89	899	<0.011	5.0	4.7	57
GWQS	2.0	400	1,200	0.2	100.0	-	-

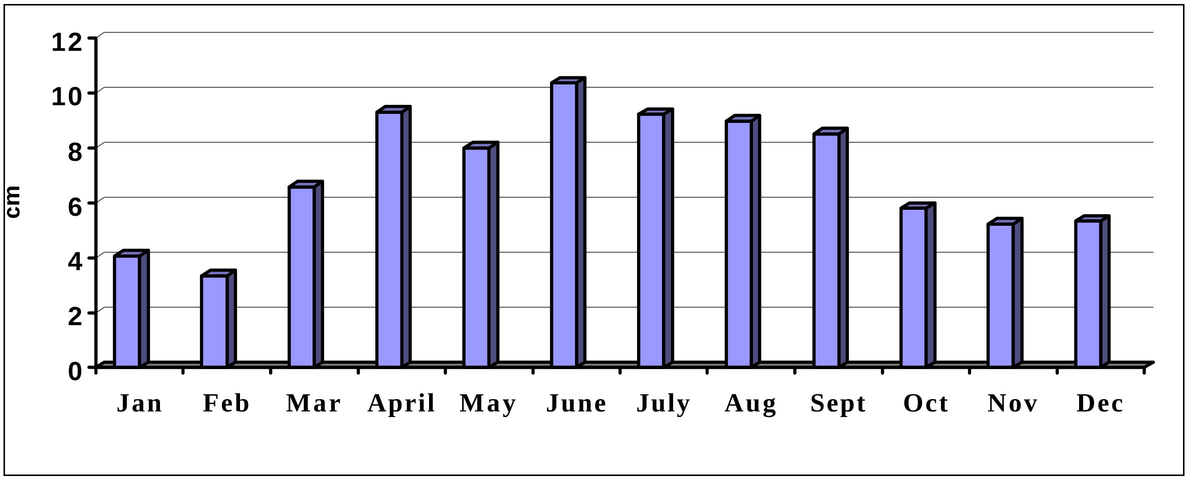

Figure 4.3.3-1. Annual monthly precipitation at ANL.

4.3.3.2 Atmospheric Dispersion

The predominant wind direction is from the south, and wind from the southwest quadrant occurs almost 50 percent of the time (Figure 4.3.3.2-1). The average wind speed at a height of 9.19 ft (2.8 m) is 7.6 mph (35 km/h); calm periods occur 3.1 percent of the time.

4.3.3.3 Air Quality

The State of Illinois has adopted the NAAQS of the Federal Clean Air Act (DOE-CH 1997) and regulates these provisions through a State Implementation Plan. <u>DuPage County is classified as severe nonattainment for ozone and attainment for all other criteria pollutants.</u>

The ambient air quality standard of concern for the proposed construction of the SNS applies to fugitive dust that results from soil disturbance of particulate matter of less than or equal to 10 micron in aerodynamic diameter (PM_{10}). The PM_{10} standard is 150 μg/m³ for an averaging time of 24 hours (not more than one exceedance per year) and 50 μg/m³ as an annual arithmetic mean. In 1995, the Naperville monitoring station reported a maximum 24-hour PM_{10} concentration of 45 μg/m³, an annual arithmetic mean concentration of 19 μg/m³ (DOE-CH 1997).

4.3.4 NOISE

The SNS site is proposed for the northwest portion of the ANL reservation in an area of obsolete buildings and structures scheduled for future demolition. Only ancillary storage is conducted in this area, and no estimate of ambient noise levels is available. The proposed SNS site is also located about 4,000 ft (1,220 m) north of the Advanced Photon Source (APS). The APS is a circular facility that produces high-energy photons similar to the SNS. The APS meets all Illinois State Noise Standards and DOE criteria for occupational safety and health.

Sensitive receptors would include both on-site workers and off-site residential populations. The proposed site would be located within 1,000 ft (305 m) of the 200 Area, which is the main complex of offices and research laboratories for ANL. In addition, residential populations exist outside the ANL reservation.

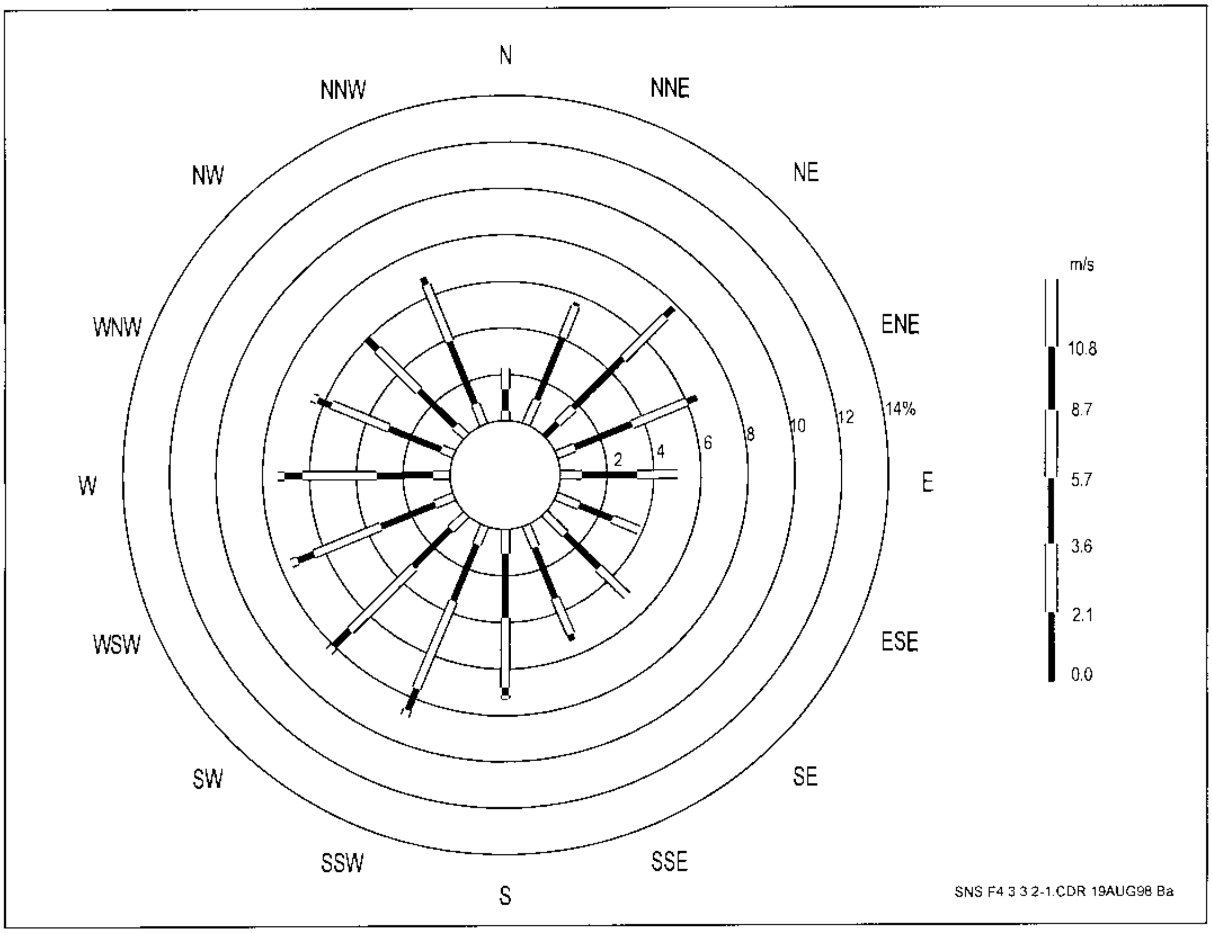

Figure 4.3.3.2-1. Windrose for ANL for the period 1992 to 1994.

Population density for the northwest quadrant adjacent to ANL is estimated at: zero for 0-1.0 miles (0-0.6 km) buffer zone, 2,990 persons for 1.0-2.0 miles (0.6-1.2 km) range, and 12,124 persons for 2.0-3.0 miles (1.2-1.8 km) range (Golchert and Kolzow 1997).

Overall ambient air quality in the vicinity of ANL is best quantified in terms of recent ambient monitoring data collected by the IEPA at nearby locations. Table 4.3.3.3-1 summarizes these data and is taken from the *Illinois Annual Air Quality Report* for 1996.

ANL contains a number of sources of conventional air pollutants, including a steam plant, oil-fired boilers, fuel-dispensing facilities, bulk chemical tanks, dust collection system, and fire training activities. The operating air pollution control permit for the steam plant requires continuous opacity and sulfur dioxide monitoring of Boiler No. 5 equipped to burn coal. No exceedances occurred during 1996. Table 4.3.3.3-2 provides the annual emissions for ANL.

Table 4.3.3.3-1. Summary of 1996 monitoring data in the vicinity of ANL.

Pollutant Averaging Time	Nearest Monitor Location	Maximum 1st	2nd	3rd	4th	NAAQS IAAQS	Number of Exceedances
PM-10	DuPage Co.						
24-hour	Naperville	47.0	42.0	35.0	34.0	150.0 μg/m^3	0
Annual		20.0				50.0 μg/m^3	0
Ozone	DuPage Co.						
1-hour	Lisle	0.102	0.087	0.087	0.085	0.12 ppm	0
NO_x	Cook Co. Schiller						
Annual	Park	0.032	—	—	—	0.05 ppm	0
SO_2	DuPage Co. Lisle						
3-hour		0.053	0.052	—	—	0.5 ppm	0
24-hour		0.021	0.019	—	—	0.14 ppm	0
Annual		0.003	—	—	—	0.03 ppm	0
CO	Cook Co. Hoffman						
1-hour	Estates	3.1	2.9	2.6	—	35.0 ppm	0
8-hour		1.9	1.9	1.8	—	9.0 ppm	0
Lead	DuPage Co.						
Quarterly	Bensenville	0.04	0.04	0.03	0.02	1.5 μg/m^3	0

Source: IEPA 1997.

Table 4.3.3.3-2. Annual emission report for ANL.

Pollutant	CO	NO_x	PM	SO_2	VOC
Total (tons/yr)	30.9	249.2	1.46	123.3	2.6

4.3.5 ECOLOGICAL RESOURCES

This section provides a general description of the ecological resources for the proposed SNS site and the surrounding area. The discussions are based on information readily available from other sources. Site-specific surveys were done for protected species and wetlands. All other information was obtained from existing publications. For the most part, the impacts from construction and operation of the proposed SNS would be minor. Therefore, much of the information presented here is summary in nature. Greater detail can be obtained from the references compiled for this section.

4.3.5.1 Terrestrial Resources

The predominant vegetation community on the proposed SNS site is open grassland, consisting of scattered areas of old-field and intermittently mowed areas (Figure 4.3.5.1-1). The dominant graminoid species in both mowed and unmowed areas are non-native grasses commonly found on disturbed soils at ANL. Orchard grass (*Dactylis glomerata*), smooth brome (*Bromus inermis*), tall fescue (*Festuca elatior*), timothy (*Phleum pratense*), and quack grass (*Agropyron repens*) are abundant in these areas, while native species, such as big bluestem (*Andropogon gerardii*), indian grass (*Sorghastrum nutans*), and prairie

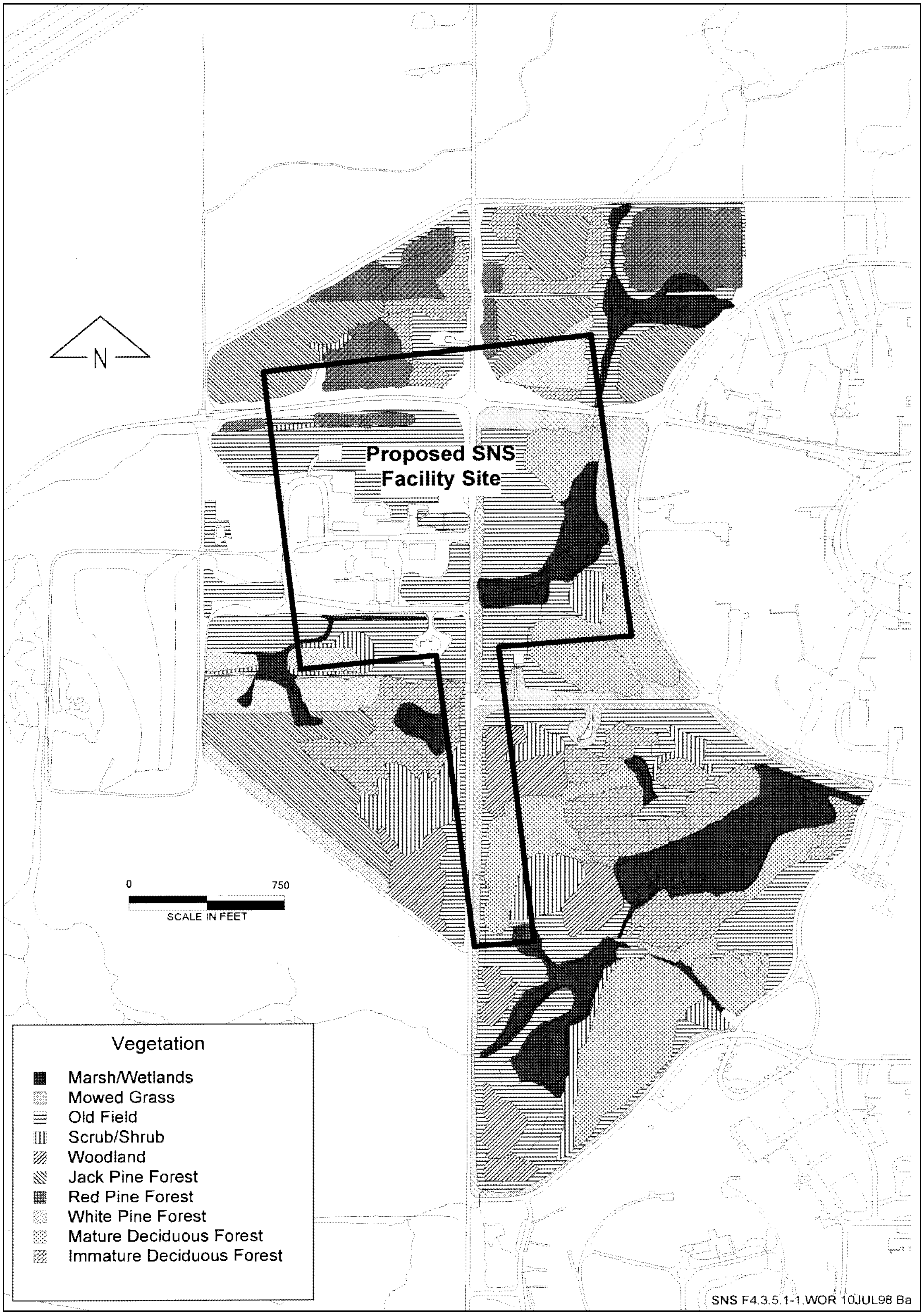

Figure 4.3.5.1-1. Vegetative cover at the proposed ANL SNS site.

cordgrass (*Spartina pectinate*) occur in small isolated patches in less disturbed areas. Other common herbaceous species in disturbed areas include crown vetch (*Coronilla varia*), wild carrot (*Daucus carota*), Canada thistle (*Cirsium arvense*), and yarrow (*Achillea millefolium*), all of which are non-natives. Old-field communities of less recent disturbance support a number of native species such as wild bergamot (*Monarda fistulosa*), Missouri ironweed (*Vernonia missurica*), and germander (*Teucrium canadense*). Undisturbed native prairie communities do not occur in the vicinity of the proposed site.

Scrub-shrub communities in early successional stages occur in the southwestern and southeastern portions of the proposed site. These communities have remained relatively undisturbed in the past decade or more and support many species found in the open grasslands. Low shrubs form scattered clumps in these areas and include gray dogwood (*Cornus racemosa*), honeysuckle (*Lonicera* spp.), and multiflora rose (*Rosa multiflora*). These communities often intergrade with forested areas, forming dense thickets of low shrubs in addition to common buckthorn (*Rhamnus cathartica*), wild black cherry (*Prunus serotina*), box elder (*Acer negundo*), and riverbank grape (*Vitis riparia*).

Woodland communities with relatively open canopies occur in the southern portion of the proposed site. Small woodlands of medium to large size box elder are scattered to the southwest. Associated species include wild black cherry, honeysuckle, and many herbaceous species such as white snakeroot (*Eupatorium rugosum*), garlic mustard (*Alliaria petiolata*), crown vetch, orchard grass, and smooth brome. A large open woodland, with less than 50 percent estimated canopy cover, lies to the southeast. Medium and large cottonwood (*Populus deltoides*) are the dominant trees, with medium size green ash (*Fraxinus pennsylvanica var subintegerrima*), and medium and small box elder. Scattered shrubs and small common buckthorn are interspersed among a predominantly graminoid herbaceous stratum of tall fescue and silky wild rye (*Elymus villosus*).

Forested communities in the vicinity of the proposed site include a wide variety of forest types. Several fairly large coniferous forests occur to the north and southwest. These areas were planted with young pines in the 1950s and consist of three types distinguished by the species planted. Jack pine (*Pinus banksiana*) forest is the most common and occurs in five distinct forest blocks to the north and southwest. Red pine (*Pinus resinosa*) forest occurs in seven areas of varying size to the north, and white pine (*Pinus strobus*) forest consists of six relatively small areas north and southwest. These pine forests are characterized by a high density of trees of uniform size. Associated deciduous species typically include scattered wild black cherry, with common buckthorn, box elder, and honeysuckle often present. Herbaceous species include garlic mustard, white snakeroot, stickseed (*Hackelia virginiana*), and white avens (*Geum canadense*).

Mature deciduous forest occurs in three blocks in the eastern portion of the site. These forests have an overstory of medium and large size red oak (*Quercus rubra*), white oak (*Quercus alba*), bur oak (*Quercus macrocarpa*), and black oak (*Quercus velutina*), in varying proportions. Understory species include various sapling oaks and wild black cherry. These forests support a high diversity of herbaceous, mostly native, species including common oak sedge (*Carex* *pensylvanica*), white snakeroot, stickseed, woodland knotweed (*Polygonum virginianum*), spring beauty (*Claytonia virginica*), enchanter's nightshade (*Circaea lutetiana var canadensis*), and the non-native garlic mustard. These oak forests contain many large oaks exceeding 2 ft (0.6 m) in diameter and have very low occurrences of invasive non-native species such as common buckthorn or honeysuckle.

Areas of immature deciduous forest occur throughout the proposed site. The dominant woody species are box elder, green ash, cottonwood, wild black cherry, and black locust (*Robinia pseudaccacia*). Associated species include common buckthorns, honeysuckle, garlic mustard, white snakeroot, and orchard grass.

A large portion of the proposed site was disturbed in 1996 and 1997 by activities associated with facility removal, resulting in limited wildlife use. However, an area of high diversity of habitats with little recent disturbance still exists in the vicinity of the proposed site, supporting a large number of wildlife species. Many species that have been observed on the ANL site are listed in Messenger et al. (1969, as cited in DOE-CH 1990) and include 9 species of amphibians and reptiles, 86 species of birds, and 26 species of mammals. Amphibians observed in wetlands on the site include leopard frog, spring peeper, and chorus frog. A variety of grassland, forest, and wetland bird species are found on or near the proposed site. Observed species include red-tailed hawk, American goldfinch, indigo bunting, downy woodpecker, red-winged blackbird, great blue heron, Canadian goose, mallard, great egret, pied-billed grebe, and black-crowned night heron. Canadian geese have been observed nesting on the proposed site. Mammals observed on the proposed site include muskrat, beaver, woodchuck, raccoon, fox squirrel, and northern gray squirrel. The proposed ANL site supports thriving populations of the native white-tailed deer and introduced fallow deer, which are frequently observed. Beavers and muskrats have intermittently occupied wetlands on and in the vicinity of the proposed site.

4.3.5.2 Wetlands

A variety of wetland types, totaling approximately 17.3 acres (7 ha), occur in and around the proposed SNS site (refer to Figure 4.3.5.1-1). Although most of these wetlands have been disturbed to some degree in the past, they continue to retain wetland value, such as wildlife habitat and flood control.

A large wetland, approximately 4 acres (1.6 ha), lies in the northeast part of the proposed site. This wetland receives surface flows from an intermittent stream to the south and storm sewer drainage to the east. Surface water is generally present throughout the year within the stream channel and storm drainage. Areas not inundated are saturated within 12 in. (30 cm) of the surface for extended periods. Common cattail (*Typha latifolia*) is the dominant species in the eastern portion of the wetland and in the southern part of the stream channel, while reed canary grass (*Phalaris arundinacea*), a non-native species, is dominant within most of the stream channel and much of the central portion. Although beavers had built a dam and lodge in this wetland in the past, they have not occupied this area since 1993.

A 2.7-acre (1.1-ha) wetland in the eastern portion of the proposed site, almost totally within the footprint of the SNS, includes a small pond at the northern end. This wetland receives surface flows from storm sewer drainages to the east and west and an excavated channel to the west. Surface water is present throughout the year within the pond. The southwestern arm is inundated early in the growing season and generally has a narrow, shallow flow during dry months of the year. Most of this wetland, other than the pond, is dominated by narrow-leaf cattail (*Typha angustifolia*). Beavers also built a dam and lodge in this wetland, yet they have not occupied this area since 1993.

A small, 0.4-acre (0.2-ha) wetland to the southeast of the proposed site receives surface water drainage from two nearby water towers. Drainage is present throughout the year and enters at the north end forming a shallow stream, which dissipates at the south end. The dominant species in this marshy wetland are common and narrow-leaf cattail.

A large wetland to the southeast of the proposed site contains surface water throughout the year that fluctuates in depth according to the level of a beaver dam at the northeast end. This wetland is 7.5 acre (3.1 ha) and receives surface flow from a small stream to the southwest (Freund Brook) and storm sewer drainages to the north. Lower water levels allow wetland plants to colonize areas that under higher levels support only submerged aquatic vegetation and non-rooted floating plants. The dominant species in this wetland are common and narrow-leaf cattail and common reed (*Phragmites australis*). Three state-listed endangered bird species have been observed at this wetland: great egret, black-crowned night heron, and pied-billed grebe.

A shallow area along Freund Brook lies immediately upstream of the previous wetland. Surface water is present throughout most of the year, although flows are sluggish during summer months. Dominant species along the muddy stream margin are large-flowered water plantain (*Alisma triviale*), rice cut-grass (*Leersia oryzoides*), lady's thumb (*Polygonum persicaria*), and marsh purslane (*Ludwigia palustris var americana*). A low marshy area along a tributary to the southeast of Freund Brook contains shallow surface water much of the year and supports rice cut grass, large-flowered water plantain, and river bulrush (*Scirpus fluviatilis*).

An 0.8-acre (0.3-ha) seasonally flooded wetland in the southern portion of the proposed site and within the SNS footprint is inundated early in the growing season, but surface water is absent by mid-summer. Dominant species are wild mint (*Mentha arvensis var villosa*), smartweed, (*Polygonum* sp.), sedge (*Carex* sp.), and white grass (*Leersia virginica*). The wetland margin is lined by mature cottonwood and black willow (*Salix nigra*) trees. Hydrologic input is primarily groundwater discharge. However, a minor surface flow in spring is received from an excavated channel to the northwest.

A 1.4-acre (0.6-ha) wetland system to the south includes a narrow channel receiving surface water from the landfill area on the west and storm sewer drainage on the north. The southern portion of the wetland is saturated early in the growing season but is seldom inundated. Surface water is present in the channel throughout the year downstream of the storm drain outlet. Common cattail is the dominant species in the channel, while dominants in the remainder include reed canary grass, swamp marigold (*Bidens aristosa*), and sedges.

A small, 4,050-ft² (380-m²) seasonal wetland occurs within a drainage ditch in the western portion of the proposed site. Surface water is present early in the growing season but usually absent by late summer. Dominant species are narrow-leaved cattail, barnyard, grass (*Echinochloa crusgalli*), common beggar's ticks (*Bidens frondosa*), and great bulrush (*Scirpus validus* var *creber*).

4.3.5.3 Aquatic Resources

There is little information on aquatic biotic resources at ANL. Section 4.3.2.1 presents a physical description of the streams at ANL. Sawmill Creek flows through the eastern portion of the site and is classified by IEPA as a general use water body. This classification provides for the protection of indigenous aquatic life, primary and secondary contact recreation, and agricultural and industrial uses. The biotic community of Sawmill Creek is relatively sparse, reflecting the high silt load and steep gradient of the creek. The invertebrate fauna consists primarily of blackflies, midges, isopods, and flatworms. Clean water invertebrates, such as mayflies or stoneflies, are rare or absent. Fish populations in Sawmill Creek are scarce, represented by minnows, sunfishes, and catfish.

Freund Brook flows just south of the proposed SNS site. The gradient of this stream is relatively steep, and riffle habitat predominates. The substrate is coarse rock and gravel on a firm mud base. Aquatic macrophytes include common arrowhead, pondweed, duckweed, and bulrush. Invertebrate fauna consists primarily of dipteran larvae, crayfish, caddisfly larvae, and midge larvae. Few fish are present because of low summer flows and high temperatures.

4.3.5.4 Threatened and Endangered Species

DOE is in the process of consulting with the USFWS at the State of Illinois regarding whether or not construction and operation of the proposed SNS at ANL would jeopardize the habitat of any threatened or endangered species, and appropriate mitigation measures. USFWS responded, stating that the only federally listed species that may be affected by the proposed SNS project would be the Hine's emerald dragonfly. The State of Illinois has not yet responded. Appendix D presents the letters of consultation on protected species.

There are no federally listed threatened or endangered species known to occur in the vicinity of the proposed site or on the ANL site. The federally listed endangered Indiana bat (*Myotis sodalis*) and the federally listed endangered Hine's emerald dragonfly (*Somatochlora hineana*) are known to occur in the surrounding area (Stull 1997).

Three state-listed endangered bird species, great egret (*Casmerodius alba*), black-crowned night heron (*Nycticorax nycticorax*), and pied-billed grebe (*Podilymbus podiceps*), have been observed in the wetlands in the southeast portion of the proposed site, but are not known to breed there or elsewhere on ANL. Hairy marsh yellow cress (*Rorippa islandica* var *hispida*), state-listed as endangered, and Kirtland's snake (*Clonophis kirtlandii*), state-listed as threatened, have been observed on the ANL site, but not in the vicinity of the proposed SNS site.

Five state-listed endangered species: river otter (*Lutra canadensis*), white lady's slipper (*Cypripedium candidum*), red-shouldered hawk (*Buteo lineatus*), slender sandwort (*Arenaria patula*), and inland shadblow (*Amelanchier interior*), and two state-listed threatened species: early fen sedge (*Carex crawei*) and marsh speedwell (*Veronica scutellata*) have not been observed at the ANL site but occur in the area.

4.3.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The ROI for the SNS at the proposed ANL site includes Cook, DuPage, Kane, and Will Counties, as shown in Figure 4.3.6-1. Approximately 95 percent of ANL employees reside in this region. The region includes the cities of Chicago, Chicago Heights, Oak Park, Naperville, Elmhurst, Elgin, Aurora, and Joliet.

This section provides a description of the following socioeconomic and demographic characteristics:

- Demographics
- Housing
- Infrastructure
- Local economy
- Environmental justice

4.3.6.1 Demographic Characteristics

Population trends and projections for each of the counties in the region are presented in Table 4.3.6.1-1. Of the four counties, Cook has the largest population, with 76 percent of the 1996 regional population of 6,754,029. DuPage County accounted for 13 percent of the regional population, Will County for 6 percent, and Kane County accounted for the remaining 5 percent. It is anticipated that the regional population will increase to more than 6.9 million by the year 2000 and to more than 7.2 million by the year 2010. (This is equivalent to an annual growth rate of more than 10 percent between 1990 and 2010.)

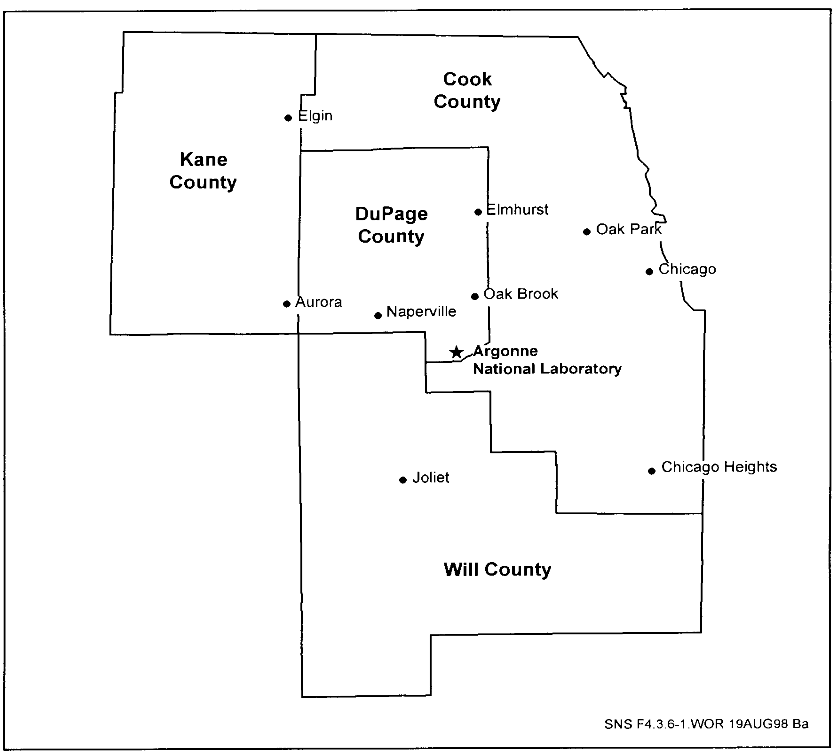

Figure 4.3.6-1. Map showing socioeconomic ROI for ANL.

Table 4.3.6.1-1. ANL regional population trends and projections.

County	1980	1990	1995	2000	2010
Cook	5,253,628	5,105,044	5,136,877	5,200,563	5,271,891
DuPage	658,858	781,689	853,458	884,949	928,133
Kane	278,405	317,471	359,950	386,997	461,453
Will	324,460	357,313	413,379	468,930	608,606
Region	6,515,351	6,561,517	6,763,664	6,941,439	7,270,083

Sources: U.S. Bureau of Census 1996; U.S. Bureau of Census 1990.

Table 4.3.6.1-2. Population for incorporated areas within the ANL region.

Communities	1990	1997
Chicago	2,783,726	2,768,483
Chicago Heights	33,072	NA
Oak Park	53,468	53,648
Naperville	85,351	121,712
Elmhurst	42,029	43,080
Oak Brook	9,178	NA
Aurora	99,581	117,500[a]
Elgin	77,010	85,068
Joliet	76,836	90,647

[a] 1996 data.
NA - Not available.
Source: U.S. Bureau of Census 1990.

Population data for the cities in the region are presented in Table 4.3.6.1-2. During the 1990s Chicago's population decreased by over 15,000 individuals, while population in the surrounding eight communities increased by 3.2 percent between 1990 and 1997. During this period, communities such as Naperville and Joliet grew at a particularly rapid pace (42 percent and 20 percent, respectively).

Population by race and ethnicity for the region is presented in Table 4.3.6.1-3. The 1990 census data reflect different racial and ethnic compositions in the four counties. All four counties are predominantly White. The African-American population comprises 26 percent in Cook County, 11 percent in Will County, and less than 10 percent in the other two counties.

4.3.6.2 Housing

Regional housing characteristics are presented in Table 4.3.6.2-1. In 1990, vacancy rates in the region ranged between a low of 4 percent in Kane County to a high of 8 percent in Cook County. Median home values varied considerably among the cities and villages in the region in 1990, from a low of $62,500 in Chicago Heights to $477,000 in Oak Brook. Similarly, median rents varied from approximately $400 to $650 per month.

Table 4.3.6.1-3. 1990 population by race and ethnicity for the ANL region.

All Persons, Race/ Ethnicity	Cook County		DuPage County		Kane County		Will County		Total	
	Number	% [a]	Number	% [a]	Number	% [a]	Number	% [a]	Number	% [a]
All Persons	5,105,087	100	781,689	100	317,471	100	357,313	100	6,561,560	100
Caucasian	3,208,115	63	714,905	91	270,301	85	303,420	85	4,496,741	69
African American	1,314,859	26	15,462	2	18,981	6	38,361	11	1,387,663	2
American Indian[b]	10,387	<1	962	<1	612	<1	692	<1	12,653	<1
Asian/ Pacific Islander	188,467	3	55,096	7	4,320	1	4,774	1	252,657	4
Hispanic of any race[c]	677,949	13	34,567	4	42,234	13	19,524	5	774,274	12
Other Races	383,259	7	10,703	1	23,257	7	10,066	3	427,285	6

[a] Percentages may not total 100 due to rounding.
[b] Numbers for Aleuts and Eskimos were placed in the “other” category given their small number.
[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from the total for all persons.
Source: U.S. Bureau of Census 1990.

Table 4.3.6.2-1. Housing summary for the ANL region, 1990.

	Cook County		DuPage County		Kane County		Will County	
	Number	Percent[a]	Number	Percent[a]	Number	Percent[a]	Number	Percent[a]
Total Housing Units	2,051,833	100	292,537	100	111,496	100	122,870	100
Occupied	1,879,488	92	279,344	95	107,176	96	116,933	95
Vacant	172,345	8	13,193	5	4,320	4	5,937	5
Median Home Value, Owner Occupied	$102,100	NA	$137,100	NA	$102,500	NA	$89,900	NA
Gross Rent	$478	NA	$625	NA	$508	NA	$453	NA

[a] May not total 100 due to rounding.
N/A - Not applicable.
Source: U.S. Bureau of Census 1990.

4.3.6.3 Infrastructure

This section characterizes the region's community services with indicators such as education, health care, and public safety.

4.3.6.3.1 Education

Information regarding school districts within the region is presented in Table 4.3.6.3.1-1.

The school districts in the region all receive funding from local, state, and federal sources, but the percentage received from each source varies. In 1994, expenditures for elementary and secondary schools ranged from a low of $3,146 per student to $10,416. By comparison, the state average was $6,158.

4.3.6.3.2 Health Care

Table 4.3.6.3.2-1 shows that there are over 70 hospitals serving the Metropolitan Chicago Region (60 of which are in Cook County) with a combined total of nearly 21,000 acute care beds. In 1996, 51 percent of these beds were available on any given day, which is considered sufficient to meet the health care needs of the local population.

4.3.6.3.3 Police and Fire Protection

Table 4.3.6.3.3-1 gives the number of full time law enforcement officers for the incorporated communities in the ANL region. Fire protection for ANL is provided by the Argonne Fire Department located onsite. The Argonne Fire Department has 23 employees who are all certified hazardous material technicians and 16 are trained as paramedics. The Fire Department has two pumper engines, two ambulances, a forest-fire rig, and a command vehicle. The Argonne Fire Department is part of the Mutual Aid Box Alarm System for Northern Illinois (Division 10) and can receive support from other member fire departments. The Argonne Fire Department routinely supports and is supported by the Lemont Fire Department, Darien-Woodridge Fire Protection District, and the Tri-State Fire Protection District (Veerman, 1999).

4.3.6.4 Local Economy

This subsection provides information on the economy of the region, including employment, education, income, and fiscal characteristics.

Table 4.3.6.3.1-1. Public school statistics in the ANL region, 1995 - 1996 school year.

District	Number of Schools	Student Enrollment[a]	Teachers[a]	Teacher/Student Ratio (1998)
Cook	663	1,324,299	63,000	1:21
DuPage	221	138,000	8,900	1:16
Kane	136	87,000	5,000	1:17
Will	117	101,606	5,300	1:19

[a] Full-time equivalent figures.
NA – Not available.
Source: Illinois Board of Education 1996.

Table 4.3.6.3.2-1. Hospital capacity and usage in the ANL region (1996).

County	Number of Hospitals	Number of Acute Beds	Annual Bed-Days Used[a] (%)
Cook	60	17,647	52
DuPage	5	1,489	52
Kane	5	1,135	44
Will	2	697	51

[a] Based on the number of people discharged and the average length of stay divided by total beds available annually.

Source: The American Hospital Directory, Inc., 1998.

Table 4.3.6.3.3-1 Full-time law enforcement officers for incorporated areas within the ANL region (1996).

Community	Officers
Cook County	528
DuPage County	142
Kane County	94
Will County	276
Chicago	13,032
Chicago Heights	86
Oak Park	115
Naperville	147
Elmhurst	68
Oak Brook	39
Aurora	242
Elgin	151
Joliet	224
Lemont	23
Darien	30
Woodridge	46

Source: Department of Justice, 1997.

4.3.6.4.1 Employment

Regional employment data for 1995 are summarized in Table 4.3.6.4.1-1. Since 1990, unemployment has decreased in the four counties within the region: the largest reduction in unemployment occurred in Cook County (from 6.7 percent in 1990 to 5.6 percent in 1995). Total 1995 employment for the region was over 3.3 million jobs. The "services" sector made up 29 percent of this total, and about one-third was associated with "retail trade" and "manufacturing."

Table 4.3.6.4.1-2 presents employment by industry for the region. Services, retail trade, and manufacturing are the principal economic sectors in the region.

4.3.6.4.2 Income

In 1995, total regional income was approximately $187 billion. Income data for the region are presented in Table 4.3.6.4.2-1. Per capita incomes in 1995 in the region varied from $22,869 in Will County to $34,840 in DuPage County. In 1989, the percentage of persons below the poverty level was approximately 14.2 percent in Cook County, 6.8 percent in Kane County, 6.0 percent in Will County, and 2.7 percent in DuPage County.

4.3.6.4.3 Fiscal Characteristics

Municipal and county general fund revenues in the ROI are presented in Table 4.3.6.4.3-1. The general funds support the ongoing operations of local governments as well as community services such as police protection and parks and recreation. Cook, Kane, and DuPage Counties rely on local taxes the most for general revenue funds. Intergovernmental transfers constitute less than 20 percent of the general fund in Kane and DuPage Counties and only 3 percent in Cook County. In contrast, Will County's general fund relies mainly on intergovernmental transfers for 40 percent of its revenue and local taxes for another 36 percent.

4.3.6.5 Environmental Justice

Figures 4.3.6.5-1 and 4.3.6.5-2 illustrate distributions for minority and low-income populations residing within 50 miles (80 km) of ANL. The definitions of minority and low-income populations and the methodology for assessing potential environmental justice effects are given in Section 5.4.6.5.

Table 4.3.6.4.1-1. ANL regional employment data, 1995.

County	Civilian Labor Force	Employed	Unemployed	Unemployment Rate (%)
Cook	2,599,063	2,454,314	144,749	5.6
DuPage	493,989	477,183	16,806	3.4
Kane	193,742	184,303	9,439	4.9
Will	213,234	202,216	11,018	5.2
Region	3,500,028	3,318,016	182,012	5.2
State of Illinois	6,054,954	5,547,300	368,837	5.1

Sources: Illinois Center for Government Studies 1990 and 1995; U.S. Bureau of Census 1990.

Table 4.3.6.4.1-2. Employment by industry for the Argonne region of influence, by county, and for the State of Illinois - 1995.

Economic Characteristic	Cook County	DuPage County	Kane County	Will County	Region of Influence	State of Illinois
Employment by Industry (1995)						
Farm	570	319	1,332	1,421	3,642	99,044
Agricultural Services	13,749	5,051	2,396	2,897	24,093	57,723
Mining	3,497	799	330	378	5,004	27,679
Construction	114,757	33,387	11,359	14,042	173,545	983,542
Manufacturing	443,455	75,669	37,998	19,607	576,629	983,542
Transportation and Public	197,075	36,744	4,967	8,168	246,954	366,356
Wholesale Trade	185,204	56,170	10,180	6,317	257,871	375,073
Retail Trade	467,383	111,156	33,619	26,667	638,825	1,115,010
Finance, Insurance, and Real Estate	336,333	54,512	14,696	9,116	414,657	589,697
Services	1,050,535	208,787	59,542	43,484	1,362,348	2,068,377
Government	370,413	44,539	18,601	20,575	457,128	858,795
Total Employment	3182971	627,033	195,020	152,672	4,157,696	6,854,787

Source: Regional Economic Information for Cook, DuPage, Kane, and Will Counties, and State of Illinois, 1990-1995 (U.S. Bureau of Census 1990).

Table 4.3.6.4.2-1. Measures of ANL regional income.

Area	Median Household Income 1989($)	Per Capita Income 1995 ($)
Cook County	32,673	27,153
DuPage County	48,876	34,840
Kane County	40,080	24,796
Will County	41,195	22,869
State of Illinois	32,252	25,293

Sources: U.S. Bureau of the Census 1990; Northern Illinois Planning Commission 1985-95.

Table 4.3.6.4.3-1. Municipal and county general fund revenues in the ANL region, FY 1996.

	Cook County		DuPage County		Kane County		Will County	
Revenue by Source	**($)**	**Percent[a]**	**($)**	**Percent[a]**	**($)**	**Percent[a]**	**($)**	**Percent[a]**
Local Taxes	587,090	71	48,774	51	21,713	57	37,726	36
Licenses and Permits	162,239	20	0[a]	N/A	1,343	4	3,335	3
Fines and Forfeitures	0[a]	N/A	23,909	25	2,186	6	943	1
Charges for Service	0[a]	N/A	0[a]	N/A	6,238	16	16,682	16
Intergovernmental	21,260	3	11,476	12	5,914	16	41,441	40
Interest	3,805	<1	6,694	7	457	1	2,901	3
Miscellaneous Income	24,018	3	4,782	5	82	<1	423	<1
Total Revenues	827,195	100	95,635	100	37,933	100	103,452	100

[a] Accounted for in other revenue sources.
N/A - Not applicable.
Percentages may not total 100 due to rounding.
Source: Comprehensive Annual Financial Reports 1997b.

Approximately 8,030,000 people live within a 50-mi (80-km) radius of the proposed ANL site. Minorities comprise 33.5 percent of this population. In 1990, minorities comprised 24.1 percent of the population nationally and 22 percent of the population in Illinois. There are no federally recognized Native American roups within 50 miles (80 km) of the proposed site. The percent of persons below the poverty level is 11.4 percent, which compares with the 1990 national average of 13.1 percent and a statewide figure of 22 percent (U.S. Census 1990).

4.3.7 CULTURAL RESOURCES

ANL is located in the Illinois and Michigan Canal National Heritage Corridor, which is an area known to have a long and complex cultural history. With the exception of the Paleo Indian Period (13,000 to 8,000 B.C.), artifacts representative of all periods in the cultural chronology of Illinois have been documented in the ANL area through professional cultural resource investigations and interviews with local artifact collectors (Golchert and Kolzow 1997: 1-18).

Archaeological surveys have been conducted throughout all of ANL (Wescott 1997: 2). As a result of these surveys, 43 prehistoric archaeological sites have been identified. These include base camps, special purpose camps, and chert quarries (Golchert and Kolzow 1997: 1-18). Three of these sites are eligible for listing on the NRHP, and 19 sites are ineligible for listing. The eligibility of the remaining 21 prehistoric sites has not been determined.

Archaeological surveys of ANL have identified six Historic Period archaeological sites. Three of these exist as historic components on sites that also contain prehistoric components. These sites are representative of farmsteads that were active prior to 1946. One site has been determined to be ineligible for listing on the NRHP. The NRHP eligibility of the other five sites has not been determined.

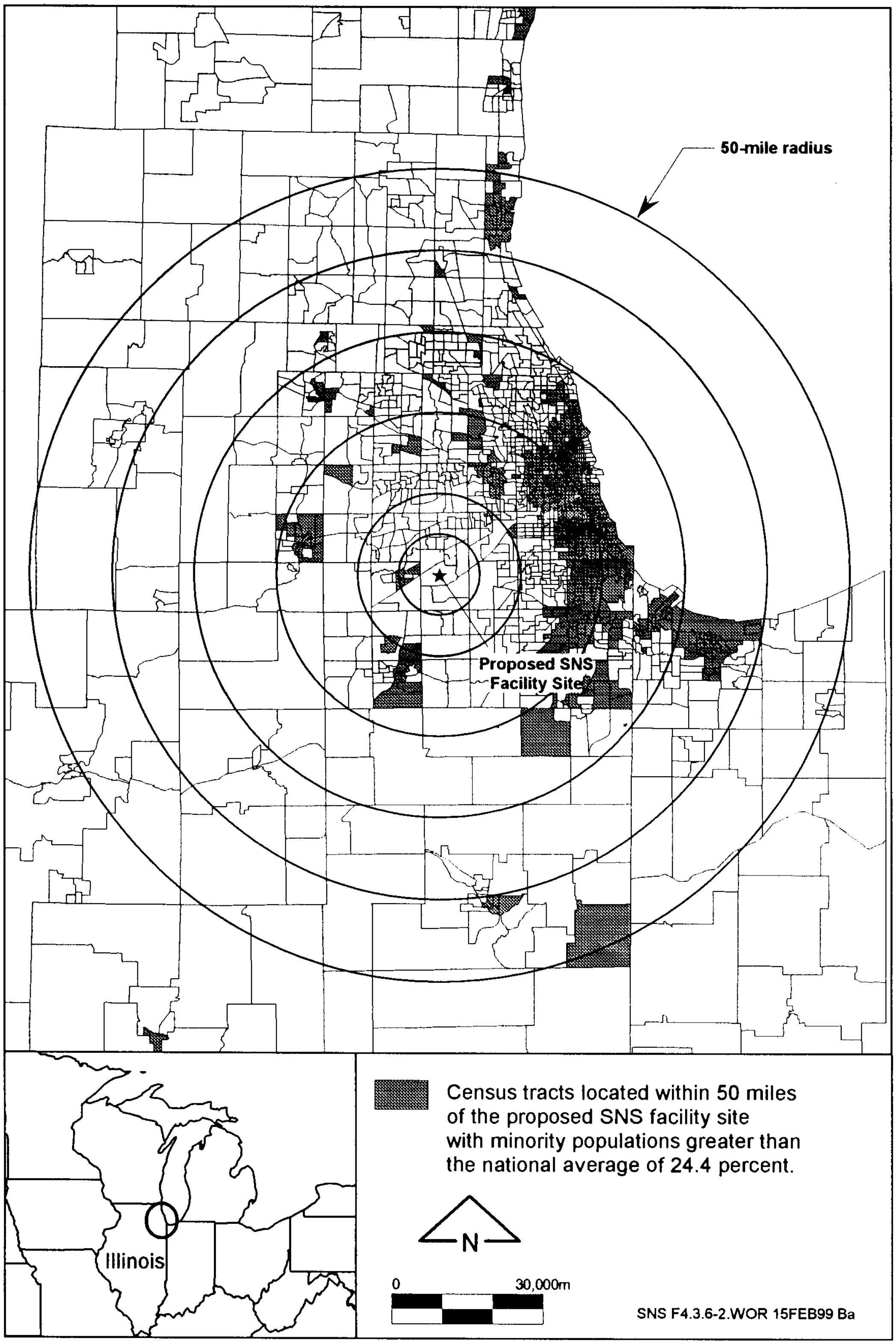

Figure 4.3.6.5-1. Distribution of minority populations at ANL.

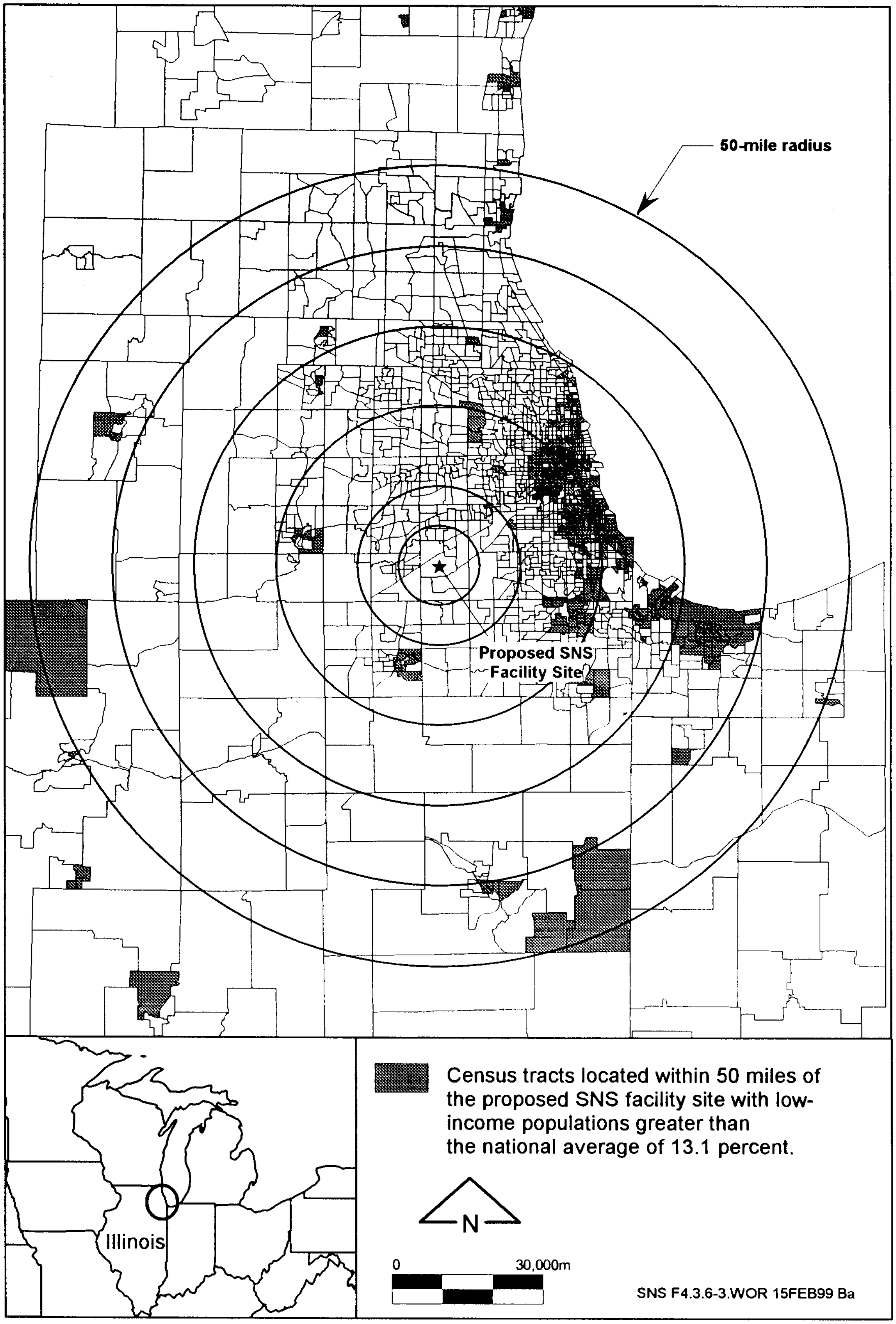

Figure 4.3.6.5-2. Distribution of low-income populations at ANL.

A formal survey of ANL for historic resources other than archaeological sites (buildings, landscape features, equipment, etc.) has not been conducted (Wescott 1997: 2). However, the former CP-5 Reactor, Experimental Boiling Water Reactor, and Argonne Thermal Source Reactor date to the Cold War Period and may be of historical significance. A formal NRHP eligibility evaluation (Porubcan 1996, as cited in DOE-CH 1997) of these facilities was submitted to the Illinois Historic Preservation Agency on August 14, 1996. However, at the request of the agency, the final eligibility of these facilities for listing on the NRHP has not been determined, pending the development of a historic context addressing the role of ANL in the development of nuclear research, experimentation, and technology in the state of Illinois and the United States (Golchert and Kolzow 1997: 2-47).

The proposed SNS site at ANL and the area surrounding it have been surveyed for prehistoric and historic archaeological sites by ANL and Midwest Archaeological Research Services, Inc. (Wescott 1997: 3). The results of these surveys have been reported in Curtis et al. (1987), Elias and Greby (1990), Bird (1992), and Demel (1993a, 1993b) (all cited in Wescott 1997). However, this area has not been surveyed formally for historic structures and features. The occurrence of cultural resources on the proposed SNS site and at locations in its vicinity is discussed in this section of the FEIS.

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at ANL. In addition, the locations of ancillary structures such as a retention basin and a switchyard have not been determined. As a result, such areas could not be surveyed for cultural resources. However, the eventual establishment of these areas would proceed in such a manner as to avoid known cultural resource locations. If the proposed SNS site at ANL were chosen for construction, these areas would be surveyed for cultural resources prior to the initiation of construction-related activities within them.

The locations of archaeological and historical sites are not provided as part of the cultural resource descriptions in this section of the FEIS. These omissions are consistent with DOE and University of Chicago efforts to protect cultural resources from vandalism by not revealing their locations in documents available to the general public. Because several of the original reports cited in this section show the locations of cultural resources in ANL, copies of them are not available in the DOE public reading rooms established as part of the SNS EIS process.

4.3.7.1 Prehistoric Resources

No prehistoric archaeological sites have been identified on the proposed SNS site. However, site 11DU207 is located adjacent to the proposed SNS site in an area that may be subject to construction activities and heavy equipment movement under the proposed action. It is characterized by a low-density surface scatter of chert debris resulting from the manufacture and/or sharpening of stone tools. The prehistoric cultural association of these remains is unknown. ANL has not assessed this site for NRHP eligibility.

4.3.7.2 Historic Resources

No Historic Period archaeological sites have been identified on the proposed SNS site at

ANL. Furthermore, no such sites are located adjacent to the site perimeter in locations that may be subject to activities under the proposed action.

The 800 Area is located within the perimeter of the proposed SNS site. This area contained a number of buildings and associated roads constructed by the initial site development contractor. This construction began about 1950 (ANL 1994a: 2-32). During the Cold War Period, the site development contractor used these buildings for storage and shop support. They were also used for accounting activities, plant maintenance shops, electronics development, and a motor pool. Most of the buildings in the 800 Area have been demolished, and several were removed as part of environmental restoration efforts in the area. As a result, only Building 829 remains, and this building is not eligible for listing on the NRHP. The 800 Area is currently used for the storage of trailers and lumber (White, B. 1998a: 1).

4.3.7.3 Traditional Cultural Properties

DOE-CH has found no Native American tribal representatives in the ANL area. Consequently, it has not been possible for DOE-CH to consult with them about the potential occurrence of TCPs on the proposed SNS site and at locations in its immediate vicinity. In addition, no Native American TCPs have been identified in the ANL area, and no Native American groups have expressed an interest in the occurrence and preservation of TCPs in ANL. As a result, it has been concluded that no TCPs occur on the proposed site or anywhere else on laboratory land (White, B. 1998c: 1; Wescott 1998a: 1).

4.3.7.4 Consultation with the State Historic Preservation Officer

Section 106 of the NHPA requires a review of proposed federal actions to determine whether or not they would impact properties listed on or eligible for listing on the NRHP. DOE-CH has consulted with the SHPO in Illinois concerning the occurrence of such properties within the area of potential impact of the proposed SNS at ANL. The consultation letter sent to the office of the SHPO at the Illinois Historic Preservation Agency is provided in Appendix D.

4.3.8 LAND USE

Descriptions of land use in the vicinity of ANL, within the boundaries of ANL, and on the proposed SNS site are provided in this section. The descriptions cover past, current, and future uses of the land in these areas. In addition, they include descriptions of environmentally sensitive land areas that have been set aside for public use, environmental protection, or research. These areas include parks, natural areas, environmental education centers, and public recreation areas. The section concludes with a discussion of visual resources.

4.3.8.1 Past Land Use

The land surrounding ANL was wilderness during the early 19th century. As people from the eastern United States gradually immigrated to the area and established settlements, this wilderness gave way to increasing agricultural and residential land use. The establishment and rapid growth of urban Chicago and Cook County, as well as its suburbs in adjacent counties, acted to minimize wilderness and agricultural land use while maximizing land uses typical of densely populated areas. As a result of being sandwiched between the growing suburban communities of Downers Grove to the north and Lemont to the south, the land surrounding ANL has developed a largely suburban character over the years. The predominant land use in this area has been residential mixed with commercial, industrial, and other typical suburban uses.

The land occupied by ANL was acquired originally as a 3,705-acre (1,500-ha) unit by the Atomic Energy Commission in 1947. At this time, it was largely agricultural land consisting of approximately 75 percent plowed fields and 25 percent pasture, oak woodlots, and oak forests. These agricultural lands were later reforested. Most of the original buffer area [2,001 acres (810 ha)] around ANL was transferred to the DuPage County Forest District in 1973 (ANL 1994a: 2-1; Golchert and Kolzow 1997: 1-16).

The development of ANL for research operations began in 1947 and generally followed the initial architectural site development planning of the 1940s and 1950s. Over the years, the current pattern of land use in ANL gradually developed (ANL 1994a: 2-1).

The proposed SNS site fully encloses the 800 Area, which currently consists of a few substandard buildings, a number of former building locations, and associated infrastructure such as roads. The northern and southern portions of the site overlap Ecology Plot Nos. 6, 7, and 8, which were once established as potential areas for ecological research. However, they were rarely used. The northern boundary of the proposed SNS site overlaps a small area that was used as a small arms firing range from the early 1950s to the late 1970s. In addition, the proposed site contains land that was previously unused Open Space (ANL 1994b: 11).

A large portion of the proposed SNS site and the land in its immediate vicinity have been a focus of intensive past use. Many of the buildings in this area were once used in support services operations for ANL. These operations included grounds maintenance, transportation center (motor pool), vehicle maintenance, and transformer storage. They involved the use of oils, fuels, and hazardous materials. As a result, a number of contaminated areas and waste disposal areas developed within the 800 Area, in other areas of the proposed SNS site, and in nearby areas outside the proposed site. For environmental restoration management purposes, these areas have been designated as Solid Waste Management Units (SWMUs) and Areas of Concern (AOC). These areas are described in Sections 4.3.8.2 and 4.3.9.2.3.

4.3.8.2 Current Land Use

The land in the vicinity of ANL continues to be suburban in character, and most of it is devoted to various kinds of residential use. Much smaller total areas of land are officially categorized as Commercial, Office/Research/ Development, Manufacturing (industrial), Institutional (schools, hospitals, etc.), Open Space (parks, recreation, reserved residential), Transportation/Commercial/ Utilities, and Forest Preserve. The ANL boundary is surrounded on all sides by forest preserve land that functions as a buffer between the laboratory and developed areas (DuPage County 1985, as cited in ANL 1994a). This area of land is the Waterfall Glen Nature Preserve (ANL 1994a: 3-103).

ANL occupies 1,500 acres (607 ha) of land in southern DuPage County (Golchert and Kolzow 1997: 1-4). Most of the buildings, research facilities, and support facilities on this land are distributed among 10 major activity areas: East Area, 100 Area, 200 Area, 300 Area, 360 Area, 400 Area, 500 Area, 600 Area, 800 Area, and ANL Park. The activities conducted in each area and the various laboratory facilities that support them are described extensively in the *Laboratory Integrated Facilities Plan* (ANL 1994a: 2-5 to 2-53).

Current land use at ANL is classified according to 10 major categories. Three categories are associated with separate programmatic research missions: Programmatic Mission–200 Area, which contains laboratory and office facilities; Programmatic Mission–APS Project, which contains the APS and related research facilities; and Programmatic Mission–Other Areas, which encompasses other mission-related research facilities. The other categories are Support Services (heating, maintenance, supplies, etc.); Housing/Amenities; Ecology Plots; ANL Park (employee recreation area and a child care facility); and ANL Landfill (inactive). Although not given a formal designation (ANL 1994a), the tenth category is land located between the preceding nine categories. This category is Open Space where very little development has occurred, except for roads and utilities (ANL 1994b: 11). Environmentally sensitive areas, such as wetlands, are present within portions of this area. Figure 4.3.8.2-1 delineates the current land use categories and shows their distribution relative to the 10 major activity areas.

The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects. The Ecology Plot land use designation refers to open, undeveloped land that would be potentially suitable for certain types of ecological research. However, the ecology plots have no official protection status relative to other areas of the laboratory, and little, if any, actual ecological research has ever been conducted in these areas. There are no currently on-going ecological research projects in Ecology Plot Nos. 6, 7, and 8 (LaGory 1998: 1).

The proposed SNS site overlaps portions of several current land use areas. These are Ecology Plot Nos. 6, 7, and 8 that support no current ecological research; Support Services (developed portions of the 800 Area); and Open Space (ANL 1994b: 11; LaGory 1998: 1). The relative proportions of land associated with these use designations on the proposed site are shown in Figure 4.3.8.2-1.

Three SWMUs and one AOC are located within the boundaries of the proposed SNS site in ANL. Another five SWMUs and two AOCs are located outside the proposed site but in relatively close proximity to it. All are formally identified, located, and described in Section 4.3.9.2.4. This description includes the current status of characterization and remediation efforts in each SWMU and AOC.

4.3.8.3 Future Land Use

Land use planning for the area surrounding ANL has been presented in the land use plan for DuPage County, Illinois. In the future, residential land use would continue to be predominant in this area. Smaller total areas of land would be used for Commercial, Office/ Research/Development, Manufacturing, Institutional, Open Space, and Transportation/ Commercial/ Utilities purposes. The large forest preserve immediately surrounding ANL would

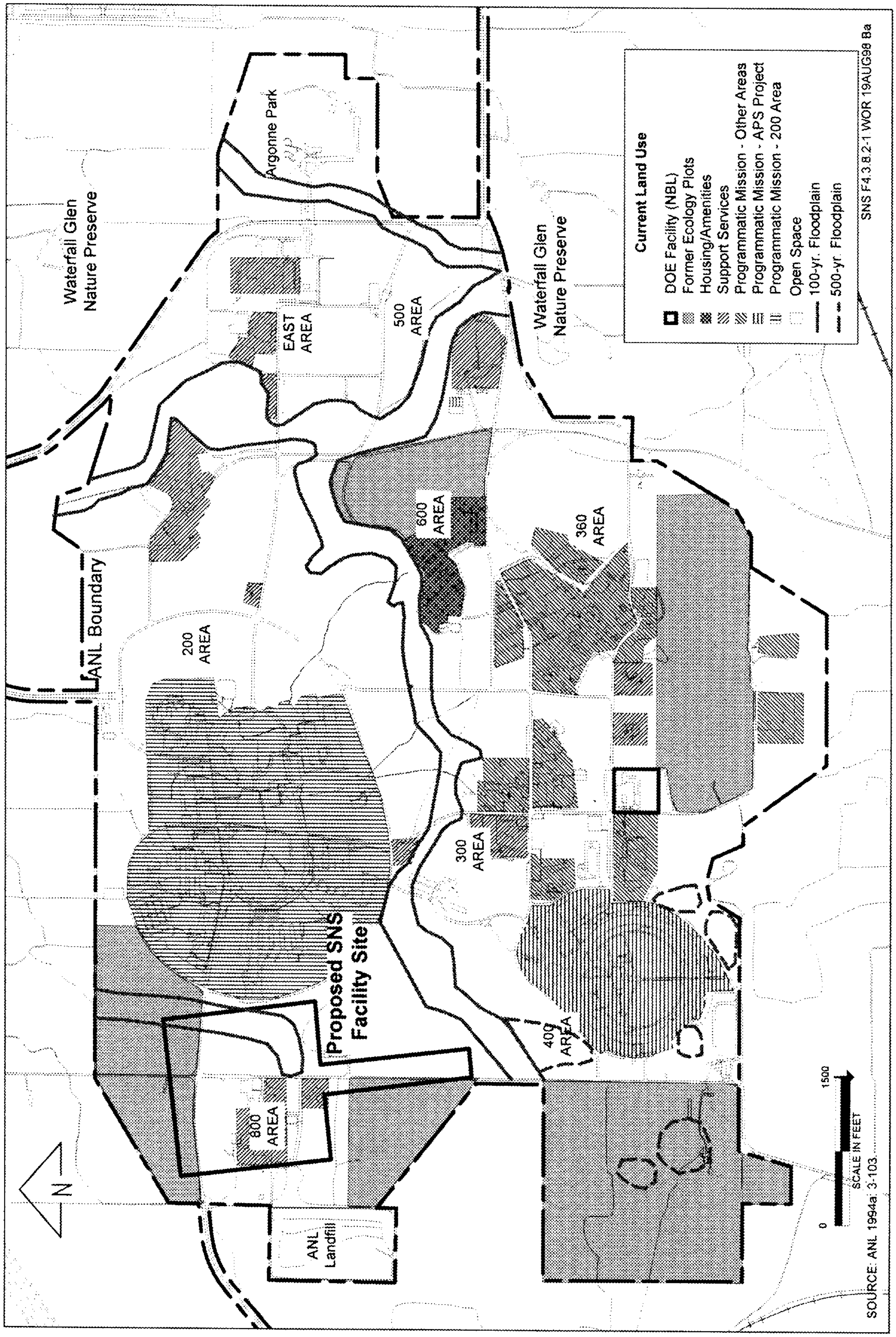

Figure 4.3.8.2-1. Map of current land use in ANL.

continue as the Waterfall Glen Nature Preserve. Moreover, its function as a buffer between ANL and nearby developed areas would continue (DuPage County 1985, as cited in ANL 1994a).

The plans for future land use in ANL reflect the pattern of past development at the laboratory and basic elements of the current land use pattern. These plans would involve continued expansion of current functional uses (programmatic research missions, housing/amenities, and support services) into dedicated expansion areas. These expansion areas would consume large portions of the existing open space at the laboratory. In addition, all of some ecology plots and portions of others would be used. However, the land use plan for ANL calls for the delineation and preservation of environmentally sensitive areas and retaining some open space and ecology plot land. These areas would function as permanent green belts or zones of transition between developed areas of the laboratory.

Future land use in ANL is zoned according to nine official categories. Three categories encompass the expansion of research facilities: Programmatic Mission–200 Area, land reserved for expansion of the current 200 Area office and laboratory facilities; Programmatic Mission–APS Project, land reserved for uses related to the APS; and Programmatic Mission–Other Areas, land reserved for special-purpose research and technology transfer facilities. The remaining categories are Support Services, Open Space, Environmentally Sensitive Areas, ANL Park, and ANL Landfill.

Figure 4.3.8.3-1 shows the future land use categories and zoning for ANL. A comparison of the future or dedicated land use zones on this map to the ecology plots and open space shown

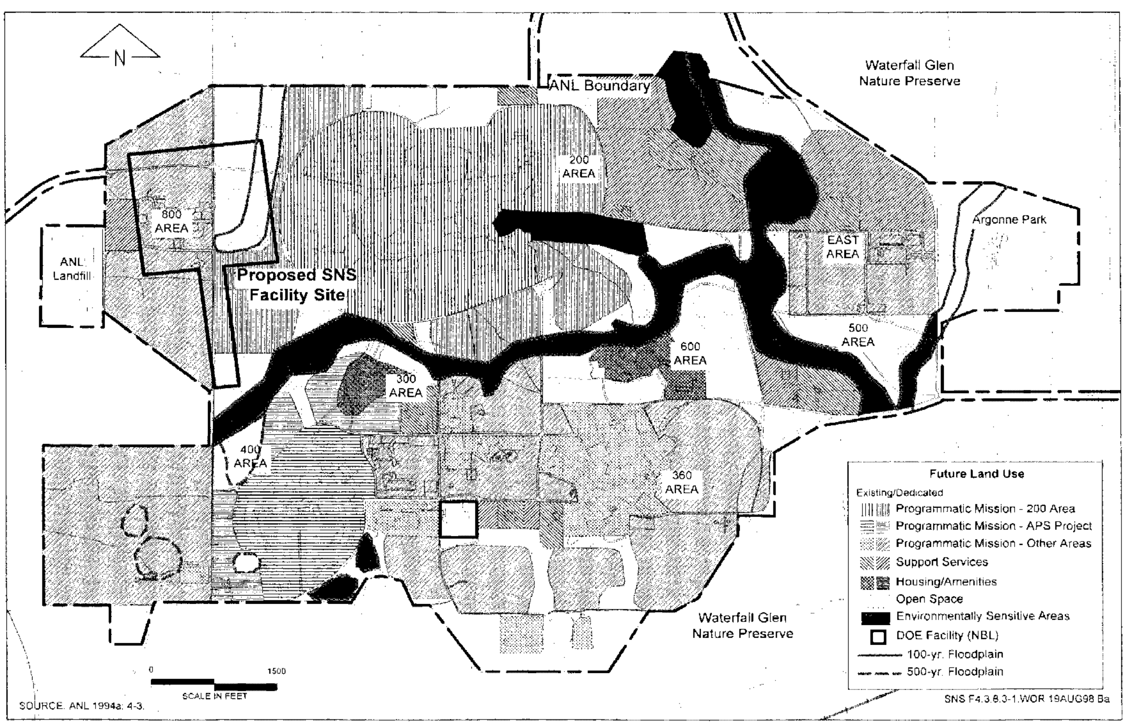

Figure 4.3.8.3-1. Land use zoning map of ANL.

in Figure 4.3.8.2-1 reveals the amounts of current ecology plot and open space land slated for future expansion of laboratory facilities and operations.

The land on the proposed SNS site is distributed among five future land use categories—Programmatic Mission–Other Areas, Programmatic Mission–200 Area, Ecology Plot No. 8, Open Space, and Support Services. The largest category within the proposed site is Programmatic Mission–Other Areas, which would include portions of current Ecology Plot Nos. 6 and 7, two current support services areas (old 800 Area developments), and Open Space. The western edge of the proposed site overlaps a portion of SWMU-744, which is also within the Programmatic Mission–Other Areas category. The amount of proposed SNS site land within each zoning category is illustrated in Figure 4.3.8.3-1. The land immediately adjacent to the proposed SNS site is zoned for future use according to these same categories.

No future uses of proposed SNS site and vicinity land for environmental research are planned. The future use of Ecology Plot Nos. 6 and 7 for ecological research is precluded by their incorporation into zoning designations for future programmatic uses. No future ecological research is planned for Ecology Plot Nos. 6, 7, and 8 (LaGory 1998: 1).

4.3.8.4 Parks, Preserves, and Recreational Resources

A number of parks, nature preserves, and recreation areas are located outside ANL but in the general vicinity of the laboratory. Several forest preserves within the Forest Preserve District of Cook County are located approximately 7 miles (11.3 km) east and southeast of ANL. They include McGinnis Slough, Saganashkee Slough, and a few smaller lakes. These areas are used by the public for picnicking, boating, fishing, and hiking (Golchert and Kolzow 1997: 1-16). Sawmill Creek and the Des Plaines River receive very little recreational use, but some duck hunting and fishing occur in areas downstream from ANL (Golchert and Kolzow 1997: 1-15; DOE-CH 1990: 32).

The principal recreation area near ANL is the Waterfall Glen Nature Preserve, which is adjacent to the laboratory on all sides. It contains 2,240 acres (907 ha) of largely forested land dedicated to ecological and forest demonstration activities, preservation of nature, and public recreation. The recreational opportunities in the preserve include hiking, skiing, and equestrian sports (DOE-CH 1990: 35; Golchert and Kolzow 1997: 1-16).

A portion of the southern ANL boundary is built around Saint Patrick’s Cemetery. An area adjacent to the southwest boundary of ANL is used by visitors to the cemetery, occasional hikers, and model airplane enthusiasts who use the area for access to a field where their models are flown (DOE-CH 1990: 35).

The ANL Park is on laboratory land at the east end of ANL. This park is used for recreational activities by ANL and DOE employees. One of the local municipalities uses the park for athletic events (Golchert and Kolzow 1997: 1-16).

4.3.8.5 Visual Resources

The land in the vicinity of ANL is topographically flat. As a result, there are no naturally elevated vantage points that provide spectacular and varied views of the area.

Because of the massive suburban development in the area, many ground level views of the landscape involve a mixture of buildings, roads, and utility features with trees and grassy open spaces. However, within natural areas, such as the Waterfall Glen Nature Preserve, pristine natural views are available. Because this densely forested nature preserve completely surrounds ANL, the laboratory is essentially hidden from the view of persons at ground level outside the preserve. However, developed areas of ANL are visible from some interior points within the preserve.

Most views within ANL are a varied mixture of research facilities, office buildings, roads, parking lots, tree stands, and cleared land with low vegetation cover. For persons inside ANL, the nature preserve creates a green visual backdrop around the laboratory perimeter.

The proposed SNS site and the land immediately surrounding it are largely clear of trees, which affords clear views of developments in the 800 Area and some other areas of the laboratory. These views are a mixture of roads, old buildings, existing buildings, open land with low vegetation cover, and a background of trees, especially in the direction of the nature preserve. Similar views are apparent to persons standing deep inside the west portion of the Waterfall Glen Nature Preserve and looking across approximately 1,700 ft (518 km) of boundary fence into the area of the proposed SNS site. The nature preserve is located approximately 400 ft (122 m) west of the proposed SNS site.

4.3.9 RADIOLOGICAL AND CHEMICAL ENVIRONMENT

This section describes the radiological and chemical environment at ANL.

4.3.9.1 Radiological Environment

The principal sources of radiation at ANL are: the APS; the Argonne Tandem Linac Accelerating System, which is a superconducting heavy ion linear accelerator; a 22-MeV pulsed electron linac; several other charged particle accelerators (principally Van de Graaff and Dynamitron types); the Intense Pulsed Neutron Source (IPNS), which is a large fast neutron source; chemical and metallurgical laboratories; and several hot cell laboratories.

4.3.9.1.1 Air

ANL operates under emission limits set for radionuclides, asbestos, and halogenated solvents by NESHAP. ANL uses continuously operating air samplers to collect samples of airborne particulate matter potentially contaminated by radionuclides. Radionuclides detected included hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, radon-220 plus decay progeny, and a number of actinides. Of total dose from airborne pathway, 80% is due to Ra-220 and decay progeny. Air samplers are placed at 14 locations around the ANL perimeter and at 6 off-site locations to determine background concentrations. Currently nonradiological air contaminants in ambient air are not monitored.

From the air pathway, the dose to the maximally exposed off-site individual in 1996 was 0.053 mrem/yr, which is well below the EPA standard of 10 mrem/yr. The full-time resident who would receive this dose is located approximately 0.5 miles (0.8 km) north-northwest of the proposed site boundary. The cumulative population dose from gaseous radioactive effluents from ANL operations in

1996 was 2.64 person-rem to the population within a 50-mi (80-km) radius.

4.3.9.1.2 Water

Surface water quality is monitored by the collection of water samples from Sawmill Creek both above and below the point at which ANL discharges its treated waste into the creek and at several outfalls within the ANL boundary. Control samples are collected from the Des Plaines River and from remote locations during the spring and fall. The results of radiological analysis of water samples collected below ANL are compared to upstream and off-site results to determine ANL contributions. In 1996, the only surface water location where radionuclides attributable to ANL operations were detected was Sawmill Creek below the wastewater outfall. Although this water is not used for drinking water purposes, the 50-year EDE was calculated for the hypothetical individual ingesting water at the sampled location. The resulting dose was estimated to be 0.0343 mrem, which is well below the DOE standard of 100 mrem/yr.

Groundwater at ANL is monitored through the collection and analysis of samples obtained from a series of groundwater monitoring wells located near several sites that have the potential of causing groundwater impact. Samples are collected from 34 monitoring wells located near the 800 Area Landfill, the 317/319 waste management area, and the site of the inactive CP-5 reactor. The Illinois EPA-approved sanitary landfill groundwater monitoring program continues to indicate that the Ground Water Quality Standards of some routine indicator parameters are consistently being exceeded. Contamination in this area will be addressed under the RCRA Corrective Action Program under way at ANL.

4.3.9.1.3 Soils

ANL collects annual soil samples from 10 perimeter and 10 remote locations. Comparative soil sampling in 1996 indicated that average radionuclide concentrations were similar for off-site and on-site soils, supporting a conclusion that soil contaminants are the result of global fallout and not ANL operations. The average annual dose equivalent in the U.S. population from fallout is <1 mrem.

4.3.9.1.4 Ambient Gamma Radiation

Measurements of gamma radiation emanating from several sources within the ANL are collected from 14 locations at the site perimeter and on-site and at 5 off-site locations. Above-normal fence-line doses attributable to ANL operations in 1996 were found at the southern boundary near the Waste Storage Facility. The closest residents are about 1 mile (1.6 km) south of the fence line. At this distance the dose rate, extrapolated from measured fence-line doses, was calculated to be 0.004 to 0.012 mrem/yr. At the fence line, where higher doses were measured, the land is wooded and unoccupied. Occasionally visitors may conduct activities near the ANL site boundary that could result in exposure to radiation from this site. Examples of these activities could be cross-country skiing, horseback riding, or running in the fire lane next to the perimeter fence. If the individual spent 10 min per week adjacent to the 317 Area boundary, the annual dose would be 0.03 mrem at the 317 Area fence. Longer presence would result in linearly scaled higher doses (10 min per day every day of the year would result in

0.2 mrem annually). This dose is well below the DOE standard of 100 mrem/yr.

4.3.9.2 Chemical Environment

The principal nonnuclear activities at ANL that have the potential to cause environmental impacts are the use of a coal-fired boiler, studies of the closed-loop heat exchanger for heat recovery, and the use of large quantities of chlorine for water treatment. The closed-loop heat exchanger studies involved the use of moderately large quantities of toxic or flammable organic compounds, such as toluene, freon, as well as others.

4.3.9.2.1 Air Pathway

Nonradiological contaminants in air are not currently monitored at ANL.

4.3.9.2.2 Water Pathway

Surface-water samples were collected from NPDES-permitted outfalls and Sawmill Creek and compared with permit limits and IEPA effluent standards. During 1996 permit limits were exceeded only two times, once each for zinc and iron. The results of chemical analyses are compared with applicable IEPA stream quality standards to determine if the ANL is degrading the quality of the creek. Nonradiological analyses performed in the vicinity of the proposed SNS site (800 Area) were conducted for outfalls in that area. Monthly monitoring showed no exceedances for storm-water runoff (flow, pH, temperature, oil, and grease) during 1996 (Golchert and Kolzow 1997).

4.3.9.2.3 Soil

Soils are not monitored for nonradiological contaminants as part of environmental surveillance activities at ANL.

4.3.9.2.4 Solid Waste Management Units

The 800 Area at ANL, the proposed location of the SNS, has served several functions during its history, but it has been primarily the grounds and transportation center, the vehicle maintenance center, as well as the location for one (or possibly two) sanitary landfills. As such, a number of sites within the 800 Area have been identified as being potentially contaminated with chemicals or construction debris. Table 4.3.9.2.4-1 lists the sites that are under active consideration (for example, these sites have not been remediated or determined not to impact the environment).

Some of the sites within the 800 Area have mitigated or proposed mitigation measures that would eliminate contaminant exposure by capping and isolating specific areas. Some of these areas would fall within the construction footprint of the proposed SNS (Figure 4.3.9.2.4-1).

4.3.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The Support Facilities and Infrastructure section characterizes the local vehicular transportation routes around the proposed SNS site. The existing utilities that are available to provide needed services to support the proposed SNS are also described.

Table 4.3.9.2.4-1. Active SWMUs in the vicinity of the SNS site[a] at ANL.

	Description	Status
SWMU 4	**800 Area Landfill** 21.78-acre landfill used for disposal of demolition debris, refuse, boiler-house ash, and other nonradioactive waste.	Because of proximity these three SWMUs have been combined—groundwater contamination of the dolomite aquifer observed—landfill was closed and capped in October 1993. An RCRA Facility Investigation was conducted and an extension to the 800 Area cap is proposed. IEPA is currently evaluating a NFA request that post closure care will identify any future releases or maintenance problems and that any remedial actions will be conducted as part of post closure care.
SWMU 20	**800 Area French Drain** From 1969-78 about 28,700 gal of liquid waste (organic and inorganic chemicals) were poured into a pipe inserted into a limestone bed located in NE corner of landfill.	
AOC-C	**800 Area Landfill Leachate Seep** Seeps escaped from the edge of the landfill and flowed into the accompanying wetlands (AOC-B) but have not been active since installation of the cap.	
SWMU 29	**Waste Oil Storage Area** Fenced area used since early 1980s for the storage of waste oil and lead-acid batteries—oil was contained in drums and a remaining UST.	Sampling has indicated a release has occurred and a Tier 1 analysis of data was started in December 1997 for both sites.
SWMU 170[b]	**Waste Oil Satellite Accumulation Area (Bldg. 815)** Waste oil accumulation for interim storage prior to transfer to Waste Oil Storage Area.	
SWMU 176[b]	**Scrap Metal Storage** From the 1950s to 1975 scrap metal and car batteries were placed in dumpsters in an area west of Bldg. 827—exact location is unknown—and nonhazardous and nonradioactive scrap was stored at this location.	Additional sampling was performed after surface and subsurface soils indicated a release had occurred—Tier 2 soil levels were exceeded for methylene chloride.
SMWU 182[b]	**Waste Oil Spread On Road** Until the 1970s waste oil was spread on one road that led to the landfill.	Request for NFA was denied by IEPA, and a Tier 1 analysis of data was started in December 1997.

Table 4.3.9.2.4-1. Active SWMUs in the vicinity of the SNS site[1] at ORNL (continued).

	Description	Status
SWMU 736[b]	**800 Area Transformer Storage Pad** Area east of Bldgs 821, 822, and 823 suspected as being a former transformer pad.	Sampling indicated that PCB concentrations were less than Tier 1 levels (25 mg/kg), but an NFA was denied. IEPA stated that a 10-in. cover was needed.
SWMU 744[b]	**Newly Identified, Suspected Solid Waste Landfill** Area northeast of the gate to the landfill suspected to contain buried waste material—dates of operation and quantities of waste are unknown.	A geophysical survey has concluded that buried metal occurs in two separate cells north and east of SWMU 29. Subsequent investigations were reported in the RFI Report
AOC-B	**800 Area Landfill Wetland Area** Located in SW corner of landfill.	Investigation indicated that contaminant levels are very low and no human receptors are at risk—preparing an NFA and ecological risk assessment.
AOC-F*	**Contaminated Soil near Bldg 827** USTs 18 and 19 near Bldg. 816.	During removal of tanks and adjacent soils for UST 18 and 19, soil contaminated from another source was discovered—work plan is in preparation to assess that source.

NFA - No further action.
PCB - Polychlorinated biphenyls.
UST - Underground storage tank.
[a]Source: Gowdy 1998.
[b]Sites located within footprint of the proposed SNS facility.

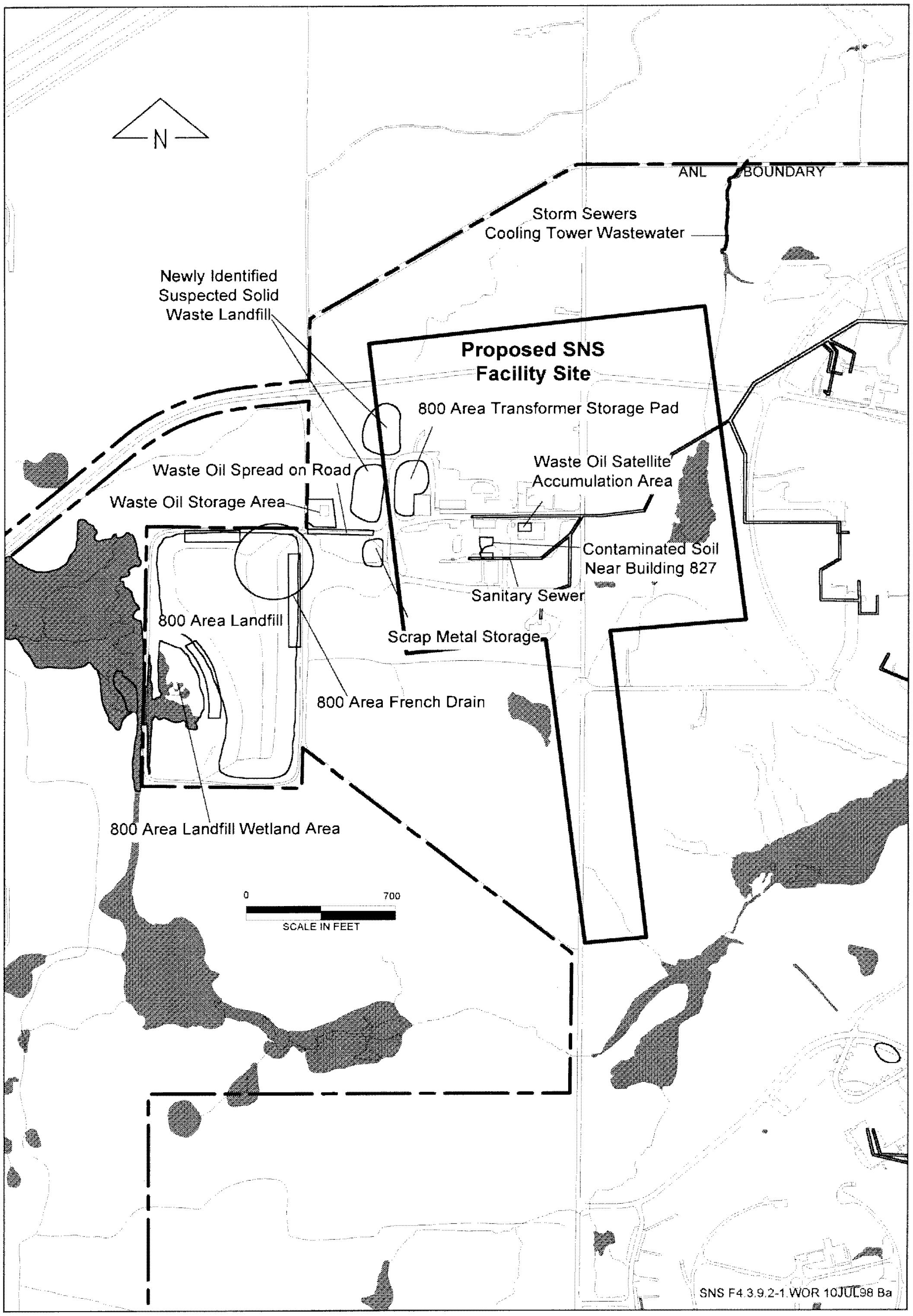

Figure 4.3.9.2.4-1. Locations of SWMUs in the 800 Area.

4.3.10.1 Transportation

ANL is located in DuPage County, Illinois, approximately 30 miles (48 km) from the city of Chicago. Figure 4.3.10.1-1 gives the location of the proposed SNS facility site and the transportation routes around the site. ANL is bordered on the north by I-55, on the east by State Highway 83, and to the south by State Highway 171, which intersects with Lemont Road. Lemont Road runs north-south on the western border of the site.

On-site travel is provided by motor vehicle. However, within each area employees walk between buildings. Vehicular circulation is controlled by the existing road configuration, but road use during most of the day differs from that between 7 a.m. and 9 a.m., or 4 p.m. and 6:30 p.m., when employees are arriving or departing the ANL. The main gate (North Gate) is open 24 hours a day, 365 days a year. The west gate is open Monday through Friday from 6:30 a.m. to 7 p.m. Many truck deliveries are made directly to the Supply Facility dock between Buildings 4 and 5 with fenced direct access from Cass Avenue. These deliveries do not contribute to on-site traffic. Other truck traffic is light so that only minor problems occur occasionally at entrance gates. At the present, no marked difficulties have been noted for on-site traffic either during peak periods of arrival and departure or during midday work hours. According to Illinois Department of Transportation standards, vehicle accumulation at intersections and gates is minor, even during rush hours.

4.3.10.2 Utilities

This section provides a description of the utility infrastructure at ANL. The following is based upon existing documentation and discussions with select ANL staff.

4.3.10.2.1 Electrical Service

ANL purchases electric power from the Commonwealth Edison Company (Edison) at 138 kV. Two Edison 138-kV lines enter ANL at Facility 543, located south of the laboratory. The majority of ANL's electricity needs are serviced by two 13.2-kV transmission lines that originate from Facility 543. The exception is the 300 Area, which uses a separate power distribution system to meet its heavy load requirements. A 138-kV overhead line connects the Edison line at Facility 543 to transformers at 549-A and -B in the 300 Area.

4.3.10.2.2 Steam

Steam is used primarily for central heating and for steam turbine-driven emergency generators. Most of the steam for ANL is produced at the Central Heating Plant (CHP) located in the 100 Area and distributed by an extensive piping network to a majority of on-site buildings. The CHP consists of five conventional (Wickes) boilers and various auxiliary systems. The CHP's maximum steam-generating capacity is 340,000 lb/hr of saturated steam at 200 psi. APS use is approximately 60,000 lb/hr (Fornek 1998a) ANL's present service distributes steam at 200 psig to all buildings on-site, where it is typically reduced to 15 psig for use in space heating and miscellaneous building services.

4.3.10.2.3 Natural Gas

Natural gas is distributed to ANL from a nearby high-pressure main. A 6-inch branch line supplies gas from the main to Building 108 at 150 psig. The gas pressure is reduced to 60 psig

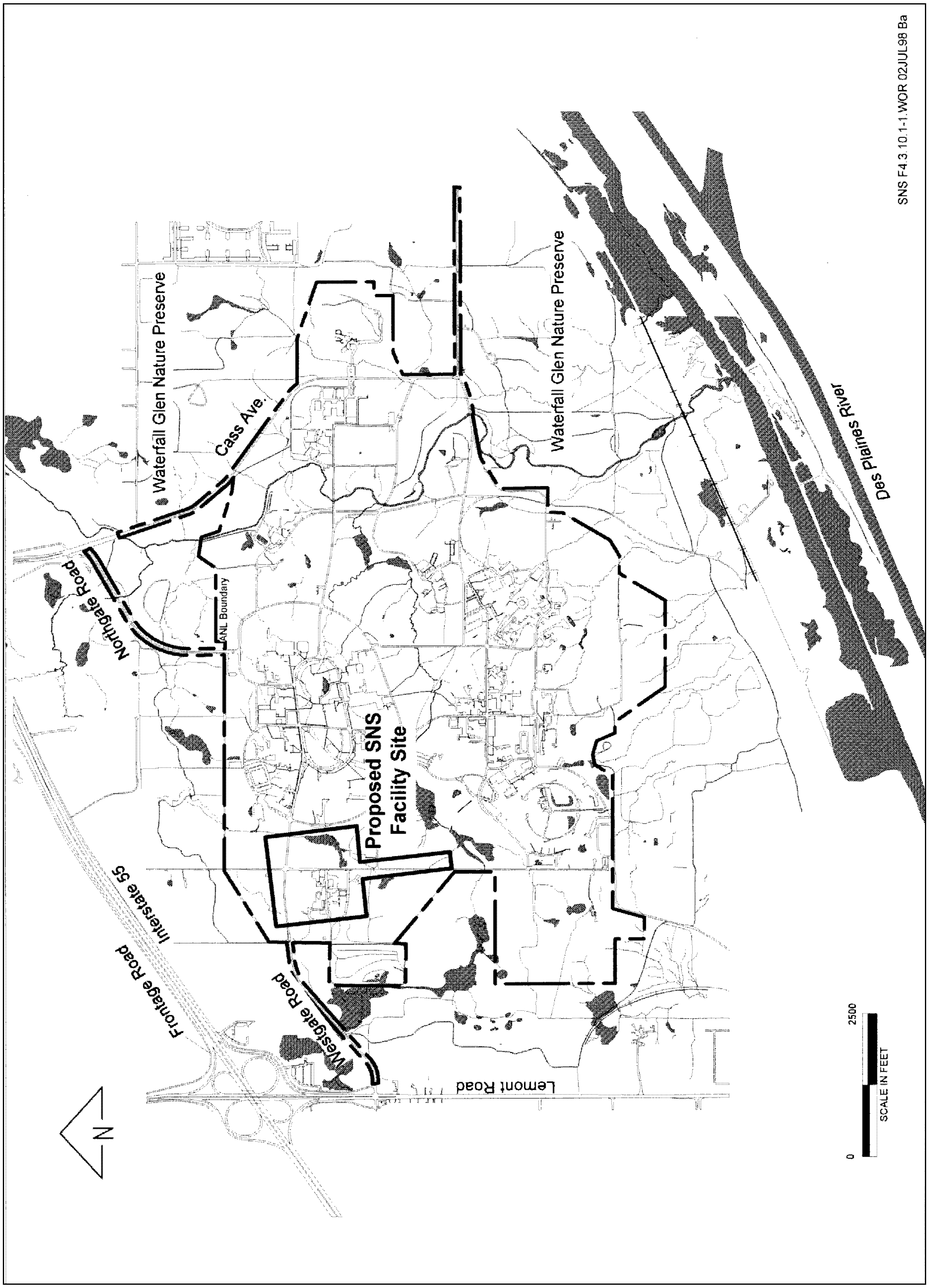

Figure 4.3.10.1-1. Transportation routes at ANL and surrounding areas.

before being piped to the CHP. A branch line extends to the north side of the CHP where the site-wide gas supply is metered and pressure regulated to 10 psig. Gas is distributed to the site for use in laboratory areas and to boilers and furnaces that are not served by the central heating system. ANL plans to upgrade its natural gas distribution system around the site in 1999.

4.3.10.2.4 Water Service

Potable water at ANL is purchased from the DuPage County Water Commission. Nonpotable water is obtained from the Chicago Sanitary and Ship Canal, located south of the laboratory. Canal water is treated on-site and piped to a 250,000-gal (946,350-L) holding tank for distribution through the canal water distribution system. Water for domestic use and fire suppression is distributed through a common network that serves most of the site. The system has three elevated storage tanks and one ground-level storage tank with capacities of 500,000, 150,000, 300,000, and 650,000 gal (1.9 million, 567,810, 1.1 million, and 2.5 million L) respectively. The water system for laboratories is segregated from the domestic and fire water systems to prevent potential contamination from backflow. Laboratory water is stored in the 800 Area in a 75,000-gal (283,905-L) elevated tank. ANL currently has a remaining capacity of approximately 2 mgpd (7.6 million lpd) of nonpotable water. The existing capacity of the process wastewater treatment system is over 1 mgpd (3.8 million lpd). ANL currently treats about 300,000 gpd (1.1 million lpd) (Fornek 1998a).

4.3.10.2.5 Sanitary Waste Treatment

Sanitary sewage from various buildings is conveyed by underground sewers to the SWTP located at Bluff Road and Railroad Drive. The treatment facility has approximately 500,000 gpd (1.9 million lpd) of remaining capacity (Fornek 1998a).

4.4 BROOKHAVEN NATIONAL LABORATORY

Brookhaven National Laboratory (BNL), a 5,000-acre (2,024-ha) site, is located close to the geographical center of Suffolk County, Long Island, about 60 miles (97 km) east of New York City. The developed area is approximately 2.6 mi² (6.7 km²). There are more than 300 structures on the laboratory property. The balance of the site is largely wooded. BNL is in a section of the Oak-Chestnut Forest Region known as the Atlantic Coastal Plain Physiographic Province. BNL was established in 1947 at the former Camp Upton, a World War I and II Army training and recovery center. BNL evaluated four potential sites for the proposed SNS facility. The preferred site is situated in the north-central part of the reservation east of the Relativistic Heavy Ion Collider (RHIC) and west of the STP (see Figure 4.4-1).

4.4.1 GEOLOGY AND SOILS

This section identifies the characteristics of the geology and soils associated with the region.

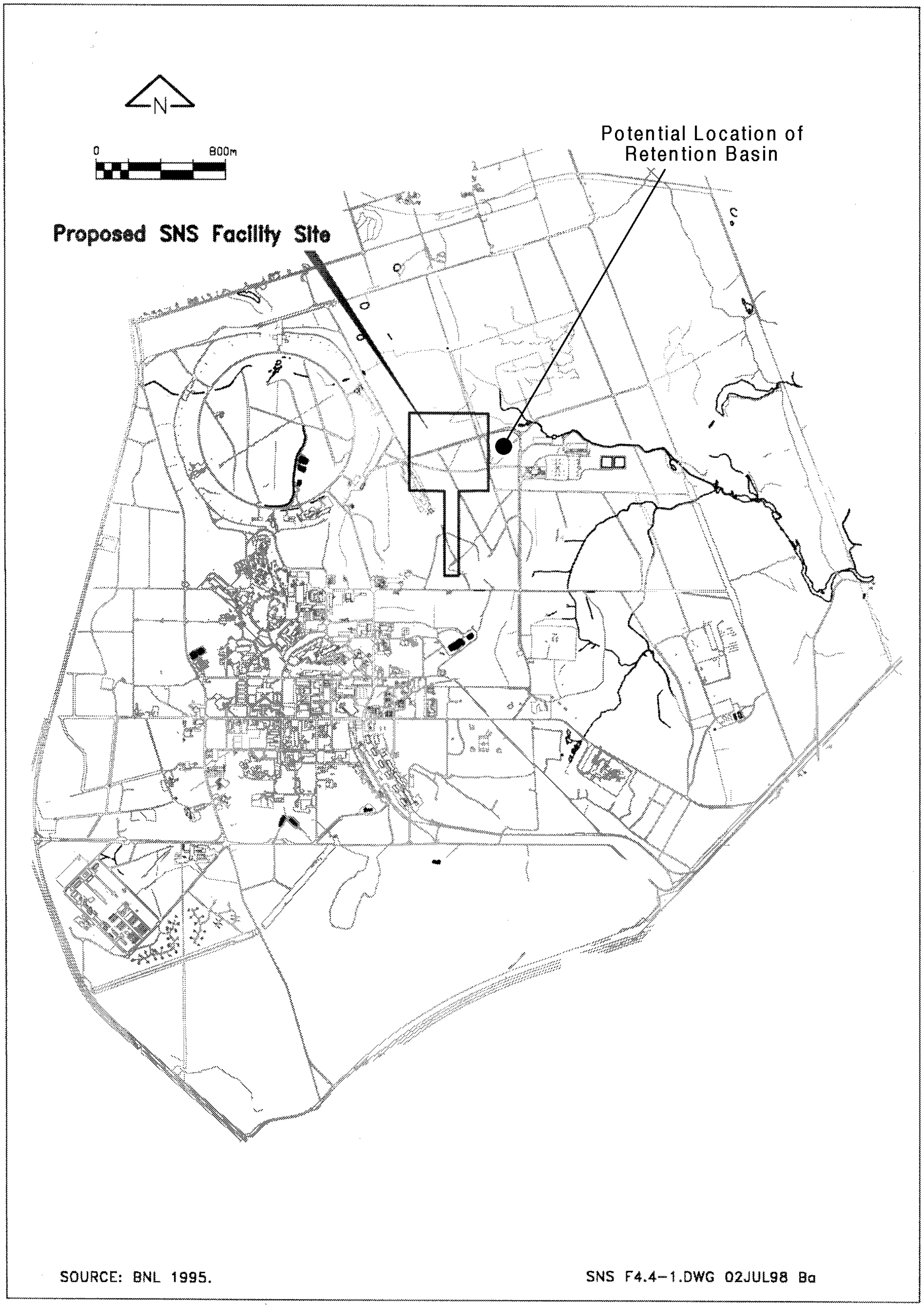

Figure 4.4-1. Proposed SNS site at BNL.

4.4.1.1 Stratigraphy

Long Island shares many of the same coastal features common to the barrier island of Massachusetts, the New Jersey Coastal Plain, and coastal regions as far south as Cape Hatteras. Surface features of eastern Long Island were shaped by the cyclical advance and retreat of glacial ice during the late Wisconsin Stage of the Pleistocene Epoch. BNL is located on the Ronkonkoma Moraine and consists of undulating morainal topography of relatively low relief with erratics present throughout. The elevation of the area is approximately 82 ft (25 m) with a total relief of 30 ft (9 m). The area of greatest relief is in the southernmost portion of the site.

Remnant glacial features include the Harbor Hill Moraine and the Ronkonkoma Moraine as prominent topographic ridges near BNL. The Harbor Hill Moraine is oriented east-west and lies to the north of BNL. The Ronkonkoma Moraine is characterized by an irregular band of hills with elevations ranging from 100 to 180 ft (30 to 55 m) above mean sea level. The laboratory lies between moraines on a relatively flat outwash plain, with elevations ranging from 40 to 120 ft (12 to 37 m), and is situated on the west rim of the shallow Peconic River watershed.

BNL is underlain by a wedge of unconsolidated sediments that thickens and dips to the southeast toward the Atlantic Ocean. These unconsolidated sediments range in age from Late Cretaceous to Recent and rest unconformably on crystalline bedrock consisting of Precambrian-age metamorphic rocks. Surficial Holocene deposits of soil and bog accumulations occur locally throughout the island, but the province is primarily covered by unconsolidated surface sediments that have been deposited and reworked by glaciation processes. Table 4.4.1.1-1 summarizes the stratigraphy in the vicinity of BNL.

Deposits of glacial origin cover the surface of the mid-island area, and range in thickness from 20 ft (6 m) to more than 600 ft (182 m) in buried valleys. Most of the glacial materials were deposited in Wisconsin time about 14,000 to 43,000 years ago and are collectively referred to as upper Pleistocene deposits. These deposits include terminal moraines, outwash deposits, ground moraine, and lake deposits. The Ronkonkoma terminal moraine marks the farthest advance of glaciation on Long Island. The moraine lies mostly above the water table and is composed of crudely stratified sand, gravel, and boulders. Outwash deposits derived from melted glacial ice lie south of the Ronkonkoma moraine. Some glacial lake deposits lie within outwash deposits but below the land surface and occur mostly between the terminal moraines. Because of the varied materials carried by the glacier, outwash deposits are stratified but consist of a heterogeneous suite of rock types. The large diversity of rock and mineral types in the Pleistocene deposits along with the presence of chemically unstable mineral suites allows differentiation from Cretaceous deposits on Long Island.

The Gardiners Clay is a marine interglacial deposit of Sangamon age. It is composed of variable amounts of massive green clay; silty and sandy green clay; and clayey silt and sand. The representative color is derived from trace amounts of glauconite and green clay minerals. The Gardiners Clay has a representative microfossil assemblage that is distinctive from the Upper Pleistocene units and the underlying

Table 4.4.1.1-1. Stratigraphy of Long Island, New York.[a]

Series	Geologic unit	Aquifer unit	Character of deposits	Water-bearing properties
Quaternary				
Holocene	Recent stream and salt marsh, alluvium and shoreline deposits	Recent deposits	Sand, gravel, clay, silt, organic mud, peat, loan, and shells.	Beach deposits are highly permeable; marsh deposits poorly permeable. Locally hydraulically connected to underlying aquifers.
Pleistocene	Upper Pleistocene deposits	Upper glacial aquifer	Till composed of clay, sand, gravel, and boulders, forms Harbor Hill and Ronkonkoma terminal moraines. Outwash deposits consist of quartzose sand, fine to very coarse, and gravel, pebble to boulder sized. Also contains lacustrine, marine, and reworked deposits.	Till is poorly permeable. Outwash deposits are moderately to highly permeable. Glacio-lacustrine and marine clay deposits are mostly poorly permeable but locally have thin, moderately permeable layers of sand and gravel. Average horizontal K=200ft/d.
	Gardiners Clay	Gardiners Clay	Clay, silt, and few layers of sand. Contains marine shells and glauconite.	Poorly permeable conditions constitute a confining layer of underlying aquifer. Sand lenses may be permeable.
Upper Cretaceous	Matawan Group-Magothy Formation; undifferentiated	Magothy aquifer	Sand, fine to medium quartzose, clayey in parts; interbedded with lenses and layers of coarse sand and sandy clay. Gravel in basal zones. Lignite, pyrite, and iron oxide common.	Most layers are poorly to moderately permeable; locally permeable. Unconfined in upper parts and confined elsewhere. Average horizontal K=50ft/d.
	Raritan Formation–unnamed clay unit	Raritan confining unit	Clay, solid and silty; few lenses and layers of sand. Lignite and pyrite are common.	Poorly to very poorly permeable; constitutes confining layer for underlying Lloyd aquifer. Average vertical K=0.001 ft/d.
	Raritan Formation–Lloyd Sand member	Lloyd aquifer	Sand, quartzose, fine to coarse, and gravel with clayey matrix; some lenses of solid and silty clay; contains thin lignite layers.	Poorly to moderately permeable. Confined aquifer conditions created by overlying Raritan clay. Average horizontal K=40/ft/d.
Precambrian	Bedrock	Bedrock	Crystalline metamorphic and igneous rocks; muscovite-biotite schist, gneiss, and granite. Soft clayey zone of weathered bedrock locally greater than 70 ft (21.3 m) thick.	Poorly permeable to impermeable; constitutes lower boundary of groundwater reservoir. Some hard freshwater in joints and fractures.

[a] IT and G&M 1997.

Magothy Formation. The northern limit of Gardiners Clay is located south of BNL; however, lobes of the clay extend to BNL. The irregular occurrence of the clay inland suggests that it was greatly affected by erosion.

The Monmouth Group is a Late Cretaceous age marine deposit consisting of a green to black clay, silt, or clayey to silty sand. It exists along the south shore of Long Island but is absent under BNL.

The undifferentiated Matawan Group/Magothy Formation comprises the Magothy aquifer of Long Island. This unit is composed of beds and lenses of fine to coarse, white to brown quartz sand with variable quantities of interstitial clay and silt. Interbedded layers of clay and silts are present, along with pyrite and lignite. The surface of this unit is highly irregular because of erosion during Tertiary and Pleistocene times. Depth to the upper surface of the Magothy aquifer range from about 100 to 500 ft (30.5 to 152.4 m).

The Late Cretaceous Raritan Formation is subdivided into the Lloyd Sand and the Raritan Clay. The Lloyd Sand overlies the bedrock and is approximately 300 ft (91 m) thick. The Lloyd Sand consists of coarse to fine quartzose sand with gravel and interbedded clay. The Raritan Clay overlies the Lloyd Sand and is approximately 200 ft (61 m) thick beneath BNL. The Raritan Clay is comprised of lignitic clay with some silt and sandy clay and lenses of sand and gravel. The Clay is present throughout Suffolk County and mimics the surface of the Lloyd Sand and underlying bedrock.

Two deep U.S. Geologic Survey exploratory wells encountered bedrock at approximately 1,600 ft (488 m) below the land surface at BNL. The bedrock consists of a banded granitic gneiss without significant primary porosity and with no indication of fracturing that would provide appreciable amounts of water. The bedrock slopes to the southeast, and represents an advanced erosional surface with little relief. It is overlain by remnant paleosoil consisting of a tough white clay.

4.4.1.2 Structure

No structures are preserved in the unconsolidated surface sediments of Long Island, and there are no known active faults in the Long Island area. Data for bedrock is limited for the BNL and elsewhere on the island by the lack of well penetrations. It is assumed to be similar to bedrock outcrops exposed on the mainland in nearby parts of New York and Connecticut. The basement rocks have a maximum relief of about 100 ft (30 m) except where modified by erosion in Pleistocene or Recent time. The low relief and localized weathering of the bedrock suggests that the surface had reached an advanced stage of peneplain. The bedrock surface slopes southeast at about 80 ft/mi (15 m/km), and its relief in the vicinity of BNL is not expected to be greater than 50 to 100 ft (15 to 30 m).

4.4.1.3 Soils

The Soil Survey of Suffolk County, New York, (IT and G&M 1997) has mapped several soil units across the BNL. The Plymouth Series is a deep, well-drained, coarse-textured sandy soil. It typically forms in a mantle of loamy sand or sand over thick layers of stratified coarse sand and gravel. These soils have very low available moisture capacity and rapid water intake. The soil type occurs on moraines and outwash plains. Slopes range from zero to 35 percent, and colors range from dark grayish brown to yellowish brown with depth.

The Carver Series consists of deep, excessively drained, coarse-textured sandy soils. This series is similar to, and often associated with, the Plymouth Series but contains more iron and humus. These soils also have slopes ranging from zero to 35 percent and are typically found on moraines and outwash plains. Color ranges from gray near the surface to brown and yellowish brown with depths greater than 8 in. (20 cm).

The Riverhead Series is a deep, well-drained, moderately coarse-textured soil that forms over stratified coarse sand and gravel. These soils occur on moraines and outwash plains and can have slopes ranging from zero to 15 percent. Riverhead soils are less sandy than Plymouth and Carver soils.

The Haven Series is a deep, well-drained, moderately coarse-textured soil that forms over stratified coarse sand and gravel. The soils most commonly occur between moraines and have slopes that range from zero to 12 percent. Haven Series soils are also less sandy than the Plymouth Series.

The southern portion of BNL is dominated by the Riverhead Series and grades into a mixture of Riverhead and Haven Soil near the center of BNL. The northern part of BNL, including the proposed site for the SNS, is covered by Plymouth loamy sands. Limited areas of Haven and Riverhead Series soils are present west of the proposed SNS location.

Approximately 69 acres (28 ha) are currently used for growing crops at BNL for biological research, but these areas are not prime or unique farmlands. No prime or unique farmlands are present on BNL land (Yadav 1999).

4.4.1.4 Stability

Construction of the proposed SNS would not be affected by site stability problems at BNL. The soil material is excellent for construction and there are no foundation or other associated problems. Soil conditions typically provide for 6,000-psi design loads (Schaeffer 1998). Neither soil liquefaction nor subsidence is a potential problem in this area. Because of the gentle rolling topography, landslides are not common to the site.

BNL is in an area of quiescent seismic activity compared to other potential sites for the proposed SNS (Figure 4.3.1.4-1). A seismic assessment suggested that a peak ground acceleration (horizontal) of 0.2 gravity be used for the Design Basis Earthquake for the High Flux Beam Reactor (HFBR) (Kelley 1998). A study for Shoreham Nuclear Power Plant indicates that 26 earthquakes have been capable of being felt at the site with an intensity of IV [Modified Mercalli (MM)] or greater. Four major earthquakes located more than 200 miles (322 km) from the site are estimated to have been felt with a maximum intensity at BNL of IV (Table 4.4.1.4-1).

Within a 200-mi (322-km) radius of the site, five earthquakes have been noted that may have influenced the site with an intensity of IV (MM) or slightly greater (Table 4.4.1.4-2).

It is indicated that 90 earthquakes are known to have occurred within 50 miles (80 km) of the site historically, but only two of these earthquakes were actually felt on-site (Table 4.4.1.4-3).

Table 4.4.1.4-1. Earthquakes greater than 200 miles (322 km) from BNL.

Date	Location	Intensity
June 11–12, 1638	Three Rivers, Quebec	IX
February 5, 1663	St. Lawrence Valley (Quebec City)	X
September 16, 1732	Montreal, Canada	IX
March 1, 1925	St. Lawrence Valley (Quebec City)	IX

Table 4.4.1.4-2. Earthquakes less than 200 miles (322 km) from BNL.

Date	Location	Intensity
November 10, 1727	Cape Ann, Mass.	VII
December 18, 1737	New York, N.Y.	VII
November 18, 1755	Cape Ann, Mass.	VIII
May 16, 1791	East Haddam, Conn.	VI–VII
August 10, 1884	New York, N.Y.	VII

Table 4.4.1.4-3. Earthquakes within 50 miles (80 km) from BNL.

Date	Intensity	Estimated BNL Intensity
May 16, 1791	VI-VII	IV-V
July 19, 1937	IV	III

4.4.2 WATER RESOURCES

The following section discusses the water resources at BNL.

4.4.2.1 Surface Water

BNL is near the western boundary of the Manorville drainage basin and contains the headwaters of the Peconic River (Figure 4.4.2.1-1). Surface drainage is poor in the Manorville basin which accounts for the marshy and swamp areas near the river. East of the Manorville drainage basin, the Peconic River valley widens and forms the Riverhead Basin. The Peconic River drains in an easterly direction and flows into Flanders Bay, an arm of the Great Peconic Bay. Like other coastal-plain streams, the Peconic River is a low-gradient, low-velocity stream with slightly acidic waters and a moderate-to-dense growth of aquatic vegetation. Stream flows are heavily influenced by groundwater levels, with discharge of groundwater to streams during periods of high rainfall and infiltration of stream flow during periods of low rainfall. The marshy area in the northern and eastern section of BNL has the potential to be a principal tributary of the Peconic River. However, this tributary has been essentially dry during the regional drought over the past 10 years. It should be noted that there has been no year-round sustained flow from BNL since 1983 (Naidu et al. 1996) even with the contribution of 242 million gal (916 million L) from the STP.

Coastal-plain ponds are naturally occurring or manmade ponds with permanent standing water.

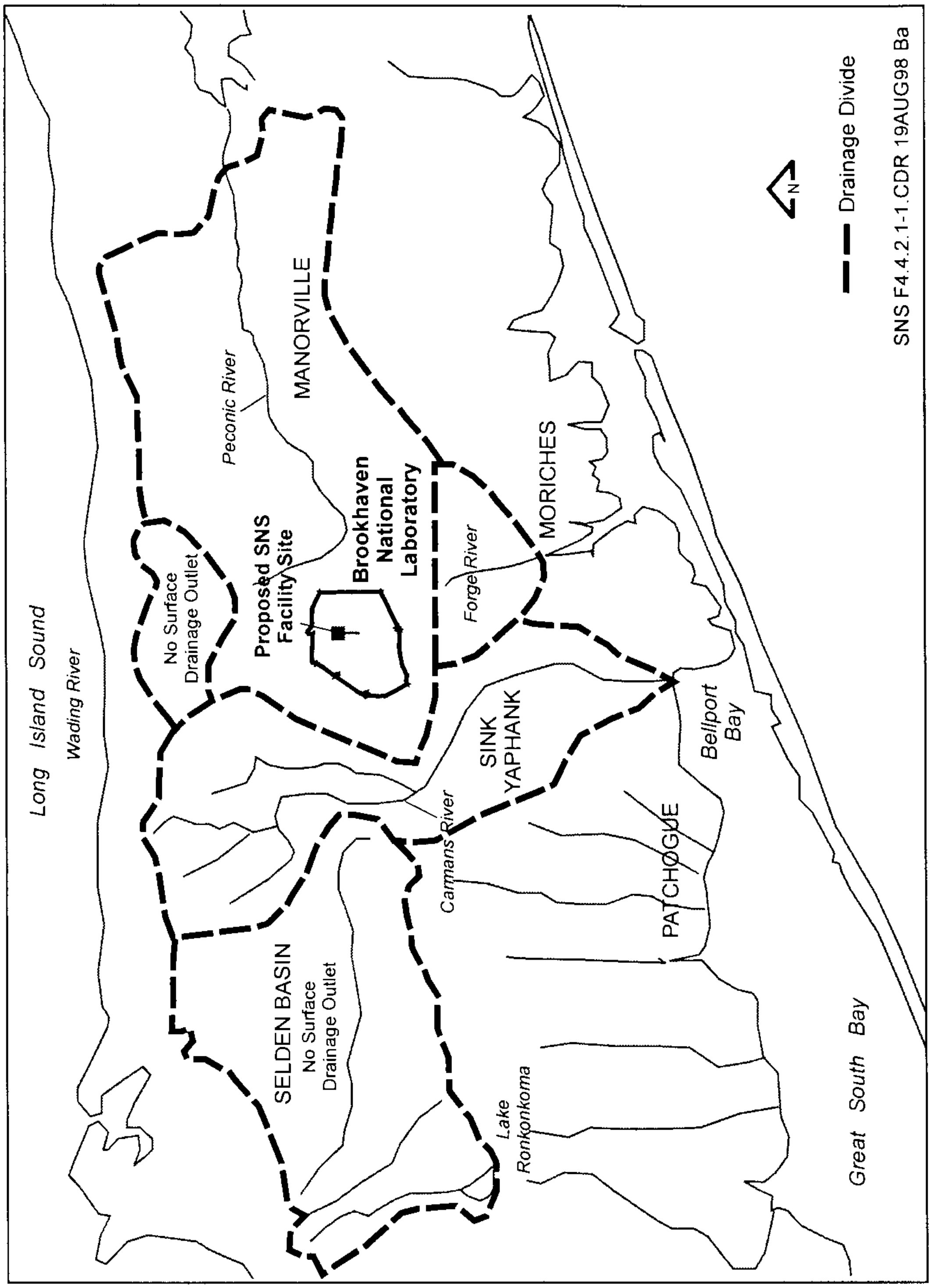

Figure 4.4.2.1-1. Drainage basin surrounding BNL.

A number of such ponds with water depths usually less than 4 ft (1.22 m) occur in the northern portion of BNL. In addition, cooling and industrial process water recharges the groundwater system via discharge into small streams or man-made recharge basins.

One-hundred-year floodplains and wetlands encompass approximately 346 acres (140 ha) of the BNL site, mostly in the areas bordering the headwaters of Peconic River. The 100-year flood maps of the Federal Emergency Management Agency's National Flood Insurance Program indicate that in the vicinity of the Relativistic Heavy Collider, immediately west of the proposed SNS location, the elevation of the 100-year floodplain is approximately 52.5 ft (16 m) above mean sea level.

Land bordering the Peconic River up to 0.5 miles (0.8 km) from the river's bank is regulated by New York State because of its designation as "Scenic" under the State's Wild, Scenic and Recreational Rivers Systems Act. Freshwater wetlands in the north and east quadrant of the BNL reservation remain in an area once part of a principal tributary to this river system. The Peconic River is not used for a drinking water supply or for irrigation.

4.4.2.2 Groundwater

The groundwater system beneath Long Island exists as a distinct well-defined system delineated by natural hydrologic boundaries. The upper boundary is defined by the water table surface [at about 45+ ft (13.7 m) mean sea level] in the Upper Glacial sediments modified by the numerous streams and surface water bodies that intersect the water table. The base of the system is bounded by the impermeable crystalline bedrock surface. The entire system is bounded laterally by salty groundwater and saltwater bodies. Along the shore, groundwater discharges from the upper glacial deposits flow directly into these saltwater bodies. Offshore, fresh groundwater flows vertically upward across the confining layers. Where the overlying groundwater is salty, the water discharges from the fresh system and mixes with salty groundwater. These areas are referred to as subsea discharge boundaries and are considered part of the lateral groundwater system boundaries. Under natural conditions, all water enters and leaves the groundwater system across these boundaries.

Precipitation on Long Island averages 45 in. (114 cm) per year, of which 23 in. (58 cm) recharges to replenish the groundwater. Trending east-west, the main groundwater divide for Long Island lies about 1 to 2 miles (1.6 to 3.2 km) north of BNL (Figure 4.4.2.2-1). Water entering the groundwater system north of the divide generally flows north into the Long Island Sound. Water entering the system south of the divide (including BNL) flows south and/or east toward the Peconic River, the Forge River, the Carmans River, or toward the south shore of Long Island. Groundwater eventually discharges either into the rivers or directly into the Great South Bay or the Atlantic Ocean across a subsea discharge boundary. The higher water table to the west of the BNL area generally inhibits westward movement.

The hydrogeologic units (Figure 4.4.2.2-2) that comprise the groundwater system are the Upper Glacial aquifer, the Gardiners Clay (aquitard), the Magothy aquifer, the Raritan confining unit, the Lloyd aquifer, and the crystalline bedrock (confining unit). Groundwater in the Upper Glacial aquifer exists under unconfined

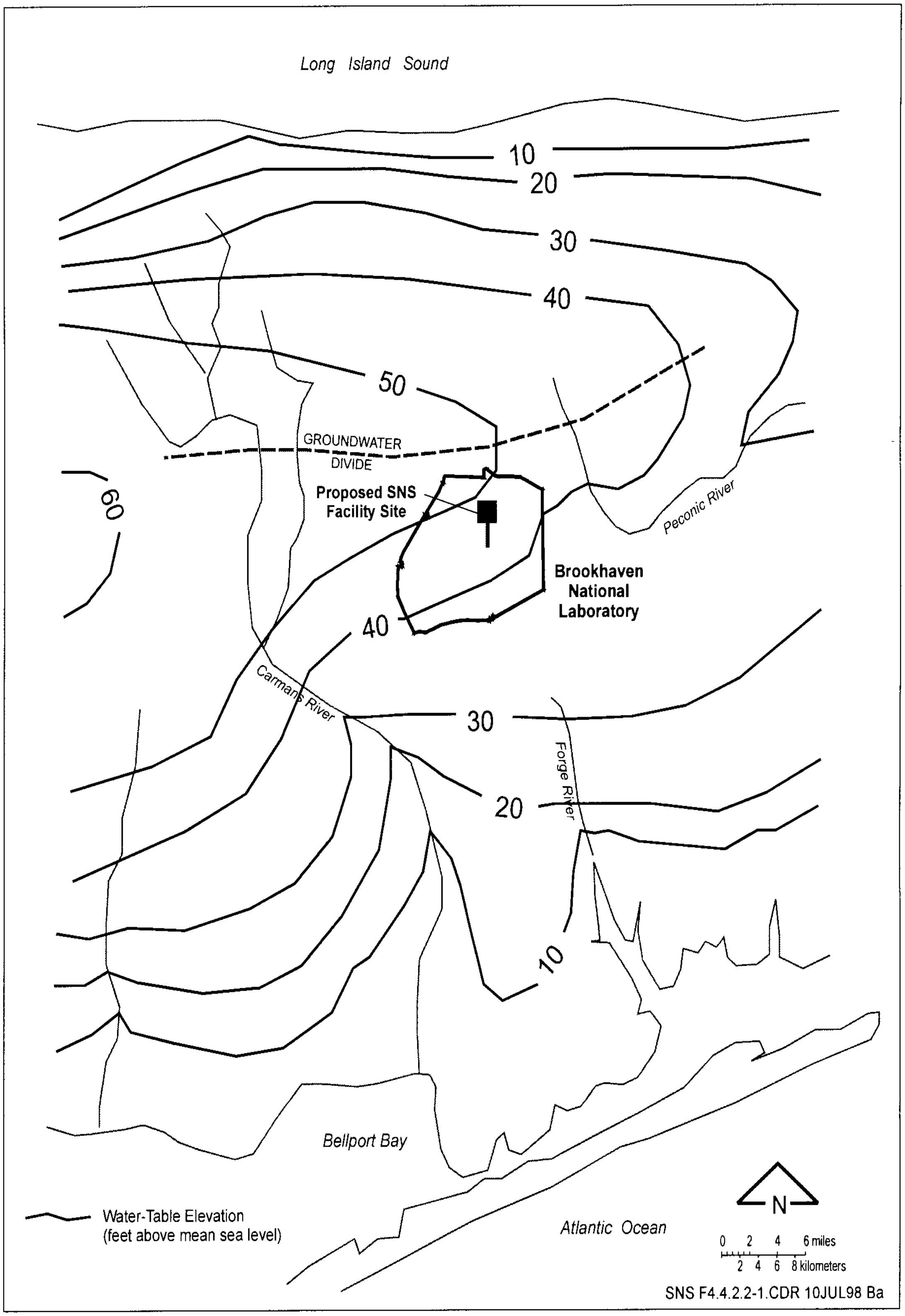

Figure 4.4.2.2-1 Groundwater divide in vicinity of BNL.

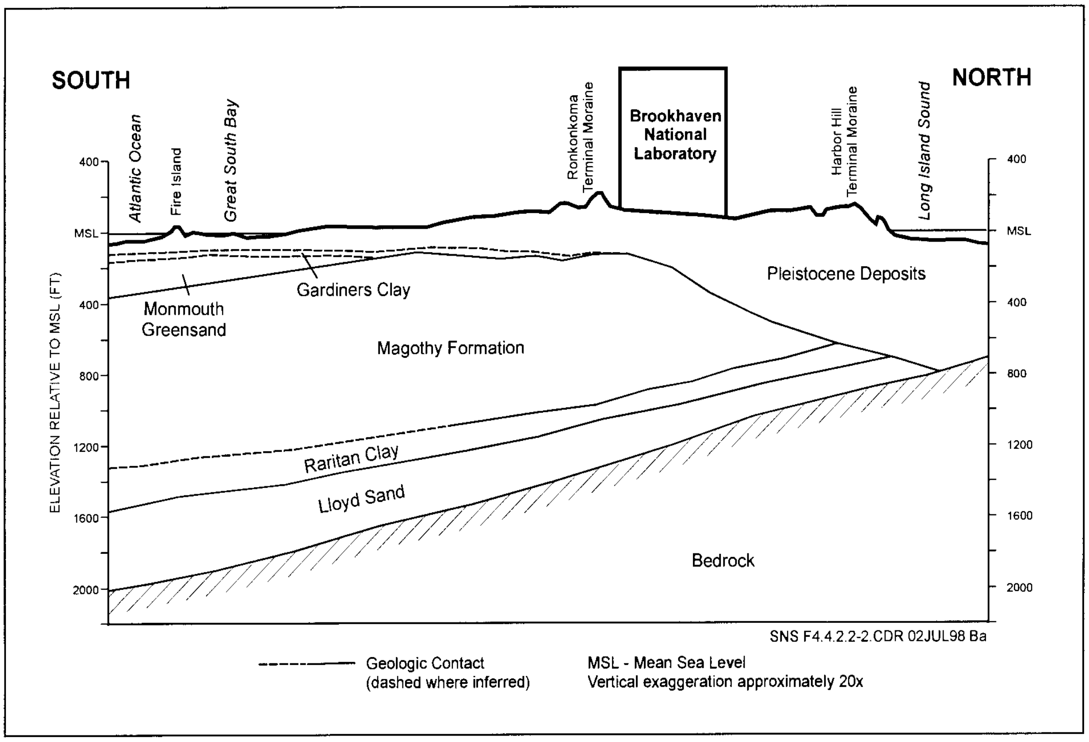

Figure 4.4.2.2-2. Stratigraphic cross section through Long Island and BNL.

conditions except where locally continuously clay lenses create semi-confined conditions. When the Magothy aquifer is overlain by the confining Gardiners Clay unit (south of BNL) groundwater exists under confined conditions. Where the Magothy is in direct hydraulic connection with the Upper Glacial aquifer, semi-confined to confined conditions are present from localized clay layers. The Lloyd aquifer is under confined conditions as a result of the continuous presence of the overlying Raritan Clay unit. Limited recharge is available to support the Lloyd aquifer, and therefore, it is very sensitive to pumpage and drawdown.

McClymonds and Franke (IT and G&M 1997) have estimated the distribution of hydraulic conductivities (K) from pump tests for the three primary aquifers underneath Long Island. The Upper Glacial aquifer has the highest and greatest range of horizontal hydraulic conductivity values (K) 20 to 300 (0.007 to 0.106 cm/s) which reflects the variations in the unconsolidated deposits. Stratification in this unit is common, yielding varied values at different locations and depths. The stratification also has a pronounced effect on the vertical K with a 10:1 ratio of horizontal to vertical hydraulic conductivity. The K of the Magothy aquifer ranges from 30 to 80 ft/d (0.011 to 0.028 cm/s) for the thicker upper zone and 45 to 120 ft/d (0.016 to 0.042 cm/s) for a coarse basal sand unit. Ratios of horizontal to vertical K approach 100:1 because of the stratified nature of the Magothy. The Lloyd aquifer is estimated to have a K in the 35 to 75 ft/d (0.012 to 0.027 cm/s) range with horizontal to vertical ratios of 100:1. Approximations of K for the confining unit are several orders of magnitude less than for the aquifers (0.01 to 0.001 ft/d).

Horizontal groundwater flow directions across BNL are generally south to southeast (see Figure 4.4.2.2-3). The overall groundwater table gradient from the northwest corner to the southern boundary of BNL averages 0.001. Using 160 ft/d (0.056 cm/s) as the mean value of the range of K estimates [20 to 300 ft/d (0.007 to 0.106 cm/s)] for the Upper Glacial aquifer and a porosity of 0.33 (Warren et al. 1963), a horizontal groundwater velocity is calculated to be 0.48 ft/d. This calculation is in close agreement with the results (0.53 ft/d) of a tracer test reported by Warren (Warren et al. 1963), where the velocity of an injected solution of ammonium chloride was recorded between two shallow wells. Data for the Magothy aquifer suggests a velocity range of 0.1 to 0.2 ft/d for horizontal groundwater flow, but the confidence of measurements is not as reliable as in the upper aquifer. Based on a 24-hr pump test, the velocity of the Lloyd aquifer is estimated to be 0.025 ft/d, substantially less than in either of the principal overlying aquifers (Warren et al. 1963).

Six wells (BNL-4, 6, 7, 10, 11, and 12) were used to supply potable water at BNL during 1995 (Naidu et al. 1996). Monitoring requirements included quarterly analyses for principal organic compounds; monthly bacteriological analyses; annual analysis for asbestos, micro-extractables, synthetic organic compounds, and pesticides; and semiannual inorganic analyses. Review of the data shows the BNL potable water supply to meet all New York State Drinking Water Standards (NYSDWS) in 1995.

In addition, BNL's Safety and Environmental Protection Division maintains a comprehensive sampling and analysis program for the potable water supply system. Specific analyses include: pH, conductivity, chlorides, sulfates and nitrates for water quality; Ag, Cd, Cr, Cu, Fe, Hg, Mn, Na, Pb, and Zn for metal analysis; and chloroform, dichloroethylene, 1,1,1 trichloro-thane, and trichloroethylene for volatile organic analysis. Their monitoring showed that water quality parameters met NYSDWS. Values for pH range from 5.8 to 6.6 which are typical for Long Island, but water from three wells is adjusted to reduce the corrosivity of the groundwater. The majority of metals were not detected in the potable water supply wells. Common constituents, such as Mn, Cu, Pb, and Zn, were observed at levels below their respective NYSDWS. Sampling of the water supply wells at the well-head showed that of 10 organic compounds, only chloroform and TCA were detected in the potable wells. However, only TCA exceeded the NYSDWS, and Well No. 11 is fitted with a carbon-adsorption treatment system that reduces the concentration to acceptable levels.

During 1995, 1,715 groundwater samples were taken from over 200 surveillance wells and over 100 temporary vertical profile wells at various waste sites at BNL. These samples were analyzed for constituents similar to the potable and process wells. Results indicate that except for pH, water quality parameters are below the New York State Ambient Water Quality Standards (AWQS) even in areas of potential contamination. Metal and volatile organic compounds (VOCs) exceed AWQS in a number of areas across the site. The VOCs are usually traceable to known spills or chemical-waste storage or former disposal areas. In several areas of BNL, iron is above AWQS reflecting natural background concentration. However, in areas such as the Current Landfill (closed in 1990), elevated iron and sodium concentrations are related to releases from the landfill.

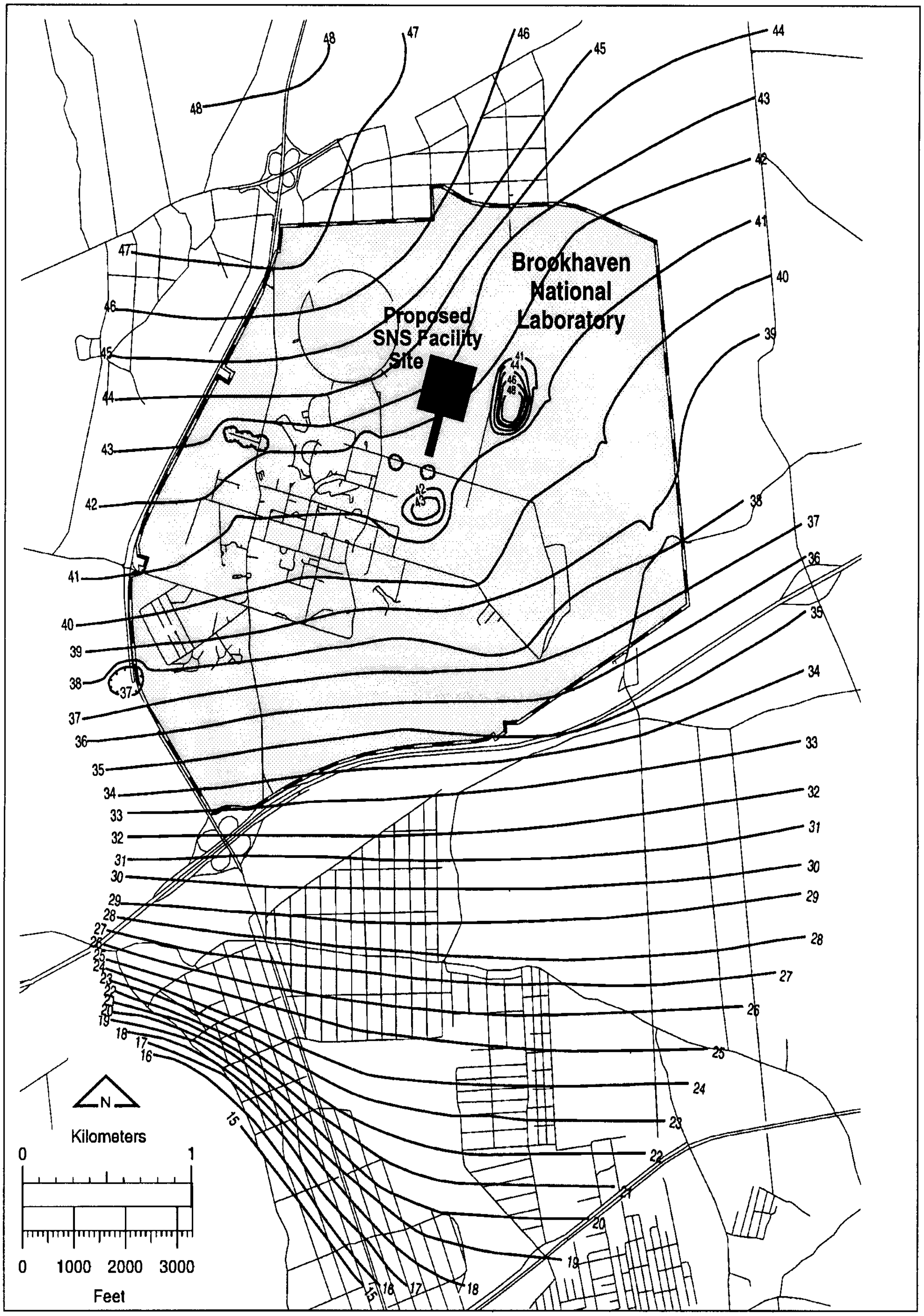

Figure 4.4.2.2-3. Water table contour map for the BNL site.

Groundwater wells in the immediate vicinity of BNL's preferred site for the proposed SNS indicate slightly elevated levels of iron and sodium.

Long Island's drinking water supply comes from groundwater. Long Island's Upper Glacial Aquifer has been designated as a sole source aquifer by the EPA.

Human consumption utilizes 4 percent of the total pumpage. Approximately 70 percent of the total pumpage is returned to the aquifer through on-site recharge basins, and about 15 percent is discharged into the Peconic River. The area occupied by BNL was identified by the Long Island Regional Planning Board and Suffolk County as being over a deep-flow recharge zone for Long Island. It is estimated that 50 percent of the precipitation recharges the lower aquifer systems (Magothy and Lloyd aquifers) lying beneath the Upper Glacial Aquifer.

4.4.3 CLIMATE AND AIR QUALITY

BNL has a climate typical to most eastern seaboard areas. Temperatures average 49.7 °F (7 °C) on an annual basis, but have ranged from a low of –23 °F (–30 °C) in 1961 to a high of 100.5 °F (38 °C) in 1991. By comparison, the average temperature in 1995 was 51 °F (10.6 °C) and the range was 44 °F (6.9 °C) to 84 °F (29.1 °C). Precipitation averages 48.13 in. (122 cm) per year with a maximum of 68.66 in. (174 cm) and a minimum of 34.55 in. (87 cm) since 1949 (Figure 4.4.3-1). Snowfall averages about 30.2 in. (76 cm) per year with a maximum annual accumulation recorded at 90.8 in. (230 cm) in the 1995-96 season. The months of December through March account for the majority of accumulations.

4.4.3.1 Severe Weather

The most severe weather for Long Island is related to hurricane occurrences with associated winds and precipitation. The peak wind speed at BNL was recorded during Hurricane Carol at 125 mph (201 km/hr) in 1954. Similarly, the maximum hourly [2.1 in. (5.3 cm)] and daily [9.02 in. (22.9 cm)] precipitation were recorded during Hurricane Edna in 1954. In addition, Suffolk County has experienced 10 tornadoes

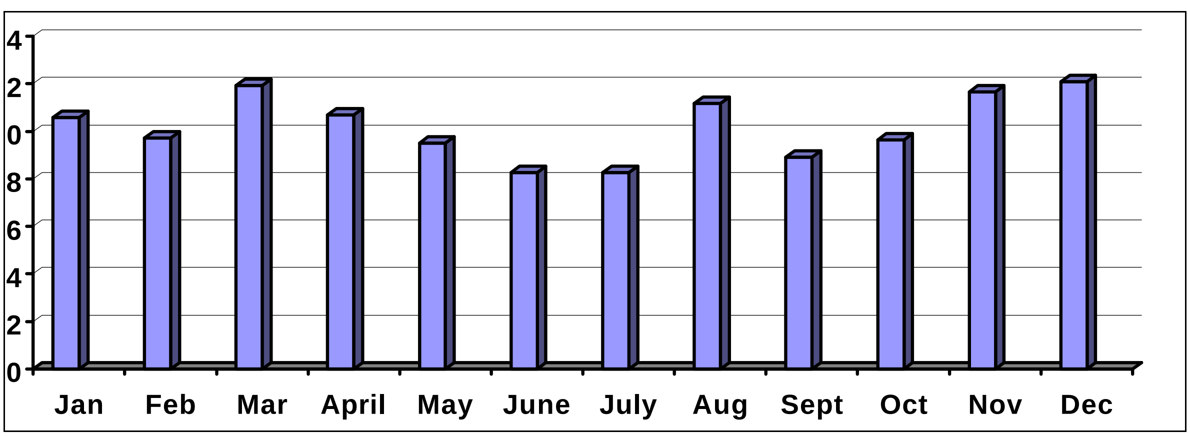

Figure 4.4.3-1 Average monthly precipitation at BNL.

during the 1950 to 1995 period (refer to Figure 4.1.3.1-1). However, the severity of these tornadoes has been relatively minor (F0-3, F1-6, F2-1) as measured on the F-scale.

4.4.3.2 Atmospheric Dispersion

BNL can be characterized as a well-ventilated area. The prevailing ground level winds are from the southwest during the summer, from the northwest during the winter, and about equally from these two directions during the spring and fall. Figure 4.4.3.2-1 displays an annual wind rose diagram for BNL (Naidu et al. 1996).

4.4.3.3 Air Quality

Suffolk County is listed as severe nonattainment for ozone and attainment for all other criteria pollutants by the New York State Department of Environmental Conservation (NYSDEC).

Existing ambient air quality in the vicinity of BNL is best quantified in terms of recent ambient monitoring data collected by NYSDEC at nearby locations. Table 4.4.3.3-1 summarizes these data and is taken from *New York State Air Quality Report: Ambient Air Monitoring System* (1997) for 1996.

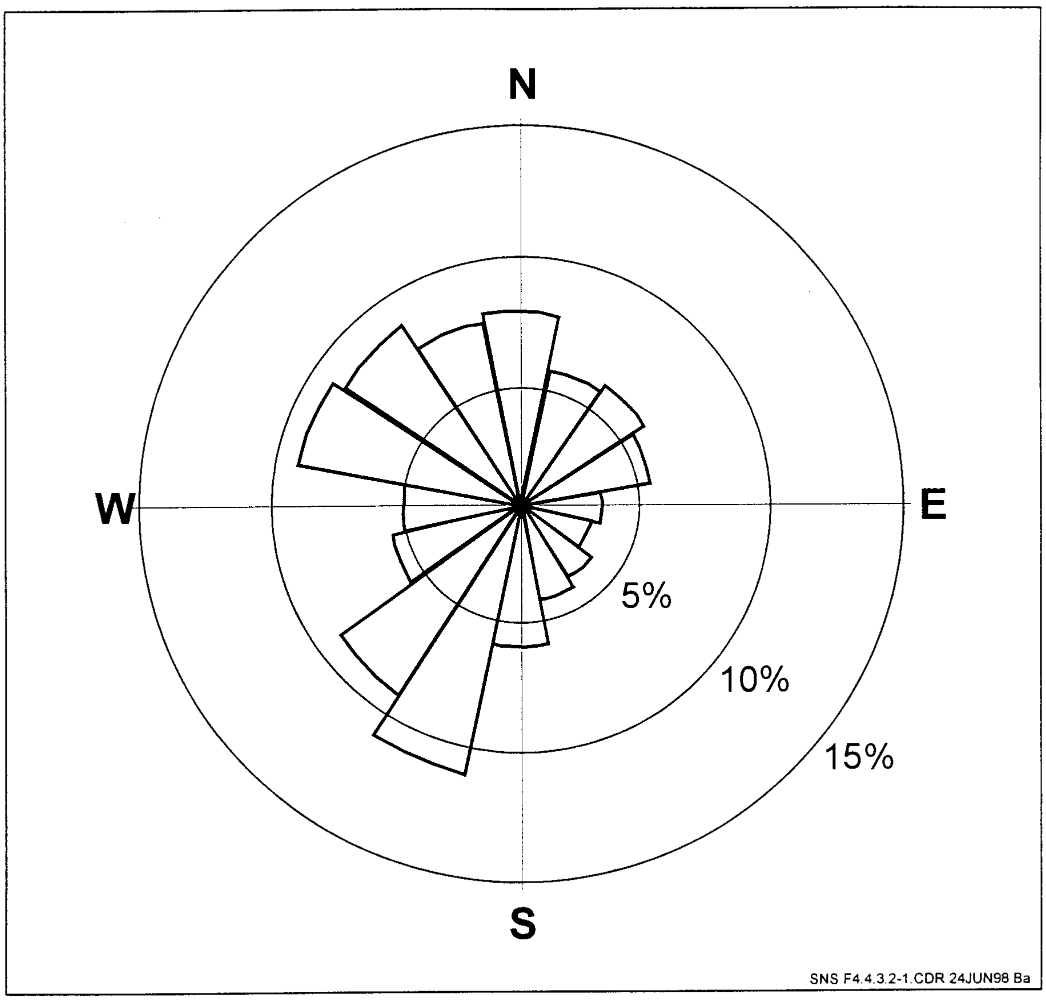

Figure 4.4.3.2-1. Annual wind rose for BNL during 1995.

Table 4.4.3.3-1. Summary of 1996 monitoring data in the vicinity of BNL.

Pollutant Averaging Time	Nearest Monitor Location	Maximum 1st	2nd	3rd	4th	NAAQS NYAAQS	Number of Exceedances
PM-10 24-hour	Babylon 41 km SW	57.0	40.0	34.0	—	150.0 μg/m^3	0
TSP 24-hour	Oster Bay 55 km NW	61.0	60.0	50.0	—	150.0 Sec. 260.0 Pri. μg/m^3	0
Ozone 1-hour	River Head 19 km NE	0.121	0.116	0.102	0.101	0.12 ppm	0
NO_x Annual	Eisenhower Park 68 km SW	0.026	—	—	—	0.05 ppm	0
SO_2	Babylon 41 km SW						
3-hour		0.085	0.050	0.043	—	0.5 ppm	0
24-hour		0.029	0.025	0.024	—	0.14 ppm	0
CO	Eisenhower Park 68 km SW						
1-hour		6.9	6.6	6.6	—	35.0 ppm	0
8-hour		5.8	4.9	4.3	—	9.0 ppm	0

Source: NYSDEC 1997. NYAAQS – New York Ambient Air Quality Standards.

4.4.4 NOISE

The SNS site is proposed for the north-central portion of the BNL reservation, which is situated between the STP and the RHIC. The proposed site is removed from the main area of offices, laboratories, and on-site workers. Ambient noise levels are not available for the proposed SNS site (Note: The RHIC will not be operational until 1999). Sensitive populations would include on-site workers and off-site residential populations. Approximately 8,000 residents live within 0.3 miles (0.5 km) of BNL's boundary, and the proposed SNS would be positioned roughly 1 mile (1.6 km) from the northern border and 2 miles (3.2 km) from the southern border. Natural buffering of sound levels is provided by the undeveloped forested buffer zone between the laboratory property and residential development.

4.4.5 ECOLOGICAL RESOURCES

This section provides a general description of the ecological resources for the proposed SNS site and the surrounding area. The discussions are based on information readily available from other sources. Site-specific surveys were done for protected species and wetlands. All other information was obtained from existing publications. For the most part, the impacts from construction and operation of the proposed SNS would be minor. Therefore, much of the information presented here is summary in nature. Greater detail can be obtained from the references compiled for this section.

4.4.5.1 Terrestrial Resources

The proposed SNS site at BNL lies within the Long Island Pine Barrens (see Section 4.4.8.4).

The southern portion of the proposed site consists of a stand of white pine (*Pinus strobus*) apparently planted during the 1930s, most likely as a Civilian Conservation Corps project. Communities composed of planted white pine are common in Suffolk County. Self-sown pitch pine (*Pinus rigida*) is scattered within this area. The understory consists of huckleberry (*Gaylussacia* sp.) with lesser amounts of blueberry (*Vaccinium* sp.) but is sparse because of shade and pine needle litter. Occasional oaks (*Quercus* sp.) are found along the edges of the firebreaks and lanes in this area. A native oak-pine woodland is present just north of the white pines.

There is evidence of extensive disturbance associated with operations at Camp Upton during World War I. These disturbed areas include an extensive system of trenches, as well as a complex of deep pits and banks that are found within a narrow area of the site and the adjacent buffer zone. Mounded areas formed in the course of trenching operations are vegetated by large white pines. Confirmation that these areas were disturbed during World War I comes from the presence of the white pines planted in the 1930s. These pines are presently overgrowing the trenches and pits.

In the extreme southern portion of the proposed SNS site, there is an assemblage of species not found elsewhere on the proposed site. These species include introduced ornamental shrubs, such as Japanese barberry (*Berberis thunbergii*) and jetbead (*Rhodotypos scandens*), as well as black locust (*Robinia pseudoaccacia*). The native red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), and grape (*Vitis* sp.) are also present. The presence of these species may be the result of the somewhat moister conditions within the deep pits.

In the more open areas along the firebreaks and lanes throughout this area the vegetation primarily consists of broomsedge (*Schizachyrium* sp.), sedges (*Carex* spp.), including the Pennsylvania sedge (*C. pensylvanica*) and lichens (*Cladina* sp.).

The remainder of the proposed site is composed of pine-oak or oak-pine communities. In the pine-oak community, pitch pine may make up as much as 90 percent of the total population. The only obvious recruitment of new individuals is along the edges of the firebreaks and lanes where pitch pine saplings are common.

The oaks inhabiting the entire site are predominantly scarlet oak (*Q. coccinea*) and white oak (*Q. alba*), with the scarlet oak being the most common. The understory is huckleberry and blueberry with occasional individuals of scrub oak (*Q. ilicifolia*) and, rarely, highbush blueberry (*V. corymbosum*).

The northeast corner of the proposed site approaches the wetlands associated with the headwaters of the Peconic River. The community structure in this section shifts abruptly from the upland vegetation of pitch pine, white and scarlet oak to a wetland vegetation of red maple, tupelo (*Nyssa sylvatica*), swamp azalea (*Rhododendron viscosum*), and sweet pepperbush (*Clethra alnifolia*). Widely dispersed, large individual pitch pine also occur in this area.

In severely disturbed portions of the proposed SNS site, where the subsoils are exposed, monospecific stands of young pitch pines are found. In addition, a 2.5-acre (1.0-ha) abandoned borrow pit located on the east side of the site is exclusively occupied by a mature stand of pitch pines.

An inventory of mammals at BNL was done in 1994 and 1995. This survey did not include the proposed SNS site. However, the survey did include areas with the same type of habitat as found on the proposed site. White-tailed deer, the most common mammal reported in this study, were found throughout both natural and developed areas. Within forests and wetlands, deer browse on saplings, grasses, and greenbrier. White-tailed deer are less common in the pine plantation areas than in the pitch pine/oak forest and wetland areas, probably because of a smaller food supply.

Other species commonly observed at BNL, but in low numbers, were raccoon, muskrat, cottontail rabbits, gray squirrel, eastern chipmunk, and red fox. White-footed mouse and indications (such as droppings or tracks) of other small mammals were found throughout the BNL site. Meadow voles, or indications of their presence, were found in fields and emergent wetland areas. Other species observed included woodchuck, pine vole, and meadow jumping mouse.

4.4.5.2 Wetlands

Information about the wetlands in the vicinity of the proposed site for the SNS is summarized from *Final Phase II — Sitewide Biological Inventory Report* (CDM 1995). There are three jurisdictional wetlands in the vicinity of the proposed site for the SNS at BNL **(**Figure 4.4.5.2-1**)**. These wetlands are associated with the upper reaches of the Peconic River.

The NYSDEC has prepared a wetland delineation manual that uses the same three parameters (soils, vegetation, and hydrology) as the 1987 USACOE manual to define and map wetlands. The delineation of the wetlands at BNL meet the regulatory criteria of both USACOE and NYSDEC. One important difference between the two sets of regulations is that NYSDEC places a 100-ft (30.5-m) wide buffer upland of wetland area boundaries whereas the USACOE does not. Hence, work performed outside a wetland regulated jointly by NYSDEC and USACOE but within the NYSDEC buffer zone requires a permit from NYSDEC under ECL Part 663.4.

Wetland WL-1 is a palustrine forested wetland with broad-leaved deciduous vegetation and is considered by NYSDEC as a Class I wetland. This wetland is split by the Peconic River. The parcel to the north is drier and characterized by a dense red maple canopy. The parcel south of the river is frequently inundated. Tree growth is

NYSDEC Class I Wetland: A wetland is classified as a Class I wetland in New York State if it has any of the following seven enumerated characteristics:

It is a classic kettlehole bog;
It is a resident habitat of an endangered or threatened animal species;
It contains an endangered or threatened plant species;
It supports an animal species in abundance or diversity unusual for the State or for the major region of the State in which it is found;
It is tributary to a body of water which could subject a substantially developed area to significant damage from flooding or from additional flooding should the wetland be modified, filled or drained;
It is adjacent or contiguous to a reservoir or other body of water that is used primarily for public water supply, or it is hydraulically connected to an aquifer which is used for public water supply; or
It contains four or more of the enumerated Class II characteristics.

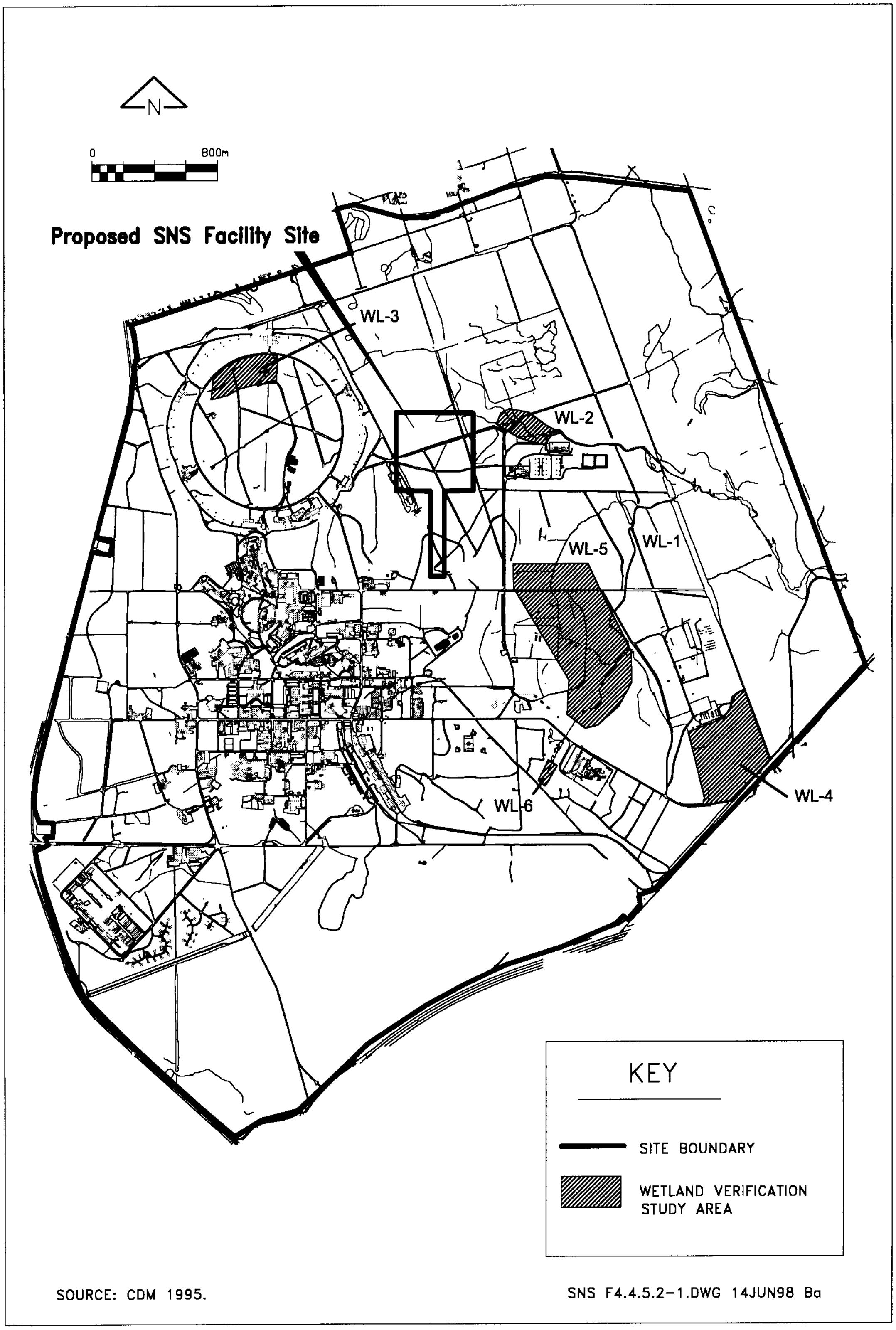

Figure 4.4.5.2-1. BNL wetlands.

sparse and there is a dense growth of annual grasses and wetland indicative plants, such as spiked bur-reed, marsh pepper smartweed, and tussock sage. Soils in the wetland are listed as Wareham loamy sand, which is a hydric soil. The discharge from the BNL STP, located just west of this wetland, is sufficient to support aquatic plant, invertebrate, and vertebrate species. As part of the delineation of this wetland, one south-to-north transect was described. The transect began in an upland oak-pine forest, crossed the flooded forested wetland and the Peconic River channel, crossed an upland peninsula of grassed-over fill, reentered the forested wetland, and ended in the oak-pine forest north of the wetland.

Wetland WL-2 also borders the Peconic River. NYSDEC considers this a Class I wetland. This wetland is described as a palustrine forested wetland with broad-leaved deciduous vegetation, seasonally saturated, and as a palustrine shrub/sapling wetland with broad-leaved deciduous vegetation, and emergent narrow-leaved persistent vegetation, seasonally saturated. This wetland is dominated by a red maple canopy forest with a weak tree canopy in the center and a tussock sedge ground cover.

Soils in the wetland are listed as Wareham loamy sand, which is a hydric soil. Three ponded areas within the wetland probably serve as a refuge for fish, amphibians, and reptiles during periods of low water. Based on field observations, the Peconic River upstream of the STP flows only from late winter to late spring. Most of the wetland appears to be inundated during spring. Therefore, the wetland probably functions as a control of flood and stormwater and potentially absorbs nutrients and sediments from upstream portions of the Peconic River. As part of the delineation of this wetland, one southwest-to-northeast transect was described. The transect began in an upland oak-pine forest, crossed a dense red maple dominated wetland, crossed the dry Peconic River channel, reentered the dense forested wetland, and ended in an oak forest.

Wetland WL-5 is a forested wetland north and south of Fifth Avenue and east of First Avenue. NYSDEC considers this a Class I wetland. This is a palustrine forested wetland with broad-leaved deciduous vegetation, seasonally saturated. Soils in this wetland are listed as Atsio sand, Berryland mucky sand, Muck, and Walpole sandy loam, all of which are hydric soils. There is evidence that the wetland was extensively ditched in the past. A series of east-west-oriented ditches merge to form a central north-south ditch that eventually enters the Peconic River. The ditches probably reduce the inundation of the wetland, encouraging growth of a red-maple-dominated palustrine forest over a shrub/sapling or herbaceous wetland community. A 2-acre (0.81-ha) area of recently killed red maples south of Fifth Avenue is indicative of poor drainage and/or an increase in the period of inundation or saturation of the soils. This wetland functions principally in the control of stormwater and flood water and as habitat for wildlife. Wildlife observed in this wetland include white-tailed deer, cottontail rabbit, gray squirrel, red-bellied woodpeckers, and several species of warblers. Many of the larger red maples are either hollow or contain holes, providing nesting sites for birds, such as flickers and wood ducks. As part of the delineation of this wetland, two west-to-east transects were described. The transect north of Fifth Avenue began in an upland pitch pine forest, crossed the red-maple-dominated palustrine forest, and ended in an upland pitch pine forest. The south transect began in an upland oak forest, crossed through a red-maple-, black-gum-, and greenbrier-dominated palustrine forest, and ended in an upland forest.

4.4.5.3 Aquatic Resources

The Peconic River flows through the northern portion of BNL. The northeast corner of the proposed SNS site is approximately 300 ft (91 m) from the river. The headwaters of the Peconic River are located approximately 0.75 miles (1.2 km) to the west of BNL and exit the site to the east. Currently the BNL STP accounts for 90 percent of the water flow in the Peconic River in the spring and early summer and almost 100 percent during late summer and fall.

The Peconic River is protected under the Freshwater Wetlands Program as it is a Class I wetland. Two reaches of the Peconic River downstream of BNL were designated as a scenic river in 1986 under the New York State Wild, Scenic, and Recreational River Act. The two reaches represent the last significant undeveloped river corridor within the Long Island Pine Barrens area. The reaches extend 10.5 miles (16.8 km) from the western boundary of the red maple swamp to the Long Island Railroad bridge between Connecticut and Edwards Avenues 3 miles (4.8 km) from Middle Country Road to its confluence with the main channel of the Peconic River.

The Peconic River downstream of the potential site for the proposed SNS is described as a Coastal Plain Stream. In general, upstream of the STP, the habitat of the river consists of a narrow, often channelized stream with dense, overhanging brush. There is a weir upstream of the STP that may restrict fish movement both upstream and downstream. A man-made pond, approximately 6 ft (1.8 m) deep and 30 ft by 30 ft (9 m by 9 m) in size is located approximately 50 ft (15.2 m) upstream of the weir. Downstream of the STP, the habitat consists of a shallow [average depth is less than 1 ft (0.3 m)], wide [10 to 15 ft (3 to 4.6 m)], low-gradient stream channel with fallen logs, brush, and aquatic vegetation providing cover for fish. A dense stand of red maple trees farther to the east precludes the growth of aquatic vegetation in that portion of the stream. Another weir is located just above the east firebreak. Farther downstream the river becomes shallow, with no distinct channel or streambed in some areas. The stream and associated wetlands are heavily vegetated with a mix of emergent herbaceous plants. Several shallow, open-water areas are located approximately 0.25 miles (0.4 km) downstream of the firebreak. The flow in the Peconic River ceases about midway between the east firebreak and the east BNL property line. No standing water was found downstream of this point to the BNL property line.

NYSDEC
Surface Water "C" Classification for the Peconic River (Summary)

Best Use – Fishing. Suitable for fish survival and propagation. Suitable for primary and secondary contact recreation.

pH – Not less than 6.5 nor more than 8.5.

Dissolved Oxygen – The minimum daily average shall not be less than 5.0 mg/L and at no time less than 4.0 mg/L.

Temperature – Water temperature at the surface of the stream shall not be raised to more than 90 °F (32 °C).

Turbidity – No increase that will cause a substantial visible contrast to natural conditions.

Results of fish collections above the weir and wastewater discharge (CDM 1995) show that the fish community in this portion of the river is characterized by certain species (Table 4.4.5.3-1).

The dominant aquatic vegetation in these reaches of the Peconic River included water-starwort (*Callitriche palustris*), reported to be very common and very dense. Other common plants include manna grass (*Glyceria grandis*), arrow arum (*Peltandra virginica*), and pickerel weed (*Pontederia cordata*).

The Peconic River was designated as a Wild and Scenic River by the State of New York in 1986 because it represented the last significant undeveloped river within the Long Island Pine Barrens area. Approximately 14 miles (22.4 km) of the Peconic River are now listed as "scenic river" by the State of New York, of which 7.5 miles (12 km) are also listed as a "recreational river." Scenic rivers are rivers or sections of rivers that are "free of diversions or impoundments (except for log dams), with limited road access and are very primitive and largely undeveloped river areas; or areas that are partially or predominantly used for agriculture, forest management, and other human activities which would not substantially interfere with public use and enjoyment of the rivers and their shores" (NYSDEC 1988a, as cited in CDM 1995: 2-3). Recreational rivers are "rivers or river sections readily accessible by road or railroad, which may have undergone development, impoundment, or diversion in the past" (NYSDEC 1988a, as cited in CDM 1995: 2-3), such as those reaches downstream of BNL.

Recreational activities afforded by the Peconic River include bird-watching, fishing, hunting, and canoeing. The entire Peconic River drainage is a Class I wetland. The Peconic River headwaters area is also identified as an "S1" habitat by the Natural Heritage Program, indicating that it is one of five or fewer coastal plain stream communities in the state.

4.4.5.4 Threatened and Endangered Species

DOE is in the process of consulting with the USFWS and the New York Department of

Table 4.4.5.3-1. Fish community above the wastewater discharge point within BNL.

Common Name	Scientific Name
Chain pickerel	*Esox niger*
Goldfish	*Carassius auratus*
Golden shiner	*Notemigonus chrysoleucas*
Creek chubsucker	*Erimyzon oblongus*
Brown bullhead	*Ameiurus nebulous*
Mummichog	*Fundulus heteroclitus*
Largemouth bass	*Micropterus salmoides*
Banded sunfish	*Enneacanthus obesus*
Pumpkinseed	*Lepomis gibbosus*
Yellow perch	*Perca flavescens*

Environmental Conservation regarding whether or not construction and operation of the proposed SNS at BNL would jeopardize the habitat of any federal or state protected species and about appropriate mitigation measures. The letters of consultation are presented in Appendix D.

New York State endangered species are defined as native species in imminent danger of extirpation or extinction in the state or listed as endangered by USFWS. State threatened species are native species likely to become endangered within the foreseeable future in New York or listed as threatened by USFWS. Special-concern species are native species for which a welfare concern or risk of endangerment has been documented by NYSDEC. Table 4.4.5.4-1 lists the state and federally listed threatened, endangered, or special-concern species. The tiger salamander is known to be breeding on laboratory property (CDM 1995).

The northwest portion of the proposed SNS site approaches wetlands associated with the Peconic River. This area may be suitable habitat for the tiger salamander and the spotted salamander.

Thirteen species of plants found on BNL are protected in New York State under Environmental Conservation Law (ECL) 9-1503 and New York State Regulation 193.3, which states the “no one may knowingly pick, pluck, sever, remove or carry away (without the consent of the owner thereof) any protected plant.” (This is a designation distinct from threatened, endangered, rare, or special concern.) (Table 4.4.5.4-2). Three of these plants, the spotted wintergreen, bayberry, and swamp azalea, have been found on the proposed SNS site (Black 1998).

Table 4.4.5.4-1. State and federally listed protected species reported to occur at BNL.

Common Name	Scientific Name	NYS Status	Federal Status
Osprey	*Pandion haliaetus*	T	
Peregrine falcon	*Falco peregrinus*	E	E
Common nighthawk	*Chordeiles minor*	SC	
Eastern bluebird	*Sialia sialia*	SC	
Spotted turtle	*Clemmys guttata*	SC	
Eastern hognose snake	*Heterodon platirhinos*	SC	
Spotted salamander	*Ambystoma maculatum*	SC	
Eastern tiger salamander	*Ambystoma tigtinum*	SC	
Banded sunfish	*Enneacanthus obesus*	SC	

T – Threatened
E – Endangered
SC – Special concern.

Table 4.4.5.4-2. Plants protected by ECL 9-1503 and New York State Regulation 193.3.

Common Name	Scientific Name
Butterfly weed	*Asclepias tuberosa*
Spotted wintergreen	*Chimaphila maculata*
Lady's slipper	*Cypripedium acaule*
Bayberry	*Myrica pensylvanica*
Flowering dogwood	*Cornus florida*
Swamp azalea	*Rhododendron viscosum*
Hayscented fern	*Dennestaedtia punctilobula*
Shield fern	*Dryopteris* sp.
Sensitive fern	*Onoclea sensibilis*
Cinnamon fern	*Osmunda cinnamomea*
Clayton's fern	*Osmunda claytoniana*
Royal fern	*Osmunda regalis*
Marsh fern	*Thelypteris palustris*
Virginia chain fern	*Woodwardia virginica*

Among the protected wildlife found in the Peconic River Basin are one endangered species, the tiger salamander; two special concern species, the spotted turtle and banded sunfish; and one candidate for threatened species, the swamp darter. The Peconic River is one of only two locations in the state known to support a population of banded sunfish. The distribution of the swamp darter in New York is limited to the eastern two-thirds of Long Island.

Four species of wildlife cited as unique (locally uncommon or color variants) are reported by NYSDEC to occur in the Peconic River drainage: a polymorphic variety of the northern water snake (*Nerodia sipedon*), a population of lead-backed salamander (color variant of the red-backed salamander), the stinkpot or musk turtle, and the river otter (*Lutra canadensis*). Although the four species are not recognized as endangered, threatened, or of special concern by NYSDEC, they are considered unique because the first two are color variants of a common species and the latter two are locally uncommon but widespread in New York. These four species were previously reported as occurring well downstream of the BNL site. Recently, the lead-backed salamander and the musk turtle have been reported on BNL property (CDM 1995).

4.4.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The ROI for the SNS at the proposed BNL site includes Nassau and Suffolk Counties, as shown in Figure 4.4.6-1. Approximately 90 percent of BNL employees reside in this region. The region includes the cities of Levitown and Hicksville.

This section provides a description of the following socioeconomic and demographic characteristics:

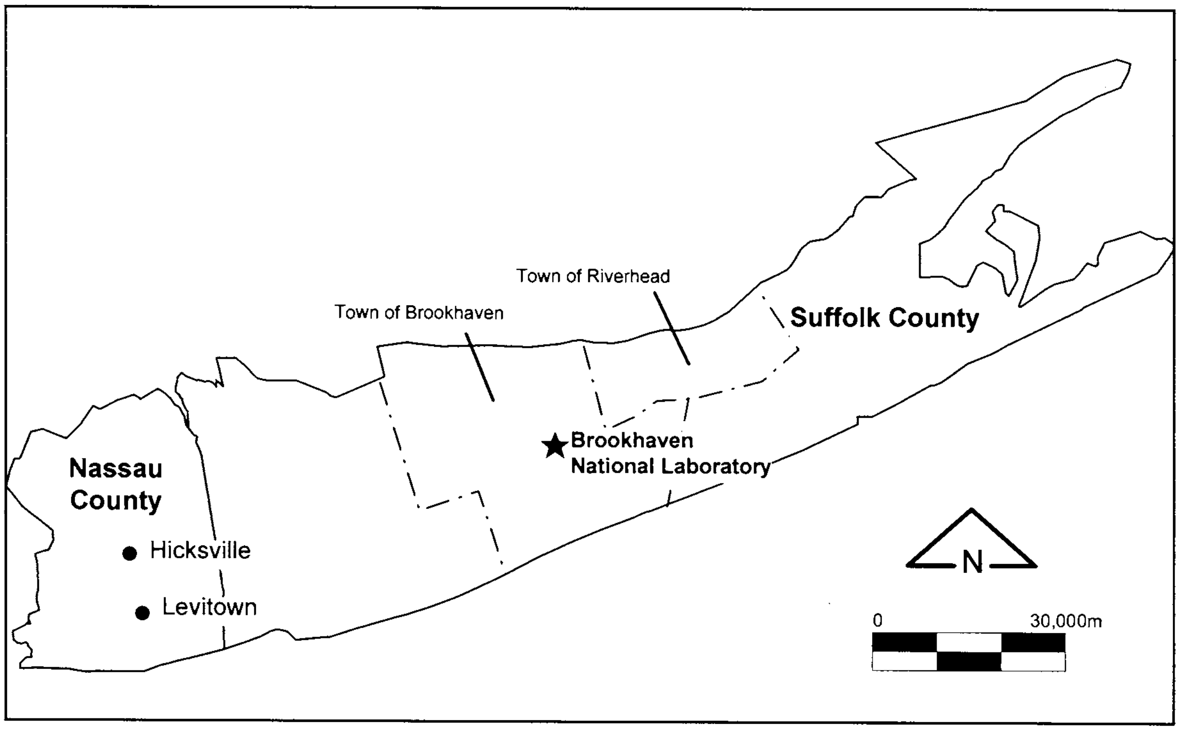

Figure 4.4.6-1. Map showing socioeconomic ROI for BNL.

- Demographics
- Housing
- Infrastructure
- Local economy
- Environmental justice

4.4.6.1 Demographic Characteristics

Population trends and projections for each of the counties in the ROI are presented in Table 4.4.6.1-1. Nassau and Suffolk Counties are of similar size, each having a population of approximately 1.3 million in 1995. Although the population of Suffolk County increased steadily since 1980, Nassau County was larger in 1980 than in 1995 (the county's population declined by 3 percent between 1980 and 1990).

Population data for selected cities in the region are presented in Table 4.4.6.1-2. Population growth has been slow throughout the region since 1980, with an increase of only 54,000 individuals (about 2 percent). Some communities, such as Levitown, have experienced population decreases between 1990 and 1997.

Population by race and ethnicity for the region is presented in Table 4.4.6.1-3. Both counties are predominantly Caucasian (87 to 90 percent). African Americans are the second largest racial group, comprising 6 to 9 percent of the two counties.

4.4.6.2 Housing

Regional housing characteristics are presented in Table 4.4.6.2-1. In 1990, vacancy rates in the region ranged between a low of 3 percent in Nassau County to a high of 12 percent in Suffolk County.

Table 4.4.6.1-1. Regional population trends and projections.

County	1980	1990	1995	2000	2010
Nassau	1,321,582	1,287,444	1,305,772	1,316,000*	1,346,000*
Suffolk	1,284,231	1,321,768	1,353,704	1,364,000*	1,418,000*
Region	2,605,813	2,609,212	2,659,476	2,680,000*	2,764,000*
State	17,558,165	17,990,778	18,136,000	18,146,000	18,916,000

* Estimated figure.
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.4.6.1-2. Population for incorporated areas within the region.

Communities	1990	1997
Levitown CDP	52,286	52,542
Hicksville	40,174	N/A
Brookhaven	407,779	419,745
Riverhead	23,011	24,589
Ridge CDP	11,734	11,935

N/A: Data for 1997 are not available.
Source: U.S. Bureau of Census 1990.

Table 4.4.6.1-3. 1990 population by race and ethnicity for the region.

All Persons, Race/ Ethnicity	Nassau		Suffolk	
	Number	Percent[a]	Number	Percent[a]
All Persons	1,287,444	100	1,321,768	100
Caucasian	1,116,949	87	192,236	90
African American	110,991	9	82,473	6
American Indian[b]	1,626	<1	3,233	<1
Asian/ Pacific Islander	38,914	3	22,185	2
Hispanic of any race[c]	77,386	6	87,852	7
Other Races	18,868	1	21,737	2

[a] Percentages may not total to 100 due to rounding.
[b] Numbers for Aleuts and Eskimos were placed in the "other" category given their small number.
[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from each of the race categories.
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.4.6.2-1. Housing summary for the region, 1990.

	Nassau County		Suffolk County	
	Number	**Percent[a]**	**Number**	**Percent[a]**
Total Housing Units	446,292	100	481,317	100
Occupied	431,515	97	424,719	88
Vacant	14,777	3	56,598	12
Median Home Value	$209,500	N/A	$165,900	N/A
Gross Rent	$749	N/A	$802	N/A

N/A = not applicable
[a] May not total 100 due to rounding
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

In 1990, median home values were highest in Hicksville and Brookhaven (approximately $175,00 and above) and lowest in Riverhead and Ridge (approximately $135,000 and below). The median housing unit price in 1990 was $209,500 for Nassau County and $165,900 in Suffolk County.

4.4.6.3 Infrastructure

The infrastructure section characterizes the region's community services with indicators such as education, health care, and public safety.

4.4.6.3.1 Education

New York is divided into 774 school districts, 126 of which (626 schools) are located in the region. Information regarding school districts within the region is presented in Table 4.4.6.3.1-1. Teacher-student ratios of below 1:15 are regarded as exceptional. By comparison, many public school districts throughout the United States staff classrooms at a ratio of around 1:20. Student enrollment in the Nassau-Suffolk area could increase by a substantial margin and still not exceed the 1:20 ratio.

The school districts in the region all receive funding from local, state, and federal sources, but the percentage received from each source varies.

4.4.6.3.2 Health Care

There are currently 27 hospitals serving the region with 8,600 acute care beds (Table 4.4.6.3.2-1). On the average, these hospitals have a relatively high use rate, with less than 10 percent of beds available.

4.4.6.3.3 Police and Fire Protection

Table 4.4.6.3.3-1 gives the number of full-time law enforcement officers for the incorporated communities in the BNL region. Nassau County has 2,988 officers and an approved FY 1998 budget of over $469 million, and Suffolk County has 129 officers. Because of the potential severity of the consequences of a BNL emergency, the fire department has been specially trained to respond to a variety of incidents.

Table 4.4.6.3.1-1. Public school statistics in the region, 1995–1996 school year.

County	Number of Schools	Student Enrollment[a]	Teachers[a]	Teacher/ Student Ratio (1998)	Per Student Operational Expenditures
Nassau	295	317,875	24,450	1:13	$11,697
Suffolk	331	347,688	24,830	1:14	$11,168
Region	626	665,563	49,280	1:14	$11,421

[a] Full-time equivalent figures.
Source: New York State Education Department 1996.

Table 4.4.6.3.2-1. Hospital capacity and usage in the region.

Hospital	Number of Hospitals	Number of Beds[a]	Annual Bed-Days Used[a](%)
Nassau	14	4,746	93
Suffolk	13	3,902	94
Region	27	8,648	93

[a] Based on the number of people discharged and the average length of stay divided by total beds available annually.
Source: New York State Department of Health 1996.

Table 4.4.6.3.3-1 Full-time law enforcement officers for incorporated areas within the BNL region (1996).

Community	Officers
Nassau County	2,988
Suffolk County	129
Riverhead	73

Source: Department of Justice, 1997.

4.4.6.4 Local Economy

This subsection provides information on the economy of the region, including employment, education, income, and fiscal characteristics.

4.4.6.4.1 Employment

Regional employment data for 1997 are summarized in Table 4.4.6.4.1-1. Since 1994, the regional unemployment rate has decreased from 5.6 percent to only 3.4 percent. The majority of new jobs in the ROI are associated with retail trade and services.

Table 4.4.6.4.1-2 presents employment industry for the ROI. Government, services, and retail trade are the principal economic sectors in the region, making up about 65 percent of all 1995 jobs. By comparison, in 1990 these three sectors comprised around 60 percent of all jobs.

4.4.6.4.2 Income

In 1995, total regional income was approximately $85.3 billion. Income data for the ROI are presented in Table 4.4.6.4.2-1. Only 3 percent of all families in the region had 1989 incomes below the poverty level, which was considerably less than the statewide average.

4.4.6.4.3 Fiscal Characteristics

Municipal and county general fund revenues in the ROI are presented in Table 4.4.6.4.3-1. The general funds support the ongoing operations of local governments, as well as community services such as police protection and parks and recreation. The largest single component for the two ROI counties was local taxes, which includes real estate, property, hotel/motel, and sales taxes. ROI local taxes represented about 60 percent of the general fund revenues in that year, and intergovernmental were about 30 percent.

Table 4.4.6.4.1-1. Regional employment data, 1997.

County	Civilian Labor Force	Employed	Unemployed	Unemployment Rate
Nassau	695,155	674,300	20,855	3.0
Suffolk	711,007	684,700	26,307	3.7
Region	1,406,162	1,359,000	47,162	3.4

Source: New York State Department of Labor 1998.

Table 4.4.6.4.1-2. Employment by county, region, and the State of New York (1995).

Economic Character	Nassau County	Suffolk County	Region	State of New York
Employment by Industry (1995)				
Farm	107	2,547	2,654	60,966
Agriculture Services	5,795	8,998	14,793	67,572
Mining	579	422	1,001	10,748
Construction	26,481	37,237	63,718	373,361
Manufacturing	47,324	72,533	119,857	982,532
Transportation and Public Utility	31,377	28,501	59,878	476,424
Wholesale Trade	45,442	39,910	85,352	463,204
Retail Trade	127,254	106,647	233,901	1,403,944
Finance, Insurance, and Real Estate	95,237	50,570	145,827	1,049,318
Services	273,388	212,722	486,110	3,433,419
Government	80,555	100,867	181,422	1,419,305
Total Employment	733,539	660,954	1,394,513	9,740,793

Source: Regional Economic Information for Nassau and Suffolk Counties, Nassau-Suffolk, NY PMSA and NYS 1990–1995 (U.S. Bureau of Census 1990).

Table 4.4.6.4.2-1. Measures of BNL regional income.

Area	Median Household Income 1989 ($)	Per Capita Income 1996 ($)
Nassau County	54,283	23,352
Suffolk County	49,128	18,481
New York State	32,965	16,501

Source: U.S. Bureau of Census 1990.

Table 4.4.6.4.3-1. Municipal and county general fund revenues in the region, FY 1997.

Revenue by Source	($1,000)	Percent[a]	($1,000)	Percent[a]
Local Taxes[a]	779,293	63	697,076	57
Licenses and Permits	3,445	<1	0[b]	N/A
Fines and Forfeitures	8,853	<1	0[b]	N/A
Charges for Service	0[b]	NA	103,784	9
Intergovernmental[c]	407,192	33	349,357	29
Interest	47,999	4	0[b]	N/A
Miscellaneous Income	450	<1	64,588	5
Total	1,247,232	100	1,214,804	100

[a] Local taxes include real estate and personal property taxes, hotel/motel taxes, and local sales taxes.
[b] This revenue item accounted for under other revenue sources.
[c] Includes payments of state and federal funds.
N/A = not available.
Source: U.S. Bureau of Census 1990; Comprehensive Annual Financial Reports 1997c.

4.4.6.5 Environmental Justice

Figures 4.4.6.5-1 and 4.4.6.5-2 illustrate distributions for minority and low-income populations residing within 50 miles (80 km) of BNL. The definitions of minority and low-income populations and the methodology for assessing potential environmental justice effects are given in Section 5.5.6.5.

Approximately 5,260,000 people live within a 50-mi (80-km) radius of BNL. Minorities comprise 21.4 percent of this population. In 1990, minorities comprised 24.1 percent of the population nationally and 26 percent of the population in New York. There are no federally recognized Native American groups within 50 miles (80 km) of the site. The percentage of persons below the poverty level is 5.4 percent, which compares with the 1990 national average of 13.1 percent and a statewide figure of 23 percent (U.S. Census 1990).

4.4.7 CULTURAL RESOURCES

BNL is located in an area of Long Island that has a long cultural history. The first inhabitants of the area were Native American groups, many

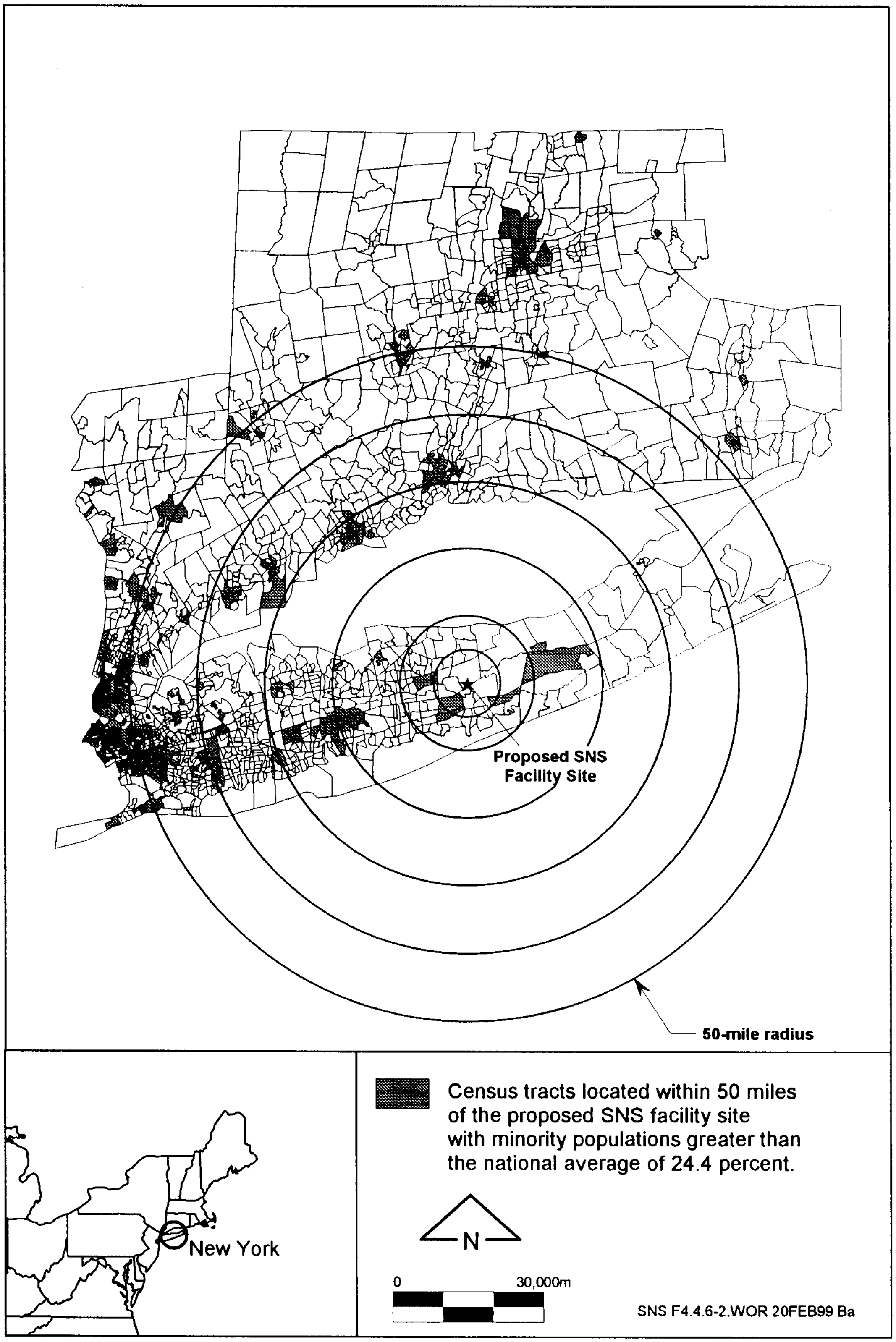

Figure 4.4.6.5-1. Distribution of minority populations at BNL.

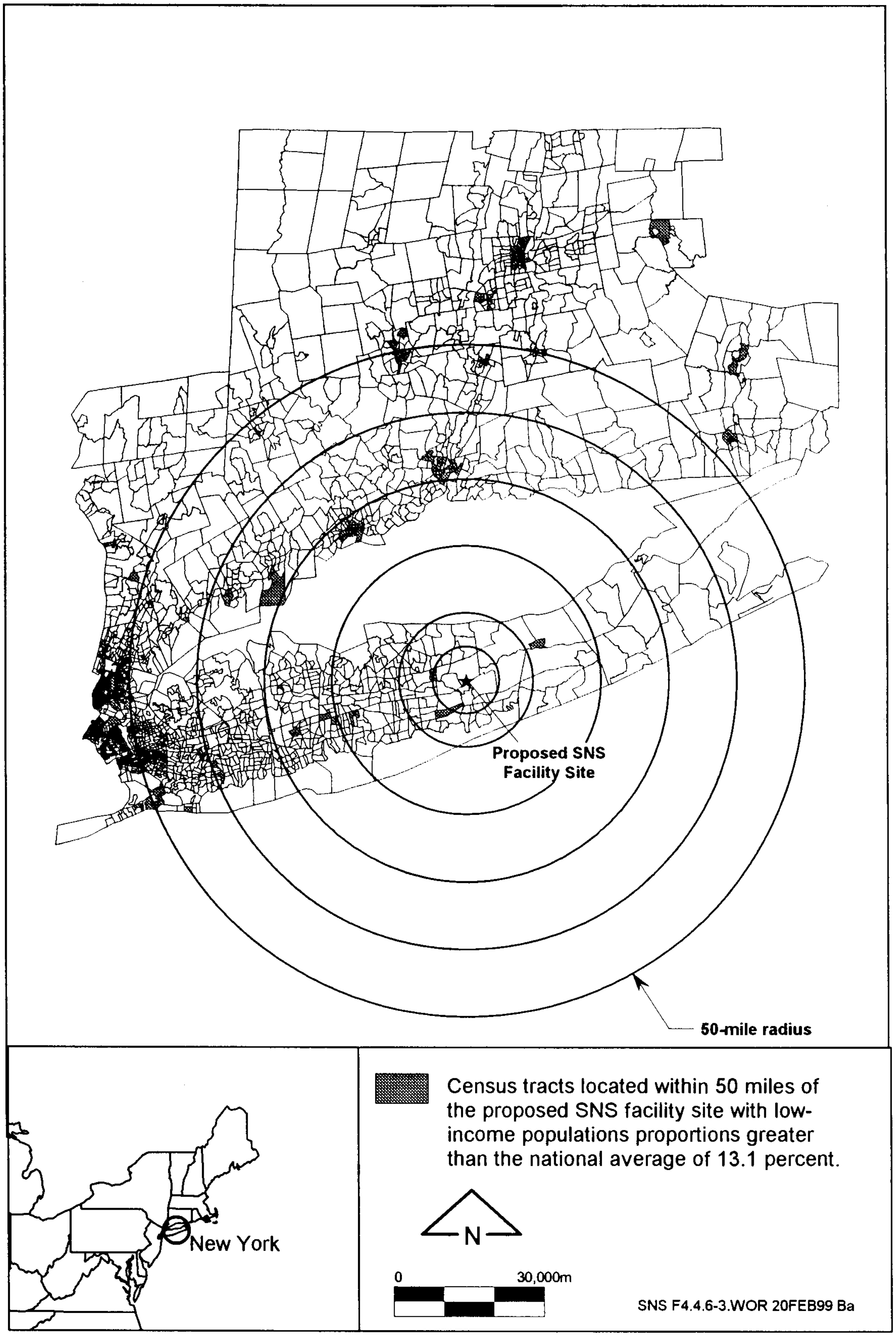

Figure 4.4.6.5-2. Distribution of low-income populations at BNL.

with cultures adapted to life in a marine coastal setting. European settlement of the area began in the 17th century. The first European settlement in Suffolk County can be traced historically to A.D. 1640, when English settlers established Southampton and Southold (BNL 1995: 4-1). Since this time, the area has been inhabited continuously, primarily by Euroamerican settlers and their descendants. Given the depth of local history, the citizens of the area are actively involved in the preservation of cultural resources such as historic sites and buildings (BNL 1995: 4-1).

The prehistory of BNL land remains largely unknown because most of it has never been surveyed for prehistoric archaeological sites (BNL 1995: 4-5). Prior to initiation of this EIS, only two archaeological studies had been conducted at BNL. One of these studies was a reconnaissance survey limited to the periphery of three ponds, a wooded area covering approximately 20 acres (8.1 ha), and areas along the Peconic River (Johannemann 1974: B-2 to B-3). The other study consisted of archaeological test excavations in the area that was to be impacted by the ISABELLE/Colliding Beam Accelerator (CBA), which was begun during the 1970s and later canceled (Johannemann and Schroeder 1977). Both studies covered small portions of the 5,261 acres (2,130 ha) of land at BNL, and no evidence of prehistoric human activity was encountered.

A brief history of land use at BNL has been prepared and published by Associated Universities, Inc. (BNL 1995), the former management and operating contractor for the laboratory. This history begins in 1917 with the establishment of Camp Upton, a large U.S. Army induction center and hospital that was occupied until about 1921. It continues with the demise of Camp Upton shortly after World War I, its reestablishment during World War II, and its final closure at the end of the war. The history concludes by tracing the general development of BNL during the period 1947 to 1997. However, this history has never been supplemented with a detailed, site-wide survey for historic archaeological sites and other types of historic cultural resources.

Fourteen historic archaeological sites dating to the Camp Upton occupation of BNL land have been identified and partially excavated within the ISABELLE project area (Johannemann and Schroeder 1977: 33-53). This area and the partially constructed accelerator facilities in it have been incorporated into construction of the RHIC.

A limited review of all BNL properties for historical resources was conducted in June 1990 by representatives from the SHPO for the state of New York. As a result of this review, three potentially significant historic resources were identified: a group of World War I trenches dating to the Camp Upton occupation, the Graphite Reactor Building (Building 701), and the Old Cyclotron Enclosure (Building 902). These resources are considered to be potentially eligible for listing on the NRHP (DOE-BNL 1994a: 19; Naidu et al. 1996: 2-44). A formal historical context for these resources has not been developed.

A cultural resources survey of the proposed SNS site and an adjacent buffer zone was conducted in January 1998. This survey focused on identifying prehistoric and historic remains in these areas. The results of the survey are summarized in Sections 4.4.7.1 and 4.4.7.2.

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at BNL. In addition, the locations of ancillary structures such as a retention basin and a switchyard have not been determined. As a result, such areas could not be surveyed for cultural resources. However, the eventual establishment of these areas would proceed in such a manner as to avoid known cultural resource locations. If the proposed SNS site at BNL were chosen for construction, these areas would be surveyed for cultural resources prior to the initiation of construction-related activities within them.

The occurrence of cultural resources on the proposed SNS site and in its vicinity is described in this section of the FEIS. However, the locations of archaeological and historic sites are not indicated in the descriptions. To better protect these sites, DOE and Brookhaven Science Associates do not reveal the locations of cultural resources in documents available to the general public. Because several of the original reports cited in this section show the locations of cultural resources on BNL, they are not included in the DOE public reading rooms established as part of the SNS FEIS process.

4.4.7.1 Prehistoric Resources

No prehistoric cultural resources have been identified on or adjacent to the proposed SNS site (Black 1998: 5).

4.4.7.2 Historic Resources

A number of earthen berms, linear trenches, pits, and mounds have been identified at four separate locations throughout the proposed SNS site. These locations were designated as Stations 2, 4, 8, and 10. The landscape features at these stations may have been associated with World War I trench warfare training at Camp Upton. At Station 2 on the proposed SNS site, a group of berms and pits may be the remains of a command post associated with adjacent trenches. If they were associated with World War I training exercises, all of these features would date to 1917–1918. No standing Historic Period structures were identified on or adjacent to the proposed SNS site (Black 1998: 4-6).

The earthen features at Stations 2, 4, 8, and 10 are considered potentially eligible for listing on the NRHP, based on the results of the 1997 site survey and past New York SHPO concern for World War I trench warfare training features at BNL (DOE-BNL 1994a: 19; Black 1998: 6; Brown 1998b: 1). However, no surface artifacts definitively dating to World War I were found in association with these features during the survey. As a result, archaeological testing would be necessary to positively determine their historical context and to obtain additional data relevant to a formal eligibility determination. Until such assessments can be made, the indicated course of action is to manage these features as significant cultural resources that are eligible for listing on the NRHP.

4.4.7.3 Traditional Cultural Properties

No Native American tribal representatives have been identified in the BNL area, and no Native American lands are located on the BNL site. Because no Native American groups have been identified, it has not been possible for DOE to consult with such groups concerning the potential occurrence of TCPs on and near the proposed SNS site. A survey of the proposed site and limited surveys of other areas at BNL have encountered no evidence of prehistoric occupations. In addition, no Native American TCPs have been identified in the BNL area. Based upon these results, it has been concluded that no TCPs occur on the proposed SNS site or anywhere else on laboratory land (White, B. 1998b: 1).

4.4.7.4 Consultation with the State Historic Preservation Officer

Section 106 of the NHPA requires a review of proposed federal actions to determine whether or not they would impact properties listed on or eligible for listing on the NRHP. DOE-Brookhaven Group has consulted with the SHPO in New York concerning the occurrence of such properties within the area of potential impact of the proposed SNS at BNL. The consultation letter sent to the SHPO at the New York State Office of Parks, Recreation, and Historic Preservation is provided in Appendix D.

4.4.8 LAND USE

Land uses in the vicinity of BNL, within the boundaries of BNL, and on the proposed SNS site are described in this section. The descriptions cover past, current, and future uses of the land in these areas. In addition, they include descriptions of environmentally sensitive land areas that have been set aside for public use, environmental protection, or research. These areas include parks, natural areas, environmental education centers, and public recreation areas. The section concludes with a discussion of visual resources.

4.4.8.1 Past Land Use

The land occupied by BNL and the surrounding area was largely wilderness prior to 1917. Although this remote inland landscape probably supported a sparse residential population and some agricultural activities during this period, most of the residential, commercial, industrial, and recreational land use in the area were centered in nearby coastal areas and urban centers such as Brookhaven and Southampton.

The U.S. Army established and operated Camp Upton on BNL land from 1917 to 1920. Because it functioned as an induction and convalescent center during this period, much of the camp land was devoted to residential use and soldier training. Considering the wide range of activities typically conducted at large military installations, some areas of the camp may have been devoted to industrial, commercial, agricultural, and recreational uses. With closure of the camp in 1920, a major shift in land use occurred. The federal lands at Camp Upton were managed for the next 20 years as Upton National Forest. From 1940 to 1945, Camp Upton was reestablished and operated once again as an induction and convalescent center. During both military periods, portions of camp land probably remained as undeveloped open space (BNL 1995: 4-1 to 4-2 and 4-5).

BNL was established on the Camp Upton site in January 1947, and the new research center began by using many of the remaining Camp Upton facilities. During the ensuing 50 years, the current pattern of land use at BNL developed (BNL 1995: 1-4 and 4-2).

The land on the proposed SNS site has been undeveloped open space for at least the past 50 years, but the major historical centers of laboratory activity surround the site and are located within 492 to 2,297 ft (150 to 700 m) of it. The only major activity that appears to have been conducted at this location was construction of several roads that crisscross the site. As a result, none of the surficial soils on the site have been contaminated by past laboratory uses of the land (BNL 1995: 4-19). The site overlaps the boundary between environmental restoration Operable Units III and V, which indicates the possibility of groundwater contamination beneath the proposed SNS site. If such contamination is present, it has probably arrived through subsurface migration from past BNL waste disposal, accidental spill, or routine release locations outside of the proposed site (BNL 1995: 7-6 to 7-9).

4.4.8.2 Current Land Use

Most of the land surrounding BNL is developed for commercial, industrial, or residential use. With respect to residential use, the area in the vicinity of BNL is lightly settled, especially compared to the dense population on west Long Island. Combined commercial, industrial, and residential use account for 38 percent of the land in the area. Another 32 percent of the land is used for recreational (parklands), institutional (educational facilities, hospitals, etc.), and transportation (airports, roads, etc.) purposes. The remaining 30 percent of the land is undeveloped woodlands and agricultural areas (BNL 1995: 6-2 to 6-4 and 8-1).

Land clearing has been initiated for a new 150-acre (60.7-ha) shopping mall (Brookhaven Town Center) located in close proximity to BNL. The mall site is at the intersection (northwest corner) of the Long Island Expressway and William Floyd Parkway. The parkway serves as a buffer between BNL and the mall site (Yadav 1998:1).

BNL occupies 5,261 acres (2,130 ha) of land near the geographic center of Suffolk County (BNL 1995: 4-5). The current use of this land is classified according to four major categories: Industrial/Commercial, Agricultural, Residential, and Open Space. The locations of these land use areas are shown in Figure 4.4.8.2-1.

Approximately 75 percent of the land within the BNL boundaries is Open Space, and with the exception of firebreaks, environmental monitoring wells and stations, utility rights-of-way, and recreation fields, most of this land is in a natural state. The large expanse of Open Space surrounding the developed central area of BNL serves as a buffer zone for the Industrial/ Commercial land use in this area.

The land areas categorized as Industrial/ Commercial contain most of BNL's buildings and major research facilities. These areas of land include the central portion of BNL, RHIC ring, STP, Hazardous Waste Management Facility, and NEXRAD weather radar facilities.

The latter are on 7.4 acres (3.0 ha) of land leased by DOE to the U.S. Department of Commerce, NOAA. The major research facilities in the Industrial/Commercial areas are the Alternating Gradient Synchrotron, National Synchrotron Light Source, Scanning Transmission Electron Microscope, HFBR (BNL 1995: 8-4).

Two areas in the southwest corner of BNL are devoted to Residential use by laboratory visitors and temporary staff. The total area of land devoted to Residential use is 170 acres (69 ha). The largest of these areas is surrounded entirely by Open Space. The smaller area is adjacent to the Industrial/Commercial use area. Apartment buildings, dormitories, summer cottages, efficiencies, mobile homes, houses, guest rooms, and a child care facility are located within the Residential use areas (BNL 1995: 8-7).

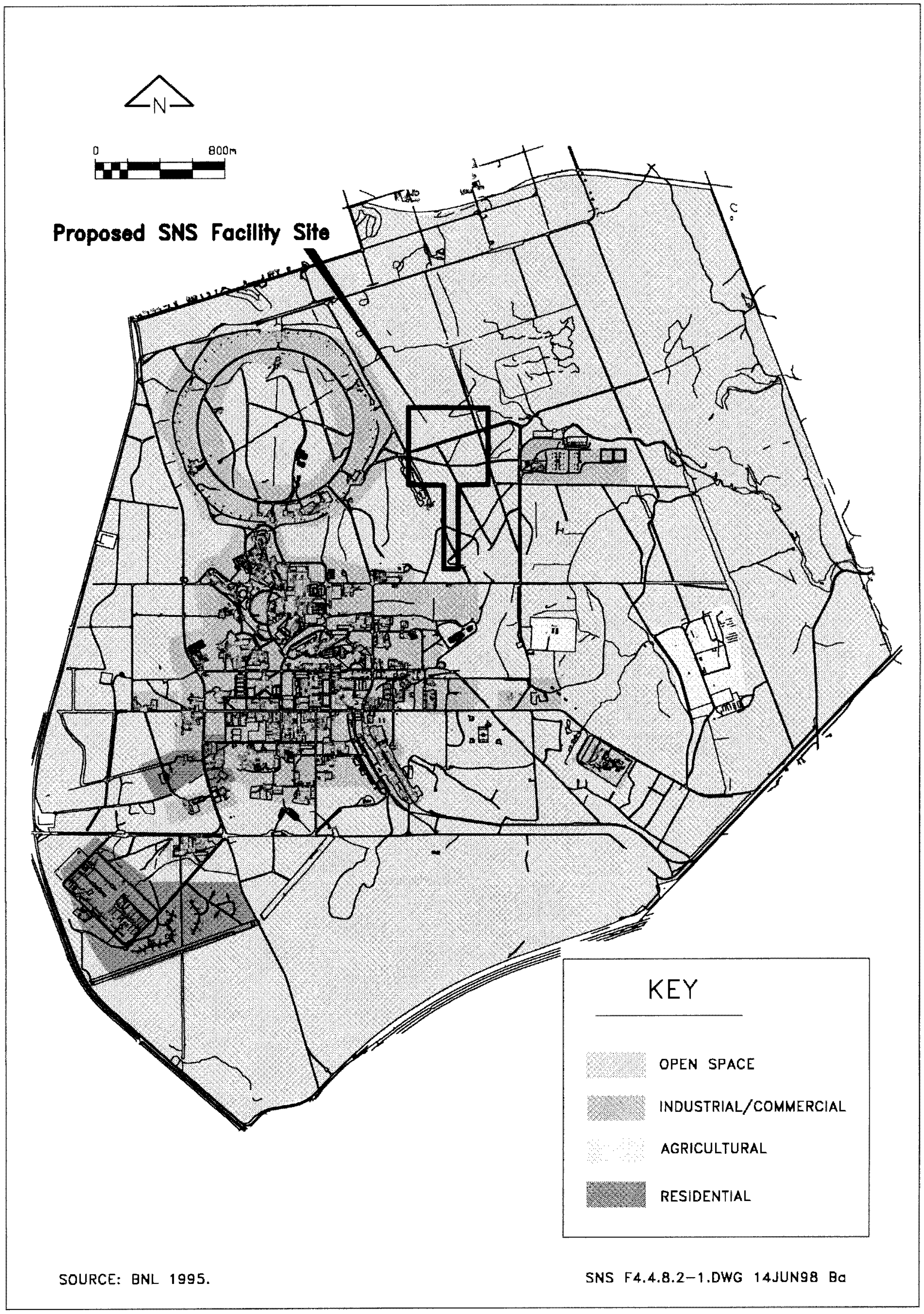

Figure 4.4.8.2-1. Map of current land use at BNL.

The proposed SNS site is located entirely within an area categorized as Open Space. Industrial/Commercial use areas surround this site in relatively close proximity. The location of the proposed site relative to current land use areas is shown in Figure 4.4.8.2-1.

Two small areas of BNL land [69.2 acres (28 ha)] are used for agricultural purposes. They are located in the eastern area of BNL, and each is completely surrounded by land categorized as Open Space. The crops grown on this land are used for biological research (BNL 1995: 8-7). None of the areas designated as Open Space are used for ecological research (BNL 1995: 9-3). Thus, the land on and in the vicinity of the proposed SNS site is not being used for environmental research projects.

4.4.8.3 Future Land Use

Future use of the land surrounding BNL has been set forth in local government master plans. These plans call for retention of residential land use on the Long Island shores. The central areas of Long Island would be developed for commerce, culture, light industry, and high technology. Adjoining areas would be devoted to high-density cluster housing and medium-density housing for single families. The local plans would preserve agricultural lands, parks, and open wooded areas (BNL 1995: 6-2).

Proposals for an industrial park and housing developments adjacent to BNL have been presented to the Town of Brookhaven. The area immediately to the north and west of BNL is wooded, privately owned, and zoned for residential development. BNL reviews local government master plans and proposed development actions such as these to assess potential impacts on its operations (BNL 1995: 6-4).

Land use at BNL has been projected for the next 20 years through a formal land use planning process. Up to 20 percent of the land that is now Open Space is zoned for future Industrial/Commercial use. Two different versions of Industrial/Commercial zoning at BNL are available, and each version is related to a large facility acquisition that might occur within the next 20 years. One is based on possible construction of a new linear accelerator (Figure 4.4.8.3-1). The other version is based on possible construction of a muon-muon collider (Figure 4.4.8.3-2). Land in the Commercial/Industrial zoning category could be used for other types of new research facilities, as well.

The areas of BNL land zoned as Open Space would remain as natural areas, except for the addition of groundwater monitoring wells on the site perimeter. Several stakeholders in the area have indicated that some Open Space could be used for short- and long-term ecological research. However, the laboratory has made no plans for ecological research, and no Open Space areas have been set aside for that purpose (BNL 1995: 9-3). The current pattern of agricultural land use would continue unchanged into the future. The Residential zoning anticipates a future contraction of the small housing area now in use in the southwest corner of BNL and an expansion of the larger residential area to meet gradually growing demands for housing (BNL 1995: 9-1 to 9-9).

The proposed SNS site is located on land that is zoned for Open Space and Industrial/Commercial use. A comparison of Figures 4.4.8.3-1 and 4.4.8.3-2 indicates that slightly

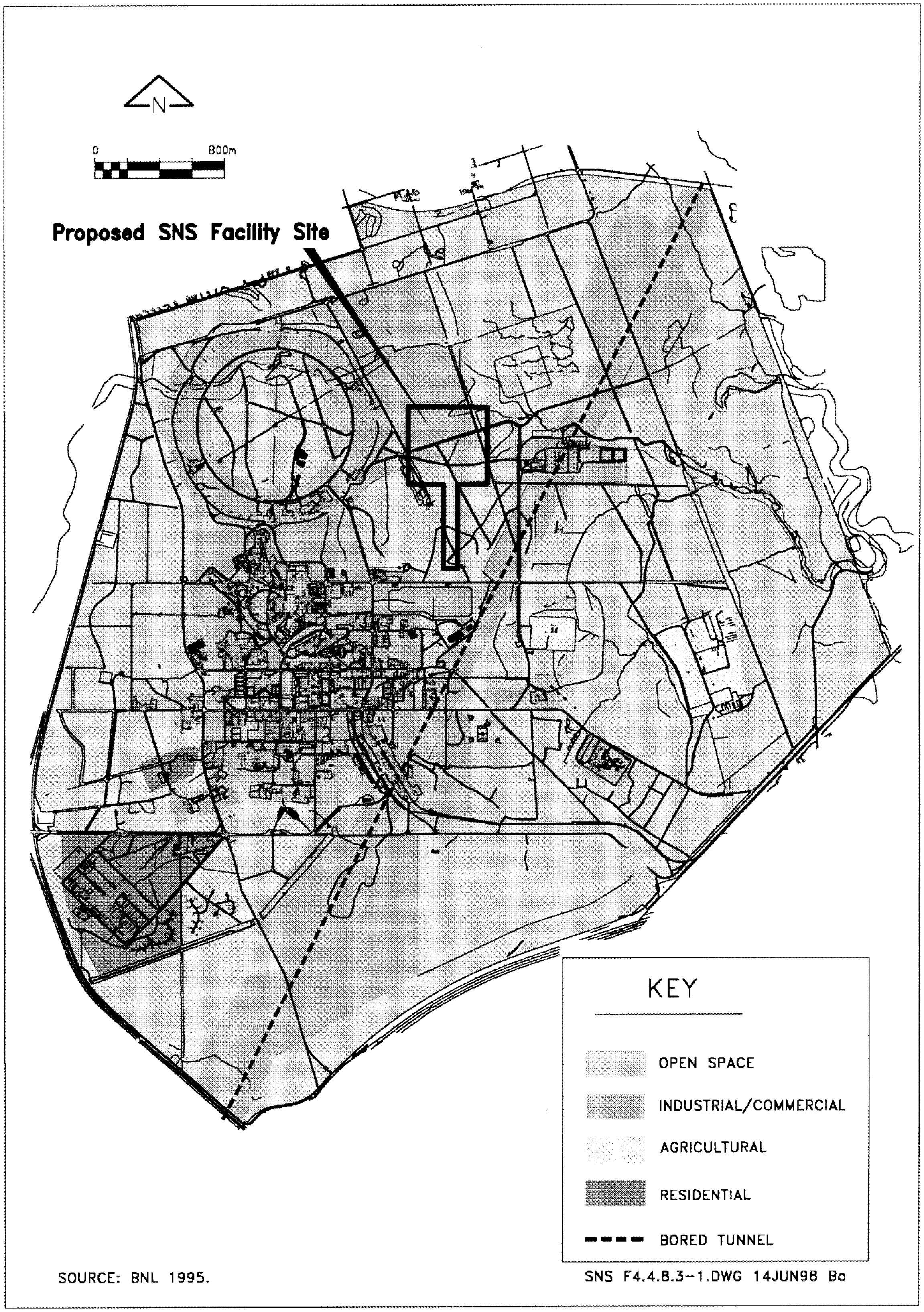

Figure 4.4.8.3-1. Map of land use zoning at BNL (Linear Accelerator Plan).

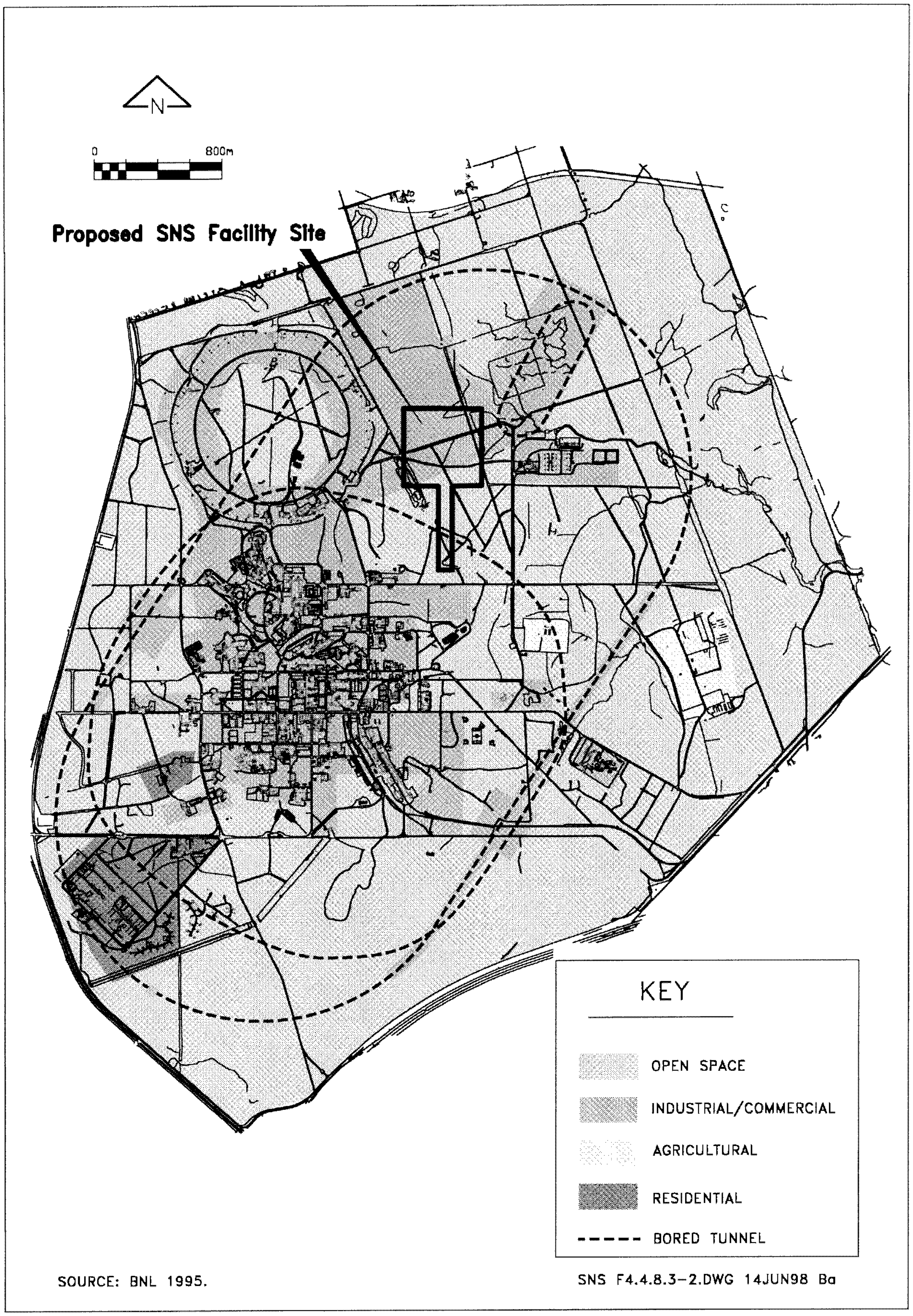

Figure 4.4.8.3-2. Map of land use zoning at BNL (Muon-Muon Collider Plan).

more Industrial/Commercial land would lie within the proposed site under the muon-muon collider version of zoning. No future uses of proposed SNS site and vicinity land for environmental research are planned.

The end uses of BNL land upon eventual closure of the laboratory have been considered in the land use planning process. The zoning for end use is shown in Figure 4.4.8.3-3. This zoning pattern reflects environmental restoration considerations and solicited input from citizen stakeholders living in the surrounding area. This zoning does not account for the possible presence of the proposed SNS, because construction of the proposed SNS at BNL was not an issue when this zoning was completed in 1995.

4.4.8.4 Parks, Preserves, and Recreational Resources

The laboratory is located in an area of Long Island where much of the land is preserved in its natural state as parkland. In 1993, the state of New York passed the Long Island Pine Barrens Protection Act, requiring the comprehensive management of environmentally sensitive pine barrens areas [100,035 acres (40,500 ha)] in the vicinity of the towns of Brookhaven, Riverhead, and Southampton, as well as two villages in Suffolk County. For protection and management purposes, the Central Pine Barrens Zone was subdivided into a Core Preservation Area and a Compatible Growth Area. The principal management goal for the Core Preservation Area is to preserve its natural state by limiting or prohibiting construction, development, and other activities. However, such activities are more possible within the Compatible Growth Area.

The Compatible Growth Area encompasses the central portion of BNL, where most of the laboratory's existing facilities are located. The Core Preservation Area encompasses 1,235 acres (500 ha) of BNL land on the north and south sides of the laboratory. The proposed SNS site and immediately adjacent land are located entirely within the Compatible Growth Area (BNL 1995: 1-2 to 1-3 and 7-2 to 7-3; Helms 1998: 4).

It is the position of DOE that the Long Island Pine Barrens Protection Act does not give the state of New York jurisdiction over the use of federal land at the laboratory. However, BNL has been providing technical support to the Pine Barrens Commission and has agreed to use the Long Island Pine Barrens Management Plan as a guide in site development and future land use planning (BNL 1995: 7-3).

A number of major parks, nature preserves, and recreational areas are located in the general vicinity of BNL. These locations are listed and described in Table 4.4.8.4-1.

4.4.8.5 Visual Resources

BNL is located on gently rolling land near the center of Long Island, New York. The area is mostly suburban in character. As a result, the broad area surrounding the laboratory is largely developed for residential and commercial purposes. In addition, large portions of laboratory land are developed. As a result, most views in the area contain a mixture of man-made and natural features. No established visual resources that include the proposed SNS site are known to exist in the vicinity of the laboratory.

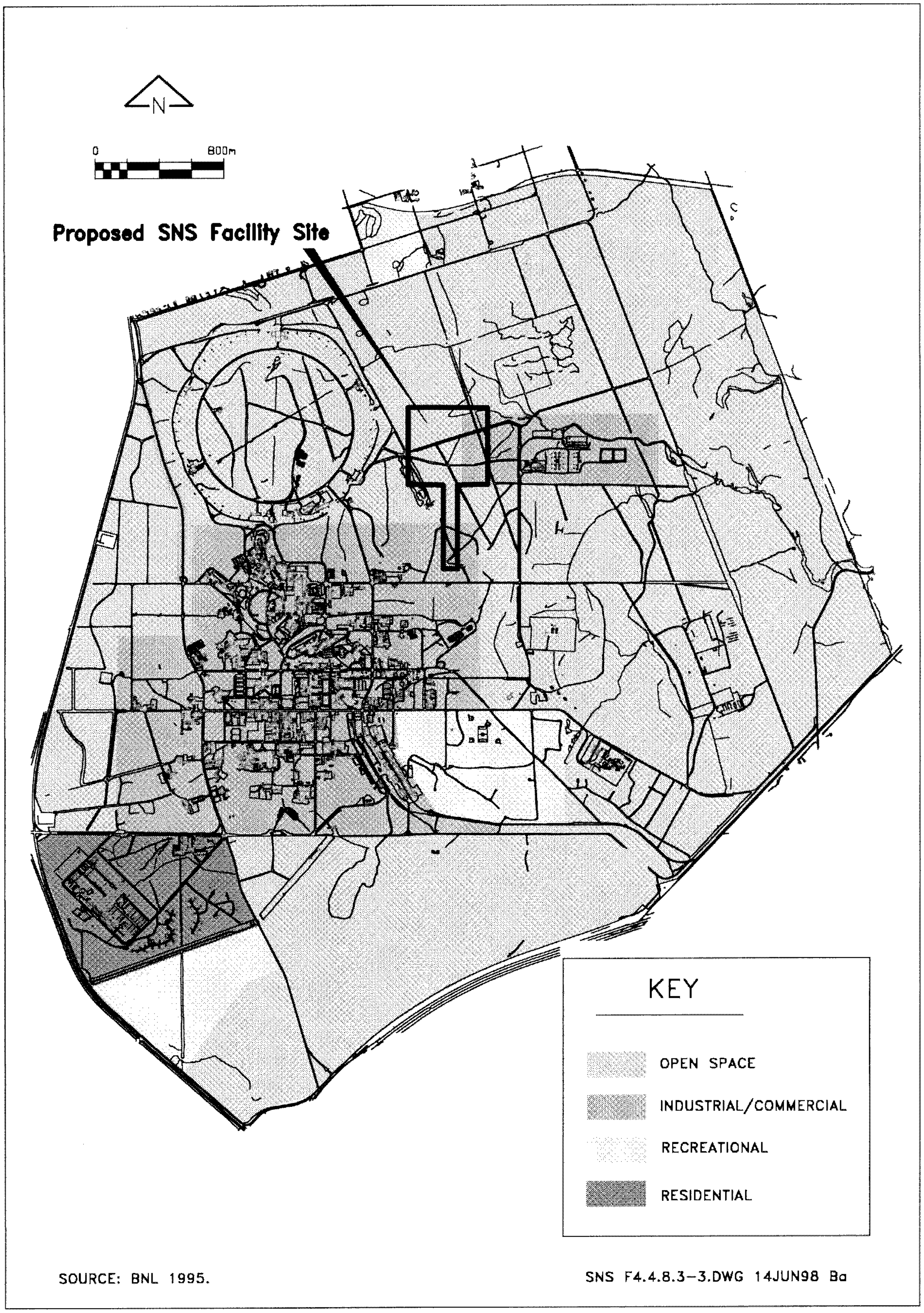

Figure 4.4.8.3-3. Map of end use zoning at BNL.

Table 4.4.8.4-1. Major parks, preserves, and recreational areas in the vicinity of BNL.

Facility	Direction from BNL[a]	Distance (mi/km)	Description and Uses
Peconic River	E	0-12.4/0-20	New York State Scenic and Recreational River. Fishing and canoeing.
Brookhaven State Park	N	0.3/0.5	Undeveloped state park. Hunting and hiking. Hiking trail along east boundary of BNL.
Rocky Point State Park	NW	1.9/3	Hunting, horseback riding, hiking, mountain biking.
Calverton Naval Weapons Plant	E-NE	0.3/0.5	Property being transferred to local government. Undeveloped portions used for hunting, hiking, fishing, horseback riding, and mountain biking.
Wildwood State Park	NE	5.6/9	State park developed for camping, swimming, and hiking.
Cathedral Pines County Park	W	1.2/2	County park used for hiking and mountain biking.
Carmens River	W	1.9/3	New York Scenic and Recreational River.
South Haven County Park (Carmens River)	W-SW	1.2/2	County park used for fishing, canoeing, hiking, picnicking, and skeet shooting.
Wertheim National Wildlife Refuge	SW	3.1/5	Protected area along the southern portion of the Carmens River to its discharge into Bellport Bay. Protection of wildlife and canoeing.
Randall Road Hunting Station	NW	0.6/1	Small state conservation area and checking station for hunters.

[a]NE- northeast, SE- southeast, SW- southwest, NW- northwest.
Source: Helms 1998.

4.4.9 RADIOLOGICAL AND CHEMICAL ENVIRONMENT

This section covers the radiological environment pathways and the chemical environment pathways associated with the site.

4.4.9.1 Radiological Environment

The principal sources of radiation at BNL include the HFBR, the Brookhaven Medical Research Reactor, and the Brookhaven Linear Accelerator Isotope Production Facility. Much smaller sources of radioactivity include Building 801 and the Alternating Gradient Synchrotron Facility.

4.4.9.1.1 Air

On a weekly basis, BNL collects air samples from six stations around the site and analyzes them for radioactive content. Results from air monitoring in 1995 indicate that the maximum tritium concentration recorded in a single event was 78 pCi/m³ at the northeast section of the laboratory. Annual gross alpha results ranged from <0.01 to 0.03 pCi/m³ while gross beta results ranged from 0.02 to 0.07 pCi/m³.

In 1995, the EDE to the maximally exposed off-site individual adjacent to the north-northeast boundary was estimated to be 0.06 mrem. Approximately 94 percent of this dose is attributed to ^{41}Ar released from the Brookhaven

Medical Research Reactor. By comparison, 0.06 mrem is well below the EPA airborne dose limit of 10 mrem per year. The collective dose to the population within a 50 miles (80 km) radius of BNL was estimated to be 3.2 person-rem.

4.4.9.1.2 Water

In early 1997 sampling in the vicinity of the HFBR identified tritium in the groundwater, with levels exceeding 600,000 pCi/L. Subsequent investigations narrowed the source of groundwater contamination to a leak in the reactor's spent fuel pool and determined that the plume extended a distance of 1200 m (4000 ft) south of the HFBR at a depth of 6–15 m (20–50 ft) below the ground surface. The contaminated plume front was located at approximately 760 m (2500 ft) from the site boundary, advancing at approximately 1 ft per day. In May 1997 BNL installed a pump-and-recharge system as an interim measure to ensure that tritium above the EPA drinking water standard (20,000 pCi/L) will not leave the BNL site boundary. A permanent remedy for the tritium plume is currently undergoing regulatory review with extensive community involvement (BNL 1998).

Monitoring of the surface water for the Peconic River watershed is performed at two stations within BNL, four stations downstream of BNL, and one station on the Carmens River for a reference location. With the following exceptions, radiological constituents in 1995 were either not detectable or at ambient levels. The ^{137}Cs levels within BNL (max 1.18 pCi/L and avg. 0.87 pCi/L at Station HM located interior to BNL) were slightly greater than ambient levels but consistent with the outfall at the STP and far below the DOE DCG of 3,000 pCi/L. The principal radionuclide detected at the STP Peconic River Outfall was tritium. The total annual release of tritium to the Peconic River in 1995 was 2.7 Ci, and the average annual tritium concentration was 2,960 pCi/L (compared to NYSDWS 20,000 pCi/L). Because the Peconic River is not used either as a drinking water supply or for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactive material.

Potable and process groundwater supply wells were sampled for gross alpha and beta activity, tritium, and gamma-emitting radionuclides in 1995. Radioactivity was typical of regional water samples. Tritium was not observed above the minimum detection limit in any of the wells and gamma emitters were not detected in all the wells but one (Well No. 4 contained gamma activity levels close to the detection limit, making the results inconclusive).

BNL collects groundwater from 207 monitoring wells and performs analysis for radioactive constituents. Data from private wells adjacent to BNL were used to estimate the potential maximum EDE to an individual from water ingestion. Tritium was the only radionuclide detected in the wells. Maximum tritium concentration observed in a private well was 2,520 pCi/L, roughly eight times less than the 20,000 pCi/L limit established by the EPA. The corresponding dose to that maximally exposed individual is 0.1 mrem. Safe Drinking Water Act Standards restrict the annual dose limit to 4 mrem per year for the drinking water pathway.

Approximately five groundwater monitoring wells are within the immediate vicinity of BNL's preferred proposed SNS site. Data from these wells indicate that most of the wells are below the detection limit for all measured radionuclides. One well exhibits very slightly elevated ^{137}Cs and ^{90}Sr, which are 4.30 pCi/L and 1.49 pCi/L, respectively. To the east of the preferred site, wells at the STP exhibit slightly elevated levels of tritium, ^{137}Cs, and ^{90}Sr, primarily due to liquid effluents processed at the STP both past and present.

4.4.9.1.3 Soils

Soil samples were collected from off-site locations as part of the Soil and Vegetative Sampling Program and analyzed for radioactive content. Soil samples were collected from local farms situated adjacent to BNL. Sampling data from 1995 indicate that all radionuclides detected were of natural origin. No nuclides attributable to laboratory operations were detected.

4.4.9.1.4 Ambient Gamma Radiation

On a quarterly basis, BNL measures external gamma radiation levels at 24 on-site locations and 24 locations off-site. The average annual on-site integrated dose for 1995 was approximately 70 mrem; the off-site integrated dose was approximately 65 mrem.

4.4.9.2 Chemical Environment

This section describes the levels of nonradiological contaminants in air and water at BNL.

4.4.9.2.1 Air

Nonradioactive air emissions at BNL are typically from minor sources such as welding, degreasing, sandblasting, painting, and parts cleaning. Boilers at the Central Steam Facility (CSF) produce a majority of the nonradioactive air emissions at BNL. The CSF contains four boilers that are monitored for opacity, O_2, and CO_2. Emissions data are reported quarterly to the NYSDEC but are not included in the BNL Site Environmental Report.

4.4.9.2.2 Water Pathway

Water-quality analyses conducted on groundwater samples collected site-wide generally show compliance with New York State Ambient Water Quality Standards (NYS AWQS). However, metals and VOCs in groundwater exceed the NYS AWQS in a number of areas across the site. In some cases high iron levels reflect natural ambient levels in the subsurface aquifer, but in the vicinity of the Current Landfill, high iron and sodium levels are associated with materials disposed there. VOCs were detected above NYS AWQS at several locations on site, as well as across the southern boundary in an industrial park area (Schroeder 1998).

The off-site portion of the VOC contaminant plume is composed primarily of carbon tetrachloride, a solvent once widely used by BNL and in industry for degreasing. The solvent has been detected in on- and off-site monitoring wells at a depth of 55–90 m (180–300 ft) in concentrations as high as 5,100 parts per billion (ppb), exceeding the EPA drinking water standard of 5 ppb. A pump-and-treat system constructed in 1997 is currently cleaning up the on-site portion of the plume and preventing further off-site migration. An in-well air stripping system was funded in 1997 for treatment of the off-site plume.

Although a 1995 residential well sampling program in the area beyond the southern boundary showed no contamination from BNL above drinking water standards, DOE has offered area home and business owners free connections to the public water supply as a precautionary measure. Through 1997, approximately 800 private owners have been connected to the public water supply at DOE expense.

Surface waters were collected from the Peconic River and from the Carmens River as an off-site control location. All water quality parameters, except pH, were within State Pollution Elimination Discharge System discharge standards or New York State AWQS. Low pH may be attributed to natural conditions of groundwater recharge to the stream or stormwater runoff. All metal concentrations were consistent with historical data and the background levels at Carmens River Station were (except for iron) below the State Pollutant Discharge Elimination System effluent limits or appropriate AWQS. With the exception of a single chloroform concentration of 2.3 g/L (detection limit = 2 g/L), all surface water measurements for VOCs were not detectable.

4.4.9.2.3. Soil

Soils are not monitored for nonradiological contaminants at BNL.

4.4.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The Support Facilities and Infrastructure section characterizes the local vehicular transportation routes around the proposed SNS site. The existing utilities that are available to provide needed services to support the proposed SNS are also described.

4.4.10.1 Transportation

BNL is located on Long Island, Suffolk County, in the state of New York. Figure 4.4.10.1-1 gives the location of the proposed SNS facility site and the transportation routes surrounding the site.

There are three primary roads that border BNL: (1) the Long Island Expressway (I-495), a four-lane divided highway that runs east-west and borders BNL on the south; (2) the William Floyd Parkway, a four-lane divided highway that runs north-south and borders BNL to the east; and (3) Route 25, a four-lane divided highway that runs north-south and borders BNL to the north.

In 1990, a transportation master plan was completed for BNL that evaluated traffic circulation impacts for a predicted future site population of 3,800 employees. At that time, the number of employees was approximately 3,400. The results of that report indicated that the transportation infrastructure in and around BNL could adequately service the predicted site workforce of 3,800. In 1995, a BNL traffic study indicated that approximately 2,500 vehicles per day enter and exit BNL.

4.4.10.2 Utilities

This section provides a description of the utility infrastructure at BNL. The following is based upon existing documentation and discussions with select BNL staff.

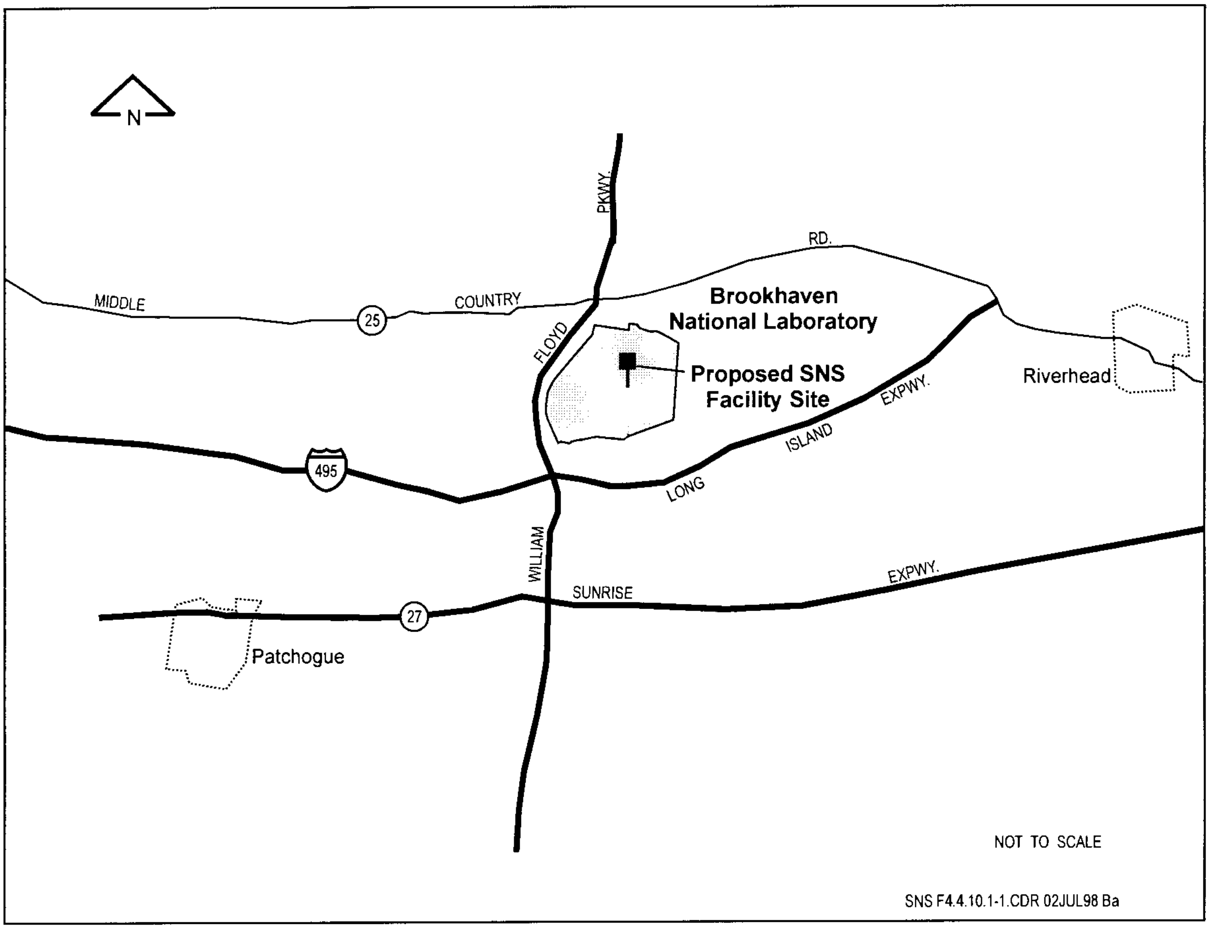

Figure 4.4.10.1-1. Transportation routes at BNL and surrounding areas.

4.4.10.2.1 Electrical Service

BNL purchases electric power from the New York Power Authority and the Long Island Lighting Company (LILCO). Power enters BNL via a 69-kV transmission line at a substation located at the southeast corner of the site. BNL has two main electrical substations that step down the power from 69 kV to 13.8 kV. The vast majority of electrical distribution at BNL is via underground lines; however, the RHIC and STP are fed via overhead distribution lines. BNL's present electrical demand is 52 MW but is expected to increase to 80 MW by the year 2000.

4.4.10.2.2 Steam

Steam originates for BNL operations on-site from the CSF. The CSF is located southwest of the BNL preferred location. The CSF consists of four boilers that have a combined capacity of 475,000 lb of steam per hour at 125 psig. The steam is distributed via 11 mile (17.6 km) of pipeline to various buildings, facilities, and laboratories and is used to power steam generators when needed. The present steam load at BNL peaks at 170,000 lb/hr.

4.4.10.2.3 Natural Gas

Natural gas is purchased from LILCO and is piped to BNL from an existing main located near the electrical substation at the southeast corner of the site. Natural gas is distributed exclusively to the CSF for steam production. The capacity of this line is 240,000 ft^3/hr (73,152 m^3/hr). BNL's present usage peaks at approximately 200,000 ft^3/hr (60,960 m^3/hr). The existing gas line is located at the CSF, approximately 4,000 ft (1,219 m) from the proposed SNS location.

4.4.10.2.4 Water Service

BNL obtains its general water supply from six on-site wells. The total pumping capacity of the wells is approximately 7,200 gpm (27,255 lpm). Currently, three of the domestic water wells are in the area of the proposed SNS location, and each is capable of producing 1,200 gpm (4,542 lpm). The average daily water usage at BNL is approximately 1 mgpd (3.8 million lpd). Water is stored on-site in three storage tanks with one million, 400,000, and 300,000 gal (14.3 million, 1.5 million, 1.1 million L) capacity, respectively. Only one of the supply wells is used for the site's water needs. BNL operates a 4.5 mgpd (17 million lpd) water treatment plant located less than 1 mile (1.6 km) west of the CSF.

4.4.10.2.5 Sanitary Waste Treatment

The BNL STP is located in the eastern portion of the site and directly east of the preferred site for the proposed SNS location. The plant receives all sanitary wastewater from the laboratory for processing before discharge to the Peconic River. The plant was renovated in 1997 to upgrade its hydraulic capacity to 3 mgpd (11.4 million lpd). Currently, the average daily volume of waste flow is less than 1 mgpd (3.8 million lpd).

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CHAPTER 5: ENVIRONMENTAL CONSEQUENCES

The U.S. Department of Energy (DOE) has assessed the effects from constructing and operating the proposed Spallation Neutron Source (SNS) on the environment at each of the four alternative sites (see Chapters 3 and 4). The potential effects described in this chapter are in addition to those that exist from other operations at each of the potential sites. DOE assessed these effects by analyzing the proposed action at each of the four alternative sites; assessing the actions that could have effects; identifying the nature of these effects; and quantifying (if possible) the magnitude of the effects.

The potential environmental impacts that could result from implementing the proposed action are described in this chapter. The proposed action could be implemented through any one of the four major siting alternatives: Oak Ridge National Laboratory (ORNL) site (Preferred Alternative), Los Alamos National Laboratory (LANL) site, Argonne National Laboratory (ANL) site, and Brookhaven National Laboratory (BNL) site. Impacts that could result from the No-Action Alternative are also described. All impacts from these alternatives are described in terms of the various aspects of the affected environment that would be expected to change over time as a result of their implementation. The impacts from the No-Action Alternative are those that would result from maintaining the status quo with respect to neutron sources. The No-Action Alternative impacts provide a basis to which the impacts expected from the other alternatives can be compared.

The CEQ regulations in 40 CFR 1501.2 require integration of the NEPA process with other planning for proposed actions "…at the earliest possible time…". In accordance with this requirement, the EIS process was initiated during the conceptual design phase of the SNS project. As a result, many of the design details normally established during later Title I and II design have not been established for the proposed SNS. These details include the final routes of access roads and utility corridors to the proposed SNS sites at the four national laboratories. In addition, the final locations of the retention basin remain uncertain. As a result, the potential effects of SNS construction and operational activities on the environment in such areas cannot be assessed realistically at this point in time. Thus, the results of such assessments are not included in the text of this chapter.

If a final site for the proposed SNS is selected, the final locations of the retention basin, roads, and utility corridors would be established at the host national laboratory. To the maximum extent possible, such areas would be delineated to avoid effects on known environmental features such as cultural resources, wetlands, and natural areas. In addition, the potential effects of the proposed action on the overall environment in these areas would be assessed. If effects are identified, appropriate mitigation measures would be implemented. Details of the mitigation measures would be included in the Mitigation Action Plan (MAP) [refer to Section 1.4]. The assessment and mitigation measures would be implemented prior to the initiation of ground-disturbing activities in the delineated areas.

5.1 METHODOLOGY

The environmental impact assessment methodologies discussed in this section address the full range of issue areas pertinent to the sites considered in the final Environmental Impact Statement (FEIS). These resource areas are land resources, air quality and noise, water resources, geology and soils, biotic resources, cultural resources, socioeconomics, human health, support facilities, and waste management. Each of the pertinent issue area methodologies is presented in detail in the following subsections.

5.1.1 GEOLOGY AND SOILS

The impacts assessments for geology and soils identify resources that may be affected by the construction and operation of the SNS and the presence of natural conditions that may affect the integrity and safety of the project. Geological resources include mineral and energy resources (coal, oil, and mineral reserves); unique geologic features; geologic hazards (earthquakes, faults, volcanoes, landslides, subsidence, and karst development); and soil resources. Mineral and energy resources are evaluated from historical activities and accounts of past production to assess the potential for future exploitation. Geologic features would identify unique or scenic topographic features or rock units that may contain mineral or energy resources. Earthquake potential is evaluated on the basis of past events and the locations of capable faults. Areas of past mass movement and conditions favorable to mass movement, such as excessive slopes and soils susceptible to liquefaction, are identified. The evaluation of soil resources includes natural earth materials, prime farmland, and erosion control.

The impacts assessments for each alternative involve locating geologic and soil features of concern. A quantitative estimate of radionuclides accumulated in the soil mass during operations of the SNS is conducted to determine levels of radioactivity in the subsurface. These levels would not be expected to vary significantly due to site-specific conditions; however, the fate and transport of radionuclides is greatly affected by the natural environment at each alternative site. A study of transport of nuclides and exposure potential is performed for the ORNL site and used as a basis for qualitative comparison to the alternative sites. Impacts are identified if the proposed site at each alternative is located within any unique geologic feature that would be subjected to irreversible physical disturbance by the project. Potential operational activities conducted in areas prone to geologic or natural hazards are assessed and presented. The geology and soils impacts are discussed qualitatively for each alternative, and mitigation measures to reduce impacts from geology and soil resources are identified.

5.1.2 WATER RESOURCES

The assessment of potential impacts to water resources includes surface water bodies, floodplains, and groundwater resources and quality. The impacts assessment includes the evaluation of water availability, water quality, drainage channel alterations, and flooding potential.

Surface waters include creeks, streams, rivers, and lakes; they are described in terms of general flow characteristics and the affected environment of each water body. Construction impacts are evaluated in relation to erosion control and floodplains encroachment. Emphasis is placed on the alteration of water bodies potentially impacted during the operational phase of the proposed SNS by increased flow within the watershed. Surface water quality is compared to existing baseline conditions and the type, rate, and concentration of potential discharge constituents. Environmental consequences are related to construction impacts in the watersheds, increased discharge to drainage channels, and other parameters with the potential to further degrade existing water quality in violation of existing National Pollution Discharge Elimination System (NPDES) permit limits.

Floodplains include any lowlands that border a stream and encompass areas that may be covered by the stream's overflow during flood stages. Any facility within a 100-year floodplain is considered a critical action.

Groundwater includes water that occurs below the water table in saturated, unconsolidated regolith and soil or in fractures and porous bedrock. Aquifers are saturated strata containing groundwater resources. Availability of groundwater varies widely among the siting alternatives because it is a function of both hydraulic characteristics of the aquifer and the competition in groundwater development and use by other consumers. The potential effects to groundwater availability are assessed for each alternative by evaluating whether the proposed project would increase groundwater withdrawal in an area, could potentially decrease groundwater levels in an area causing substantial depletion, or could exceed available supply limits. Potential effects on groundwater quality are associated with radiological contamination over the operational life of the SNS. The potential for contaminant migration to potable aquifers and other water sources is assessed and compared to federal and Nuclear Regulatory Commission (NRC) standards. Parameters with the potential to further degrade existing groundwater quality are identified for each alternative.

5.1.3 CLIMATOLOGY AND AIR QUALITY

The air quality assessment evaluates the environmental consequences of criteria pollutants that could be emitted during construction or operational activities at the four proposed SNS sites. Air quality impacts are evaluated within the context of the Clean Air Act as amended, the Environmental Protection Agency's (EPA's) National Primary and Secondary Ambient Air Quality Standards (40 CFR 50), and state-proposed or state-adopted standards and guidelines. Air quality concentrations from modeling proposed site emission rates are used to determine those effects of pollutants at each site.

Air quality impacts during construction are not strictly quantified, but fugitive dust and construction vehicle emissions are predicted to be minimal with temporary elevations of levels comparable to local construction and land fill operations.

The primary nonradiological airborne release during operations at the proposed SNS would be combustion products derived from the use of natural gas. Criteria pollutant emission rates for ten small boilers are derived from EPA's "Emission Factors for Stationary Sources" (AP-42).

EPA's Screen 3 model is then employed to calculate the SNS impact to air quality by comparing projected ambient concentrations from calculated emissions against the National Ambient Air Quality Standards (NAAQS). Conversion factors are applied to predict concentrations for longer periods corresponding to NAAQS parameters. Background (baseline) concentrations (based upon maximum ambient-monitored concentrations at nearby locations to each site) were also added to the model projected maximums before final comparison to the NAAQS. Air quality effects of periodic discharges from diesel backup generators are stated to be negligible.

5.1.4 NOISE

The on-site and off-site acoustical environments may be impacted during facility construction and operation. General construction noise sources that may affect nearby receptors were taken from the reference Golden et al, 1980. This source provides noise levels anticipated at varying distances (up to 400 ft) from the construction activity. Since the nearest public accommodation is more than 400 ft from any construction, these values were used as conservative baselines for expected noise levels during construction. These noise levels are then compared to noise levels commonly encountered by the general public as taken from Harris et al, 1992.

Operation of the SNS would generate some noise, caused particularly by site traffic and cooling towers. In general, sound levels are stated to be characteristic of a light industrial setting. Effects upon residential areas are attenuated by the distance from the SNS and by a forested buffer zone. On-site, the level of noise from the SNS is stated to be typical of accelerator facilities, and any effects are stated to be negligible when compared to ambient levels.

5.1.5 ECOLOGICAL RESOURCES

The assessment of potential impacts to ecological resources is performed for terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Potential impacts are assessed by evaluating changes to the baseline environment at each of the potential sites (no action) that could result from construction and operation of the SNS. The baseline conditions at the sites are descriptive and qualitative in nature. Assessing the potential impacts resulting from construction and operation of the SNS involves determining the amount of habitat lost or disturbed. Mitigation and monitoring strategies are discussed as appropriate.

5.1.5.1. Terrestrial Resources

Potential impacts to terrestrial resources include loss and disturbance of wildlife and wildlife habitat. Two important considerations in assessing the potential effects on habitat are the presence and regional importance of affected habitats and the size of the habitat area temporarily or permanently disturbed.

Potential impacts on terrestrial plant communities resulting from project activities are evaluated by comparing regional vegetation information to proposed land requirements for construction and operation of the SNS. Impacts to wildlife are based on plant community loss, which is closely related to wildlife habitat. The loss of important or sensitive species or habitats is more significant than the loss of species or habitats that are regionally abundant. Evaluation of the effects of construction and operation of the SNS on terrestrial resources involves looking at the disturbance, displacement, and loss of wildlife and wildlife habitat in the vicinity of the alternative sites for the SNS as well as the surrounding area.

5.1.5.2. Wetlands

Potential effects on wetlands caused by construction of the SNS include encroachment on the wetland and degradation of the wetland caused by activities outside of the wetland, such as soil erosion, siltation, and sedimentation. Operational effects may occur from effluents released from the SNS. The assessment of potential effects on wetlands includes determining whether construction of the SNS would encroach on or indirectly affect an existing wetland and evaluating the potential effects from increased runoff of water and effluents released from the SNS during operations.

5.1.5.3. Aquatic Resources

Effects to aquatic resources depend on the nature of the water body and the aquatic life present. Potential effects due to habitat loss, sedimentation, increased flows, and introduction of waste heat are discussed in a qualitative manner for the aquatic resources at each of the alternative sites.

5.1.5.4. Threatened and Endangered Species

Information on threatened and endangered species at each of the alternate sites comes from informal consultation with the U.S. Fish and Wildlife Service, state agencies, and surveillance surveys conducted at each site (See Sections 4.1.5.4, 4.2.5.4, 4.3.5.4, and 4.4.5.4). The site-specific surveillance surveys were done to obtain an initial indication of whether protected species were present at each site. Effects are assessed by determining if construction of the SNS would disrupt existing threatened or endangered species or encroach on habitat critical for the survival of a protected species.

5.1.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

Socioeconomic impact analysis assesses the environmental consequences of demographic and economic changes resulting from the implementation of the SNS at each of the alternative sites. Increasing the level of activity at the four alternative sites could potentially burden existing community services and create additional demands on available housing stock. The primary determinants of community impacts are changes in the economic base and demographic composition usually associated with the in-migration of new workers. Assuming that total employment would rise from a proposed activity and that some of this increase could be associated with in-migration, the demand for local services could rise. The new workers and their families would require public services (for example, schools and health care) and, thus, create conditions for an expansion of the economic base of the region. Whether this occurs would depend in part on the degree of excess capacity that may already exist. Potential impacts could occur in regions that cannot expand to accommodate new population growth if the demands of this growth are rapid or excessive.

Socioeconomic impacts from new workers needed to construct the SNS and for the operational phase are assessed. The study focuses on the potential effects of additional workers on housing availability and community services, including health care services, education, and public safety. Potential socioeconomic effects are assessed for the geographic region-of-influence (ROI) that would be most affected. The ROI includes those cities and counties where 90 percent or more of the current site workers reside.

The proposed project would require additional workers at any of the alternative site's ROI during construction and operations phases. In addition to jobs created directly by the proposed SNS, other job opportunities would be indirectly created within the ROI because of the increased spending of money. This money would be respent locally as jobs are created and business activity increases. The "multiplied" economic effect of this "respending" is estimated using the IMPLAN input-output model developed by the U.S. Forest Service, the Bureau of Land Management, and the University of Minnesota. Specifically, ROI estimates are made for employment, indirect business taxes, personal income, and total economic output. For each of these industry indicators, impacts are generated for direct effects, indirect effects, and induced effects. Direct effects are associated with the construction and operation of the facilities, but they also include the regional jobs necessary to support regional purchases of supplies and equipment. Indirect effects measure the increases in interindustry purchases (businesses buying more from other businesses), and induced effects reflect changes in household spending as regional income increases.

5.1.6.1 Environmental Justice Assessment

The environmental justice analysis focuses on potential disproportionately high and adverse human health or environmental effects from proposed alternatives to minority and low-income populations. The assessment is pursuant to Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, dated February 16, 1994, which directs federal agencies to incorporate environmental justice as part of their missions.

The approach used to address the potential for environmental justice impacts is based on data developed for the *Waste Management Programmatic EIS* (DOE 1997a). Minority and low-income populations residing within 50 miles (80 km) of DOE sites are identified and mapped. The 50-mi (80-km) radius around the site is consistent with the 50-mi (80-km) radius used to assess human health for all populations around the site. Data on geographic distribution of low-income and minority populations and prevailing wind conditions are used to assess whether toxic/hazardous pollutants and radiological releases from the proposed action would be emitted disproportionately in the direction of these populations.

For purposes of this analysis, a minority population consists of any census tract within 50 miles (80 km) of the SNS site with a minority population proportion greater than the national average of 24.4 percent. Minorities include persons classified by the U.S. Bureau of the Census as Negro/Black/African-American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, or other nonwhite, based on self-classification by the people according to the race with which they most closely identify. To avoid double-counting minority Hispanic persons (Hispanics can be of any race), only white Hispanics were included in the tabulation of racially based minorities. Nonwhite Hispanics had already been counted under their respective minority racial classification (for instance, Black, American Indian). A low-income population refers to U.S. Census Bureau data definitions of individuals living below the poverty line. For purposes of this analysis, a low-income population consists of any census tract within 50 miles (80 km) of the SNS site with a low-income population proportion greater than the national average of 13.1 percent.

5.1.7 CULTURAL RESOURCES

The assessment of potential impacts on cultural resources involves an evaluation of the projected effects of the proposed action, through the four siting alternatives, and the No-Action Alternative on prehistoric resources, historic resources, and traditional cultural properties (TCPs). A description of the baseline cultural resources environment at each of the four alternative sites for the proposed action is developed. Each description is based on the results of surveys and studies designed to identify cultural resources on and in the vicinity of these sites. The potential impacts are assessed by comparing the existing, baseline cultural resources environment to known, location-specific disturbances of this environment that would occur under the proposed action and the No-Action Alternative. Information obtained through consultations with the State Historic Preservation Officers (SHPOs) in Tennessee, New Mexico, Illinois, and New York is used to support the identification of cultural resources, their description, and the assessments of potential impacts on them.

5.1.7.1 Prehistoric Resources

Prehistoric resources in the United States consist of the significant physical remains of human activities that predate written records. They include, but are not limited to, sites containing stone tools, pottery, and the remains of ancient structures and hearths. To be identified as a prehistoric resource, such sites must be listed on, or eligible for listing on, the National Register of Historic Places (NRHP). The federal laws that protect such resources include the Archaeological Resources Protection Act and the National Historic Preservation Act (NHPA).

Archaeological surveys and studies are used to provide a baseline description of the prehistoric remains located on and in the vicinity of the four alternative SNS sites. Those remains that are listed on or eligible for listing on the NRHP are identified. These baseline descriptions of the existing prehistoric resources environment at each alternative site are provided in Sections 4.1.7.1, 4.2.7.1, 4.3.7.1, and 4.4.7.1.

The FEIS assesses how existing prehistoric resources on and in the vicinity of the four alternative SNS sites would be affected by implementation of the proposed action and the No-Action Alternative. This is done by closely comparing the locations of known prehistoric resources to the types and degrees of ground surface and soil disturbance that would occur from various aspects of the proposed action and the No-Action Alternative. As a result of such comparisons, a qualitative evaluation of potential damage or effects on resources is generated. Activities under the proposed action that would have the ability to remove surface features and disturb archaeological materials would typically include land clearing and excavation associated with construction of the SNS. Because the four alternative sites would be entirely cleared and excavated at an early point during construction of the SNS, any prehistoric resources on and adjacent to the four alternative sites would be susceptible to disturbance or destruction during this stage of the proposed action. Subsequent operation of the SNS would not be expected to affect any prehistoric resources that have already been destroyed by construction. Operation of the SNS would not involve the generation of intense ground vibrations or airborne shock waves that could affect prehistoric resources beyond the SNS site boundaries. The process of assessing potential effects includes the identification of measures to mitigate these effects.

If the proposed action, as implemented through the siting alternatives, or No-Action Alternative would have adverse effects on one or more prehistoric cultural resources, DOE would consult with the SHPO in the appropriate state to seek ways of avoiding or reducing these effects. As required by the federal regulations in 36 CFR 800.5(e)(1)(iii), the Advisory Council on Historic Preservation and other interested persons would also be afforded an opportunity to participate in these required consultations.

The identification of potential mitigation measures in the FEIS is based on the characteristics of the resources, their locations, and the nature of the anticipated effects. Such measures include the recovery of archaeological data through excavations, recording of architectural information, or the avoidance of effects by relocating a proposed site or activity. Typically, such measures must be taken prior to implementation of a proposed action or alternative.

If any artifacts or other remains indicative of a prehistoric cultural resource are inadvertently discovered during construction of the proposed SNS, construction activities on and in the vicinity of the discovery location would cease. DOE would then perform the above-described consultation with the SHPO. For purposes of compliance with Section 3(d) of the Native American Graves Protection and Repatriation Act, inadvertent discovery of human remains and funerary objects (associated and unassociated) would result in the cessation of construction activities, protection of the discovered items, notice of the discovery sent to the Indian tribes with the closest know cultural affiliation, and direction asked for treatment and disposition of the human remains or funerary objects. The 30-day delay period following official certification that notification of the accidental discovery has been received by the agency or tribe would be followed.

5.1.7.2 Historic Resources

Historic resources are the significant physical remains of human activities that post-date written records in the United States. They include, but are not limited to, historic archaeological sites, residential structures, commercial structures, and trails. To be identified as a historic resource, such remains must be listed on, or eligible for listing on, the NRHP. The federal laws that protect such resources include the Archaeological Resources Protection Act and the NHPA. In the United States, historic cultural resources date to the Historic Period, which spans the time from A.D. 1492 to the present day.

Archaeological site survey reports, historic site survey reports, and reports on historic site excavations are used to provide a baseline description of the historic remains located on and in the vicinity of the four alternative SNS sites. Those remains that are listed on or eligible for listing on the NRHP are identified. These descriptions of the historic cultural resources environment at each alternative site are provided in Sections 4.1.7.2, 4.2.7.2, 4.3.7.2, and 4.4.7.2.

The FEIS assesses how historic resources on and in the vicinity of the four alternative SNS sites would be affected by implementation of the proposed action and the No-Action Alternative. This is done by closely comparing the locations of known historic resources to the types and degrees of ground surface and soil disturbance that would occur at these locations as a result of the proposed action and the No-Action Alternative. From such comparisons, a qualitative evaluation of potential damage or effects on resources is generated. Activities under the proposed action that would have the ability to remove surface structures and disturb historic archaeological materials would typically include land clearing and excavation associated with construction of the SNS. Because the four alternative sites would be entirely cleared and excavated at an early point during construction of the SNS, any historic resources on and adjacent to the four alternative sites would be susceptible to disturbance or destruction during this stage of the proposed action. Subsequent operation of the SNS would not be expected to affect any historic resources that have already been destroyed by construction. Operation of the SNS would not involve the generation of ground vibrations or airborne shock waves that could affect historic resources beyond the SNS site boundaries.

If the proposed action, as implemented through the siting alternatives, or No-Action Alternative would have adverse effects on one or more historic cultural resources, DOE would consult with the SHPO in the appropriate state to seek ways of avoiding or reducing these effects. As required by the federal regulations in 36 CFR 800.5(e)(1)(iii), the Advisory Council on Historic Preservation and other interested persons would also be afforded an opportunity to participate in these required consultations.

The identification of potential mitigation measures in the FEIS is based on the characteristics of the resources, their locations, and the nature of the anticipated effects. Such measures include the recovery of archaeological data through excavations, recording of information on historic structures and features, or the avoidance of effects by relocating a proposed site or activity. Typically, such measures must be taken prior to implementation of a proposed action or alternative.

The inadvertent discovery of historic resources during construction of the proposed SNS would be handled in the manner described in Section 5.1.7.1.

5.1.7.3 Traditional Cultural Properties

A TCP is a significant place or object associated with the historical and cultural practices or beliefs of a living community. It is rooted in the community's history and is important for maintaining the continuing cultural identity of the community. A TCP may include a prehistoric or historic archaeological site, natural resource, traditional use area, shrine, sacred place, trail, spring, river, traditional hunting area, cemetery or burial site, or rock art. In addition, it may include a rural community or urban neighborhood with a unique cultural tradition and identity. The term is not limited to ethnic minority groups. All Americans have properties to which they ascribe traditional cultural value.

TCPs are protected under the American Indian Religious Freedom Act and the Native American Graves Protection and Repatriation Act. These laws and their implementing regulations establish procedures for the identification and protection of TCPs. Sites that are sacred to

American Indians and access to these sites by Indian religious practitioners are protected under Executive Order 13007. (Refer to Section 6.1.8).

Existing reports of consultations with Native American tribal groups and Hispanic groups are used, when possible, to identify and locate TCPs on and in the vicinity of the four alternative SNS sites. If the site at LANL is selected for construction of the SNS, additional consultations with tribal and Hispanic groups are planned to identify other specific TCPs on the SNS site. Descriptions of the TCP environment at each alternative site are provided in Sections 4.1.7.3, 4.2.7.3, 4.3.7.3, and 4.4.7.3.

The same basic methodological approach used to assess the effects of the proposed action and No-Action Alternative on prehistoric and historic resources is used to assess their effects on TCPs. DOE plans to develop and implement mitigation measures in close consultation with those tribal and Hispanic groups that ascribe traditional cultural value to the affected TCPs.

5.1.8 LAND USE

The land use analysis assesses the potential effects construction and operation of the SNS would have on land use patterns on and in the vicinity of the four alternative sites for the proposed action. In addition, the potential effects of the No-Action Alternative on land use are also assessed.

Descriptions of the past, current, and planned future land use environments of the four alternative SNS sites are developed using a variety of information sources. These include data calls, facility site development plans, land use plans, reports on stakeholder land use recommendations to DOE, technical reports, and aerial photographs. These descriptions of the affected land use environment provide a baseline framework for assessing the effects of the proposed action on land use at the four alternative SNS sites. The descriptions are presented in Sections 4.1.8, 4.2.8, 4.3.8, and 4.4.8.

A qualitative approach is used to assess the extent and magnitude of potential effects on land use patterns that would result from implementing the proposed action on each alternative site and from implementing the No-Action Alternative. This is done by comparing current land uses and land use plans to anticipated changes in land use that would occur as a result of implementing the proposed action and the No-Action Alternative. The land use analysis assesses the following: effects on land use outside laboratory boundaries and throughout most laboratory land; effects on undeveloped land; effects on the current use of SNS site land; effects on the use of laboratory land for research purposes; effects involving the zoning of SNS site land for future use; effects on the future use of SNS site land and land adjacent to it; and effects on the use of land for parks, nature preserves, and recreation.

Potential effects on visual resources are assessed qualitatively using the degree of visual contrast between activities under the proposed action and No-Action Alternatives and the existing landscape character as seen from viewpoints accessible to the public. The sensitivity levels of viewpoints and visibility of the SNS sites to the public are taken into consideration in the assessments.

5.1.9 HUMAN HEALTH

The assessment of impacts to workers and the public for radiological and toxic material releases considers both normal operations and facility accident conditions. Doses and consequences are calculated in a parallel manner for all alternatives to provide quantifiable indicators for comparison between the alternatives. The steps in evaluating quantifiable consequences follows:

- Identify and quantify emissions (source terms);
- Identify and select human exposure pathways;
- Analyze transport of contaminants through each exposure pathway;
- Calculate dose to individual, group, or population;
- Quantify consequences in terms of excess latent cancer fatalities (LCFs); and
- Discuss and evaluate consequences.

The emission of radioactive and toxic materials and the human exposure pathways are generic for the SNS and are independent of the specific proposed site. The analysis of material transport from the SNS to the potentially exposed individual(s) and the calculation of resulting concentrations and doses use site-dependent factors such as recent meteorology, actual population distributions, and the proposed facility location with respect to the site boundary. Site-specific doses are then converted to the projected number of incremental or excess fatal cancers using dose-to-risk conversion factors (DOE 1993b). A discussion of the methods and assumptions used in each of these steps is provided below. Additional details of emission identification and calculations of atmospheric dispersion and doses are provided in Appendix G.

5.1.9.1 Radioactive Emissions

Radioactivity would not be discharged from the proposed SNS to surface water under normal conditions of operation. Liquid low-level waste (LLLW) and process waste would be collected and transported by tanker truck to existing waste processing facilities. Radioactive emissions to the atmosphere from the proposed SNS would consist of releases from two stacks—the Tunnel Confinement Exhaust Stack and the Target Building Exhaust Stack. The locations of these stacks are shown in Figure 3.2.1.5-1.

Annual emissions from these systems are summarized in Table 3.2.3.5-1 for power levels of both 1 MW and 4 MW. A detailed list of radionuclide emissions used for dose calculations is provided in Table F-1 of Appendix G. Assumptions on facility design for upgrade from 1 MW to 4 MW result in a linear scaling of off-gases from the cooling system and the target. Off-gases from the beam stops and exhausts from the various tunnels through the Tunnel Confinement Exhaust do not scale linearly due to specifics of the proposed upgrade design.

5.1.9.2 Exposure Pathways

Routine airborne emissions of radionuclides result in internal exposures of on-site workers by way of inhalation and external exposures via immersion in the plume of released radionuclides and from radionuclides deposited on the ground surface. The off-site public could be exposed through these same pathways as the workers and could receive additional internal exposures by way of a series of ingestion pathways initiated by the deposition of radionuclides on the ground surface and leafy surfaces in pasture lands and gardens. These radionuclides are then taken up directly through ingestion of contaminated vegetation or indirectly through ingestion of meat or dairy products from animals that had ingested the vegetation.

Many of the mercury radionuclides produced in the target and emitted from the Target Building Exhaust Stack decay through a series of radioactive progeny called a decay chain. The half-lives of the various members of a decay chain cause individual members of the chain to be more or less important in the various exposure pathways. Radionuclides with a short half-life are a more significant hazard for inhalation, an exposure that occurs within minutes or hours of release; but a radionuclide with a long half-life could be important for ingestion, which would occur within days to months following the release.

5.1.9.3 Calculation of Atmospheric Dispersion and Doses

A number of computer codes are available that can account for dispersion, deposition, and radioactive decay of radionuclides released to the environment. Codes such as GENII and MACCS are comprehensive codes that model atmospheric dispersion and calculate doses in a single evaluation. CAP88-PC is a widely used code that performs such calculations for continuous releases such as SNS normal emissions. However, these codes could not be used in this analysis because of the unique radionuclide products activated in the mercury target of the SNS. The activated mercury products and members of the associated decay chains were not included in the databases of these codes, their decay and in-growth during dispersion could not be modeled, conversion factors from environmental concentration to individual dose were not available, or the source code did not enable additional radionuclides to be added to the analysis.

For normal conditions of continuous low-magnitude emissions, a set of Microsoft Excel 97 spreadsheet and Visual Basic macros were developed to implement the methodology used in CAP88-PC and allow the evaluation of the unique SNS radionuclides. This methodology is described in the code user guide (EPA 402-B-92-001 – EPA 1992). The documentation for AIRDOS-EPA (Moore 1979), a mainframe predecessor of CAP88-PC, contains additional detail and a source code listing. Details of the implementation of the methodology are discussed in Appendix G.

This methodology uses a Gaussian plume model to calculate sector-averaged depleted ground-level concentrations in air and ground deposition rates of radionuclides. The depletion mechanisms considered are radioactive decay and ingrowth, precipitation scavenging, and dry deposition. Buildup of radionuclides deposited on the ground and on plant surfaces are also considered. Concentrations in vegetation, beef, and milk consumed by humans are calculated using soil-to-plant, animal feed-to-milk, and animal feed-to-beef transfer factors. Intake of radionuclides by humans is calculated based on agricultural production data for the appropriate state and consumption rates of leafy vegetables, produce, milk, and beef.

For short-term releases occurring in accidents, atmospheric dispersion calculations were performed using PAVAN, a public-domain compiled program used by the NRC to calculate ground-level normalized atmospheric dispersion factors for short-term releases at ground level and at elevation (PNL 1982). PAVAN uses site-specific annual wind patterns to determine short-term or averaged dispersion in 22.5^{o} sectors surrounding the site.

The computer spreadsheets developed to estimate dose from airborne emissions incorporated the atmospheric dispersion from the codes, the duration and source terms for the individual release scenario (normal operations or accident), site-specific data on population distribution of on-site workers and off-site public, and radionuclide-specific dose conversion factors (DCFs) to convert environmental concentration to individual dose. Population effects are calculated using actual population distributions within 80 km (50 mi) of each release site. These spreadsheets perform rigorous decay calculations for all radionuclide chains for the proposed SNS and calculate the dose to workers and the public from inhalation and immersion. The analysis also includes the estimated contribution of dose from radionuclides deposited on the ground and from ingestion as discussed in Appendix G (Section F.5.3).

Most radiological dose assessments use DCFs published by the U.S. EPA in Federal Guidance Report No. 12 (Eckerman and Ryman 1993). However, these published and accepted DCFs do not include data for all of the mercury and iodine radionuclides or their decay products that are anticipated in SNS emissions. At DOE request, staff at ORNL, who produced the published data, developed DCFs for inhalation, ingestion, immersion, and ground plane exposure to isotopes of mercury, iodine, and their decay products (Eckerman 1998a, Eckerman 1998b). The discussion in Appendix G provides more detail of, and the basis for, the use of the various DCFs in this dose calculation.

5.1.9.4 Quantification of Radiological Consequences

DOE uses the linear dose response, no threshold model to compute the potential risk of radiological exposures for each alternative considered in an EIS (DOE 1993b). This model estimates excess LCFs using dose-to-risk conversion factors recommended by the International Commission on Radiation Protection (ICRP) (ICRP 1991). For low-dose, low-dose rate exposures (< 20 rad, < 10 rad/hr), ICRP recommends factors of 0.0004 LCF per person-rem for workers and 0.0005 LCF per person-rem for the public. The higher risk factor for the public reflects the presence of children in the public who are not present in the workforce.

To estimate the total potential risk to the population within 50 miles of the SNS facility from the radioactive emissions from the facility over its 40-year life span, the annual population dose is multiplied by the operating life of the facility and the dose-to-risk conversion factor of 0.0005 LCF per person-rem.

This method of quantifying effects is a conservative assumption of biological response to radiation dose. To compare potential impacts, dose-to-risk conversion factors are applied as if any radiation exposure, no matter how small, involves some potential risk. While the human body has the ability to repair cell damage caused by radiation and other agents, the present state of scientific knowledge does not allow the threshold at which radiation dose would lead to the development of a fatal cancer to be determined with any certainty. Accordingly, DOE conservative estimates provide an assurance that the potential effects will not be underestimated, while accepting that assumptions may lead to an overestimate of potential consequences.

5.1.9.5 Toxic Material Emissions and Consequences

The only toxic material that would be emitted from the proposed SNS during normal operations is elemental mercury vapor. Lead would be used for radiation shielding in the target areas and other areas of the proposed SNS, but it is not volatile at the temperatures to which it would be subjected. Elemental mercury vapor would be present in the gases released from the Target Building Exhaust Stack from two sources: off-gassing from the target and in air from the target cell ventilation system due to evaporation of small droplets assumed to be adhering to the cell drain surfaces. Exposures of individual workers to mercury vapors are evaluated by comparing calculated concentrations to limits promulgated by the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH). For continuous or unlimited duration exposure of the general public, the EPA has established a Reference Concentration (RfC) intended to prevent the occurrence of observable detrimental effects.

5.1.9.6 Accident Conditions

During operation of the proposed SNS, it is possible that equipment failures, human errors, or natural phenomena would result in the release of radiation, radioactive materials, or toxic materials. Such releases could have potential adverse effects on the health of workers and the public. The significance of these potential effects is evaluated in terms of probability that a given accidental release would occur and the consequences of the release if it does occur.

5.1.9.6.1 Accident Scenarios

DOE has analyzed a wide range of potential hazards associated with operation of the proposed SNS and, based on this analysis, has selected bounding accidents. For each of the bounding accidents, the frequency of occurrence and source terms has been estimated. A source term specifies the quantity or activity of material released and duration of the release. The accident analysis is included as Appendix C of this FEIS.

Accident frequencies are described using the terms "anticipated," "unlikely," "extremely unlikely," and "beyond extremely unlikely." These terms and their corresponding ranges of frequencies of occurrence are defined in Table 5.1.9.6.1-1. Some accidents are described as "beyond design basis." Such accidents usually have frequencies of occurrence less than 1×10^{-6}/yr. Table G-2 (refer to Appendix G), summarizes information about the accidents described in detail in Appendix C.

5.1.9.6.2 Direct Radiation in Accidents

Accidents involving exposure to direct radiation are not specifically addressed in Appendix C. Very high levels of radiation would exist in the linac tunnel, ring tunnel(s), high-energy beam transport tunnels, and target areas when the particle beam is present, but they would rapidly decrease immediately after the beam is shut off. A combination of administrative controls, written procedures and training, and design features would be used to prevent exposures to

Table 5.1.9.6.1-1 Accident frequency categories

Category	Description	Annual Frequency of Occurrence (yr^{-1})
Anticipated	May occur several times during the lifetime of the facility	1 to 10^{-2}
Unlikely	Not anticipated to occur at some time during the lifetime of the facility (includes accidents initiated by Uniform Building Code-level earthquake, 100-year floods, maximum wind gust, etc.)	10^{-2} to 10^{-4}
Extremely Unlikely	Probably will not occur during the lifetime of the facility (includes design basis accidents)	10^{-4} to 10^{-6}
Beyond Extremely Unlikely	Not credible during the lifetime of the facility (beyond design basis accidents)	$<10^{-6}$

high levels of direct radiation in accordance with the requirements of 10 CFR 835 Subpart F, "Entry Control Program." DOE's Shielding Design Policy for the proposed SNS is such that for the worst-case design-basis accident, the dose to the maximum exposed individual in an uncontrolled area would be limited to 1 rem and for a worker in a controlled area would be limited to 25 rem.

5.1.9.6.3 Radioactive Materials Accidents

The consequences of accidents resulting in the release of radioactive materials have been evaluated using the same methods and site-specific data used to evaluate the effects of normal operations. These methods and data are discussed in detail in Appendix G. Exposures that would result from the release of radioactive materials during credible and beyond design-basis accidents at the proposed SNS are low-dose, and low-dose rate events. Accordingly, the same dose-to-risk conversion factors of 0.0005 LCF per person-rem for exposures of the public and 0.0004 LCF per person-rem for workers used to estimate effects of normal operations have been used to estimate accident consequences.

5.1.9.7 Consequence Evaluation

For each location, doses to the maximum exposed individual, both the uninvolved worker and the member of the public, and the population dose are estimated using site-specific population distributions. Doses are converted to consequences expressed as excess LCFs, using factors recommended by the ICRP.

5.1.9.7.1 Releases in Routine Operations

The proposed SNS would be operated so that radiation dose to workers and the public from radiation and radioactive emissions in routine operations would not exceed applicable regulatory limits. The Shielding Design Policy for the Proposed SNS (ORNL 1997a) was developed to ensure compliance with the requirements of Title 10 CFR Part 835, *Occupational Radiation Protection*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. Further, adherence to the as low as reasonably achievable (ALARA) program requirements will ensure that operations are conducted in a manner to maintain the exposures far below these regulatory limits. Consequences to the uninvolved on-site worker and to the off-site population resulting from routine emissions of radioactivity and mercury have been quantified as discussed above. The numerical results are presented in individual sections addressing each alternative site.

5.1.9.7.2 Accidental Releases

The evaluation of accidents is based on the potential exposures of uninvolved workers and the public to airborne radioactivity during the period of uncontrolled release. These exposures are limited to dose from inhalation and immersion. This FEIS presents an analysis of risk based on a conceptual design, one of the earliest stages of the design process. As a result, the mitigating effects of many systems and design features that would reduce the likelihood and/or the consequences of postulated accidents have not been incorporated or have been assumed to function at reduced efficiency.

In the quantification of consequences, an LCF estimate of 1.0 or greater does not mean that a fatality will necessarily occur. Instead, the calculation of estimated LCFs provides a numerical value to compare whether impacts to human health could be greater for one alternative than for another. The magnitude of LCFs are calculated based on the assumption that a release has occurred; the probability that the LCFs will appear depends on the probability of the radionuclide release. At this stage of design, releases during normal operations and the probability of an accident occurring cannot be separately evaluated by alternative. Probabilities or accidental frequencies are provided in Appendix C.

5.1.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The following sections present the methods used to evaluate the potential effects on transportation and utilities for the proposed construction and operation of the SNS.

5.1.10.1 Transportation

The transportation impact analysis examines the predicted increases in traffic on roads in proximity to the alternative SNS sites versus the baseline average daily traffic those same roads currently handle. The primary determinants of transportation effects are changes in traffic at peak use times (rush hr) that diminish the level of service (LOS) for those traveling on the road. The analysis of traffic effects also includes accounting for the non-passenger vehicles (i.e., trucks, heavy equipment) associated with both construction and operational phases at each of the four proposed SNS sites.

Based on the design of the proposed action (as described in Section 3.2), assumptions are made regarding the number of vehicles that would travel to the proposed SNS location for the construction and operational phases. Specifically, site employees are assumed to drive a maximum of 466 passenger vehicles to the site during peak year construction (2002) at each of the four alternative sites. Construction vehicles account for an additional seven trucks per workday of the 5-year construction period. Service vehicles are assumed to add an additional three trucks per day during both the construction and operational phases of the proposed SNS. Three hundred and two passenger vehicles are assumed to support SNS operations at its maximum (4 MW) operating power. Using the maximum construction-year number of employees and the maximum operations number of employees for the analysis provides the most conservative analysis (worst case) of the potential effects on transportation.

Baseline average daily traffic data are compiled from site-specific traffic analyses or from recent local traffic counts. The predicted change in traffic is based on the number of employees currently traveling to the respective sites, added to the incremental increase in traffic attributable to the SNS construction and operational activities, minus a factor for carpooling. This increase in traffic volume to the site, added to the total number of vehicles currently utilizing the same access roads, provides the basis for analyzing the changes in service.

5.1.10.2 Utilities

Basic utility services are necessary for construction and operation of the proposed SNS and are evaluated to examine the accessibility and available capacity to service the SNS at each of the locations considered. The design requirements for utility services (electrical, steam, natural gas, water, and sanitary waste treatment) would be the same at each of the four sites and provide a consistent basis of comparison for the site-specific analysis. The site-specific information to support the utilities analysis (accessibility and capacity) is developed by phone interviews with individuals at each of the alternative sites being considered. This information is then used to assess the effects from providing the required services to the proposed SNS. Where possible, these services are assumed to extend from the points where existing sources of sufficient quantity make their nearest approaches to the SNS site.

5.1.11 WASTE MANAGEMENT

The analysis for waste management evaluates impacts of the proposed action on the existing and projected waste management activities at the alternative sites against the No-Action Alternative at that site. The assessment addresses the waste types and waste capacities from the various waste management facilities at each site and compares them with the No-Action Alternative.

The FEIS assesses the environmental effects associated with waste management for construction and operation of the proposed action. The following categories of waste are analyzed: hazardous, low-level, mixed, and sanitary. Design capacity, site waste projections, SNS waste operations projections, and remaining site capacity data are reviewed for all waste facilities at each of the four alternative sites. Based upon this information, the potential effects the proposed action would have on the existing waste management facilities, and hence the overall site, are assessed. Effects are assessed if the current waste management facilities at each alternative site are not adequate for accommodating the waste that would be generated by the proposed SNS. The waste management information provided for this assessment is based on figures and estimates obtained from current waste management documentation and information provided by waste management subject matter experts from each site.

5.2 OAK RIDGE NATIONAL LABORATORY

This section describes the potential environmental impacts or changes that would be expected to occur at ORNL if the proposed action were to be implemented. Included in the discussion of this section are the impacts to the physical environment; the ecological and biological resources; the existing social and demographic environment; the cultural, land, and infrastructure resources; and public/worker health.

5.2.1 GEOLOGY AND SOILS

Effects on the geology and soils from construction and operation of the proposed SNS on the proposed Chestnut Ridge site at DOE's Oak Ridge Reservation (ORR) are described in the following sections.

5.2.1.1 Site Stability

Survey data accumulated to date indicate that no effects would occur from the construction or operation of the proposed SNS at the Chestnut Ridge site. Results from a preliminary geotechnical investigation (LAW 1997) have not encountered soil stability problems at the site. Soil borings have determined that depth to bedrock is highly variable and in excess of 100 ft (30 m) deep.

Karst voids in the bedrock may occur at depth on the proposed SNS site, and anthropogenic factors such as construction of the SNS can increase the rate of sinkhole formation. Site characterization studies would discover active sinkholes. Therefore, if the Record of Decision selects the proposed action, DOE would complete an optimization study for the selected siting alternative. This study, which would include detailed boring and geophysical surveys, would determine the optimal layout of facilities on the selected site and would include the avoidance of sinkholes.

It should also be noted that cost-effective engineering methods are available to mitigate the potential effects of karst formation. The conceptual design proposes to construct the SNS foundation with a floating slab design supported by the soil column. Foundation designs would account for specific loading factors for each component of the facility to achieve acceptable levels of differential settling between accelerator components. If the final design requires heavily loaded structures that are extremely sensitive to differential settlement, mitigation measures may include the removal of soil and replacement with a less compressible medium (for example, flowable fill or crushed stone). In extreme cases, foundation supports could be installed by driving piles or drilling piers to solid rock at depth. No effects are anticipated from site stability.

5.2.1.2 Seismic Risk

Components of the proposed SNS would be designed and constructed to withstand the magnitude of earthquake shocks that are considered likely to occur in this area. In 1989, DOE issued Order 6430.1A to be used for seismic design of new facilities and the evaluation of existing facilities. Because of the many uncertainties about seismicity of the central and eastern United States, new efforts to evaluate seismicity were undertaken by the Electric Power Research Institute and Lawrence Livermore National Laboratory (sponsored by the NRC). Based on those facilities' studies, additional studies by Lockheed Martin Energy Systems (LMES), specifications required under new DOE orders, and other advances in the art of evaluating seismic hazards, revised assessments to support the design of new facilities and the evaluation of existing facilities were conducted (Beavers 1995). This assessment resulted in new seismic criteria for DOE-Oak Ridge Operations (DOE-ORO). Table 5.2.1.2-1 presents estimated peak ground acceleration (PGA) at locations with greater than 30 ft (10 m) of soil cover (as would be the case with the proposed SNS at Chestnut Ridge). Buildings and components of the proposed SNS would be designed to withstand corresponding earthquake levels without sustaining serious damage. As such, predictable seismicity for the proposed Chestnut Ridge site would have no effect on the construction, operation, or retirement of the proposed SNS.

5.2.1.3 Soils

Excavations required for construction of the proposed SNS would disturb the native soils. Excavated soils would be stockpiled according to soil type and horizon. If the excavated soils possess the proper characteristics, they would be used to construct the shielding berm. Otherwise, the soils would be placed in the spoils area (refer to Section 3.2.5.2). Topsoil removed during excavation would be used for grading and landscaping of the site at the finish of construction.

Construction of the SNS would require grading of the site and removal of vegetative cover. As a result, the potential exists for soil erosion and stream siltation especially during periodic storm events. Best management practices would be followed to minimize the impacts of erosion during construction activities. Section 3.2.2.3, Site Preparation, discusses the elements (retention basin, silt fences, temporary storm water drainages, etc.) that would follow an erosion control plan to prevent erosion and siltation of White Oak Creek.

Operation of the proposed SNS would affect soils used for shielding surrounding the linac tunnel. The proposed SNS would produce particles that would diffuse outward from the center of the beam within the linac tunnel and would interact with any physical matter, producing a series of nuclear cascades. This reaction is termed neutron activation, whereby the soils would become radioactive. Analyses show that activation products would be concentrated toward the last 65.6 ft (20 m) of the linac tunnel nearest the target structure and that 99.9 percent of the radionuclides in the activation zone would be contained within the first 4 m of soil surrounding the tunnel. The radionuclides created within the soil and in pore waters within the matrix of the soil would then be subject to leaching and transport via groundwater movement. An assessment of radionuclide activities or concentrations at a boundary 32.8 ft (10 m) from the tunnel was made for a 10-year period after closure. It is estimated that if the activation were spread uniformly over the full length of the linac tunnel, 309,000 Ci would be contained within the soil (see Section 5.2.2.3). The primary effects due to activation of the soil would be its effect on groundwater (refer to Section 5.2.2.3 for groundwater impacts) and the mitigation of a radioactive source term to close the facility at

Neutron Activation is the process of creating unstable radioisotopes or nuclides by the adsorption of neutrons into the nucleus of an atom.

Table 5.2.1.2-1. Seismic design criteria for ORR.

Return Period (years)	Mean PGA[a] New Site-Specific Criteria [depth of soil >30 ft (10 m)] Horizontal	Vertical
0	0.00	0.00
500	0.15	0.10
1,000	0.20	0.13
2,000	0.30	0.20
10,000	NA	NA

[a] Beavers 1995.
NA - Not available.

the end of its operational life. An evaluation of the activation products generated and transported in the subsurface was conducted to determine the effect on the environment (Dole 1998).

Multiple conservative assumptions were made in the study to ensure the protection of the environment. These assumptions were employed for the site-specific study at ORNL but would apply to the alternative sites in the qualitative comparison between site-alternatives. Several of the key conservative assumptions would overstate the potential for migration of the radionuclides:

- The facility operates continuously for 30 years—overestimating significant periods of time when the SNS linac is not operational and radionuclides are not generated.
- The entire soil volume surrounding the tunnel is subjected to the same level of neutron activation as the high-energy end of the linac—resulting in an overestimation by several factors in the volume of the activation products generated.
- Activation products remain within the berm and do not begin to move until the end of the facility's life, and all of the radionuclides are immediately available for diffusion and hydraulic transport—thereby overestimating the maximum starting concentrations and transport potential of radionuclides.
- Saturated flow continuously exists around the outer surface of the berm to carry contaminants to the water table—even though the linac tunnel will be located in the unsaturated soil horizon.
- The use of laboratory-measured diffusion coefficients to simulate real-world conditions provides a high estimate of diffusion and transport of radionuclides.

Even using very conservative assumptions, it is concluded that radioactive decay would eliminate any significant effects to human or ecological receptors because of the slow movement by the groundwater.

No prime or unique farmlands are present on or in the vicinity of the proposed SNS site at ORNL. As a result, the proposed action would have no effects on prime or unique farmlands.

5.2.2 WATER RESOURCES

Effects on the water resources from the construction and operation of the proposed SNS located on the proposed Chestnut Ridge site at DOE's ORR are described in the following sections.

5.2.2.1 Surface Water

The effects on surface water resources from operation of the proposed SNS are discussed in this section. Best management practices would be employed to minimize any effects on surface water due to erosion and siltation during construction (see Section 5.2.1.3).

5.2.2.1.1 Water Supply

Melton Hill Lake is the primary water source for the City of Oak Ridge and DOE facilities. Potable water supplies would be delivered to the proposed SNS site by an existing 24-in. (61-cm) line from the Oak Ridge Water Plant. Currently, there is no estimate of the amount of water required for construction. However, it is expected that construction water requirements would be negligible compared to the available supply. Demands ranging from 800 to 1,600 gpm (3,028 to 6,057 lpm) would be required to support operations at the proposed SNS facility, which may be upgraded throughout its operational life from 1 MW to 4 MW. These demands could be met by the existing capacity of the system.

5.2.2.1.2 Discharge

Of the total water demands, conventional cooling tower usage would require 700 gpm (2,650 lpm) for a 4-MW facility. Roughly one-half of this volume [350 gpm (1,325 lpm)] would be needed to replenish water lost through evaporation, and one-half [350 gpm (1,325 lpm)] would be needed for make-up water to replace blowdown water discharges. Cooling tower usage is estimated at about 500 gpm (1,893 lpm) for a 2-MW facility. A continuous discharge or blowdown would be released into a retention basin on the proposed SNS site. At the conceptual design stage, the size of the retention basin required is estimated at approximately 2 acres (0.81 ha). This basin would be designed to allow sufficient residence time for the discharge to cool to ambient temperatures. If necessary, active cooling systems such as recirculating fountains may be employed. From the retention pond, the discharge would be piped to below the White Oak Creek weir located at the base of Chestnut Ridge before release in the White Oak Creek drainage system.

Base flow at the White Oak Creek weir has been gauged at 0.15 to 0.25 mgpd (0.57 to 0.95 million lpd) during the dry season and at 0.75 to 1.0 mgpd (2.84 to 3.8 million lpd) during the wet season (refer to Section 4.1.2.1). The addition of the proposed SNS discharge [0.36 to 0.50 mgpd (1.4 to 1.9 million lpd)] to White Oak Creek would increase the flow rate by roughly 50 percent in the wet season and by a factor of two or more during the dry season. Effects resulting from a 50 to 200 percent increase in flow would include increased stream velocity, channel size, erosion and sediment transport (at least until an equilibrium is reached), and possibly water parameter changes from ambient conditions.

Polyphosphonates for antiscaling and ozone as a biocide would be used in the cooling towers as is the common practice at other ORNL cooling towers. Discharge from the towers would be regulated to contain about four times the dissolved solids content of potable water (i.e., 1,000 to 1,200 mmhos conductivity).

Discharge by the proposed SNS into White Oak Creek would provide a net increase to the water budget of the Bethel Valley and Melton Valley watersheds. As such, it is possible that discharge by White Oak Creek into White Oak Lake could increase, which in turn might lead to an increase in flow over White Oak Dam. The discharges from the SNS would not be a source of additional radionuclides to White Oak Creek. Because White Oak Lake acts as a reservoir for radionuclides in suspension and in solution, an increase of flow over the dam could effect the release of radionuclides. Assuming no loss by evapotranspiration and no infiltration or recharge to the intermediate and deep groundwater regimes, the maximum estimated discharge (at full loading for 4 MW) from the proposed SNS would increase the White Oak Dam flow by 2 to 4 percent during the wet weather season and by 10 to 15 percent during the dry weather season (Figure 5.2.2.1.2-1). Actual losses by infiltration and evapo-transpiration would reduce the contribution by the proposed SNS over White Oak Dam by well over 50 percent of the maximum. In fact, the measure of any real contribution to actual flow over White Oak Dam would be lost in the noise of monthly variance in precipitation. Accordingly, the effect of the proposed SNS on radionuclide releases from ORNL is considered minimal.

5.2.2.2 Flood Potential and Floodplain Activities

The proposed SNS at ORNL does not lie within a floodplain or designated flood fringe area; therefore, flood potential of the site is negligible. Seasonal storm events may cause limited flooding along Chestnut Ridge and portions of the proposed site when man-made storm drains and natural drainage channels exceed capacity. The effect would be localized and temporary.

5.2.2.3 Groundwater

The effects of proposed SNS construction and operations on groundwater are discussed in this section.

5.2.2.3.1 Resources

Construction and operation of the proposed SNS would have minimal to no effect on the intermediate and deep groundwater systems at the proposed Chestnut Ridge site, and no groundwater resources would be utilized by SNS construction or operations. Depth to

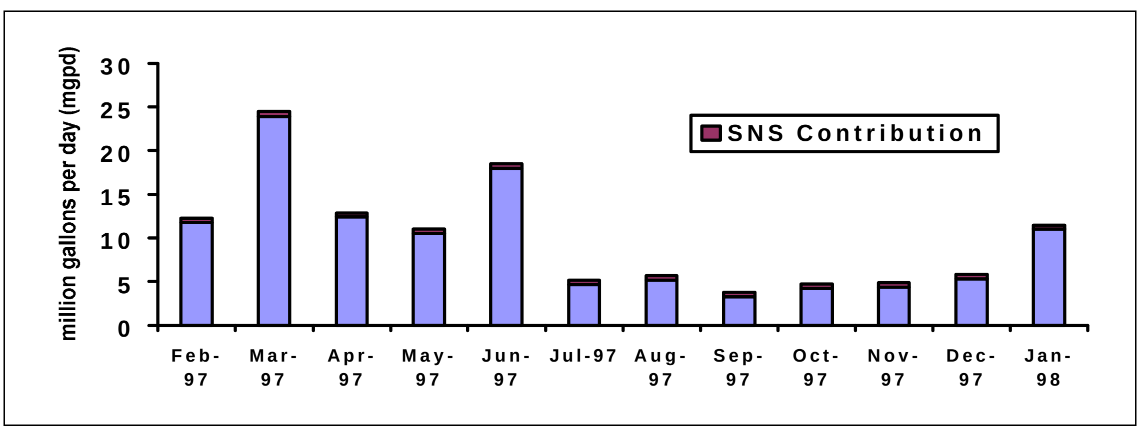

Figure 5.2.2.1.2-1. Proposed SNS contribution to flow over White Oak Dam.

groundwater observed during preliminary site characterization activities may be as deep as 100 ft (30.5 m), and the maximum planned excavation should not intersect the water table. If conduit flow of groundwater within the bedrock exists beneath Chestnut Ridge, the surface excavations required to construct the facility would not affect the flow capacity or yield from these zones. Also, the limited footprint of the proposed SNS would not materially affect the recharge by infiltration to the shallow groundwater zone or to the Knox aquifer underneath Chestnut Ridge. There could be increased recharge to the groundwater system if the proposed SNS retention pond is built above a karst system. However, the final location of the retention basin has not been determined yet. If the ORNL site is selected in the ROD for construction of the SNS, the Chestnut Ridge site will undergo an extensive characterization to provide detailed information necessary for Title I and Title II (preliminary and detailed) design. A site optimization study would also be completed to identify the optimal layout of the SNS facilities, including the retention basin. If problematic karst features are discovered, the optimal site layout may avoid these features. If the retention basin cannot be placed in an area that avoids karst formation, the appropriate engineering solutions, such as grouting, would be implemented.

5.2.2.3.2 Contamination

In addition to determining the types and quantities of radionuclides generated in the soil berm, an evaluation of transport of these contaminants under natural conditions was conducted. Figure 5.2.2.3.2-1 depicts the hydrologic cross section used to calculate the infiltration of precipitation from above and the flow of groundwater below the proposed site.

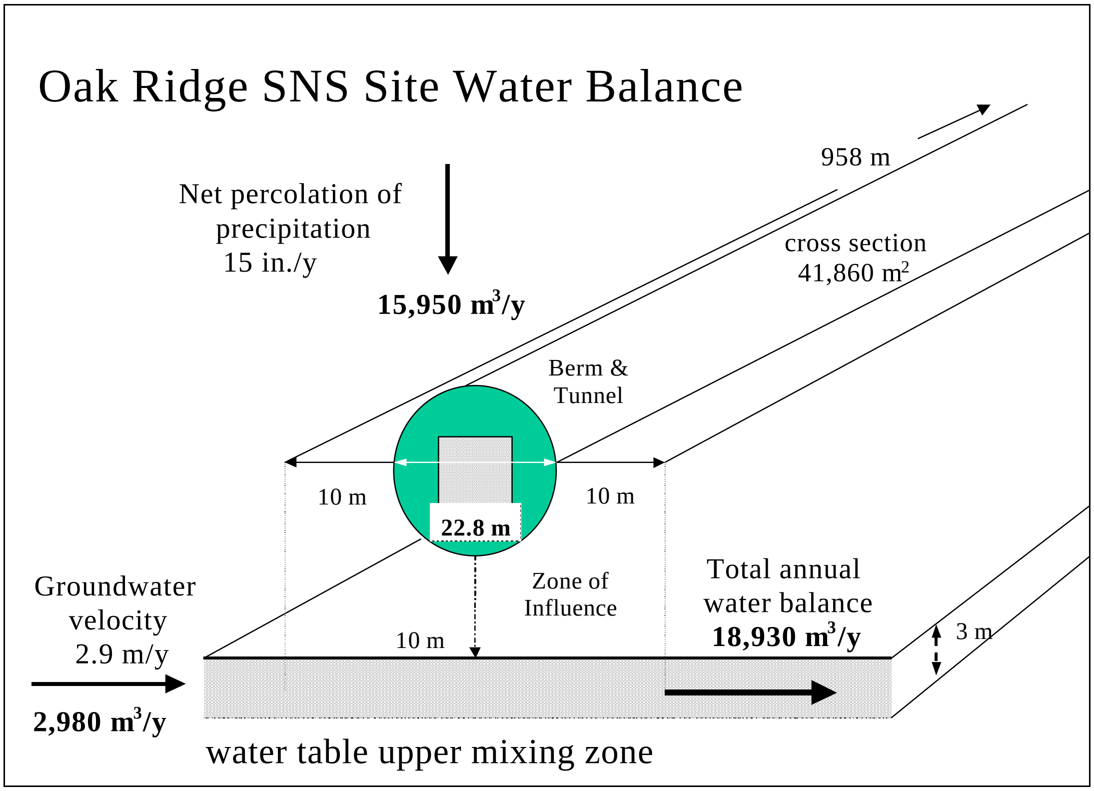

Figure 5.2.2.3.2-1. Hydrologic cross section of the proposed SNS site at ORNL.

Assuming an arbitrary 32.8-ft (10-m) compliance boundary beyond the 72-ft (22-m) diameter of the berm, the cross section of the 3,143-ft (958-m) long proposed SNS tunnel system has an effective area of 450,577 ft² (41,860 m²). With 15 in. (38.1 cm) of annual recharge at the ORNL site, a volume of 563,274 ft³ (15,950 m³) per year would infiltrate through the berm into the groundwater. With a 9.8-ft (3-m) thick mixing zone and groundwater velocity under this site at 2.9 m/yr, the annual horizontal contribution of groundwater under the proposed SNS tunnels is only 105,238 ft³ (2,980 m³). This brings the total annual water balance under the proposed SNS facility and its 32.8-ft (10-m) zones of influence to an annual turnover of 668,513 ft³ (18,930 m³) per year. The flow-through rate was combined with the calculation of migration rates of contaminants to the outer berm surface and was used to estimate concentrations of radionuclides in the groundwater. Using an assumed saturated hydraulic conductivity for the vadose zone of 1 m/yr (a conservative assumption compared to measurements approaching 0.2 m/yr), water carrying contaminants from the berm's surface would reach the 32.8-ft (10-m) boundary zone in only 10 years. During that time, a number of radionuclides in transport would decline in activity due to half-life decay. Table 5.2.2.3.2-1 displays the estimate of isotope activities at the 32.8-ft (10-m) boundary 10 years after closure of the facility (Dole 1998). The NRC limits for uncontrolled releases are included on this table as a benchmark for comparison.

Table 5.2.2.3.2-1. Estimates of radionuclide concentrations in soils and water surrounding the proposed SNS.

Isotope	Half-Life (years)	Total Curies in berm at 0 - 4 m Over 958-m Length	Estimated[a] Soil Berm Activity (µCi/g)	Estimated[b] Groundwater Activity at 10 m (µCi/cc)	10 CFR 20 NRC Limits for Uncontrolled Releases (µCi/cc)
H-3	1.23E+01	2.278E-02	4.66E-08	6.85E-08	1.00E-03
Be-10	1.50E+06	1.976E-04	4.04E-10	4.23E-10	2.00E-05
C-14	5.73E+03	1.546E+02	3.16E-04	4.43E-04	3.00E-05
Na-22	2.60E+00	3.283E+02	6.72E-04	5.54E-05	6.00E-06
Al-26	7.15E+05	2.202E-01	4.50E-07	4.58E-08	6.00E-06
Cl-36	3.01E+05	8.593E-02	1.76E-07	4.54E-07	2.00E-05
Ar-39	2.69E+02	3.795E+02	7.76E-04	2.00E-03	NA
K-40	1.27E+09	2.684E-03	5.48E-09	6.50E-09	4.00E-06
Ca-41	1.03E+05	8.448E-01	1.73E-06	1.76E-07	6.00E-05
Mn-53	3.70E+06	1.639E-03	3.35E-09	3.14E-09	7.00E-04
Mn-54	8.54E-01	2.861E+05	5.85E-01	1.64E-04	3.00E-05
Fe-55	2.73E+00	2.202E+04	4.50E-02	1.09E-15	1.00E-04
	Total =	3.09E+05			

[a] Uniform distribution of isotopes over its entire length and diameter in the proposed SNS berm.
[b] Groundwater activities at a 32.8-ft (10-m) boundary 10 years after the end of 30 years of operations, assuming no retardation of the isotope migration by soils.
NA - Not available.

Based on very conservative assumptions incorporated into this evaluation (see Section 5.2.1.3), only 3 (^{14}C, ^{22}Na, and ^{54}Mn) of 12 isotopes would have any potential for affecting groundwater quality within a 32.8-ft (10-m) zone of influence at the proposed SNS facility. In the case of ^{22}Na and ^{54}Mn, these isotopes have short half-lives of 2.6 years and 0.854 years, respectively. If less conservative but realistic retardation factors are applied to account for slowed contaminant migration through ORNL-type soils, then these isotopes would decay to below levels of concern before they might reach the 32.8-ft (10-m) boundary.

Lastly, the only nuclide of potential concern would be ^{14}C because of its mobility, long half-life, and high specific activity. If a realistic (i.e., not conservative) groundwater travel time is used and a retardation factor is applied, the decay in ^{14}C would still result in approximately a 22 percent reduction. This concentration would still be above drinking water limits, but it does not account for a corresponding natural dilution (5 to 208 times) due to the increase in travel time of 50 to 2080.

A very conservative treatment of many factors and assumptions is used in this evaluation. The net effect of this multiplication of conservative assumptions is to overestimate the potential concentrations in the groundwater below the proposed SNS site by a factor of between 25 to over 100 times. When the predictions show that the radionuclides are below 10 Code of Federal Regulations (CFR) 20 NRC Dose Limits for an individual member of the public, there is a very high confidence level that these limits would never be exceeded during the post-operation period of the proposed SNS facility. In summary, this assessment indicates that an exceedance of drinking water limits for an actual receptor under realistic conditions would be highly unlikely (even for ^{14}C). If necessary, DOE would implement routine monitoring of the groundwater to ensure that nuclide migration would not occur. If required, modifications to the shield design of the proposed SNS would be incorporated to further protect against nuclide transport, including the placement of a crushed limestone interval covered by a geomembrane to protect and inhibit groundwater flow surrounding the tunnel (Dole 1998) [refer to Section 3.2.2.9]. Thus, operation of the proposed SNS would have minimal to no effect on intermediate and deep groundwater systems on the ORR.

5.2.3 CLIMATOLOGY AND AIR QUALITY

Impacts on the climate and air quality from the construction and operation of the SNS located on the proposed Chestnut Ridge site at DOE's ORR are described in the following sections.

5.2.3.1 Climatology

Construction and operation of the proposed SNS would not affect regional or localized climates within the Oak Ridge area. Emissions from the proposed SNS facility may affect meteorological measurements, air indices, or measurements taken for research projects at the nearby Walker Branch Watershed. These impacts are discussed in Section 5.2.8.

5.2.3.2 Air Quality

Only negligible impacts would occur to nonradiological air quality. The nonradiological air quality assessment is presented in this section, while airborne radiological releases are evaluated under human health impacts (refer to Section 5.2.9). Construction activities would create temporary impacts from fugitive dust during the early construction phase of the project. This impact would be greatest during the clearing, contouring, and excavation stages but would decrease within a relatively short time period. In addition, fugitive dust would be most elevated during work hours (with an assumed 10-hr work day). While no estimates of suspended particulate matter have been prepared, PM_{10} measurements are predicted to be minimal when normalized for the standard 24-hr period. Moreover, the proposed SNS site is located in a remote section of the ORR several miles from the reservation boundary. Temporary elevation of particulate matter during excavation would contribute less impact to off-site receptors than operations at local construction sites or landfill operations.

The primary nonradiological airborne release during operations at the proposed SNS would be combustion products derived from the use of natural gas. Peak usage of natural gas would be during winter months at an approximate rate of 1,447 lb/hr. Emission rates for the maximum use of natural gas at 4-MW operations are estimated in Table 5.2.3.2-1. The projected emission levels would be well below those required for prevention of significant deterioration (PSD) review (i.e., this "minor source" would not be subject to the PSD permitting process).

The EPA Screen 3 Model (version 96043) was employed to calculate the impact of the proposed SNS to air quality by comparing projected ambient concentrations from calculated emissions against the NAAQS. A simple approach was undertaken for a screening-level assessment of the impacts. It was conservatively assumed that all emissions (from 10 stacks) would emanate from one stack (on the target building), and the simple elevated terrain (with maximum terrain height equal to stack top height) option was selected. The above emission rates were incorporated into the model to provide the calculated distance and maximum concentration ($\mu g/m^3$) for a 1-hr average period. Conversion factors were applied to predict concentrations for longer periods corresponding to NAAQS parameters. Table 5.2.3.2-2 compares the projected ambient concentrations against the ambient air quality standards. Impacts to air quality at a 984-ft (300-m) site boundary from the burning of natural gas at the proposed SNS facility would be below all indicated limits. Adding maximum background concentrations to maximum projected impacts from the proposed SNS sources (a very conservative procedure since the two do not occur at the same location or time) also does not provide any violations of the NAAQS.

Five 200-kW diesel backup generators would be tested for short durations several times a year. Discharge from these generators is rated at 1,450 cfm at 910°F (487°C). Periodic discharges from these generator testings would not impact overall air quality, and impacts to air quality by the construction or operation of the proposed SNS would be negligible.

5.2.4 NOISE

Noise levels resulting from construction and operation of the proposed SNS within the affected environment are discussed in this section.

Noise levels would be elevated both during construction and during operation of the proposed SNS. Two types of noise may be emitted during the proposed SNS construction phase. Continuous moderate noise levels would

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Table 5.2.3.2-1. Combustion products from natural-gas-fired boilers at the proposed SNS.

Combustion Products	Rate ($lb/10^6 ft^3$)[a]	Total Load (lb/hr)[b]
SO_2	0.6	0.02
NO_x	100	3.49
CO	21	0.73
CO_2	1.2E+05	4184
Organic Compounds (total)	5.3	0.18
Particulate Matter (PM_{10})	12	0.42

[a] Emission factors from EPA AP42 for commercial boilers (rating: 0.3 to < 10^6 Btu/hr).
[b] Based on cumulative output of 10 boilers at the proposed SNS with total heat load of 34,870,000 Btu/hr.

Table 5.2.3.2-2. Impact of natural gas combustion at the proposed SNS.

NAAQS Compound	Period[a]	Estimate (μg/m³) at 984 ft (300 m)	Maximum Concentration[b]	Assumed Background (μg/m³) (Table 4.1.3.3-1)	Background + 300 m Location (μg/m³)	NAAQS Limits (μg/m³)
Sulfur dioxide (SO_2)	Annual[c]	0.1	0.8	13.3	13.4	80
	24-hr	1.0	10.0	85.0	86.0	365
	3-hr	2.4	22.7	403.7	406.1	1,300
Carbon monoxide (CO)	8-hr	69.0	644	5,693	5,762	10,000
	1-hr	99.0	921	11,967	12,066	40,000
Nitrogen dioxide (NO_2)[d]	Annual[c]	16.0	147	28.6	44.6	100
Particulate (PM_{10})	Annual[c]	1.9	17.7	33.0	34.9	50
	24-hr	23.0	212.0	69.0	92.0	150

[a] Factors used to convert from 1-hr averages to long periods taken from EPA 1977. Annual averages based on conservative 0.1 factor.
[b] Concentration at 984 ft (300 m) estimated boundary and maximum concentration [occurring at 174 ft (53 m)] estimated by EPA – Screen 3 Model (version 96043). Maximum concentration location is expected to be "on-site."
[c] Annual concentrations reflect 33% estimated (conservative) annual usage factor.
[d] Estimated concentration in this table includes all NO_x compounds and not only NO_2 for NAAQS.

be created during the period of construction activities. Earth-moving, transportation, and construction activities would produce peak noise levels as indicated in Table 3.2.2.12-1.

As Table 3.2.2.12-1 indicates, sound levels for a point source will decrease by 6 dBA for each doubling of distance [Department of Transportation (DOT) 1995]. Since the nearest public accommodations are considerably more than 400 ft (122 m) from the SNS site, the noise levels shown at 400 ft in Table 3.2.2.12-1 could serve as a very conservative estimate of peak noise levels anticipated off-site during construction. Comparison of the maximum 400-ft noise level of 84 dBA from this table to common sound levels shown in Figure 5.2.4-1 indicates that this maximum would be no greater than a "noisy urban" atmosphere or a household food blender. General construction noise levels of 55 to 77 dBA would be typical of a "commercial area" or normal speech. Thus, off-site construction sound levels should be typical of those most likely experienced by the general public.

Site traffic would contribute to elevated noise levels, but the incremental increase for the region would be insignificant, and site-specific levels would be elevated primarily during shift change. Moreover, traffic noise would not be a problem for people who live more than 100 to 200 ft (30 to 60 m) from lightly traveled roads (DOT 1995).

5.2.5 ECOLOGICAL RESOURCES

The effects of proposed SNS construction and operations on ecological resources are discussed in this section.

5.2.5.1 Terrestrial Resources

Preparation of the proposed SNS site for construction would result in clearing the existing vegetation, which is primarily mixed hardwood forest and pine plantations, from 110 acres (45 ha) of ORR land on Chestnut Ridge. The entire area of the proposed site would be cleared during the first year of construction. The timber harvested during site preparation would be sold. Areas that are not immediately required for the construction of facilities would be planted with grasses to minimize erosion.

Removal of vegetation would increase forest fragmentation; however, the area around the proposed SNS site would remain forested. In addition, current construction plans call for a minimum of forest clearing, which would reduce the fragmentation effects of the clear cutting. The specific locations of utility corridors are not known at this time; however, they would be constructed in existing rights-of-way whenever possible to reduce the area of land disturbance. The 161-kV electrical transmission line that would provide power to the proposed SNS is located less than 3,000 ft (914.4 m) west of the site, and the existing water main passes through the eastern end of the site. Other utilities, such as natural gas

> Federal policy on wetland protection is contained in Executive Order 11990. In addition, 10 CFR 1022 describes DOE's implementation of this Executive Order. This order requires federal agencies to identify potential impacts to wetlands resulting from the proposed activities and to minimize these impacts. Where impacts cannot be avoided, action must be taken to mitigate the damage by repairing the damage or replacing the wetlands with an equal or greater amount of man-made wetland as much like the original wetland as possible. The current DOE policy is for no net decrease in the amount of wetlands as a result of DOE activities.

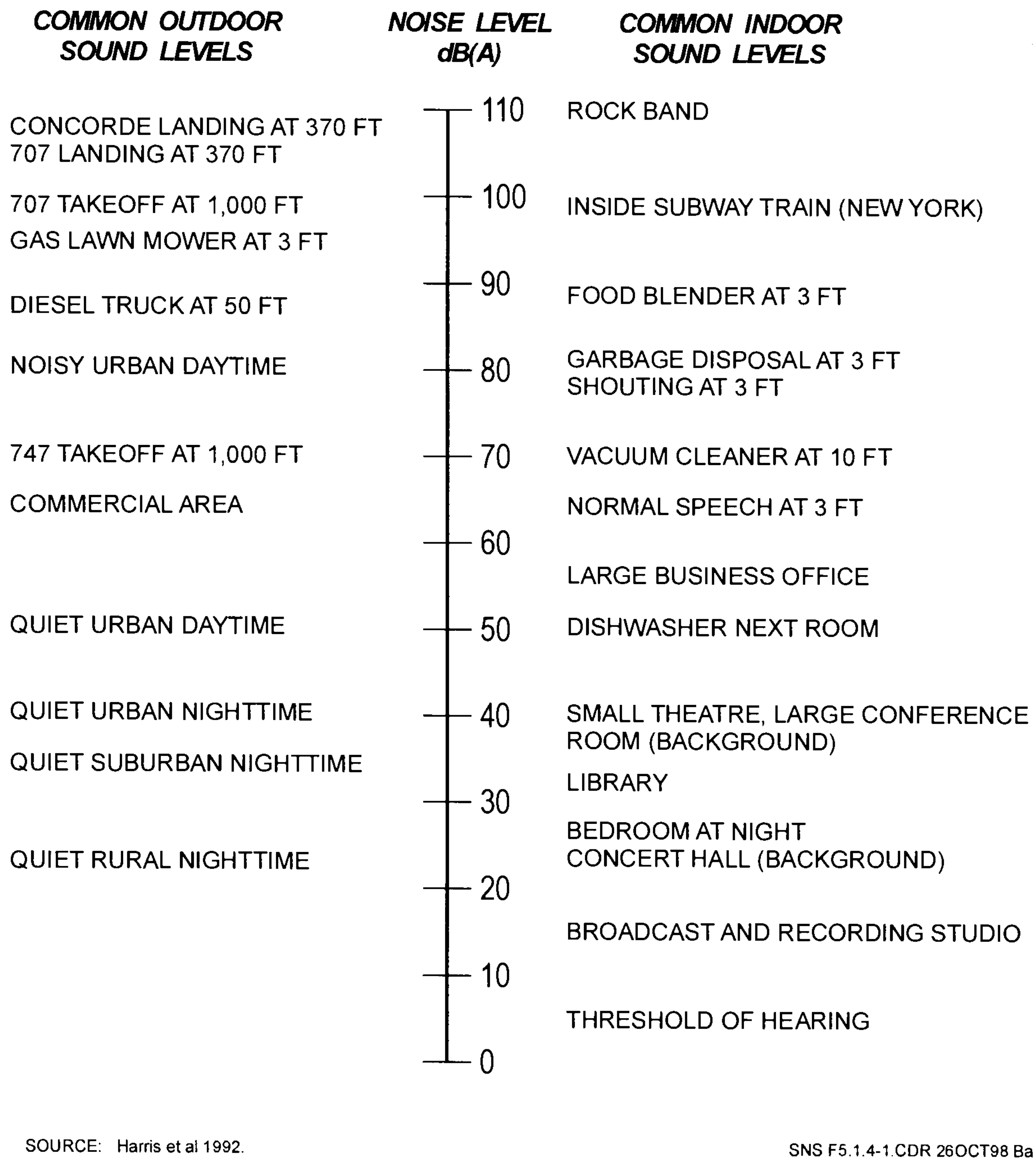

Figure 5.2.4-1. Common sound levels.

and telephone service, would be brought into the site along Chestnut Ridge Road.

The general vegetation cover on the ORR is approximately 80 percent forest (LMES 1996). Although movement of wildlife across the proposed site would be slightly disrupted, there would still be a continuously forested path across Chestnut Ridge. The 110-acre (45-ha) site represents less than one-half percent of the total forested area on the ORR.

Clearing operations for construction of the SNS may cause the direct loss of small animals. Also, wildlife would be displaced from cleared areas and the surrounding habitat. Large mammals would be mostly excluded from controlled areas by access control fences. While additional forest-edge habitat would be created, cleared land would represent long-term loss of habitat.

Construction and operation activities and the associated noise and human presence would disturb wildlife occupying areas adjacent to the proposed site. This could result in emigration of some sensitive species from the surrounding area, although many of the species would adjust to the disturbance. To help minimize disturbance to wildlife, construction machinery would be kept in proper operating condition, and workers would be prevented from entering undisturbed areas delineated before construction.

In summary, the potential effect of the proposed vegetation removal on terrestrial wildlife would be minimal.

The proposed SNS would operate on land where natural features have been largely removed or altered by construction activities. Consequently, proposed SNS operations would have a minimal effect on terrestrial resources at this location and in immediately adjacent areas.

5.2.5.2 Wetlands

Eight wetland areas are located in and around the proposed SNS site. There will be encroachment on three wetlands, totaling 0.23 acres (0.09 ha) of fill, for the upgrade of Chestnut Ridge Road. The retention basin (approximately 2 acres or 0.81 ha) for the proposed SNS cooling water may have indirect effects on wetland WONT1-1. Indirect effects on wetlands can occur during construction as a result of increased runoff and sedimentation. The implementation of proper construction techniques, including erosion control, would serve to minimize effects on the area.

The upgrade of Chestnut Ridge Road would require the filling of 0.23 acres (0.09 ha) of wetlands. The laying of utility lines may also encroach on a small area of these wetlands adjacent to the road. The 0.23 acres (0.09 ha) includes the southwest corner of WOM16, the southern half of WOM15, and all of WOM14. Wetland WOM16 covers approximately 2.36 acres (0.96 ha), which makes it the largest of the

> Federal policy on floodplain protection is contained in Executive Order 11988, *Floodplain Management*. In addition, 10 CFR 1022 describes DOE's Implementation of this Executive Order. This order requires federal agencies to ensure that potential effects of flood hazards and floodplain management are considered for actions undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable. Where impacts cannot be avoided, action must be taken to mitigate the damage and minimize the impact.

Wetlands Function: Wetlands perform several functions within an ecosystem, including groundwater recharge and discharge, flood flow alteration, sediment stabilization, nutrient removal and transformation, sediment and toxicant retention, production export, and provision of wildlife and aquatic species habitat. Not all functions will be performed in every wetland. The factors that affect wetland functions are numerous and include geographic and topographic location; wetland position in the watershed; water source and flow dynamics; substrate; and other physical, chemical, and biological characteristics of the wetland.

Wetland functions, as described by Adamus et al. (1991), that could be present in headwater wetlands include the following:

Flood flow alteration. The process by which peak flows from runoff, surface flow, and precipitation enter a wetland and are stored or delayed from their downstream movement.

Nutrient removal and transformation. The storage of nutrients (primarily nitrogen and phosphorus) within the sediment or plant substrate, the transformation of inorganic nutrients to their inorganic forms, and the transformation and removal of nitrogen (Adamus et al. 1991).

Sediment and toxicant retention: The process by which suspended solids and adsorbed contaminants are retained and deposited in a wetland.

Production export: The flushing of organic material from the wetland to downstream or adjacent waters.

Wildlife diversity: All wildlife species that are wetland dependant or that may use wetlands on a daily, seasonal, or intermittent basis.

three wetlands in this area. This wetland encompasses seeps and springs in the forested floodplain of White Oak Creek. Although there is diffuse groundwater discharge in a part of the southwest corner that would be filled, there are no discrete seeps or springs. This wetland is also habitat for two plant species, *Carex leptalea* and *Bartonia paniculatum*, that are uncommon in East Tennessee; however, these plants have not been observed in the area that would be filled. The functions of this wetland include provision of wildlife habitat, nutrient removal and transformations, and production export.

Wetland areas WOM14 and WOM15 are located adjacent to White Oak Creek and Chestnut Ridge Road and have a combined area of 0.06 acres (0.02 ha). Wetland WOM14 is a small, man-made depression that is seasonally saturated or ponded by storm runoff. It has no surface connection to other wetlands or streams. Its functions are probably limited to potential amphibian breeding habitat if the depth and duration of temporary ponding is sufficient. Wetland WOM15 is a spring-fed swale that empties into White Oak Creek. The southern half of this wetland would be filled for road construction. The functions performed by this wetland may include sediment and contaminant removal, nutrient removal and transformation, production export, and possibly amphibian breeding habitat.

During construction of the proposed SNS, wetlands WOM16 and WONT1-1 could be potentially affected by increased runoff and siltation. Appropriate mitigation measures, including control of runoff and use of silt fences, would be incorporated to minimize these effects. However, because of its close proximity to Chestnut Ridge Road, WOM16 would continue to receive increased runoff during rain events. The diversion of road runoff into stormwater control structures, such as vegetated swales, would minimize the volume of additional runoff and sediments entering the wetland.

All runoff and water discharges would be directed to the retention basin during operations at the proposed SNS. The outflow from this basin would not be channeled into the upper reaches of White Oak Creek (refer to Section 5.2.5.3). So, no effects to the wetlands from increased surface flows would be expected. However, wetland WONT1-1 may be indirectly affected by construction of the retention basin. Changes in the vegetation community can occur as a result of the clearing (creation of forest edge) and possible introduction of invasive, exotic species such as privet (*Ligustrum sinens*). These potential effects can be minimized by increasing the distance between the wetland and the holding pond as much as reasonably practicable.

Mitigation measures that would be considered include creation of a new wetland area along the stream channel of one of the tributaries of White Oak Creek or enlarging an existing wetland. One potential site may be the area around the existing springs in wetland WOM15. DOE would consult with the U.S. Army Corps of Engineers (USACOE) and the State of Tennessee to finalize the mitigation plan prior to the start of construction. Details of the mitigation measures would be included in the MAP (refer to Section 1.4).

Effects on the remaining four wetland areas (BCST2-1, WOM17, WOM18, and WONT2-1) would be minimal. These wetlands are not in areas that would be disturbed by construction of the proposed SNS. Proper control of runoff, especially during site preparation, would minimize effects on these wetland areas.
A formal floodplain/wetlands assessment document has been prepared for the proposed action at the ORNL site in accordance with the DOE regulations in 10 CFR 1022.12. This document is included as Appendix H of this FEIS.

5.2.5.3 Aquatic Resources

The proposed SNS site is located in the headwaters area of White Oak Creek. During land clearing for improvement of the access road and construction, there would be a potential for increased precipitation runoff and sediment loading in the creek. In addition, clear cutting of vegetation could expose the creek channel to increased solar radiation, which would increase the water temperature in the stream. Increasing the water temperature could disrupt the life cycle of cooler water fish, such as the banded sculpin and the blacknose dace. As a result, these species could be displaced by warmer water species migrating from the lower reaches of the creek.

DOE would establish a 100 to 200 ft (34 to 68 m) buffer zone around White Oak Creek. Trees within this buffer zone would not be cut, thus preserving the vegetative cover of the creek and avoiding increases in its water temperature. Runoff and erosion control measures, including silt fencing and preservation of native vegetation, would minimize the increased runoff and sediment load to the creek during construction. As a result of these measures, construction activities would have minimal effects on the aquatic resources in White Oak Creek.

No discharges from the proposed SNS to the headwaters of White Oak Creek would occur during operation of the proposed SNS. All surface runoff from the proposed SNS site would be directed to the retention basin. Steam condensate and cooling tower blowdown water would also be released to this basin. The basin would discharge up to 350 gpm (1,325 lpm) of water through a standpipe, and the discharge would be piped off-site. The discharge pipe would empty into White Oak Creek, south of Bethel Valley Road near the intersection of White Oak Creek Road and Melton Valley Access Road. Thus, no impacts on aquatic resources in the headwaters of White Oak Creek would be expected from the proposed SNS operations.

The cooling tower blowdown water would be elevated in temperature and would contain biocides and antiscaling agents. The makeup water for the cooling towers would be obtained from the potable water supply for the proposed SNS site; therefore, the blowdown would contain chlorine. The blowdown would be dechlorinated prior to its release into the retention basin. As described in Chapter 3, the retention basin would be designed to reduce the temperature of the blowdown to the ambient temperature of White Oak Creek (refer to Section 5.2.2.1.2).

5.2.5.4 Threatened and Endangered Species

The results of the survey of the proposed SNS site verified the presence of two protected plant species at three locations in the immediate vicinity of the proposed SNS site (refer to Section 4.1.5.4). These species are pink lady's slipper—a Tennessee endangered species due to commercial exploitation; and American ginseng—a threatened species in Tennessee. However, these plants are not located in areas expected to be heavily disturbed by construction or operation of the proposed SNS.

As stated in Section 4.1.5.4, the proposed SNS site encroaches on a NERP-designated Natural Area. This Natural Area, NA52, was established based on the presence of protected species and habitat that may be used by protected species. Approximately 20 percent of the 147 acres (59.5 ha) of NA52 overlap the proposed SNS site. The vegetation in this area would be cleared during construction.

The U.S. Fish and Wildlife Services, in response to DOE's informal consultation letter, submitted a list of federally listed or proposed endangered or threatened species that may occur in the project impact area (see Appendix D). However, no indications that these species occur at the ORNL site have been found to date.

A systematic survey of the potential habitat areas for protected species would be conducted prior to the start of land clearing for utility corridors, access roads, and construction. Because definitive identifications of many protected plants can be made only when they are flowering, this survey would extend over the spring, summer, and fall seasons to maximize the probability of finding these plants. If found in areas subject to disturbance, DOE would begin formal consultation with the USFWS and the State of Tennessee and implement an appropriate conservation plan to protect them during construction and operation of the proposed SNS. Possible conservation measures could include placing a fence around the habitat containing protected plants so the construction workers and equipment cannot cause damage, or transplanting the plants to areas of similar habitat. DOE would include details of the mitigation measures in the MAP (refer to Section 1.4). Overall, impacts on protected species by the proposed action are expected to be minimal.

5.2.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The socioeconomic effects section identifies whether construction and operation of the proposed SNS and associated worker in-migration from outside the ROI may adversely affect regional services and infrastructure. It also presents an estimate of the financial effects (employment, income, taxes, and economic output) that would be generated locally in the form of worker salaries, indirect effects, and induced effects. Unless otherwise noted, economic effects are described in escalated-year dollars.

The ROI associated with the proposed SNS at the ORNL site includes Anderson, Knox, Loudon, and Roane Counties in Tennessee. This 1,436-mi² (3,719-km²) region was selected because it is the region within which at least 90 percent of Oak Ridge workers currently reside. It is, therefore, the area within which the majority of socioeconomic impacts are expected to occur. Socioeconomic effects beyond the ROI area are generally expected to be minor.

The total local construction cost is estimated to be approximately $332 million (escalated dollars), and the peak construction year would be 2002, when 578 workers would be on-site (Brown 1998a). Of this total, about three-fourths (433 individuals) would likely be hired from the local area, and 144 would come from outside the ROI. An approximate average of 300 workers per year would be on-site, including all construction, management, engineering design personnel, and other technical and commissioning staff. Construction of the 1-MW proposed SNS is the bounding case for analysis of construction effects. If the SNS is upgraded to 4 MW, additional construction would occur, but this would be much less than the effects associated with the initial construction of the 1-MW SNS.

Operations of the proposed SNS at 1 MW would begin in the year 2006 with a staff of 250 persons. Later, if the proposed SNS is upgraded to 4 MW, 375 persons would be employed. The 4-MW case is used for this analysis as the bounding case. The effects of the 1-MW proposed SNS on the ROI would be similar but slightly less than the 4-MW case.

5.2.6.1 Demographic Characteristics

It is assumed that approximately 75 percent of all construction workers would come from the local area (Brown 1998a). Most of the construction workers would be general craft laborers, and the specialized technical components would be contracted out and fabricated in places not yet known. All locally hired construction workers would commute to the job site from existing residences and would not relocate closer to the site. The experience with other major construction projects has been that most in-migrating workers would temporarily move to the project area but would usually commute home periodically or on weekends. Generally, these individuals would not bring families to the ROI for the construction period. However, even if all of the in-migrating workers brought families into the area, the total (temporary) population increase would be less than 500 persons (including spouses and children) in the peak year. This would be a temporary increase in population of less than 0.01 percent and is, therefore, negligible.

People with the technical expertise needed to operate the proposed SNS currently reside in the

ROI. However, it is also expected that some plant operators would come from outside the local area. It is assumed that about half of the 375-person operating workforce (for the bounding 4-MW case) would come from outside the area. It is further assumed that these households would be the same size as the national average because it is not known from where they would in-migrate. It is conservatively estimated that in 2006, the total population increase associated with operations would be about 600 individuals, including spouses and children. The facility operators would be "permanent" residents of the ROI, and little additional in-migration would occur in subsequent years. The population increase associated with construction and operations would represent approximately 0.01 percent of the local population and is, therefore, negligible.

5.2.6.2 Housing

With about 14,600 vacant dwelling units (refer to Section 4.1.6.2) in the four-county ROI, workers should be able to find apartments to rent or houses to purchase easily. This is especially true because of recent downsizing of DOE program operations on the ORR. The effects on housing would be minor.

5.2.6.3 Infrastructure

Potential effects on infrastructure are closely tied to population growth. Because the expected permanent in-migration would be only 600 individuals, impacts to infrastructure would be relatively minimal. There are 138 schools with an enrollment of over 75,000 students in the area. The addition of less than 300 children to the ROI would be a minor effect. Even if all 300 children attended schools in Knox County, the current teacher-student ratio of 1:19 would be unchanged. Also, effects would be minimal for police and fire protection, health care, and other services.

5.2.6.4 Local Economy

Design of the SNS would begin in 1999, and the first construction managers and workers would begin work in FY 2000. The majority of the construction would occur from FY 2001 through FY 2004, with the peak construction employment occurring in FY 2002. Testing of the SNS would be from FY 2003 through FY 2005. Operations are planned to begin by the end of FY 2005; FY 2006 would be the first full year of operations (see Figure 3.2.2-1).

Table 5.2.6.4-1 presents the results of the IMPLAN modeling for the period 1999 through 2006. Economic benefits in the form of jobs, wages, business taxes, and income would begin to accrue during the first year of the project in FY 1999. These economic benefits in the ROI would increase as construction and other associated project activities increase. Design and construction employment would be highest in FY 2002, and there would be an estimated 1,499 total (direct, indirect, and induced) new jobs created at ORNL. This trend would begin to diminish in FY 2003 as design and construction employment decreased and would continue to decrease until construction is completed in FY 2004. Facility operations would begin in FY 2005. Operations would reflect substantial regional spending for operator salaries, supplies, utilities, and administrative costs.

The SNS is planned to operate for 40 years. If the level of operation is the same as the 4-MW case measured in the first full year (FY 2006), it is estimated that facility operation would continue to support 1,704 direct, indirect, and

Table 5.2.6.4-1. ORNL IMPLAN modeling results—construction and operations impacts.

	1999	2000	2001	2002	2003	2004	2005	2006
Employment								
Direct	80	168	387	460	320	213	29	744
Indirect	96	172	413	517	372	255	35	328
Induced	95	178	423	522	372	253	35	632
Total	271	518	1,223	1,499	1,064	722	99	1,704
Wages								
Direct	$5,393,195	$10,461,635	$25,209,789	$31,551,929	$22,870,276	$15,825,858	$2,214,385	$42,288,062
Indirect	$2,602,596	$4,789,126	$11,720,166	$14,947,307	$10,963,754	$7,675,011	$1,076,888	$10,192,999
Induced	$2,153,266	$4,093,319	$9,872,770	$12,431,138	$9,025,748	$6,255,302	$874,191	$16,185,791
Total	$10,149,057	$19,344,080	$46,822,724	$58,930,373	$42,859,777	$29,756,171	$4,165,464	$68,666,850
Business Tax								
Direct	$115,218	$237,187	$563,537	$691,797	$495,116	$338,324	$47,327	$2,147,003
Indirect	$521,081	$949,166	$2,314,978	$2,941,707	$2,148,064	$1,496,606	$208,816	$1,397,183
Induced	$531,318	$1,008,037	$2,431,249	$3,048,597	$2,208,599	$1,527,191	$212,926	$3,932,794
Total	$1,167,617	$2,194,390	$5,309,763	$6,682,100	$4,851,779	$3,362,121	$469,070	$7,476,980
Income								
Direct	$6,121,350	$11,835,876	$28,545,240	$35,765,984	$25,942,069	$17,962,928	$2,513,568	$44,391,954
Indirect	$3,012,179	$5,543,681	$13,576,165	$17,327,200	$12,718,333	$8,909,689	$1,250,971	$12,374,347
Induced	$2,545,442	$4,840,266	$11,701,405	$14,798,082	$10,681,986	$7,405,248	$1,035,187	$19,171,977
Total	$11,678,971	$22,219,822	$53,822,810	$67,801,266	$49,342,388	$34,277,864	$4,799,726	$75,938,279
Output								
Direct	$23,268,421	$43,760,128	$106,356,197	$134,502,188	$98,102,769	$68,290,104	$9,560,702	$92,847,043
Indirect	$7,305,926	$13,581,143	$33,109,038	$42,039,272	$30,745,296	$21,462,300	$3,008,388	$30,427,843
Induced	$7,029,522	$13,372,419	$32,340,621	$40,665,590	$29,544,359	$20,488,217	$2,864,941	$53,074,479
Total	$37,603,869	$70,713,690	$171,805,856	$217,207,050	$158,392,423	$110,240,621	$15,434,031	$176,349,365

induced jobs for each of the following years of operation. Other annual operations effects would include $68.7 million in local wages, $7.5 million in business taxes, $75.9 million in personal income, and $176.3 million in total output.

Construction of the facility would create new jobs and could potentially lower the region's total unemployment rate from about 3.2 percent to 3.0 percent. During operations, the unemployment rate would likely decrease further, although this would depend on whether construction workers and engineers (un-employed following project completion) stay in the ROI. The effects of operating the 1-MW proposed SNS would be similar but slightly lower.

5.2.6.5 Environmental Justice

As identified in Figures 4.1.6.5-1 and 4.1.6.5-2, minority populations and low-income populations reside within 50 miles (80 km) of the proposed SNS site. For environmental justice impacts to occur, there must be high and adverse human health or environmental effects that disproportionately affect minority populations or low-income populations.

The human health and safety analyses show that hazardous chemical and radiological releases from normal operations of the proposed SNS at 1-MW and 4-MW power levels would be within regulatory limits. Annual radiological doses are given in Section 5.2.9, and the data show that normal air emissions of the 1-MW proposed SNS would be negligible and would not result in adverse human health or environmental effects on the off-site public. Therefore, operation of the proposed SNS would not have disproportionately high and adverse effects on minority or low-income populations.

Radiation doses to the public from both normal operations and accident conditions would not create high and adverse impacts. Less than one (0.3) LCF is calculated at the 4-MW power level over a 40-year operations period. If the facility operated for 10 years at 1 MW and 30 years at 4 MW, the calculated number of LCFs would be reduced (refer to Section 5.2.9.2.1). An LCF is a cumulative measure from the entire population (within 50 miles or 80 km radius) of about 880,000 people used for comparing alternatives and does not necessarily indicate that a fatality would occur (refer to Section 5.2.9.2.1). Also, there are 25 accident scenarios that would result in airborne releases. The consequences of most of these accidents would be negligible at power levels of both 1 MW and 4 MW. Three accidents are calculated to induce LCFs in the off-site population. The prevailing winds follow the general topography of the ridges. Up-valley winds come from the southwest during the daytime, and down-valley winds come from the northeast during the nighttime (refer to Figure 4.1.3-2). Figures 4.1.6.5-1 and 4.1.6.5-2 show a concentration of minority and low-income population and nonminority higher income population northeast of the proposed SNS site in the path of the daytime prevailing wind. These figures indicate that no concentrations of minority or low-income population are located southwest (path of the nighttime prevailing wind) of the proposed SNS site. The public, including minority and low-income persons, could be in the path of an off-site airborne release. However, the analysis has shown that there would not be high and/or adverse impacts to any of the population; therefore, there would be no disproportionate risk of significantly high and adverse impacts to minority and low-income populations.

A number of uncertainties are associated with the evaluation of potential impacts due to subsistence consumption. ANL developed an article reviewing the literature on subsistence consumption (Elliot 1994) and found that (1) ”the majority of the studies that have been conducted to date are focused on site- or region-specific exposure concerns. … At present, it is unclear whether the findings of these studies are representative of consumption and exposure levels among minority populations at a national level;” (2) “a large number of risk assessment studies focusing on fish and wildlife consumption examined whole populations without distinguishing between consumption and exposure patterns of specific ethnic (or other) subpopulations;” (3) “the vast majority of studies have focused on fish consumption as an exposure pathway. Few examined wildlife consumption and contamination, and even in such cases, the studies were not motivated by minority exposure concerns;” and (4) “the majority populations were not significantly higher than for the population as a whole.” Specific data on subsistence living are not available for the ORR region, and DOE is unaware of any subsistence populations residing in the vicinity of the proposed SNS site. Therefore, no adverse impacts to such populations are expected.

To assemble and disseminate information on subsistence hunting and fishing, DOE began publishing *A Department of Energy Environmental Justice Newsletter: Subsistence and Environmental Health* in the spring of 1996. The newsletter is available in the public reading rooms. Three goals of the newsletter are (1) “to provide useful information about the health implications of consuming contaminated fish, wildlife, livestock products, or vegetation;” (2) ”to provide information about projects and programs at DOE and other federal and state agencies that address the problems associated with consuming contaminated fish, wildlife, livestock products, or vegetation;” and (3) “to receive relevant information from readers.” In addition to the newsletter, DOE has a new project under way to identify what information is being collected on subsistence consumption by other federal agencies and to serve as a clearinghouse for such information (DOE 1996e).

No discharges of radioactive water to surface waters would occur because these liquids would be trucked to existing waste processing facilities at ORNL. These facilities and the management processes for these wastes are described in Section 5.2.11. All chemical releases would be regulated by NPDES permits and would be in compliance with federal and state regulations. As such, there would be no incremental effects on fish or other edible aquatic life in areas surrounding the proposed SNS site.

The analyses indicate that socioeconomic changes resulting from implementing the proposed SNS would not lead to environmental justice impacts. The proposed SNS project would provide economic benefits through generating additional employment and income in the affected region (refer to Table 5.2.6.4-1). There would be increased traffic congestion; however, this impact would not disproportionately affect minority or low-income communities because traffic patterns would not be different between low income and minority populations and the rest of the surrounding population (see Section 5.2.10.1). Overall, there is nothing from the construction or operation of the proposed SNS that would pose high and adverse human health or environmental effects that disproportionately affect minority and low-income populations.

5.2.7 CULTURAL RESOURCES

Surface and subsurface cultural resources can be affected by a number of activities. Surface resources such as standing structures, TCPs, artifacts, and landscape features are especially susceptible to damage by activities that involve their direct physical impact by objects such as heavy equipment. These activities include land clearing and grading. Subsurface artifacts and the archaeological context of the artifacts can be damaged by any activity that disturbs the soil. Such activities include the clearing of vegetation, excavations, and compression of soil by heavy objects resting or moving on the ground surface.

The SNS design team has not established the areas where construction or improvement of utility corridors would be necessary to support the proposed SNS, and the full route of the southwest access road has not been determined. As a result, the effects of the proposed action on cultural resources in these areas cannot be assessed at this time. If the site at ORNL were chosen for implementation of the proposed action, the SNS design team would establish the final routes of the southwest access road and utility corridors. A cultural resources survey and an assessment of potential effects on cultural resources would be conducted. Appropriate measures would be implemented to mitigate any identified effects. The survey and mitigation would be implemented prior to the initiation of construction-related activities in these areas. The mitigation measures would include avoidance (e.g. choosing another route or fencing a prehistoric site to protect it), where possible, or data recovery operations. The data recovery operations would include detailed recording of surface features and/or archaeological excavation. Details of the mitigation measures to be implemented would be included in the MAP (refer to Section 1.4).

5.2.7.1 Prehistoric Resources

No prehistoric archaeological sites have been identified on the 110-acre (45-ha) proposed SNS site at ORNL. As a result, implementation of the proposed action on this site would have no effect on prehistoric cultural resources listed on or eligible for listing on the NRHP.

Loci FN-1, FN-1A, and FN-7 denote isolated occurrences of prehistoric artifacts in the vicinity of the proposed SNS site. In addition, a prehistoric component was identified at 40RE488, which is also located in the vicinity of the proposed SNS site. Because of their locations, the isolated occurrence loci may be destroyed by heavy equipment movements. Access road improvements under the proposed action may destroy the east portion of the prehistoric component at 40RE488. Neither these loci nor the site component are listed on or considered to be eligible for listing on the NRHP. Consequently, their destruction would not represent an effect on prehistoric cultural resources.

5.2.7.2 Historic Resources

No Historic Period archaeological sites, structures, or features have been identified on the 110-acre (45-ha) proposed SNS site at ORNL. As a result, implementation of the proposed action on this site would have no effect on Historic Period cultural remains listed on or eligible for listing on the NRHP.

A Historic Period archaeological component has been identified in the vicinity of the proposed SNS site at 40RE488. This site is in an area slated for access road improvements under the proposed action. The east portion of this previously disturbed late 19th or early 20th century farmstead component may be destroyed by the proposed road improvements. However, this component is not listed on or considered to be eligible for listing on the NRHP. As a result, partial destruction of the component by road improvements would not be an effect on a cultural resource.

5.2.7.3 Traditional Cultural Properties

DOE-ORO has consulted with the Eastern Band of the Cherokee concerning the presence of TCPs on the ORR. No TCPs of special sensitivity or concern to the Cherokee are known to exist anywhere on the ORR. Consequently, no TCPs would be affected by implementation of the proposed action on the proposed SNS site at ORNL.

5.2.8 LAND USE

Land use in the vicinity of the ORR, within the boundaries of the reservation including ORNL, and on the proposed SNS site are assessed in this section for potential effects of the proposed action. The assessments cover potential effects on current land uses and zoning for future land use. Furthermore, the potential effects of the proposed action on parklands, nature preserves, major recreational resources, and visual resources are assessed.

> **40RE488: A Multicomponent Archaeological Site**
>
> Many archaeological sites in the United States contain the separate and distinctive material remains of occupations by different cultural groups. Each of these occupations may be associated with a particular period in time, and the individual occupations may be separated from each other in time by thousands of years. In American archaeology, each culturally and temporally distinctive occupation of a single site is referred to as a component. One archaeological site may have a single component, but another may have numerous components. Sites with more than one component are referred to as multicomponent sites.
>
> Site 40RE488 is a multicomponent site. It contains archaeological remains indicative of a prehistoric occupation, and it was also the site of a late 19th or early 20th century Anglo-American occupation. Potential effects on the prehistoric component at this site are assessed in Section 5.2.7.1, and potential effects on the Anglo-American component are assessed in Section 5.2.7.2.

5.2.8.1 Current Land Use

Current land use in the area surrounding the ORR is driven by the relationship between existing land characteristics and socioeconomic forces acting at the local and regional levels. Similarly, current land use on the ORR results from selectively using the existing characteristics of the land to meet various DOE mission requirements. The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the basic land characteristics and other forces that influence land use in these areas. Consequently, implementation of the proposed action on the proposed SNS site at ORNL would have no reasonably discernible effects on land use in the vicinity of the ORR and throughout most of the reservation. However, current uses of the land within the proposed SNS site and in nearby areas would be more subject to effects.

The proposed SNS site and adjoining land are located within a current land use category referred to as Mixed Research/Future Initiatives. This category includes most of the Oak Ridge NERP and applies to predominantly undeveloped land that is used or available for use in environmental field research. This land is also reserved for future DOE initiatives, including new research facilities. With the exception of Chestnut Ridge Road, utility corridors, a system of unimproved access roads, and a few other features, this area is undeveloped land that has been returning to its natural state since 1942. Implementation of the proposed action would introduce large-scale development to the proposed SNS site, utility corridors, and rights-of-way. However, this would result in minimal overall effects on undeveloped ORR land, because approximately 64 percent of the 34,516 acres (13,794 ha) of land on the reservation is undeveloped.

DOE has a federally mandated role as trustee of the natural and cultural resources on its lands. The use of undeveloped land for the SNS is proposed only because no previously developed ORR lands that meet project requirements are available.

Construction and operation of the proposed SNS would effectively change land use on the proposed SNS site from the current Mixed Research/Future Initiatives use category to the Institutional/Research category. In addition, the current uses of land within planned utility corridors and road rights-of-way would be changed from their current uses to these new infrastructure uses.

5.2.8.1.1 Walker Branch Watershed

The National Oceanic and Atmospheric Administration/Atmospheric Turbulence and Diffusion Division (NOAA/ATDD) is conducting the Temperate Deciduous Forest Continuous Monitoring Program (TDFCMP) in the Walker Branch Watershed. This project is measuring the continuous exchange of CO_2, water vapor, and energy between the deciduous forest in the Walker Branch Watershed and the atmosphere. The aim of the program is to continuously monitor these exchanges over a long period of time to gain a better understanding of local, regional, and global carbon budgets and the effects of elevated atmospheric CO_2 on temperate forests worldwide.

The facility heating system for the proposed SNS would include ten natural gas boiler units with ten small stacks. The operation of these units would result in the emission of combustion products to the atmosphere. These products would include CO_2, water vapor, and NO_x. Heavy equipment and automobile traffic associated with proposed SNS construction and operations would produce additional CO_2. Minor sources such as chain saws, mowing equipment, and diesel-powered electric generators may be used during construction and operations. Construction would begin in the year 2000, and operation of the proposed SNS facility would begin in late 2005.

The monitoring instruments for the TDFCMP are located 0.75 miles (1.2 km) east of the proposed SNS site. The prevailing winds blow from the proposed SNS site to the east-northeast toward the Walker Branch Watershed and the instrument stations during the daytime hours. Wind movement from the proposed SNS site towards the Walker Branch Watershed is also a function of current weather conditions. Consequently, the CO_2 from the proposed SNS could be transported to the monitoring instruments in the Walker Branch Watershed. It was recognized that this could affect the quality of the CO_2 monitoring data being collected, because some measurements would reflect activity from the proposed SNS instead of the physical, chemical, and biological activity in the forest biomass and soils of the Walker Branch Watershed. Furthermore, the presence of these nonrepresentative measurements could hinder comparisons of data collected after the start of construction of the proposed SNS to monitoring data collected prior to construction and operation.

Air quality modeling was performed to provide a preliminary assessment of the potential effects the proposed SNS boiler stack emissions would have on CO_2, NO_x, and water vapor monitoring data collected at the NOAA/ATDD research tower in the Walker Branch Watershed area. This modeling was conservative in nature, essentially reflecting the results of a worst-case scenario. Basic assumptions in the modeling effort were operation of the proposed SNS at a fully upgraded power of 4 MW and continuous annual operation of the natural gas boilers at their full rated capacity. This level of operation would consume 1,447 lb/hr of natural gas and emit 4,184 lb/hr of CO_2. The 1991 meteorological data input to the model were collected at the NOAA/ATDD tower in the Walker Branch Watershed area. These data were 1 year of 15-minute averages for wind direction, mean wind speed, ambient temperature, solar radiation, and sigma-theta. Missing data were filled by using data from nearby monitoring towers or by averaging surrounding period data for short missing periods. The full report on the results of the air quality modeling is in Appendix I.

The modeling indicated that local winds would transport CO_2 toward the NOAA/ATDD tower 15 to 20 percent of the time. The maximum 15-minute average CO_2 detection at the monitoring tower would be 27,569 μg/hr.

NOAA/ATDD has determined a threshold limit to serve as an indicator of potential effects of the proposed SNS on the quality of CO_2 monitoring data for the Walker Branch Watershed. This threshold is any amount > 6680 $\mu g/m^3$, which is 1 percent of the background level of CO_2 at the Walker Branch Watershed. A number of the modeled 15-minute average CO_2 measurements at the NOAA/ATDD tower exceed the established threshold. The numbers of modeled CO_2 measurements that exceed the threshold are listed in Table 5.2.8.1.1-1.

These results reflect a worst-case scenario, as previously noted. Normal operating conditions may produce fewer exceedances. Nonetheless, the presence of these measurements indicates that emissions from the proposed SNS boiler stacks would adversely affect the quality and temporal comparability of the CO_2 monitoring data collected under the TDFCMP.

The effects of CO_2 from construction equipment and automobiles on TDFCMP monitoring data are not entirely known. During construction of

Table 5.2.8.1.1-1. Modeled CO_2 measurements exceeding the effects threshold (6,680 $\mu g/m^3$) at the NOAA/ATDD tower in the Walker Branch Watershed.

Measurement Period (Based on 1991 Data)	Total Measurements in Period	Number of Measurements Exceeding Threshold	Percent of Measurements Exceeding Threshold
January – March	8,760	184	2.10
April – June	8,760	258	2.95
June- September	8,760	317	3.62
October – December	8,760	212	2.42
Annual Average	35,040	971	2.77

the proposed SNS, workers could park their personal vehicles at parking lots on the floor of Bethel Valley. The CO_2 emissions from these vehicles would be expected to have little more effect on TDFCMP monitoring than current traffic in the Bethel Valley Road area. However, emissions from on-site construction vehicles and the parking of automobiles at the proposed SNS site after operational startup could further affect TDFCMP monitoring data.

Two approaches to mitigating the adverse effects of CO_2 emissions from the proposed SNS on TDFCMP data are being considered.

- Relocate the NOAA/ATDD meteorological monitoring tower to a Walker Branch Watershed location less susceptible to the effects of CO_2 emissions from the proposed SNS or build a new tower at this new location.
- Eliminate CO_2 emissions from the proposed SNS heating system by installing electric heat pumps rather than natural gas boilers.

Proper relocation of the meteorological monitoring tower would have the potential to mitigate effects on CO_2 readings from both construction and operation of the SNS. These effects would potentially result from emissions by boiler stacks in the operational SNS heating system, vehicles, and minor sources.

The use of electric heat pumps instead of natural gas boilers would eliminate all CO_2 emissions and effects from direct operation of the SNS heating system, which would be the largest and most continuous emitter of CO_2. However, this option would not mitigate the effects of vehicle emissions on CO_2 readings during construction and operation of the SNS. In addition, it would not mitigate any effects that might result from minor sources during SNS construction and operations.

It is anticipated that the effects of the proposed SNS on CO_2 monitoring at the NOAA/ATDD tower would be minimal after implementation of a mitigation measure. Details of the mitigation measures to be implemented would be included in the MAP (refer to Section 1.4).

The cooling towers at the proposed SNS would emit water vapor to the atmosphere. Modeling indicated that the maximum 15-minute average detection of the proposed SNS water vapor at the NOAA/ATDD monitoring tower would be 1.04 g/m^3 of air. Although the results of the modeling did not allow an assessment of specific effects on TDFCMP monitoring data, effects on data quality and comparability may occur. Such effects could be mitigated by moving the NOAA/ATDD monitoring tower to a Walker Branch Watershed location less susceptible to them or by building a new tower at this new location.

The boiler stacks at the proposed SNS would emit NO_x at a rate of 3.48 lb/hr. Modeling indicated that the maximum 15-minute average detection of NO_x from the proposed SNS boilers at the NOAA/ATDD monitoring tower would be 23 $\mu g/m^3$ of air. NOAA/ATDD has indicated that these low levels would have minimal effects on their monitoring efforts in the Walker Branch Watershed.

The ORNL-Environmental Sciences Division (ESD) has nine major ecological research projects in the Walker Branch Watershed. Most of these projects depend on data inputs from the long-term NOAA/ATDD atmospheric and deposition monitoring sites associated with the watershed. Although these sites are located on the side of the Walker Branch Watershed nearest to the proposed SNS site, their data are considered to be representative of the entire watershed.

Emissions from the natural gas boilers at the proposed SNS would adversely affect CO_2 measurements at the NOAA/ATDD tower in the Walker Branch Watershed. Emissions of CO_2 from construction equipment and automobiles may also affect these measurements. If such nonrepresentative data were used in current ecological research projects, they could result in inaccurate experimental results. These projects would be further affected because the data obtained and the experimental results would not be comparable to data and results obtained prior to construction and operation of the proposed SNS.

One of the nine current ecological research projects in the Walker Branch Watershed would be adversely affected by the incorporation of nonrepresentative CO_2 data from the NOAA/ATDD tower (refer to Table 4.1.8.2-1). Project No. C-9 is a long-term project (>10 years) that incorporates CO_2 exchange measurements from the tower into the modeling of ecosystem carbon cycle processes. After implementation of a mitigation option, it is anticipated that these effects would be minimal.

Water vapor emissions from the proposed SNS cooling towers may affect ORNL-ESD ecological research projects in the Walker Branch Watershed. The current research efforts that may be adversely affected are Project Nos. C-1 and C-2, which are long-term projects extending beyond the fiscal year (FY) 2005 start date for operation of the proposed SNS and its cooling towers. Project Nos. C-3, C-4, C-6, and C-9 would not be affected because the current efforts on these projects would be completed by FY 2005.

5.2.8.2 Future Land Use

The land on the proposed SNS site and adjacent land are zoned as Mixed Research/Future Initiatives. This DOE zoning allows for a mixture of environmental research in the NERP, which includes all of the proposed SNS site land, with the construction and operation of future research facilities. Construction of the proposed SNS would be compatible with this zoning. Consequently, implementation of the proposed action would have no potential effects relevant to current DOE zoning of the proposed SNS site.

Portions of the proposed SNS site would become contaminated with pollutants from operations. Current plans call for in-situ decommissioning of the SNS when its operational life cycle is completed. As a result of in-situ decommissioning, some contaminated components would remain in place on the SNS site. This could limit the future use of land on the site for other purposes. Construction and operation of the SNS could limit the future use of land areas adjacent to the SNS site.

The zoning of the proposed SNS site and adjacent land is currently overlain by the buffer zone for the Walker Branch Watershed (Figure 4.1.8.2-2). The purpose of this buffer zone is to exclude from its boundaries any future activities and operations that could adversely affect environmental monitoring and experiments in the Walker Branch Watershed. The entire proposed SNS site is located within this buffer zone.

Construction and operation of the proposed SNS would adversely affect on-going and future environmental monitoring and research efforts in the Walker Branch Watershed, as indicated in Section 5.2.8.1.1 and the following subsection. Consequently, construction and operation of the proposed SNS on the preferred site at ORNL would be at variance with the intended purpose of the Walker Branch Watershed buffer zone.

The Reservation Management Organization (RMO) has been charged with reviewing proposed activities in the Walker Branch Watershed buffer zone (refer to Section 4.1.8.3). After reviewing the ORNL siting options for the proposed SNS, the RMO has recommended use of the preferred site within the Walker Branch Watershed buffer zone for construction of the proposed SNS (Teer 1997: 1). The site selection report, which documents the process used for selection and recommendation of the preferred proposed SNS site at ORNL, is in Appendix B.

5.2.8.2.1 Walker Branch Watershed

The TDFCMP is a long-term monitoring project that NOAA/ATDD plans to continue for many years (> 10 years) into the future. Operation of the proposed SNS over a 40-year period would have continuing adverse effects on CO_2 monitoring under the TDFCMP. The potential effects would be the same as those indicated in Section 5.2.8.1.1, and they would be mitigated by implementing one of the options identified in that section of the FEIS. After implementation of a mitigation measure, it is anticipated that the effects of the proposed SNS on CO_2 monitoring would be minimal.

A number of the current ORNL-ESD ecological research projects in the Walker Branch Watershed are expected to continue for many years. Other projects are expected to generate closely related follow-on work. Several major ORNL-ESD proposals for future ecological research in the Walker Branch Watershed are pending, and a number of the future research initiatives identified in the ORNL-ESD Strategic Plan would be tied to the historical research record and an understanding of ecological processes gained on the Oak Ridge NERP, including the Walker Branch Watershed.

Project No. C-9 is a long-term effort that would be adversely affected by the future incorporation of nonrepresentative CO_2 data from the NOAA/ATDD tower into its modeling of ecosystem carbon cycling processes (refer to Table 4.1.8.2-1). Project No. C-7 involves theoretical studies of CO_2 and energy exchange in the Walker Branch Watershed ecosystem. A proposal is anticipated to continue this project beyond the current FY 1999 completion date. This project could also be adversely affected by the incorporation of nonrepresentative CO_2 data from the NOAA/ATDD tower, especially if the project extends beyond late 2005 when the proposed SNS operations begin. After implementation of a mitigation option specified in Section 5.2.8.1.1, it is anticipated that the effects on both projects would be minimal.

Water vapor emissions from the proposed SNS cooling towers may affect future TDFCMP monitoring data and future ORNL-ESD ecological research projects in the Walker Branch Watershed. These potential effects would be the same as those indicated in Section 5.2.8.1.1.

These water vapor emissions could affect ORNL-ESD Project Nos. C-1 and C-2, which are long-term projects that would continue for more than 10 years. Project No. C-4, a priority subject for long-term research, could also be affected. Anticipated follow-on work on Project Nos. C-3 and C-8 could also be affected, but only if these efforts extend beyond the start date for the proposed SNS operations.

Proposals are pending on four major ecological research projects in the Walker Branch Watershed. Project Nos. F-1, F-2, and F-3 may also be affected by water vapor (refer to Table 4.1.8.3-2). Project Nos. F-1 and F-2 would be long-term projects (> 10 years). Project No. F-3 would be completed by FY 2001, but the subject of this project is a priority for long-term research in the future.

The potential effects of the proposed action on future research initiatives identified in the ORNL-ESD Strategic Plan cannot be fully determined at this time. However, given the potential for effects from nonrepresentative CO_2 and water vapor monitoring inputs to experiments, the effects described in Section 5.2.8.1.1 may apply to a number of these initiatives.

5.2.8.2.2 Common Ground Process and End Uses of ORR Land

The Common Ground process has resulted in citizen stakeholder recommendations to DOE on the future use of ORR land. Based on the presence of areas with High Significance biodiversity rankings, their recommendation for the proposed SNS site and adjacent land is a zoning category called Conservation Area Uses. These uses would include protection of the environment, environmental research sites, forestry, agricultural research, and passive recreation. Extensive development of the proposed site and related areas such as utility corridors and roads would be at variance with this zoning recommendation.

Recommendations for the end use of contaminated sites on the ORR have been developed and submitted to DOE by an Oak Ridge citizens' organization known as the End Use Working Group. These recommendations include the end use of contaminated sites in specific watersheds and a broader set of community land use guidelines. One of the group's principal concerns is the use of brownfield sites on the ORR to preserve undeveloped greenfield areas. The community guidelines recommend the siting of additional DOE facilities on brownfield sites rather than greenfield sites. The proposed SNS site at ORNL is a greenfield site.

The siting of the proposed SNS at ORNL would appear to be at variance with the recommendation of the End Use Working Group. However, construction of the proposed SNS would require a large 110-acre (45-ha) brownfield site with a configuration that could accommodate the proposed facility. This site would need to be available by the scheduled FY 2000 start date for construction of the proposed SNS. No brownfield site that meets these criteria is present on the ORR, thus necessitating use of a greenfield site for the proposed SNS.

5.2.8.3 Parks, Preserves, and Recreational Resources

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses outside the ORR and at one location on the ORR. Consequently, implementation of the proposed action on the SNS site at ORNL would have no reasonably discernible effects on the following specific land uses: University of Tennessee Arboretum, University of Tennessee Forest Experiment Station, Tennessee Valley Authority (TVA) recreation areas on Melton Hill Lake and Watts Bar Lake, and Clark Center Recreation Park.

The proposed SNS site is located within the Oak Ridge Wildlife Management Area on the ORR, and it is within a zone of the management area designated for public deer hunting. The proposed action would affect recreational hunting by slightly reducing the area of ORR land open to the public for deer hunting. The reduction would be approximately 110 acres (45 ha) of undeveloped land. This effect would be minimal because approximately 26,604 acres (10,735 ha) of ORR land would still be open to the public for recreational deer hunting.

The land areas within and adjacent to the proposed SNS site are part of the Oak Ridge NERP. The NERP would be affected by the proposed action. The potential effects of the proposed action within the NERP are discussed in the two preceding sections of the FEIS and Section 5.2.5.

5.2.8.4 Visual Resources

The proposed SNS would not be visible to the public from land-based vantage points outside the ORR and from most points on the reservation, including points along Bethel Valley and Bear Creek Roads. The proposed SNS facilities would come into view only along the upper reaches of Chestnut Ridge Road and the southwest access road to the proposed SNS site. During construction, these roads would be traveled by DOE and ORNL personnel, construction workers, and service providers. During operations, they would be traveled by DOE personnel, SNS employees, service providers, and visitors to the SNS facilities, including visiting scientists. Moreover, there are no established visual resources on the reservation that would include the proposed SNS. Therefore, implementation of the proposed action on the SNS site at ORNL would have minimal effects on visual resources.

5.2.9 HUMAN HEALTH

Construction and operation of the proposed SNS at ORNL could pose a potential risk of adverse effects on the health of workers and of the public living in the vicinity of the facility. Potential adverse effects include:

- Traffic-related fatalities and injuries to workers and the public.
- Occupational fatalities and injuries to workers.
- Exposure of workers and the public to radiation or radioactive materials.
- Exposure of workers and the public to toxic or hazardous materials.

This section evaluates the potential magnitude of these effects and the likelihood that they would occur during three phases or conditions:

- construction,
- normal operations, and
- accident conditions.

5.2.9.1 Construction

Construction of the 1-MW proposed SNS would require a total of 2,074 person-years of labor during the 7-year construction period and would reach a peak of 578 full-time workers during the fourth year of construction. At this stage of design, estimates of the number of workers that would be required to upgrade the facility for 2-MW or 4-MW operation are not available. Potential adverse effects on the health of workers and the public during construction activities include an increased risk of vehicle accidents due to increased traffic and the risk of occupational injuries or fatalities among construction workers. Construction workers, other ORNL site workers, and the public would not be exposed to toxic or radioactive materials as a result of construction activities because the preferred site for the proposed SNS at ORNL is not contaminated with such materials.

The increase in risk of disabling injuries or fatalities to the public and other ORNL workers due to construction workers commuting to the site can be estimated based on data provided in Section 5.2.10.1. The 9,690 workers now employed at ORNL make an estimated 7,810 daily round-trips as they enter and leave (0.806 round-trips/worker). During the peak year of construction, construction workers would add 466 round-trips (0.806 round-trips/worker × 578 workers), an increase of 6 percent.

It is assumed that the average round-trip distance traveled by construction workers is the same as that for other workers at ORNL. An increase of no more than 6 percent in injuries and fatalities from motor vehicle accidents would be expected during construction of the proposed SNS. It is also assumed that the average round-trip distance for an ORNL worker is 20 miles (32 km); the total of 417,911 daily round-trips by construction workers over the 7-year construction period (2,074 person-years × 250 work days/person-year × 0.806 daily round-trips/worker) would add 8,360,000 miles (13,400,000 km) of travel. Data available from the National Safety Council (http://www.nsc.org/lrs/statinfo/afp78.html) for 1996 indicate that 1.74×10^{-8} fatalities per vehicle mile and 1.05×10^{-6} disabling injuries per vehicle mile occurred on average in the United States. On the basis of these rates and the anticipated total mileage, less than one additional fatality (0.15) and nine additional disabling injuries could occur as the result of increased commuter traffic during the 7-year construction period of the proposed SNS. Although these impacts would be due to the addition of SNS construction workers to traffic flow, the injuries or fatalities could affect anyone operating a motor vehicle in the vicinity, including other ORNL workers and members of the public.

The potential risk of occupational injuries and fatalities to workers constructing the proposed SNS would be expected to be bounded by injury and fatality rates for general industrial construction. Data available from the National Safety Council for the years 1992 through 1996 (http://www.nsc.org/lrs/statinfo/afp48.htm) indicate that the fatality rate of construction workers has been relatively constant, averaging 15 to 16 deaths per 100,000 workers (0.00015 to 0.00016 fatalities per worker-year). For 1996 the risk of occupational fatality was 0.00015 per construction worker-year, and the risk of disabling injury was 0.053 per construction worker-year. On this basis, less than 1 fatality (0.000015 fatalities/worker-year × 2,074 worker-years = 0.31 fatalities) and 110 disabling injuries (0.053 disabling injuries/worker-year × 2,074 worker-years) could occur as the result of occupational accidents during construction of the proposed SNS.

The previous discussion is based on construction of the 1-MW proposed SNS facility. At this stage of design, estimates of the number of workers that would be required to upgrade the facility to 4-MW operation are not available. Because the amount of construction required for upgrade to 4 MW would be less than that required for construction of the original facility, injuries and fatalities for traffic-related and construction accidents for the 4-MW facility would be less than those for construction of the original facility regardless of where the SNS is located.

5.2.9.2 Normal Operations

During normal (accident-free) operations, a maximum of 375 workers would commute daily to the proposed SNS. This number of workers would represent an increase of approximately 4 percent in traffic due to the ORNL workforce and could be expected to increase the number of motor-vehicle-related disabling injuries and fatalities to workers and the public in the vicinity by this same percentage.

On the basis of national traffic accident rates (0.0174 fatalities per million vehicle-mile and 1.05 disabling injuries per million vehicle-mile) and the anticipated total mileage of 60 million miles (375 commuting workers × 20 miles/trip × 0.806 trips/day × 250 days/year × 40 years), one additional fatality and 63 additional disabling injuries could occur as the result of increased commuter traffic during the 40-year operational life of the proposed SNS.

Based on 1996 data available from the National Safety Council (http://www.nsc.org/lrs/statinfo/afp48.htm), 3.4 accident deaths and 3,400 disabling injuries would be expected each year in a work force of 100,000 in a standard industrial environment. Applying this data to the work force for the proposed SNS, less than 1 fatality (3.4 deaths annually/100,000 workers × 375 workers × 40 years = 0.5 deaths) and 510 disabling injuries (3,400 disabling injuries annually/100,000 workers × 375 workers × 40 years = 510 disabling injuries) could occur over the 40-year operational life of the proposed SNS.

The proposed SNS would generate and release direct radiation, radioactive materials, and toxic materials. Members of the public and workers at the proposed SNS and other adjacent facilities would be exposed to such radiation and emissions. The quantities and release rates of these materials would be the same as for the preferred alternative. The impact of the ORNL site-specific meteorology, distances to site boundaries, and population density and distribution are discussed in the following sections.

5.2.9.2.1 Radiation and Radioactive Emissions

This section assesses the potential effects of direct radiation and airborne emissions of radioactive materials from the proposed SNS based on the methods and dose-to-risk conversion factors discussed in Section 5.1.9.

Direct Radiation

Direct radiation is ionizing, penetrating radiation emitted from sources external to the human body. High levels of direct radiation would exist in the linac and beam tunnels, and very high levels would exist in the target area when the proton beam is on. These levels would subside rapidly in most areas once the beam is cut off; however, the mercury target itself and some target components would continue to emit radiation levels high enough to require that these components be handled remotely.

At the current stage of design, specific estimates of potential direct radiation exposures of workers or the public from the proposed SNS are not available. The Shielding Design Policy for the proposed SNS has been established to guide design by specifying maximum allowable radiation exposure rates for various areas inside and outside the SNS (ORNL 1997a). The policy is intended to ensure that facility design incorporates sufficient shielding to allow compliance with the requirements of 10 CFR Part 835, *Occupational Radiation Protection*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment for Operation of the SNS* at a proton beam power of 4 MW. The policy is based on consideration of dose limits and requirements for the use of personal dosimeters by members of the public in controlled areas, for nonradiological workers, and for radiological workers. This policy is also based on the length of time that each category of individual could be expected to occupy a given area.

Under this policy, the annual dose to members of the public, including site visitors, would not exceed 100 mrem outside the controlled area or 50 mrem inside the controlled area. The annual dose to workers who are not radiological workers would not exceed 100 mrem at any location from the proposed SNS operations. Radiological workers (workers who could receive an annual dose of more than 100 mrem during performance of their routine duties) could receive up to 5 rem annually under the regulations of 10 CFR Part 835. However, common practice at DOE facilities is to impose administrative controls that limit exposures to some fraction of the allowable limit.

Actual doses from direct radiation at the proposed SNS are expected to be much less than these limits, based on experience at other particle accelerators operated by DOE. These accelerators include electron, positron, proton, and heavy ion accelerators. These accelerators must address many of the same radiation protection issues as the proposed SNS. These issues include activation of air and accelerator components due to beam loss and high radiation levels from nuclear interactions in targets and target components. During the period 1994 through 1996, individual monitored workers at any DOE accelerator facility did not receive an annual dose in excess of 2 rem, and the average annual dose to monitored individuals at all DOE accelerator facilities ranged from 0.065 rem to 0.098 rem (DOE 1996f). These average annual doses include both external and internal exposures and are less than 2 percent of the 5-rem limit. These data indicate that doses to the public would also be far below the 100-mrem annual limit.

During the first full year of operation, approximately 250 people would work at the proposed SNS. This number would increase to 375 people when the second target is completed. Based on a risk factor for workers of 0.0004 LCF per person-rem, less than one excess LCF could be estimated among these workers if each worker received an annual dose of 0.098 rem each year of the 40-year life of the facility (0.4 excess LCF for 250 workforce and 0.6 excess LCF for 375 workforce).

Radioactive Emissions

Radioactivity would not be discharged from the proposed SNS to surface water under normal conditions of operation. LLLW and process waste would be collected and transported by tanker truck to existing waste processing facilities. As discussed in Section 5.2.11, the existing waste management systems at ORNL have sufficient capacity to accommodate the proposed SNS wastes. Effluents from treatment of the proposed SNS wastes would be released in accordance with existing permits for these facilities.

Radioactive emissions to the atmosphere from the proposed SNS would consist of releases from two stacks—the Tunnel Confinement Exhaust Stack and the Target Building Exhaust Stack. The locations of these stacks are shown in Figure 3.2.1.5-1. Annual emissions from these systems are summarized in Table 3.2.3.5-1 for power levels of both 1 MW and 4 MW. A detailed list of radionuclide emissions used for dose calculations is provided in Table G-1 of Appendix G.

Doses to workers and members of the public due to exposures from routine operational releases of radionuclides from the SNS at ORNL are shown in Table 5.2.9.2.1-1. Based on the conservative assumptions and calculation methods discussed in Section 5.1.9, annual doses to workers and the public from airborne emissions from the SNS would be comparable to annual doses from existing ORNL airborne emissions. The estimated dose from all 1996 airborne emissions at ORNL to the maximally exposed off-site individual was 0.45 mrem, and estimated dose to the off-site population was 9.9 person-rem (ORNL, OR Y-12, and ETTP 1997). If it is assumed that the current ORNL maximally exposed individual and the proposed SNS maximally exposed individual would be in the same location, then SNS operations would increase the annual dose to the maximally exposed individual to 0.84 mrem for operations at 1 MW and to 2.0 mrem for operations at 4 MW. The limit for annual dose to the public from all airborne emissions from DOE facilities is 10 mrem (40 CFR Part 61), and DOE expects the facility to meet this limit. These doses would be 8 percent and 20 percent, respectively, of this limit for all exposure pathways for airborne emissions.

Dose at the ORNL boundary due to emissions from the Tunnel Confinement Exhaust is 0.008 mrem and dominated by radionuclides in activated concrete dust. The annual dose at the ORNL boundary due to emissions from the Target Building Exhaust is 0.39 mrem and is dominated by H-3 (54 percent) with smaller contributions from C-14, I-125, Hg-203, and

Table 5.2.9.2.1-1. Estimated annual radiological dose from proposed SNS normal emissions at ORNL.[a]

	1-MW Power Level		4-MW Power Level	
Receptor	Target Building[b]	Tunnel Confinement[c]	Target Building[b]	Tunnel Confinement[c]
Maximum Individuals (mrem)				
Off-site Public[d]	0.39	0.008	1.5	0.009
Uninvolved Workers[d]	0.31	0.20	1.2	0.30
Populations (person-rem)				
Off-site Public[e] (879,546 persons)	3.3	0.049	13	0.049
Uninvolved Workers[e] (271 persons)	0.006	0.001	0.023	0.002

[a] Doses shown include the contributions of inhalation, immersion, and “ground shine” for workers and the off-site public and ingestion for the off-site public.
[b] Target Building emissions include hot offgas exhaust, primary confinement exhaust, secondary confinement exhaust from the target building, and activated air from the beam dump buildings.
[c] Tunnel confinement emissions include activated air and concrete dust from the linac tunnel, high-energy beam transport (HEBT) tunnel(s), ring tunnel(s), and ring-to-target beam transport tunnel(s).
[d] The maximally exposed individuals are hypothetical receptors. The member of the public is assumed to occupy a position at the ORR boundary for 8,760 hr/yr and to produce their entire food supply at this location. The maximally exposed uninvolved worker is assumed to occupy a position within 1.2 miles (2 km) of the stack for 2,000 hr/yr.
[e] The off-site population consists of all individuals residing outside the ORR boundary within 50 miles (80 km) of the site and is assumed to be present for 8,760 hr/yr. The uninvolved worker population consists of all workers normally within 1.2 miles (2 km) of the facility. These workers are assumed to be present for 2,000 hr/yr.

Te-121. These radionuclides are listed in order of decreasing dose and account for 99 percent of the annual dose.

To estimate the total potential risk from the proposed SNS emissions of radioactive materials over the entire life of the facility, annual population dose is multiplied by the operating life of the facility and the dose-to-risk conversion factor of 0.0005 LCF/person-rem. For 40 years of operation at 1 MW, 0.07 excess LCF would be projected in the off-site population (3.3 person-rem/yr × 40 years × 0.0005 LCF/ person-rem = 0.07 LCF). For 40 years of operation at 4 MW, 0.3 LCF could be projected (13 person-rem/yr × 40 years × 0.0005 LCF/ person-rem = 0.3 LCF).

The proposed SNS would not operate at a single power level over its entire life, so the projected impact is between the two values indicated. After several years of operation at lower power levels, facilities would be upgraded to operate at 4 MW. If the facility operated for 10 years at 1 MW and 30 years at 4 MW, the projected number of excess LCFs would drop to 0.2. These projections are based on very conservative assumptions regarding pathway exposures and on the assumption that any exposure to radiation, no matter how small, involves some potential risk. Calculated excess

LCFs provide a quantified value of risk to compare alternative actions.

5.2.9.2.2. Toxic Material Emissions

The only toxic material that would be emitted from the proposed SNS during normal operations is elemental mercury vapor. Lead would be used for radiation shielding in the target areas and other areas of the proposed SNS, but it is not volatile at the temperatures to which it would be subjected. Methods used to estimate atmospheric concentrations of toxic material emissions are discussed in Section 5.1.9.

At the annualized mercury release rate of 0.0171 mg/sec and considering historical wind patterns at ORNL, the maximally exposed uninvolved worker (one who is outside and within 2,000 m or 6,500 ft of the SNS) would be exposed to a peak concentration of 3.3 × 10-6 mg/m^3 (1/300,000th of the OSHA limit) and to an 8-hr average concentration of 1.1 × 10-6 mg/m^3 (1/200,000th of the ACGIH limit). On this basis, toxic effects due to mercury exposure would not be expected among workers.

Using the same annual mercury release rate and historical wind patterns, the maximum airborne concentration of mercury at the ORNL boundary is estimated to be 8.7×10^{-9} mg/m^3. This is only 1/800,000th of the EPA RfC applicable to the general public residing in the vicinity of the proposed SNS site. On this basis, toxic effects due to mercury exposure would not be expected among the off-site population.

5.2.9.3 Accident Conditions

This section discusses the impacts on human health of accidents that could potentially occur during operation of the proposed SNS at ORNL. Methods used in the calculation of accident consequences are discussed in Section 5.1.9. Accident consequences are calculated based on the assumption that an accidental release has occurred; the probability that the consequences would actually appear depends on the probability that the accident actually occurs. Probabilities or frequencies of accidents are addressed in Appendix C.

5.2.9.3.1 Accident Scenarios

The accident scenarios and source terms for accidents that could potentially occur at the proposed SNS facility are the same for all alternative sites and are summarized in Table G-2 (refer to Appendix G). The details of these scenarios and source terms are provided in Appendix C. Table 3.2 defines the terminology used to describe the probability or likelihood that a given accident could occur.

5.2.9.3.2 Direct Radiation

The frequencies of occurrence and consequences of accidents involving exposure to direct radiation have not been specifically analyzed by DOE. DOE's Shielding Design Policy for the proposed SNS is such that for the worst-case design-basis accident, the dose to the maximum exposed individual in an uncontrolled area would be limited to 1 rem and for a worker in a controlled area would be limited to 25 rem. The risks of this category of accidents would be the same for all alternative sites.

5.2.9.3.3 Radioactive Materials Accidents

DOE has performed a hazard analysis of potential accidents at the proposed SNS facility; for those that could result in a release of radioactive material, it has estimated source terms. The DOE analysis is included as Appendix C. Accident scenarios, estimated frequencies of occurrence, and source terms are summarized in Table G-2 and are the same for all SNS alternative sites. The methods used to evaluate the consequences of these accidents are discussed in Section 5.1.9 and in more detail in Appendix G. Consequences of accidents vary by alternative due to site-specific weather patterns and population distributions.

Doses for these accidents, should they occur at the proposed SNS facility at ORNL, are listed in Table 5.2.9.3.3-1. Source terms listed in Table 5.2.9.3.3-1 are expressed in terms of percent of the inventory (mass or volume) of material released. With the exception of accident ID 16, source terms expressed in these terms are independent of power level; that is, the accident releases the same mass of the source materials, but at 4-MW operation, the mass has four times as much radioactivity as at 1-MW operation. For accident ID 16, this 4:1 ratio is not maintained; while the radioactivity per gram is still four times as much, the target boiling assumed to occur in the 4-MW accident releases more volume, so that the radioactivity released is greater than four times as much (refer to Exhibit F of Appendix C).

The quantities of radioactive materials that could be released in many of the accidents that could potentially occur at the proposed SNS are so small that the individual worker or member of the public would not be expected to receive a dose of more than 0.001 mrem. This is approximately 1/1,000th of the radiation exposure that the average person in the United States receives from natural background in a single day.

For accidents involving targets or target components, the beyond-design-basis mercury spill (ID 16) would have the greatest calculated doses. Based on the dose-to-risk conversion factor of 0.0005 LCF/person-rem, adverse health effects in the off-site population are estimated at 0.29 excess LCF for the 1-MW accident and 31 excess LCFs for the 4-MW accident. The probability of this accident is categorized as "beyond extremely unlikely" or less than 1/1,000,000 per year.

Two accidents involving the off-gas waste system could result in high consequences. Doses for these two accidents, an "anticipated" valve sequence error for the off-gas decay tank (ID 24) and an "extremely unlikely" failure of the decay tank itself (ID 31), are identical. For the accident at 1-MW operation, the population dose of 290 person-rem corresponds to 0.14 excess LCF. For the accident at 4-MW operation, the dose to the off-site population of 1,100 person-rem corresponds to 0.57 excess LCF. The scenario for ID 24 is "anticipated" due to an accident caused by a human error, but it takes no credit for possible mitigation factors such as administrative procedures that could require independent verification of valve sequences for the tank or a radiation-activated valve on the vent line. Either one would reduce the frequency of ID 24 to "unlikely."

5.2.9.3.4. Hazardous Materials Accidents

The analysis of accidents at the proposed SNS (Appendix C) classifies accidents involving nonradioactive materials as standard industrial accidents and does not estimate source terms for

Table 5.2.9.3.3-1. Radiological dose for SNS accident scenarios at ORNL.

ID	Event	Frequency[b]	Source Term[c]	Maximum Individual (mrem)[a] Off-site Public 1-MW Beam	Maximum Individual (mrem)[a] Off-site Public 4-MW Beam	Maximum Individual (mrem)[a] Uninvolved Workers 1-MW Beam	Maximum Individual (mrem)[a] Uninvolved Workers 4-MW Beam	Population (person-rem)[a] Off-site Public 1-MW Beam	Population (person-rem)[a] Off-site Public 4-MW Beam	Population (person-rem)[a] Uninvolved Workers 1-MW Beam	Population (person-rem)[a] Uninvolved Workers 4-MW Beam
A. Accidents Involving Proposed SNS Target or Target Components											
2	Major Loss of Integrity of Hg Target Vessel or Piping (Appendix C, Section 3.3)	a) Unlikely	Percent Inventory: Mercury 0.142, Iodine 0.142	2.2	8.8	7.9	31.6	81.0	324.0	0.20	0.80
		b) Extremely Unlikely	Percent Inventory: Mercury 0.243, Iodine 100	9.5	38.0	19	76.0	360.0	1,440.0	0.47	1.88
8	Loss of Integrity in Target Component Cooling Loop (Appendix C, Section 3.9)	a) Anticipated	Bounded by annual release limits[d]	<10	<10	NA	NA	NA	NA	NA	NA
		b) Anticipated	Gases + Mist + 150 L of D_2O	0.33	1.32	0.62	2.48	6.1	24.4	0.006	.024
		c) Anticipated	18 L of D_2O	<0.001	<0.001	0.003	0.012	0.016	0.064	<0.001	<0.001
		d) Anticipated	Gases + Mist + 150 L of H_2O	0.20	0.80	0.54	2.16	0.91	3.64	0.004	0.016
16	Beyond-Design-Basis Hg Spill (Appendix C, Section 3.17)	a) Beyond Extremely Unlikely	1 MW Percent Inventory: Mercury 1.11, Iodine 100	16		57		570		1.4	
		b) Beyond Extremely Unlikely	4 MW Percent Inventory: Mercury 1.28, Iodine 100		1,600		1,800		62,000		46

Table 5.2.9.3.3-1. Radiological dose for SNS accident scenarios at ORNL – (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	Event	Frequency[b]	Source Term[c]	1-MW Beam	4-MW Beam	1-MW Beam	4-MW Beam	1-MW Beam	4-MW Beam	1-MW Beam	4-MW Beam
B. Accidents Involving Proposed SNS Waste Systems											
17	Hg Condenser Failure (Appendix C, Section 4.1.1)	Anticipated	13.7 g mercury	0.005	0.02	0.009	0.036	0.16	0.64	<0.001	<0.004
18	Hg Charcoal Absorber Failure [d] (Appendix C, Section 4.1.2)	Unlikely	14.8 g mercury	<0.001	<0.001	0.006	0.024	0.031	0.124	<0.001	<0.001
19	He Circulator Failure (Appendix C, Section 4.2.1)	Anticipated	1 day of tritium production	<0.001	<0.001	<0.001	<0.001	0.003	0.012	<0.001	<0.001
20	Oxidation of Getter Bed (Appendix C, Section 4.2.2)	Unlikely	1 day of tritium production	<0.001	<0.001	<0.001	<0.001	0.003	0.012	<0.001	<0.001
21	Combustion of Getter Bed (Appendix C, Section 4.3.1)	Extremely Unlikely	1 year of tritium production, 200 g depleted uranium	2.9	11.6	2.0	8.0	120	480	0.050	0.20
22	Failure of Cryogenic Charcoal Absorber [e] (Appendix C, Section 4.4.1)	Unlikely	1 day of xenon production	0.089	0.356	0.038	0.152	3.0	12.0	<0.001	<0.001
23	Valve Sequence Error in Tritium Removal System (Appendix C, Section 4.5.1)	Unlikely	1 year of tritium production	2.8	11.2	1.9	7.6	110	440	0.048	0.192
24	Valve Sequence Error in Offgas Decay System (Appendix C, Section 4.5.2)	Anticipated	7 days of xenon accumulation (1 decay tank)	7.3	29.2	4.8	19.2	290	1,160	0.12	0.48

Table 5.2.9.3.3-1. Radiological dose for SNS accident scenarios at ORNL – (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	**Event**	**Frequency[b]**	**Source Term[c]**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**
B. Accidents Involving Proposed SNS Waste Systems (continued)											
25	Spill During Filling Of Tanker Truck For LLLW Storage Tanks (Appendix C, Section 4.5.3)	Anticipated	0.00005% of contents of LLLW tank	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
26	Spray During Filling Of Tanker Truck For LLLW (Appendix C, Section 4.5.4)	Anticipated	1.9 ml of LLLW	0.03	0.12	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
27	Spill During Filling Of Tanker Truck For Process Waste Storage Tanks (Appendix C, Section 4.5.5)	Anticipated	51,100 L process waste to surface water + 57 L to atmosphere	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
28	Spray During Filling Of Tanker Truck For Process Waste (Appendix C, Section 4.5.6)	Anticipated	28.4 L of process waste	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
29	Offgas Treatment Pipe Break (Appendix C, Section 4.6.1)	Unlikely	24 hrs of xenon production	0.96	3.84	0.28	1.12	13	52	0.009	0.036
30	Offgas Compressor Failure (Appendix C, Section 4.6.2)	Unlikely	1 hr of xenon production	0.14	0.56	0.35	1.4	2.0	4.0	0.001	0.004

Table 5.2.9.3.3-1. Radiological dose for SNS accident scenarios at ORNL – (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	**Event**	**Frequency[b]**	**Source Term[c]**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**
	B. Accidents Involving Proposed SNS Waste Systems (continued)										
31	Off-gas Decay Tank Failure (Appendix C, Section 4.6.3)	Extremely Unlikely	7 days of xenon accumulation	7.3	29.2	4.8	19.2	290	1,160	0.12	0.48
32	Offgas Charcoal Filter Failure (Appendix C, Section 4.6.4)	Unlikely	7 days of iodine production	0.048	0.192	0.042	0.168	0.30	1.2	<0.001	<0.001
33	LLLW System Piping Failure (Appendix C, Section 4.6.5)	Unlikely	0.00005% of contents of LLLW tank	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
34	LLLW Storage Tank Failure (Appendix C, Section 4.6.6)	Extremely Unlikely	0.00005% of contents of LLLW tank	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
37	Process Waste Storage Tank Failure (Appendix C, Section 4.6.9)	Extremely Unlikely	57 L to atmosphere	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table 5.2.9.3.3-1. Radiological dose for SNS accident scenarios at ORNL – (continued).

[a] Unless otherwise indicated, radiological doses are based on radiological source terms for a 1-MW power level and would be four times greater if the facility is operating at 4 MW. These doses are total EDEs and include dose from inhalation and immersion. "Off-site" means outside the site boundary rather than outside the proposed SNS facility boundary. Individual receptors are hypothetical and do not correspond to any actual person. Population receptors are based on the actual number of people residing outside the site boundary and within 50 miles (80 km) of the facility and the number of site workers normally within 1.2 miles (2 km) of the facility and not involved in facility operation.

[b] See Table 5.2.9-2 for the numerical ranges associated with accident frequencies categories.

[c] Source terms are expressed in units that are independent of power level. Except for beyond-design-basis accidents (IDs 16a, 16b), the radioactivity released in accidents at 4 MW is four times that released at 1 MW.

[d] Installation of sulfur-impregnated charcoal filters is being considered to serve as a "polishing filter" for the mercury condenser (refer to Event 17).

[e] Cryogenic charcoal absorbers are being considered as an alternative to the offgas compressor, decay storage tanks, and ambient temperature charcoal filters (refer to Events 24, 30, 31, and 32).

NA - Not available.

these accidents. Four accident scenarios involve the release of radioactive mercury: IDs 2a, 2b, 16a, and 16b. Each of these accidents involves relatively high rates of mercury release during the first few minutes of the accident followed by much lower rates of release. The second and third stages of these accidents are conservatively assumed to last from 7 to 30 days. In reality, administrative and emergency response actions would more probably terminate the release in a shorter time period.

Three of these accidents could result in workers being exposed to airborne concentrations of mercury in excess of the OSHA ceiling concentration of 0.1 mg/m^3. The peak concentrations for these accidents are 0.65 mg/m^3 for ID 2b, 0.28 mg/m^3 for ID 16a, and 7.9 mg/m^3 for ID 16b. In all cases, concentrations would fall below the ceiling concentration within minutes after the beginning of the release. OSHA does not specify a time-weighted-average or peak concentration above the ceiling for mercury; however, the ACGIH recommended concentration limit of 0.05 mg/m^3 is an 8-hr averaged concentration.
For only a few minutes at the start of the accident, mercury concentrations at or beyond the site boundary might exceed the temporary emergency exposure limit (TEEL)-1 (0.075 mg/m^3) but would not exceed TEEL-2 (0.10 mg/m^3) described in Appendix G.5.2. Individuals at the boundary at the precise passage of the initial emission might perceive an odor but would not experience or develop irreversible health effects or symptoms that could impair the ability to take protective action.

During the second and third phases of the release, maximum mercury concentrations are two to three orders of magnitude below TEEL-0 of 0.05 mg/m^3. Since maximum concentrations at the ORNL boundary are approximately one-half the maximum concentrations in areas that could be occupied by workers, it is likely that any observable health effects would not occur among workers or the public should any of these accidents occur.

Accident ID 2b is "extremely unlikely," and IDs 16a and 16b are "beyond extremely unlikely." Accordingly, the risk of adverse health effects due to accidental releases of toxic materials from the proposed SNS is very low.

5.2.10 SUPPORT FACILITIES AND INFRASTRUCTURE

This section summarizes the facilities and infrastructure effects to ORNL transportation and utility systems resulting from construction and operation of the proposed SNS project.

5.2.10.1 Transportation

As described in Section 3.2.5, Alternative Sites, construction of the proposed SNS-related infrastructure and support systems would occur at ORNL, located in the vicinity of the City of Oak Ridge, Tennessee. The site would be accessible by numerous state and federal highways and would be serviced on the north by Bear Creek Road and on the south by Bethel Valley Road.

As noted in Section 4.1.10.1, the transportation analysis for the Advanced Neutron Source (ANS) (Blasing et al. 1992) included a detailed transportation analysis that is directly relevant to the proposed SNS action. Evaluated roadways included Bethel Valley Road, State Road (SR)-95, and SR-62.

Construction employee and vehicle activity would increase during the first years of construction of the proposed SNS, peaking in the year 2002, and would decrease significantly during the last year (2004) of construction. The estimated total of 578 construction-related employees in the peak construction year (2002), is expected to add approximately 466 daily round-trips and 10 material/service trucks to the total ORNL site traffic of 6,771 round-trips. This represents a 7 percent increase.

Traffic impacts could include changes in existing vehicle flow, speed, and maneuverability and general congestion because of new vehicles traveling the roadways as a result of construction of the proposed SNS.

Operation of the proposed SNS project would result in an additional 250 resident/visiting scientists by the year 2006, plus another 125 employees during future facility upgrades, such as a second target station. If fully upgraded to the 4-MW power level, 375 employees and 3 service trucks per day would result in approximately 305 daily round-trips, or a 5 percent increase. Traffic effects would occur from the increased volume created by the proposed SNS. Traffic effects could include changes in existing vehicle flow, speed, and maneuverability and general congestion as a result of the comparatively high amount of new vehicles traveling the roadways.

Table 5.2.10.1-1 compares the No-Action Alternative with the proposed action at the Oak Ridge site. The table provides the percent increase in traffic resulting from the proposed SNS during construction and operation, as compared to the No-Action Alternative. The effect on traffic on the ORR is expected to be minimal. These potential effects could be reduced by having craft and non-craft workers report to work at different times, thus reducing the adverse effects on traffic flow during rush hours. Additionally, this analysis assumed there would be no transferring of personnel from within ORNL. If some of the workers were previously working at ORNL, the impact on traffic would be reduced.

5.2.10.2 Utilities

Effects from meeting the proposed SNS utility requirements would be limited to extending the existing site services to the Chestnut Ridge area. Substantial upgrades or construction of new facilities would not be required. Modifications to existing electrical, steam, natural gas, water, and sewage treatment are discussed in the subsections below.

5.2.10.2.1 Electrical Service

As described in Section 4.1.10.2.1, two existing 161-kV transmission lines terminate into a substation approximately 6,000 ft (1800 m) west of the proposed site. TVA has adequate capacity to supply the 90 MW of electrical power required for the 4-MW SNS via the existing 161-kV transmission line (Schubert 1997).

A new 161-kV transmission line would be constructed from the existing transmission line, approximately 3,000 ft (914 m) west of the proposed site, to a new substation to be located on the SNS site. Construction effects would be limited to minor excavation for the transmission line poles, and a minor amount of clearing and excavation for electrical equipment pads at the proposed SNS. No upgrades to the existing site service are expected. Environmental effects from constructing a new transmission line to the proposed SNS are expected to be negligible.

Table 5.2.10.1-1. ORNL traffic increases compared to No-Action Alternative.

	Baseline/ No-Action	(Peak Year) SNS Construction	(4-MW) SNS Operation
Passenger vehicle trips[a]/day	6295	466	302
Material transport trucks/day	0	7	0
Service trucks/day	0	3	3
Total (% increase)	0 (0%)	476 (7%)	305 (5%)

[a]Based on 7810 ORNL employees (Blasing et al. 1992)

5.2.10.2.2 Steam

The current design calls for steam to be produced at the proposed SNS facility using natural-gas-fired boilers (refer to Section 5.2.10.2.3). However, steam requirements during operation of the proposed SNS could be satisfied by the existing on-site steam service. ORNL has the capacity to service the proposed SNS without upgrading the steam plant. The available capacity of the existing on-site steam is sufficient to accommodate any demand for steam that the proposed SNS may require. As described in Section 4.1.10.2.2, the closest tie in point is an existing 8-in. (20.3-cm) steam line located between the 6000 and 7000 Areas. To service the proposed SNS facility, this line would be extended approximately 1.5 to 2 miles (2.4 to 3.2 km) to the proposed SNS facility. Environmental effects from constructing a new steam line to the proposed SNS are expected to be negligible. A final decision on the steam supply would be made during Title 1 design and would take into account environmental effects as well as cost.

5.2.10.2.3 Natural Gas

Natural gas would provide energy for operational functions in the proposed SNS, such as fuel for the boilers and localized unit heaters in the facility heating system. East Tennessee Natural Gas (ETNG) has indicated that the current 22-in. (55.9-cm) gas main has adequate capacity for proposed SNS operational requirements.

As described in Section 4.1.10.2.3, the distribution header is approximately 1 mile (1.6 km) from the proposed SNS site. Based on current design plans, approximately 5,000 ft (1,524 m) of new natural gas pipeline would be required to service the proposed SNS facility. Current plans would route the pipeline extension along Chestnut Ridge Road, the main access road, to the proposed SNS facility. This would encroach on 0.12 acres of wetlands (see Section 5.2.5.2).

5.2.10.2.4 Water Service

The proposed SNS would require water supplies for the following systems: tower water cooling, deionized cooling, chilled water, building heating, process water, potable water, demineralized water, fire suppression, and target moderators. Based on the operational needs of the proposed SNS facility, ORNL's water distribution system is considered adequate and has available capacity to serve the proposed SNS facility.

As described in Section 4.1.10.2.4, the existing water service is located adjacent to the southern and eastern edge of the proposed SNS site. However, there are no water lines on-site. Environmental effects from constructing a new water line to the proposed SNS are expected to be negligible.

5.2.10.2.5 Sanitary Waste Treatment

The existing sewage treatment plant (STP) at ORNL has adequate capacity for demands of the proposed SNS. Approximately 100,000 gpd (378,540 lpd) of sewage treatment capacity is available at the STP. Operation of the proposed SNS would generate approximately 12,500 gpd (47,318 lpd) at the 1-MW facility and 18,150 gpd (68,705 lpd) at the 4-MW facility.

The proposed SNS sewage system would tie into the existing sewage system at a point west of the 6000 Area and approximately 1 mile (1.6 km) from the site. This is a gravity system with an 8-in. (20.3-cm) line. Environmental effects from constructing a new sewer line to the proposed SNS are expected to be negligible.

5.2.11 WASTE MANAGEMENT

All of the wastes generated during construction and operation of the proposed SNS would be transferred to ORNL for processing. The existing waste management systems, either at ORNL or at other facilities on the ORR, have sufficient capacity to accommodate the proposed SNS waste streams. Additionally, standard DOE practice has been to dispose of hazardous waste at off-site, DOE-approved licensed commercial facilities. Therefore, DOE anticipates only minimal effects on the environment from waste management activities associated with the SNS..

The proposed SNS facility construction/ operations projection of waste streams includes the following: hazardous waste, low-level waste (LLW), mixed waste, and sanitary/industrial waste, as listed in Table 3.2.3.7. A summary of existing waste management facilities located at ORNL, along with facility design and/or permitted capacities and remaining capacities available, can be found in Table 5.2.11-1. The projected waste stream forecast for ORNL's individual operations, proposed SNS operations at 4 MW, and the projected combination of the aforementioned wastes, as well as potential effects, are also included in Table 5.2.11-1. Forecasts are projected from 1998 to 2040, unless otherwise noted, and they are based on estimates received from waste management facility contacts and waste management documentation.

The current waste management activities at ORR include the treatment and storage of LLMW on site, and the treatment and disposal of LLW on site. Under the preferred alternatives in the Waste Management PEIS (DOE 1997a), ORR is one of six candidate sites for regional disposal of LLW and LLMW. DOE will choose two or three regional disposal sites from the six candidate sites. These sites are those at which DOE already has established LLW disposal operations and has large waste volumes for disposal. The ORR, along with the other sites, would have more than adequate capacity for the amounts of LLW that DOE will need to dispose. Based on DOE's analysis in the Waste Management PEIS, it is anticipated that the ORR has sufficient capacity to meet the LLW streams for the proposed SNS.

The Tennessee Department of Environment and Conservation (TDEC) may, in the future, regulate the management of radioactive products and wastes produced by accelerator facilities. If the ORNL site is selected for construction of the SNS, DOE would consult with the State of Tennessee and implement procedures to comply with all applicable regulations.

As shown in Table 5.2.11-1, ORNL does have the capability to store hazardous wastes; however, there are no hazardous waste treatment or disposal facilities at ORNL. DOE is phasing out the use of on-site hazardous waste [Resource Conservation and Recovery Act (RCRA)-permitted] storage facilities. Hazardous wastes will be collected and transferred to facilities at East Tennessee Technology Park (ETTP) or DOE-approved licensed commercial facilities. Oil acceptable for off-site recycling is accumulated on-site prior to transporting to an off-site facility (ESWMO 1995).

ORNL's solid LLW that meets GTS Duratek WAC is shipped directly to them for three volume reduction treatments including incineration, compaction, and smelting. LLW that cannot be sent to GTS Duratek is grouted at Solid Waste Storage Area (SWSA) 6, temporarily stored, and then transported to an off-site, DOE-approved licensed commercial disposal facility.

Presently, no facilities specifically designed for the disposal of mixed wastes are located at ORNL. Mixed wastes are temporarily stored on the ORR then transported to an off-site, DOE-approved licensed commercial disposal facility. Liquid mixed wastes that meet the WAC of the LLLW treatment facility or the process waste treatment facility can be treated at ORNL.

ORNL has a waste certification process in place to assure that wastes meet the WACs for LLW disposal. However, because of the uncertainty of the composition of LLW and mixed wastes that may be generated from operation of the SNS, the waste may not meet the current WAC for waste management facilities at ORNL. DOE would take action to assure the proper disposition of these wastes. For example, pretreatment of the wastes may assure they meet the WAC. DOE may be able to amend the license at current waste disposal facilities to allow acceptance of wastes from the SNS.

Solid sanitary/industrial wastes from ORNL are disposed of at Sanitary Landfill II, Industrial Landfill V, and Construction Disposal Landfill VI, located on Chestnut Ridge. ORNL solid sanitary waste projections indicate that a total of 7,645 m^3/yr of solid sanitary/industrial and construction/demolition wastes will be generated for the next 40 years. As listed in Table 3.2.3.7-1, the proposed SNS operations would add an additional 1,349 m^3/yr over the next 40 years to the ORNL solid sanitary/ industrial waste stream. Wastes must meet appropriate WAC before being transported for disposal (ESWMO 1995; DeVore 1998d).

Soil, construction, and sanitary wastes would be generated during the construction phase of the proposed SNS facility. Excavated soil and rock would be utilized, when applicable, for backfill, erosion control, or other environmental purposes. Construction debris would be sent to a Class IV landfill. Liquid sanitary wastes would be transported to the site sanitary wastewater treatment plant for disposal, and solid sanitary wastes would be sent to a sanitary landfill (ORNL 1997b).

To minimize the production of waste streams from the proposed SNS facility and to comply with the Pollution Prevention Act of 1990, along with other federal pollution prevention

Table 5.2.11-1. ORNL waste management facility description and capacities.

Waste Disposition	Waste Type and Facility	Total Design Capacity for ORNL Site	ORNL Waste Projections for 1998-2040	Total Remaining Capacity for ORNL Site (Excludes Proposed SNS Operations)	Proposed SNS Waste Operations Projection for 1998-2040	Potential Effect of Waste Management on the Environment
HAZARDOUS WASTE						
STORAGE	Drummed Liquid and Solids 7507, 7651, 7652, 7653	139 m³	160 m^3/yr	No long-term storage	Hazardous Liquid 40 m^3/yr	Minimal effects anticipated. Standard DOE practice has been to dispose of waste at off-site, DOE-approved, licensed commercial facilities.
LOW-LEVEL WASTE						
TREATMENT	Liquid a) LLLW Evaporator Facility b) Process Waste Treatment Plant (PWTP) c) Nonradiological Wastewater Treatment Plant	a) LLW Evaporator 2.63E06 gal/yr capacity b) PWTP - 350 gpm c) 760 gpm	a) LLW Evaporator- 500,000 gal/yr b) Process waste 140 gpm (0.74E08 gal/yr) c) 320 gpm (1.68E08 gal/yr)	a) LLW Evaporator- 2.13E06 gal/yr b) Process wastes - 210 gpm (1.1E08 gal/yr) c) 440 gpm (2.3E08 gal/yr)	a) LLW Evaporator 175,600 gal/yr b) 4.15E06 gal/yr potentially LLW c) 4.3E06 gal/yr	a) No effect anticipated. b) No effect anticipated. c) No effect anticipated.
	Solid None					
STORAGE	Liquid None					
	Solid Buildings 7823B, 7823C, 7823E, 7827, 7878A	NA	Solid 2,520 m³/yr	Limited	Solid 1,026 m³/yr	Limited storage available. Long-term storage is not necessary. DOE has contracts in place to dispose of LLW at off-site, DOE-approved licensed commercial facilities.

Table 5.2.11-1. ORNL waste management facility description and capacities (continued).

Waste Disposition	Waste Type and Facility	Total Design Capacity for ORNL Site	ORNL Waste Projections for 1998-2040	Total Remaining Capacity for ORNL Site (Excludes Proposed SNS Operations)	Proposed SNS Waste Operations Projection for 1998-2040	Potential Effect of Waste Management on the Environment
MIXED WASTE						
STORAGE	Solid/ Liquids 7654, 7507W, 7830a, 7823	Maximum storage is 300 drums.	Liquid 55 drums/yr Solid 45 drums/yr	NA	Liquid 50 drums/yr Solid 35 drums/yr	Minimal effects anticipated. Standard DOE practice has been to dispose of waste at off-site, DOE-approved, licensed commercial facilities.
SANITARY WASTE						
TREATMENT	Liquid Waste Water Treatment Facility	300,000 gpd	240,000 gpd	60,000 gpd	18,000 gpd	No effect anticipated.
	Solid None					
DISPOSAL	Solid ORR Landfills	1.45E6 m^3	7,645 m^3/yr	1.09E6 m^3	1,350 m^3/yr	No effect anticipated.

NA - Not applicable.
Sources: Martin Marietta Energy Systems, Inc. 1994; Parrott et al. 1991; DeVore 1998a; 1998b; 1998c; 1998d; 1998e; 1998f; and 1998g.

regulations, the SNS conceptional design team developed the *NSNS Waste Minimization and Pollution Prevention Plan NSNS/97-5*. This written plan includes use of the Pollution Prevention Electronic Design Guideline (P2-Edge) software database. The P2-Edge software allows for assessment and identification of pollution prevention opportunities, evaluation of their cost, and selection of appropriate opportunities for implementation. An example of categories and considerations included in the P2-Edge software package can be found in Attachment 1 of the *NSNS Waste Minimization and Pollution Prevention Plan* (ORNL 1997a, LMES 1997).

5.3 LOS ALAMOS NATIONAL LABORATORY

This section describes the potential environmental effects or changes that would be expected to occur at LANL if the proposed action were to be implemented. Included in the discussion of this section are effects on the physical environment; ecological and biological resources; the existing social and demographic environment; cultural, land, and infrastructure resources; and human health.

5.3.1 GEOLOGY AND SOILS

Effects on geology and soils from construction and operation of the SNS on the proposed LANL site are described in this section.

5.3.1.1 Site Stability

The proposed SNS site at LANL is situated on a high mesa with a thin, unsaturated soil horizon overlying competent bedrock. Rockfalls from steep canyon ledges could be a potential problem if the proposed SNS is located near the edge of the mesa. However, the proposed setback from the mesa rim is sufficient to ensure that rockfalls or landslides are not a problem. Because of the nature of the soils and bedrock at this proposed site, neither soil liquefaction nor subsidence is considered likely. Construction and operation of the proposed SNS at Technical Area (TA)-70 would not be affected by site stability problems.

5.3.1.2 Seismic Risk

A LANL seismic hazards study indicates that the Pajarito fault system provides the greatest potential seismic risk with an estimated maximum earthquake magnitude of about seven. The PGAs for an earthquake at eight technical areas within LANL (not including TA-70) were calculated, and the maximum results among those areas were 0.15 gravity for a 500-year return period; 0.22 gravity for a 1,000-year return period; 0.31 gravity for a 2,000-year return period; and 0.57 gravity for a 10,000-year return period. Proximity to the three main faults of the Pajarito system increases the potential for higher ground acceleration during earthquakes (other factors being equal). While a site-specific seismicity study has not been conducted for TA-70, it is the location within the LANL reservation farthest from the surface expression of documented faults. PGA estimates for the proposed SNS location (TA-70) would be less than the maximum predictions for the other technical areas.

Components of the proposed SNS facility would be built at LANL to the DOE Standard 1020-94 (DOE 1996a) and would be capable of withstanding maximum horizontal ground accelerations in the range of 0.10 to 0.14 for a 500-year return period; 0.14 to 0.19 for a 1,000 year-return period, 0.17 to 0.25 for a 2,000-year return period; and 0.31 to 0.43 for a 10,000-year return period. The beam for the proposed SNS would be designed to immediately shut down in the event of an earthquake. Predictable seismicity for the TA-70 site would have no effect on the construction, operation, or retirement of the proposed SNS.

5.3.1.3 Soils

Excavation required for construction of the proposed SNS would disturb the native soils. Excavated soils would be stockpiled according to soil types and horizon. If the excavated soils possess the proper characteristics, they would be used to construct the shielding berm. Otherwise the soils would be placed in the spoils area (refer to Section 3.2.5.3). Top soil removed during excavation would be used for grading and landscaping of the site at the finish of construction.

Construction of the SNS would require removal grading of the site and removal of vegetative cover. As a result the potential exists for soil erosion and stream siltation especially during periodic storm events. Best management practices would be followed to minimize the impacts of erosion during construction activities. Section 3.2.2.3, Site Preparation, discusses the elements (retention basin, silt fences, temporary storm water drainages, etc.) that would follow an erosion control.

Although limited borrow materials are available within LANL, the Los Alamos County Landfill could supply additional soil for the berm. The material use for the proposed SNS would not affect the local supply for other uses.

Operation of the proposed SNS at LANL would activate soils adjacent to the linac tunnel (refer to Section 5.2.1.3). Site-specific calculations of nuclide concentrations and transport potential have not been performed for LANL. In general, however, groundwater at LANL is not very susceptible to contamination for two reasons. Soils and bedrock aquifers in the LANL region are derived from volcanic materials that exhibit a mineralogical composition that retards nuclide transport. The depth to the main bedrock aquifer is much greater than at ORNL (refer to Section 5.3.2.3). This combination of factors indicates that potential exposure effects would be the same or less than those at ORNL, which are predicted to be minimal.

No prime or unique farmlands are present on or in the vicinity of the proposed SNS site at LANL. As a result, the proposed action would have no effects on prime or unique farmlands.

5.3.2 WATER RESOURCES

The effects on water resources from construction and operation of the proposed SNS on the Pajarito Mesa site in TA-70 at LANL are described in the following sections. Best management practices would be employed to minimize any effects on surface water due to erosion and siltation during construction (see Section 5.2.1.3).

5.3.2.1 Surface Water

No surface water would be used to support construction or operation of the proposed SNS; therefore, there would be no effects on surface water supplies.

Conventional cooling tower blowdown for the proposed SNS would be released into surface drainages at TA-70. Continuous releases would occur at a rate of 250 gpm (946 lpm) for a 2-MW facility and 350 gpm (1,325 lpm) for a 4-MW facility. Surface water drainages in this area exhibit only intermittent flow. Flow volume attributable to blowdown would range between 0.36 to 0.50 mgpd (1.4 to 1.9 million lpd). The nearest perennial stream is the Rio Grande River approximately 1 to 2 miles (1.6 to 3.2 km) away. A significant portion, if not all, of the cooling tower blowdown would be dispersed by infiltration and evapotranspiration before it would reach the Rio Grande.

At the site, cooling tower blowdown would be temporarily held in a retention basin before release to the surface drainages. At the conceptual design stage, the size of the retention basin required is estimated at approximately 2 acres (0.81 ha). This basin would be designed to allow sufficient residence time for the discharge to cool to ambient temperatures. If necessary, active cooling systems such as recirculating fountains would be employed.

Polyphosphonates for antiscaling and ozone as a biocide would be used in the cooling towers. Discharge from the towers would be regulated to contain about four times the dissolved solids content of potable water (i.e., 1,000 to 1,200 mmhos conductivity). Contributions of solids or chemical agents are not anticipated to significantly effect the stream. Releases from the basin would be regulated under an NPDES permit that defines water quality parameters.

Effects on surface waters at TA-70 would result in sustained flow that is currently intermittent, thereby providing additional recharge to the groundwater and supporting limited flora and fauna in the drainage channels. It is not expected that the amount of infiltration from the limited discharge would impact perched water tables at depth or the occurrence of springs along the canyon walls.

5.3.2.2 Flood Potential and Floodplain Activities

The proposed SNS site at LANL does not lie within a floodplain or designated flood fringe area. Therefore, no flood potential exists. Seasonal storm events may cause localized flooding along the Pajarito Plateau and portions of the proposed SNS site when man-made storm drains and natural drainage exceed capacity. This result would be infrequent and temporary.

5.3.2.3 Groundwater

The main aquifer beneath LANL is the primary source of water for LANL and surrounding communities. Demands ranging from 800 to 1,600 gpm (3,028 lpm to 6,057 lpm) would be required to support the proposed SNS facility that may be upgraded from 1 MW to 4 MW. If, for example, one-half of the maximum water usage for a 4-MW facility would be the continuous daily demand for facility operations, then production from the main aquifer must increase by more than 25 percent. Sustained pumping at this magnitude could create a cone of depression that would lower water levels in nearby wells and ultimately affect the long-term productivity from the main aquifer (if withdrawal rates exceed recharge). Historic water level measurements in the main aquifer wells in the LANL region have indicated water level declines due to pumping and natural discharges exceeding recharge and inflow (DOE-AL, 1998). However, the drawdown is not considered to be a major depletion. Mitigation measures to reduce the drawdown of the aquifer, including the possible construction of a dry cooling tower to recycle process water used at the site, can be undertaken if LANL is selected for site construction. DOE would include details of the mitigation measures in the MAP (refer to Section 1.4). However, based on the aforementioned historic studies that indicate water declines, some decline in the groundwater level from SNS operations may be inevitable, although the decline is not expected to impact the available municipal water supply. Future water demands of the proposed SNS would be in direct competition with future growth demands from commercial and residential users. Approximately half of the water required for the cooling towers would be released to the atmosphere, mostly in the form of water vapor. The other half, approximately 250 to 350 gpm, would be released as cooling tower blowdown to the retention basin. The rate at which the water would be released from the retention basin at the discharge point has not been determined; however, it would likely be less than 250 gpm. The discharge rate from the retention basin could be controlled to prevent large-scale surface water runoff during storm events. Accordingly, DOE believes that the water would infiltrate the ground before reaching the Rio Grande. If the LANL site is selected in the Record of Decision (ROD) for construction of the SNS, DOE would implement appropriate treatment, if necessary, to assure that all water discharge meets the requirements of the New Mexico Cold Water Fishery Standards.

Operation of the proposed SNS would affect the soil adjacent to the linac tunnel. This soil would act as a radiological source available for leaching and transport of nuclides via the groundwater system. Calculations for LANL have not been performed; however, characteristics of the groundwater system at LANL would make this site less susceptible than ORNL to effects on the groundwater from radionuclide contamination. The vadose zone is about 820 ft (250 m) thick at LANL, providing a much longer pathway for nuclides to reach the main aquifer. In addition, the vertical migration rate at LANL would be less due to reduced groundwater infiltration (approximately 5 cm/yr compared to 38 cm/yr at ORNL). The additional time would allow for greater radioactive decay and would result in less nuclide concentrations in the groundwater. Relative to ORNL (which has been shown to have minimal potential for concern), it is less likely that these activation products would be transported to off-site receptors at levels of concern. Effects causing groundwater contamination are considered minimal for LANL.

5.3.3 CLIMATOLOGY AND AIR QUALITY

Effects on the climate and air quality from construction and operation of the proposed SNS in TA-70 at LANL are described in the following sections.

5.3.3.1 Climatology

Construction and operation of the proposed SNS would not affect regional or localized climates within the LANL area.

5.3.3.2 Air Quality

Impacts on nonradiological air quality are presented in this section. Airborne radiological releases are evaluated under human health impacts (Section 5.3.9). Construction activities would create temporary effects in regard to particulate matter (PM_{10}) measurements during the construction phase of the project. These effects would be greatest during early clearing and excavation efforts but would decrease within a relatively short time period. While no formal estimates of suspended particulate matter have been prepared, this level is predicted to be minimal when weighted over the usual 24-hr averaging period. Moreover, the proposed SNS site is located several miles from residential inhabitants in a remote section of LANL.

The primary nonradiological airborne release during operations at the proposed SNS would be combustion products from the use of natural gas. Currently, natural gas is not available at TA-70; pipeline construction would be necessary to extend service into this area. The primary nonradiological airborne release during operations at the proposed SNS would be combustion products from the use of natural gas. Peak usage of natural gas would be during the winter months at an approximate rate of 1,447 lb/hr (4-MW scenario). Emission rates related to the maximum period of natural gas usage are listed in Table 5.2.3.2-1.

Ambient effects from natural gas usage can be projected with the Screen 3 model as in Section 5.2.3.2. However, since this location is relatively flat (unlike the Oak Ridge location), zero terrain height is used. The results of this modeling are shown in Table 5.3.3.2-1. Adding maximum background concentrations to maximum projected effects from the proposed SNS sources (a very conservative procedure since the two do not occur at the same location or time) does not provide any violations of the NAAQS.

5.3.4 NOISE

Construction and operation of the proposed SNS at LANL would slightly elevate ambient noise levels. Sensitive receptors (except for native wildlife) are not present at this remote location. Any noise effects on wildlife would be temporary; habitualized wildlife behavior

Table 5.3.3.2-1. Impact of natural gas combustion at the proposed SNS.

NAAQS Compound	Period[a]	Estimate (μg/m³) at 984 ft (300 m)	Maximum Concentration[b]	Assumed Background (μg/m³) (Table 4.2.3.3-1)	Background + 300-m Location (μg/m³)	NAAQS Limits (μg/m³)
Sulfur dioxide (SO_2)	Annual[c]	0.03	0.05	7.4	7.4	80
	24-hr	0.30	0.60	26.6	26.9	365
	3-hr	0.70	1.40	108.9	109.6	1,300
Carbon monoxide (CO)	8-hr	21	40	2,672	2,693	10,000
	1-hr	30	57	8,365	8,395	40,000
Nitrogen dioxide (NO_2)[d]	Annual[c]	5.0	9.0	5.7	10.7	100
Particulate (PM_{10})	Annual[c]	0.60	1.10	9.0	9.6	50
	24-hr	6.80	13.30	29.0	35.8	150

[a] Factors used to convert from 1-hr averages to long periods taken from EPA 1977.
[b] Concentration at 984-ft (300-m) estimated boundary and maximum concentration [occurring at 174 ft (53 m)] estimated by EPA – Screen 3 Model (v. 96043). Maximum concentration location is expected to be "on-site."
[c] Annual concentrations reflect 33% estimated (conservative) annual usage factor.
[d] Estimated concentration in this table includes all NO_x compounds and not only NO_2 for NAAQS.

patterns would be re-established in short duration.

Five 200-kW diesel backup generators would be tested for short durations several times a year. Periodic discharges from these generator testings would not affect overall air quality, and effects on air quality from the construction or operation of the proposed SNS would be negligible.

5.3.5 ECOLOGICAL RESOURCES

This section describes the potential effects that the proposed SNS would have on ecological resources at LANL.

5.3.5.1 Terrestrial Resources

Construction of the proposed SNS in TA-70 would result in the clearing of vegetation from 110 acres (45 ha) of land dominated by piñon-juniper woodlands and scattered juniper savannas. This clearing represents approximately 10 percent of the land area within TA-70. Implementation of erosion control measures and revegetation of disturbed areas would minimize soil erosion during construction.

Rocky Mountain elk use piñon-juniper woodlands for wintering habitat, and some year-round use of these areas by elk has been documented. However, because 90 percent of the land in TA-70 would remain undeveloped after construction of the proposed SNS, minimal impacts on the movements of elk or other wildlife across this area would be expected from implementation of the proposed action. Losing 10 percent of the piñon-juniper habitat in TA-70 would not be expected to affect bird populations that use the area for roosting, feeding, and reproduction.

Clearing operations for construction of the SNS may cause the direct loss of small animals. Also, wildlife would be displaced from cleared areas and the surrounding habitat. Large mammals would be mostly excluded from controlled areas by access control fences.

Construction and operation activities and the associated noise and human presence would disturb wildlife occupying areas adjacent to the proposed site. This could result in emigration of some sensitive species from the surrounding area, although many of the species would adjust to the disturbance. To help minimize disturbance to wildlife, construction machinery would be kept in proper operating condition and workers would be prevented from entering undisturbed areas delineated before construction.

The proposed SNS would operate on land where natural features will have been largely removed or altered by construction activities. Consequently, the proposed SNS operations would have a minimal effect on terrestrial resources at this location and in immediately adjacent areas.

5.3.5.2 Wetlands

Construction and operation of the proposed SNS would not be expected to affect wetlands since these resources are not located on or near the proposed site. Cooling tower blowdown released to an arid land drainage feature would not reach the intermittent riverine wetlands associated with the arroyos in Ancho Canyon or the unnamed canyon to the northeast, except possibly in the case of a heavy rain event.

Overland runoff would be mitigated by the approximately 2-acre (0.81-ha) SNS retention basin. Consequently, the proposed action would have a minimal effect on wetland areas.

5.3.5.3 Aquatic Resources

Construction and operation of the proposed SNS would not be expected to affect aquatic resources since these resources are not located on or near the proposed site. All aqueous discharges from the proposed SNS would be directed to the retention basin. A water outflow from the basin of up to 350 gpm (1,325 lpm) would empty into dryland drainage. This discharge would not be expected to reach the Rio Grande River.

5.3.5.4 Threatened and Endangered Species

Construction of the proposed SNS would reduce the foraging habitat for the American peregrine falcon and the foraging and roosting habitat for the bald eagle in TA-70 by approximately 10 percent. The nearest identified peregrine falcon nesting habitat is in White Rock Canyon, approximately 1.2 miles (1.9 km) from the proposed SNS site. The area surrounding the site would not be extensively used by peregrine falcons (Johnson 1985). The bald eagle uses White Rock Canyon and connecting canyons for foraging and roosting. Also, this species may use White Rock Canyon as a migration route.

These small reductions in nonnesting habitat would result in permanent, but minimal effects on the peregrine falcon and bald eagle.

A systematic survey of the potential habitat areas for protected species would be conducted prior to the start of land clearing and construction on the proposed SNS site. Because definitive identification of many protected plants can only be made when the plant is flowering, this survey would extend over the spring, summer, and fall seasons to maximize the probability of finding them. If found, appropriate mitigation measures would be taken to protect these species during construction and operation of the proposed SNS. DOE would include details of the mitigation measures in the MAP (refer to Section 1.4).

5.3.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The socioeconomic impact section identifies whether construction and operation of the proposed project (and associated worker in-migration from outside the ROI) may adversely affect regional services and infrastructure. It also presents an estimate of the financial effects (employment, income, taxes, and economic output) that would be generated locally in the form of worker salaries, indirect effects, and induced effects. Unless otherwise noted, economic effects are described in escalated-year dollars.

The ROI associated with the LANL site includes Los Alamos, Rio Arriba, and Santa Fe Counties in New Mexico. This 7,800-mi^2 (20,202-km^2) region was selected because it forms the area within which at least 90 percent of Los Alamos workers currently reside. It is, therefore, the region within which the majority of socioeconomic impacts are expected to occur. Socioeconomic effects beyond the ROI are generally expected to be minor.

The total local construction cost is estimated to be approximately $332 million (escalated dollars), and the peak construction year would be 2002, when 578 workers would be on-site (Brown 1998a). Of this total, about three-fourths (433 individuals) would likely be hired from the local area, and 144 would come from outside the ROI. An approximate average of 300 workers per year would be on-site, including all construction, management, and engineering design personnel and other technical and commissioning staff. Construction of the 1-MW SNS is the bounding case for analysis of construction effects. If the SNS is upgraded to 4 MW, additional construction would occur, but this would be much less than the effects associated with the initial construction of the 1-MW SNS.

Operations of the proposed SNS at 1 MW would begin in the year 2006 with a staff of 250 persons. Later, if the proposed SNS is upgraded to 4 MW, 375 persons would be employed. The 4-MW case is used for this analysis as the bounding case, and the effects of the proposed 1-MW SNS on the ROI would be similar but slightly less than the 4-MW case.

5.3.6.1 Demographic Characteristics

It is assumed that approximately 75 percent of all construction workers would come from the local area (Brown 1998a). Most of the construction workers would be general craft laborers, and the specialized technical components would be contracted out and fabricated in places not yet known. All locally hired construction workers would commute to the job site from existing residences and would not relocate closer to the site. The experience with other past major construction projects is that most in-migrating workers would temporarily move to the project area but would usually commute home on weekends or periodically. These individuals would generally not bring families to the local area for the construction period. However, even if all of the in-migrating workers brought families into the area, the total (temporary) population increase would be less than 500 persons in the peak year, including spouses and children. This would be a temporary increase in population of about 0.02 percent and is, therefore, negligible.

People with the technical expertise needed to operate the proposed SNS currently reside in the ROI. However, it is also expected that some plant operators would come from outside the local region. It is assumed that about half of the 375-person operating (for the bounding 4-MW case) workforce would come from outside the area. It is further assumed that these households would be the same size as the national average because it is not known from where they would in-migrate. It is conservatively estimated that in 2006 the total population increase associated with operations would be about 600 individuals, including spouses and children. The facility operators would be “permanent” residents of the ROI, and little additional in-migration would occur in subsequent years. The population increase associated with construction and operations would represent about 0.03 percent of the local population and is, therefore, negligible.

5.3.6.2 Housing

With about 6,900 vacant “dwelling units” (refer to Section 4.2.6.2) in the three-county ROI, workers should easily be able to find apartments to rent or houses to purchase. Some new houses would probably be constructed. However, existing vacancies and historic construction rates indicate that housing would be available to accommodate this small in-migration.

5.3.6.3 Infrastructure

Potential impacts on infrastructure are closely tied to population growth. Because the expected permanent in-migration is only 600 individuals, effects upon infrastructure would be relatively minor.

Nearly 29,000 students reside in the area. The addition of less than 300 children to the ROI would, therefore, be minor. Even if all 300 children attended schools in Los Alamos County, the current teacher-student ratio of 1:15 would be unchanged. Effects would also be minor for police and fire protection, health care, and other services.

5.3.6.4 Local Economy

Design of the proposed SNS would begin in 1999, and the first construction managers and workers would begin work in FY 2000. The majority of the construction would occur from FY 2001 through FY 2004, with the peak construction employment occurring in FY 2002. Testing of the proposed SNS would be from FY 2003 through FY 2005. Operations are planned to begin by the end of FY 2005; FY 2006 would be the first full year of operations (see Figure 3.2.2-1).

Table 5.3.6.4-1 presents the results of the IMPLAN modeling for the period 1999 through 2006. Economic benefits in the form of jobs, wages, business taxes, and income would begin to accrue during the first year of the project in FY 1999. These economic benefits in the ROI would increase as construction and other associated project activities increase. Design and construction employment would be highest in FY 2002, and there would be an estimated 1,447 total (direct, indirect, and induced) new jobs created at LANL. This trend would begin to diminish in FY 2003 as design and construction employment decreased and would continue to decrease until construction is completed in FY 2004. Facility operations would begin in FY 2005. Operations would reflect substantial regional spending for operator salaries, supplies, utilities, and administrative costs.

The proposed SNS is planned to operate for 40 years. If the level of operation is the same as the 4-MW case measured in the first full year (FY 2006), it is estimated that facility operation would continue to support 1,486 jobs for each of the following years of operation. Other annual operations effects would include $66.8 million in local wages, $7.6 million in business taxes, $71.4 million in personal income, and $171.6 million in total output.

Construction of the facility would create new jobs and may potentially result in the region’s unemployment rate dropping from 6.6 percent to 5.8 percent. During operations, the unemployment rate may decrease further, depending on whether construction workers and engineers (unemployed following project completion) stay in the ROI. The effects of operating the proposed 1-MW SNS would be similar but slightly lower.

5.3.6.5 Environmental Justice

As identified in Figures 4.2.6.5-1 and 4.2.6.5-2, minority populations and low-income populations reside within 50 miles (80 km) of the proposed SNS site. The minority populations living around the proposed site are mostly Native American and Hispanic. For environmental justice impacts to occur, there must be high and adverse human health or environmental impacts that disproportionately affect minority populations or low-income populations.

Table 5.3.6.4-1. LANL IMPLAN modeling results—construction and operations impacts.

	1999	2000	2001	2002	2003	2004	2005	2006
Employment								
Direct	92	195	448	531	369	245	34	640
Indirect	82	147	353	441	317	217	30	288
Induced	87	161	384	476	340	232	32	558
Total	261	503	1,185	1,447	1,026	694	95	1,486
Wages								
Direct	$6,610,816	$12,470,472	$30,283,823	$38,259,362	$27,888,348	$19,401,919	$2,716,178	$44,814,575
Indirect	$2,035,776	$3,730,568	$9,121,179	$11,624,370	$8,516,543	$5,954,408	$833,978	$8,781,731
Induced	$1,826,780	$3,430,981	$8,318,759	$10,493,959	$7,636,286	$5,303,408	$741,161	$13,209,288
Total	$10,473,371	$19,632,020	$47,723,761	$60,377,691	$44,041,177	$30,659,735	$4,291,317	$66,805,595
Business Tax								
Direct	$178,758	$425,227	$973,483	$1,139,218	$790,864	$524,064	$73,037	$3,282,725
Indirect	$341,175	$629,504	$1,532,020	$1,941,854	$1,416,708	$986,383	$137,798	$1,302,234
Induced	$416,484	$781,464	$1,892,840	$2,385,320	$1,733,919	$1,202,897	$167,919	$2,989,309
Total	$936,417	$1,836,194	$4,398,343	$5,466,393	$3,941,491	$2,713,345	$378,754	$7,574,269
Income								
Direct	$7,189,941	$13,608,341	$33,015,093	$41,663,724	$30,349,857	$21,101,180	$2,953,885	$45,883,971
Indirect	$2,291,450	$4,210,366	$10,294,973	$13,119,963	$9,614,889	$6,724,403	$942,463	$10,341,188
Induced	$2,094,716	$3,935,365	$9,544,454	$12,043,588	$8,766,393	$6,089,960	$851,317	$15,176,644
Total	$11,576,106	$21,754,073	$52,854,520	$66,827,274	$48,731,139	$33,915,543	$4,747,665	$71,401,805
Output								
Direct	$23,287,632	$44,348,648	$107,410,220	$135,264,146	$98,411,126	$68,341,639	$9,565,690	$101,858,828
Indirect	$5,662,857	$10,547,981	$25,664,403	$32,527,007	$23,755,543	$16,561,696	$2,319,388	$27,128,753
Induced	$5,849,635	$10,998,301	$26,695,085	$33,711,512	$24,557,695	$17,073,685	$2,388,646	$42,617,261
Total	$34,800,123	$65,894,930	$159,769,708	$201,502,664	$146,724,363	$101,977,020	$14,273,724	$171,604,842

Source: IMPLAN Pro.

The human health and safety analyses show that hazardous chemical and radiological releases from normal operations of the proposed SNS at 1-MW and 4-MW power levels would be within regulatory limits. Annual radiological doses are given in Section 5.3.9, and the data show that normal air emissions of the proposed 1-MW SNS would be negligible and would not result in adverse human health or environmental impacts to the public off-site. Therefore, operation of the proposed SNS would not have disproportionately high and adverse impacts on minority or low-income populations.

Radiation doses to the public from both normal operations and accident conditions would not create high and adverse impacts. Less than one (0.1) LCF is calculated at the 4-MW power level over a 40-year operations period. If the facility operated for 10 years at 1 MW and 30 years at 4 MW, the calculated number of LCFs would be reduced (refer to Section 5.2.9.2.1). Twenty-five accident scenarios at the SNS would result in airborne releases. The consequences of most of these accidents would be negligible at power levels of both 1 MW and 4 MW. Only one accident is calculated to induce LCFs in the off-site population. An LCF is a cumulative measure from the entire population (within 50 miles or 80 km radius) of approximately 250,000 people used for comparing alternatives and does not necessarily indicate that a fatality would occur (see Section 5.2.9.2.1). If the facility operated for 10 years at 1 MW and 30 years at 4 MW, the calculated number of LCFs would be reduced (see Section 5.2.9.2.1). Winds over the plateau show considerable spatial structure and temporal variability, but a southerly flow usually prevails during the day. The prevailing nighttime flow over the western portion of the site is west-southwesterly to northwesterly (Figures 4.2.3.2-1 and 4.2.3.2-2). Figures 4.2.6.5-1 and 4.2.6.5-2 show that the proposed SNS site is completely surrounded by minority and low-income populations greater than the national average. The highest concentrations of these communities are located to the north of the site, and the highest concentration of non-minority and higher income populations are located closest to the site on the north, south, and western borders (DOE-AL 1995b, Figures 4-22 and 4-24). The public, including minority and low-income persons, could be in the path of an off-site airborne release. However, the analysis has shown that there would not be high and/or adverse impacts to any of the population; therefore, there would be no disproportionate risk of significantly high and adverse impacts to minority and low-income populations.

A number of uncertainties are associated with the evaluation of potential impacts due to subsistence consumption. ANL developed an article reviewing the literature on subsistence consumption (Elliot 1994) and found that (1) ”the majority of the studies that have been conducted to date are focused on site- or region-specific exposure concerns. . . At present, it is unclear whether the findings of these studies are representative of consumption and exposure levels among minority populations at a national level;” (2) “a large number of risk assessment studies focusing on fish and wildlife consumption examined whole populations without distinguishing between consumption and exposure patterns of specific ethnic (or other) subpopulations;” (3) “the vast majority of studies have focused on fish consumption as an exposure pathway. Few examined wildlife consumption and contamination, and even in such cases the studies were not motivated by minority exposure concerns;” and (4) “the majority populations were not significantly higher than for the population as a whole." Specific data on subsistence populations are not available for the LANL region. However, DOE is unaware of any subsistence populations residing in the vicinity of the proposed SNS site. Therefore, no adverse impacts on such populations are expected.

To assemble and disseminate information on subsistence hunting and fishing, DOE began publishing *A Department of Energy Environmental Justice Newsletter: Subsistence and Environmental Health* in the spring of 1996. The newsletter is available in the public reading rooms. Three goals of the newsletter are (1) "to provide useful information about the health implications of consuming contaminated fish, wildlife, livestock products, or vegetation;" (2) "to provide information about projects and programs at DOE and other federal and state agencies that address the problems associated with consuming contaminated fish, wildlife, livestock products, or vegetation;" and (3) "to receive relevant information from readers." In addition to the newsletter, DOE has a new project under way to identify information being collected on subsistence consumption by other federal agencies and to serve as a clearinghouse for such information (DOE 1996e).

All of the wastes generated during construction and operations would be transferred to LANL waste operations for processing. The waste management facilities and the disposal processes for these wastes are described in Section 5.3.11. However, the LANL treatment facility cannot accommodate wastes from tritium, and an alternative disposal method would be necessary for these wastes from the SNS. All chemical releases would be regulated by NPDES permits and would be in compliance with federal and state regulations. As such, there would be no incremental effects on fish or other edible aquatic life in areas surrounding the proposed SNS site.

The analyses indicate that socioeconomic changes resulting from implementing the proposed SNS would not lead to environmental justice impacts. The proposed SNS project would provide economic benefits through generating additional employment and income in the affected region (refer to Table 5.3.6.4-1). Traffic congestion would increase; however, this impact would not disproportionately affect minority or low-income communities because traffic patterns would not be different between low-income and minority populations and the rest of the surrounding population (refer to Section 5.3.10.1). Overall, nothing associated with construction or operation of the proposed SNS would pose high and adverse human health or environmental effects that disproportionately affect minority and low-income populations.

5.3.7 CULTURAL RESOURCES

The potential effects of the proposed action on cultural resources in the vicinity of the proposed SNS site at LANL are assessed in this section. These assessments involve prehistoric archaeological sites; structures, features, and archaeological sites dating to the Historic Period; and TCPs.

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at LANL. In addition, the locations of ancillary structures such as a retention basin, switchyard, and waste treatment system have not been determined. As a result, the effects of the proposed action on any cultural resources that may occur in these areas cannot be assessed at this time. If the proposed SNS site at LANL were chosen for construction, a cultural resources survey and an assessment of potential effects would be conducted prior to the initiation of construction-related activities in these areas. Appropriate measures would be implemented to mitigate any identified effects on cultural resources. These measures would include avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation.

Approximately 35 percent of the proposed SNS site and an associated buffer zone have not been surveyed for cultural resources. If the proposed site at LANL were chosen for construction of the SNS, a survey of this area and an assessment of specific effects on cultural resources would be conducted prior to the initiation of construction-related activities in these areas. These effects would be mitigated through data recovery operations, including detailed recording of surface features and/or archaeological excavation.

5.3.7.1 Prehistoric Resources

Five prehistoric archaeological sites have been identified on and adjacent to the proposed SNS site at LANL. These sites are pueblos with 2 to 10 rooms and field houses with 1 to 2 rooms. Three of the sites date to the Coalition Period (A.D. 1100-1325), and two sites date to the Classic Period (A.D. 1325-1600).

All of these sites are significant cultural resources, and they are eligible for listing on the NRHP under Criterion D. Construction on the proposed SNS site would affect these cultural resources. They would be destroyed by site preparation activities. In the unsurveyed area of the proposed SNS site, any prehistoric sites listed on or eligible for listing on the NRHP would also be destroyed during site preparation. These effects would be mitigated through archaeological data recovery.

5.3.7.2 Historic Resources

No archaeological sites, structures, or features dating to the Historic Period have been identified on the surveyed portion (65 percent) of the proposed SNS site or in its vicinity. Consequently, in these areas, no Historic Period cultural resources listed on or eligible for listing on the NRHP would be affected by implementation of the proposed action. Site preparation activities in the unsurveyed portion (35 percent) of the proposed SNS site would destroy any historic sites, structures, or features listed on or eligible for listing on the NRHP. These effects would be mitigated through data recovery.

5.3.7.3 Traditional Cultural Properties

Five prehistoric archaeological sites have been identified on and adjacent to the SNS site at LANL. All are located within the 65 percent area that has been surveyed for cultural resources. These sites would be considered TCPs by American Indian groups in the area. They would be destroyed by site preparation activities associated with construction of the proposed SNS. If any prehistoric archaeological sites are located within the unsurveyed 35 percent of the proposed SNS site, these TCPs would also be destroyed by site preparation.

Some tribal groups have identified water resources (surface water and groundwater) as TCPs (DOE-AL 1998: 5-120). As discussed in Sections 5.2.2.3 and 5.2.10.2.3, the high water demand of the SNS during operations could adversely affect local groundwater supplies.

The specific identities and locations of other TCPs on and adjacent to the SNS site are not known and cannot be reasonably estimated (see Section 4.2.7.3). As a result, the specific effects of the proposed action on such TCPs would be uncertain.

DOE and the LANL Cultural Resource Management Team have implemented a program to manage the laboratory's cultural resources for compliance with the American Indian Religious Freedom Act and the Native American Graves Protection and Repatriation Act. When an action is proposed, DOE and LANL arrange for site visits by tribal representatives, particularly representatives of the San Ildefonso, Santa Clara, Jemez, and Cochiti pueblos. These consultations are used to solicit concerns and comply with applicable requirements and agreements. If the SNS site at LANL were selected for construction, representatives of tribal groups and the Hispanic community would be further consulted about the occurrence of specific TCPs on and adjacent to the SNS site. If any are identified, potential effects of the proposed action on these resources would be assessed. If effects would occur, appropriate and feasible mitigation measures would be designed and implemented in consultation with the affected groups and communities. DOE would include details of the mitigation measures in the MAP (refer to Section 1.4).

5.3.8 LAND USE

The potential effects of the proposed action on land use in the vicinity of LANL, within the boundaries of LANL, and on the SNS site are assessed in this section. The assessments cover potential effects on current land use and zoning for future land use. Furthermore, the potential effects of the proposed action on parklands, nature preserves, major recreational resources, and visual resources are assessed.

5.3.8.1 Current Land Use

Current land use in the urban areas and tribal lands surrounding LANL is driven by the relationship between existing land characteristics and socioeconomic forces acting at the local and regional levels. Similarly, current land use in Santa Fe National Forest, Bandelier National Monument, and LANL result from the selective use of existing land characteristics to meet federal mission requirements. The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the basic land characteristics and other forces that influence land use in these areas. Therefore, implementation of the proposed action on the SNS site at LANL would have no reasonably discernible effects on current land use in the vicinity of the laboratory and across the laboratory as a whole. However, uses of the land within and near the proposed SNS site would be more subject to effects.

The current use of land on and adjacent to the proposed SNS site in TA-70 is categorized as Environmental Research/Buffer. This classification indicates that the land is largely undeveloped open space suitable for use in NERP environmental research and as a buffer zone between activity areas at the laboratory. The proposed action would introduce large-scale development to the proposed SNS site, utility corridors, and rights-of-way. Current land use on the site would change from Environmental Research/Buffer to Experimental Science.

The 110-acre section (45 ha) of undeveloped land on the proposed SNS site is only about 3 percent of the total undeveloped land in TA-6, 69, 70, and 71 and only about 0.6 percent of the 16,000 acres (6,478 ha) of LANL land that has never been developed. In addition, the piñon-juniper woodlands that cover the proposed SNS site constitute less than 1 percent of the 12,770 acres (5,108 ha) of piñon-juniper woodlands at LANL. Consequently, the loss of 110 acres (45 ha) of undeveloped piñon-juniper woodlands would represent a minimal effect on undeveloped lands as a whole at LANL.

DOE has a federally mandated role as trustee of the natural and cultural resources on its lands. The use of undeveloped trusteeship land for the SNS is proposed only because no previously developed LANL lands that meet project requirements are available.

The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects. As a result, the proposed action would have no effects on the use of land by such projects.

5.3.8.2 Future Land Use

The land on the proposed SNS site is zoned for future use in Experimental Science. This zoning category applies to land reserved for the construction and operation of future research facilities. The proposed SNS would be a new research facility. Consequently, implementation of the proposed action would have no potential effects relevant to current DOE zoning of the proposed SNS site.

Portions of the proposed SNS site would become contaminated with pollutants from operations. Current plans call for in-situ decommissioning of the SNS when its operational life cycle is completed. As a result of in-situ decommissioning, some contaminated components would remain in place on the SNS site. This could limit the future use of land on the site for other purposes. Construction and operation of the SNS could also limit the future use of land areas adjacent to the SNS site.

No future uses of proposed SNS site and vicinity land for environmental research are planned. As a result, effects of the proposed action on specific future research projects cannot be assessed.

5.3.8.3 Parks, Preserves, and Recreational Resources

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics and other factors that support park, nature preserve, and recreational land uses outside the LANL boundaries. Consequently, implementation of the proposed action on the SNS site at the laboratory would have minimal effects on the use of nearby land for Santa Fe National Forest or Bandelier National Monument.

The proposed action would have no reasonably discernible effects on most recreational uses of LANL land, and it would have no effect on environmental research activities within the NERP. However, public use of the hiking trails located near the proposed SNS site could potentially be restricted or eliminated.

5.3.8.4 Visual Resources

The proposed SNS facilities would be located in a remote woodland area. Their presence would change the viewscape of the area from that of undeveloped pinion-juniper woodlands to industrial development. During construction and operations, they would be visible to travelers along State Route 4 and the access road leading to the facilities. The SNS facilities would also be visible from points on the proposed SNS site and various points within TA-70. This would include locations on the recreational hiking trails used by the public in TA-70. During the night hours, facility lighting would be highly noticeable to viewers because no other large, lighted facilities are present in this remote area.

These facilities would not be visible from the nearby community of White Rock or popular public use areas in Bandelier National Monument.

5.3.9 HUMAN HEALTH

Construction and operation of the proposed SNS at LANL could pose a potential risk of adverse effects on the health of workers and of the public living in the vicinity of the facility. Potential adverse effects include:

- Traffic-related fatalities and injuries to workers and the public.
- Occupational fatalities and injuries to workers.
- Exposure of workers and the public to radiation or radioactive materials.
- Exposure of workers and the public to toxic or hazardous materials.

This section evaluates the potential magnitude of these effects and the likelihood that they would occur during three phases or conditions:

- construction,
- normal operations, and
- accident conditions.

5.3.9.1 Construction

The potential effects on the health of construction workers, other LANL workers, and members of the public would be essentially the same as those for any of the proposed locations because the size of the construction work force would be the same. Potential effects of construction of the SNS include construction accidents and traffic accidents.

On the basis of national traffic accident rates (1.74×10^{-8} fatalities per vehicle mile and 1.05×10^{-6} disabling injuries per vehicle mile) and the anticipated total mileage of commuting construction workers (2,074 person-years × 250 work days/person-year × 0.806 daily round-trips/worker × 20 miles/round trip), less than one additional fatality and nine additional disabling injuries could occur as the result of increased commuter traffic during the seven-year construction period of the proposed SNS.

On the basis of national construction accident rates, 0.31 fatality (0.00015 fatalities/worker-year × 2,074 worker-years) and 110 disabling injuries (0.053 disabling injuries/ worker-year × 2,074 worker-years) could occur as the result of occupational accidents during construction of the proposed SNS. The existing LANL workforce of 8,655 is smaller than that of ORNL and larger than BNL and ANL, so that the relative increase in traffic-related injuries and fatalities would be slightly greater during construction of the proposed SNS facility at LANL. Based on traffic data shown in Section

5.3.10.1 and the approach described in Section 5.2.9.1, traffic-related disabling injuries and fatalities would be expected to increase by approximately 6.7 percent during the peak year of construction relative to existing injury and fatality rates at LANL.

No known construction activities or requirements would place construction workers at the proposed SNS facility and the public at LANL at a different risk of occupational injury or fatalities than the risk posed to these same groups by construction at any of the proposed locations.

The previous discussion is based on construction of the 1-MW proposed SNS facility. At this stage of design, estimates of the number of workers that would be required to upgrade the facility for 4-MW operation are not available. Because the amount of construction required for upgrade to 4-MW would be less than that required for construction of the original facility, injuries and fatalities for traffic-related and construction accidents for the 4-MW facility would be less than those for construction of the original facility regardless of where the SNS is located.

5.3.9.2 Normal Operations

The number of SNS workers is independent of the location of the facility. The absolute number of industrial accidents and traffic-related injuries and fatalities would be expected to be essentially the same as at the other proposed locations.

On the basis of national traffic accident rates (0.0174 fatalities per million vehicle-mile and 1.05 disabling injuries per million vehicle-mile) and the anticipated total mileage of 60 million miles (375 commuting workers × 20 miles/trip × 0.806 trips/day × 250 days/year × 40 years), one additional fatality and 63 additional disabling injuries could occur as the result of increased commuter traffic during the 40-year operational life of the proposed SNS.

National industrial workplace accident rate data applied to the work force for the proposed SNS would yield less than one fatality (3.4 deaths annually/100,000 workers × 375 workers × 40 years) and 500 disabling injuries (3,400 disabling injuries annually/100,000 workers × 375 workers × 40 years) occurring over the 40-year operational life of the proposed SNS.

The relative increase of disabling injuries and fatalities would be less than the other proposed locations at LANL because of the larger existing work force. Based on data shown in Section 5.3.10.1, the addition of the maximum of 375 SNS workers to the daily LANL traffic flow could increase the number of disabling injuries and fatalities by approximately 4.3 percent relative to existing rates at LANL.

The proposed SNS facility would generate and release direct radiation, radioactive materials, and toxic materials. Members of the public and workers at the proposed SNS facility and other adjacent facilities would be exposed to these radiations and emissions. The quantities and release rates of these materials would be the same for any of the proposed locations. The impact of the LANL site-specific meteorology, distances to site boundaries, and population density and distribution are discussed in the following sections.

5.3.9.2.1 Radiation and Radioactive Emissions

This section assesses the effects of direct radiation and airborne emissions of radioactive materials from the proposed SNS based on the methods and dose-to-risk conversion factors discussed in Section 5.1.9.

Direct Radiation

Exposure of SNS workers to direct radiation at LANL is expected to be the same as at other proposed locations because the SNS Shielding Design Policy is applicable regardless of location (e.g., ORNL, LANL, ANL, or BNL).

Because the preferred location of the proposed SNS facility at LANL is remote from other facilities and at generally greater distances from areas where members of the public could reside, direct radiation exposures to the public may be somewhat less than for other proposed locations. This difference, if real, would be small and cannot be quantified based on information currently available.

Radioactive Emissions

Radioactive emissions during normal operations of the proposed SNS at LANL would include airborne releases from the Tunnel Confinement Exhaust Stack and the Target Building Exhaust Stack. These emissions are the same regardless of facility location and are listed in Table G-1 of Appendix G. As discussed in Section 5.3.11, the LLLW and process waste generated by the proposed SNS facility at LANL would be handled by the TA-53 radioactive liquid waste (RLW), which is currently under construction.

The estimated annual doses to workers and the public for normal airborne emissions from the proposed SNS facility are shown in Table 5.3.9.2.1-1. The methods and assumptions used in the calculation of doses is discussed in Section 5.1.9 and in greater detail in Appendix G.

Even under the conservative assumptions made in this assessment regarding exposure pathways, doses shown in Table 5.3.9.2.1-1 for the maximally exposed individuals are comparable to those for the maximally exposed individuals for existing LANL operations, but SNS population doses are higher. Calculations reported by LANL for National Emissions Standards for Hazardous Air Pollutants (NESHAP) compliance estimated a dose of 1.93 mrem/yr to the maximally exposed individual in 1996 (LANL 1997d). More realistic calculations, based on a combination of environmental measurements and transport modeling, estimated a median dose of 1.4 mrem/yr to the maximally exposed individual and a dose of 1.2 person-rem to the off-site population (LANL 1997d). LANL estimates that 99 percent of these doses are the result of airborne releases.

Annual doses to the maximally exposed individual for proposed SNS operations at LANL would be 0.47 mrem at 1 MW and 1.8 mrem at 4 MW. Population doses from the proposed SNS facility would be 2.0 person-rem at 1 MW and 5.3 person-rem at 4 MW. Using the information from the LANL environmental report (LANL 1997d), this would increase the estimated dose to the maximally exposed individual to 2.4 mrem, which is 24 percent of the 10-mrem limit (40 CFR Part 61) that DOE expects the facility to meet.

Table 5.3.9.2.1-1. Estimated annual radiological dose from proposed SNS normal emissions at LANL.[a]

	1-MW Power Level		4-MW Power Level	
Receptor	**Target Building[b]**	**Tunnel Confinement[c]**	**Target Building[b]**	**Tunnel Confinement[c]**
Maximum Individuals (mrem)				
Off-site Public[d]	0.46	0.008	1.8	0.009
Uninvolved Workers[d]	0.098	0.12	0.39	0.19
Populations (person-rem)				
Off-site Public[e] (246,294 persons)	2.0	0.036	5.2	0.032
Uninvolved Workers[e] [None within 1.2 miles (2 km)]	NA	NA	NA	NA

[a] Doses shown include the contributions from inhalation, immersion, and "ground shine" for workers and the off-site public and ingestion for the off-site public.
[b] Target Building emissions include hot off-gas exhaust, primary confinement exhaust, secondary confinement exhaust from the target building, and activated air from the beam dump buildings.
[c] Tunnel confinement emissions include activated air and concrete dust from the linac tunnel, HEBT tunnel(s), ring tunnel(s), and ring-to-target beam transport tunnel(s).
[d] The maximally exposed individuals are hypothetical receptors. The member of the public is assumed to occupy a position at the LANL site boundary for 8,760 hr/yr and to produce the entire food supply at this location. The maximally exposed uninvolved worker is assumed to occupy a position within 1.2 miles (2 km) of the stack for 2,000 hr/yr.
[e] The off-site population consists of all individuals residing outside the LANL site boundary within 50 miles (80 km) of the site and is assumed to be present for 8,760 hr/yr. The involved/uninvolved worker population consists of all workers normally within 1.2 miles (2 km) of the facility. There are no workers within 1.2 miles (2 km) of the preferred SNS location at LANL.
NA - Not applicable. No workers within 2 km.

Dose at the LANL boundary due to emissions from Tunnel Confinement Exhaust is 0.008 mrem and is dominated by radionuclides in activated concrete dust. Dose at the LANL boundary due to emissions from Target Building Exhaust would be dominated by ^{3}H (58 percent), with smaller contributions from ^{14}C, ^{203}Hg, ^{125}I, and ^{121}Te. These radionuclides are listed in order of decreasing dose and account for 99 percent of the dose of this component of the total air pathway dose.

To estimate the total risk to members of the public from the proposed SNS facility emissions of radioactive materials over the entire life of the facility, annual population dose is multiplied by operating life of the facility and by the dose-to-risk conversion factor of 0.0005 LCF per person-rem. For 40 years of operation at 1 MW, 0.04 excess LCF would be projected. For 40 years at 4 MW, 0.1 excess LCF would be projected. If the facility operated for 10 years at 1 MW and 30 years at 4 MW, 0.09 excess LCF would be projected. These projected excess LCFs do not mean that any actual fatalities would occur as the result of the proposed SNS operations, but provide a quantified magnitude for comparison to excess LCFs estimated for the other alternatives.

5.3.9.2.2. Toxic Material Emissions

As discussed in Section 5.2.9.2.2, elemental mercury vapor is the only toxic material expected to be released from the proposed SNS facility under normal conditions. The mercury would be released from the Target Building Exhaust Stack at an annualized rate of 0.0171 mg/s. Based on atmospheric dispersion factors specific to LANL, the maximum mercury concentration in areas that could be occupied by uninvolved workers is 2.35×10^{-6} mg/m^3 in any 2-hr period and 3.41×10^{-7} mg/m^3 in any 8-hr period. These concentrations are at least 1/100,000th of the OSHA ceiling limit (0.1 mg/m^3) and the ACGIH-recommended threshold limit value-time weighted average (TLV-TWA) (0.05 mg/m^3) for workers. The average annual airborne mercury concentration at the site boundary would be 8.77×10^{-9} mg/m^3, 1/35,000th of the EPA Reference concentration for members of the public (0.0003 mg/m^3).

5.3.9.3 Accident Conditions

This section discusses the impacts on human health of accidents that could potentially occur during operation of the proposed SNS at LANL.

5.3.9.3.1 Accident Scenarios

The accident scenarios and source terms for accidents that could potentially occur at the proposed SNS facility are the same for all proposed sites and are summarized in Table G-2 (refer to Appendix G). The details of these scenarios and source terms is provided in Appendix C. Table 3.2 defines the terminology used to describe the likelihood that a given accident could occur.

5.3.9.3.2 Direct Radiation

The frequencies of occurrence and consequences of accidents involving exposure to direct radiation have not been specifically analyzed. DOE's Shielding Design Policy for the proposed SNS is such that for the worst-case design-basis accident, the dose to the maximum exposed individual in an uncontrolled area would be limited to 1 rem, and a worker in a controlled area would be limited to 25 rem. The risks of this category of accidents would be the same for all proposed sites.

5.3.9.3.3 Radioactive Materials Accidents

DOE has performed a hazard analysis of potential accidents at the proposed SNS facility, and for those that could result in a release of radioactive material, it has estimated source terms. The DOE analysis is included as Appendix C. Accident scenarios, estimated frequencies of occurrence, and source terms are summarized in Table G-2 and are the same for all proposed SNS sites. The methods used to evaluate the consequences of these accidents are discussed in Section 5.1.9 and in more detail in Appendix G.

Doses for these accidents, should they occur at the proposed SNS facility at LANL, are listed in Table 5.3.9.3.3-1. With the exception of accident ID 16, all doses for accidents at a 4-MW facility would be four times higher than at a 1-MW facility. This is not the case for ID 16, the beyond-design-basis mercury spill, due to differences in the source term model (refer to Exhibit F of Appendix C). At 4 MW (ID 16b) some boiling of mercury is assumed, releasing a larger quantity of mercury than at 1 MW (16a) where only evaporation is assumed.

Table 5.3.9.3.3-1. Radiological dose for SNS accident scenarios at LANL.

ID	Event	Frequency[b]	Source Term[c]	Maximum Individual (mrem)[a] Off-site Public 1-MW Beam	Maximum Individual (mrem)[a] Off-site Public 4-MW Beam	Maximum Individual (mrem)[a] Uninvolved Workers 1-MW Beam	Maximum Individual (mrem)[a] Uninvolved Workers 4-MW Beam	Population (person-rem)[a] Off-site Public 1-MW Beam	Population (person-rem)[a] Off-site Public 4-MW Beam	Population (person-rem)[a] Uninvolved Workers 1-MW Beam	Population (person-rem)[a] Uninvolved Workers 4-MW Beam
A. Accidents Involving Proposed SNS Target or Target Components											
2	Major Loss Of Integrity of Hg Target Vessel or Piping (Appendix C, Section 3.3)	a) Unlikely	Percent Inventory Mercury Iodine 0.142 0.142	1.2	4.8	4.9	19.6	12.0	48.0	NA	NA
		b) Extremely Unlikely	Percent Inventory Mercury Iodine 0.243 100	4.0	16.0	11	44	49	196	NA	NA
8	Loss of Integrity in Target Component Cooling Loop (Appendix C, Section 3.9)	a) Anticipated	Bounded by Annual Release Limits[d]	<10	<10	NA	NA	NA	NA	NA	NA
		b) Anticipated	Gases + Mist + 150 L of D_2O	0.33	1.32	0.41	0.84	1.7	6.8	NA	NA
		c) Anticipated	18 L of D_2O	<0.001	<0.001	0.002	0.008	0.003	0.012	NA	NA
		d) Anticipated	Gases + Mist + 150 L of H_2O	0.29	1.16	0.36	1.44	1.1	4.4	NA	NA
16	Beyond-Design-Basis Hg Spill (Appendix C, Section 3.17)	a) Beyond Extremely Unlikely	1 MW Percent Inventory Mercury Iodine 1.11 100	9.0		35		88		NA	
		b) Beyond Extremely Unlikely	4 MW Percent Inventory Mercury Iodine 1.28 100		590		1,100		8,000		NA

Table 5.3.9.3.3-1. Radiological dose for SNS accident scenarios at LANL – (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	Event	Frequency[b]	Source Term[c]	1-MW Beam	4-MW Beam	1-MW Beam	4-MW Beam	1-MW Beam	4-MW Beam	1-MW Beam	4-MW Beam
B. Accidents Involving Proposed SNS Waste Systems											
17	Hg Condenser Failure (Appendix C, Section 4.1.1)	Anticipated	13.7 g mercury	0.002	0.008	0.006	0.024	0.025	0.10	NA	NA
18	Hg Charcoal Absorber Failure[e] (Appendix C, Section 4.1.2)	Unlikely	14.8 g mercury	<0.001	<0.001	0.003	0.012	0.006	0.024	NA	NA
19	He Circulator Failure (Appendix C, Section 4.2.1)	Anticipated	1 day of tritium production	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	NA	NA
20	Oxidation of Getter Bed (Appendix C, Section 4.2.2)	Unlikely	1 day of tritium production	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	NA	NA
21	Combustion of Getter Bed (Appendix C, Section 4.3.1)	Extremely Unlikely	1 year of tritium production, 200 g depleted uranium	0.97	3.88	1.2	4.8	14	56	NA	NA
22	Failure of Cryogenic Charcoal Absorber [f] (Appendix C, Section 4.4.1)	Unlikely	1 day of xenon production	0.040	0.16	0.023	0.92	0.45	3.6	NA	NA
23	Valve Sequence Error in Tritium Removal System (Appendix C, Section 4.5.1)	Unlikely	1 year of tritium production	0.93	3.72	1.2	4.8	14	56	NA	NA
24	Valve Sequence Error in Offgas Decay System (Appendix C, Section 4.5.2)	Anticipated	7 days of xenon accumulation (1 decay tank)	2.5	10.0	3.0	12.0	36	144	NA	NA

Table 5.3.9.3.3-1. Radiological dose for SNS accident scenarios at LANL – (continued).

ID	Event	Frequency[b]	Source Term[c]	Maximum Individual (mrem) [a] Off-site Public 1-MW Beam	Maximum Individual (mrem) [a] Off-site Public 4-MW Beam	Maximum Individual (mrem) [a] Uninvolved Workers 1-MW Beam	Maximum Individual (mrem) [a] Uninvolved Workers 4-MW Beam	Population (person-rem) [a] Off-site Public 1-MW Beam	Population (person-rem) [a] Off-site Public 4-MW Beam	Population (person-rem) [a] Uninvolved Workers 1-MW Beam	Population (person-rem) [a] Uninvolved Workers 4-MW Beam
B. Accidents Involving Proposed SNS Waste Systems (continued)											
25	Spill During Filling of Tanker Truck for LLLW Storage Tanks[g] (Appendix C, Section 4.5.3)	Anticipated	0.00005% of Contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
26	Spray During Filling of Tanker truck for LLLW[g] (Appendix C, Section 4.5.4)	Anticipated	1.9 ml of LLLW	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
27	Spill During Filling of Tanker Truck for Process Waste Storage Tanks[g] (Appendix C, Section 4.5.5)	Anticipated	51,100 L Process Waste to Surface Water + 57 L to Atmosphere	See footnote "h"		See footnote "h"		See footnote "h"		NA	NA
28	Spray During Filling of Tanker Truck for Process Waste[g] (Appendix C, Section 4.5.6)	Anticipated	28.4 L of Process Waste	See footnote "h"		See footnote "h"		See footnote "h"		NA	NA
29	Offgas Treatment Pipe Break (Appendix C, Section 4.6.1)	Unlikely	24 hrs of xenon production	0.49	1.96	0.17	0.68	3.9	15.6	NA	NA
30	Offgas Compressor Failure (Appendix C, Section 4.6.2)	Unlikely	1 hr of xenon production	0.056	0.224	0.021	0.084	0.52	2.08	NA	NA
31	Offgas Decay Tank Failure (Appendix C, Section 4.6.3)	Extremely Unlikely	7 days of xenon accumulation	2.5	10.0	3.0	12.0	36	144	NA	NA
32	Offgas Charcoal Filter Failure (Appendix C, Section 4.6.4)	Unlikely	7 days of iodine production	0.040	0.160	0.027	0.108	0.21	0.84	NA	NA

Table 5.3.9.3.3-1. Radiological dose for SNS accident scenarios at LANL – (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	**Event**	**Frequency[b]**	**Source Term[c]**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**	**1-MW Beam**	**4-MW Beam**
B. Accidents Involving Proposed SNS Waste Systems (continued)											
33	LLLW System Piping Failure (Appendix C, Section 4.6.5)	Unlikely	0.00005% of Contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
34	LLLW Storage Tank Failure (Appendix C, Section 4.6.6)	Extremely Unlikely	0.00005% of Contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
37	Process Waste Storage Tank Failure (Appendix C, Section 4.6.9)	Extremely Unlikely	57 L to Atmosphere	See footnote "h"		See footnote "h"		See footnote "h"		NA	NA

[a] Unless otherwise indicated, radiological doses are based on radiological source terms for a 1-MW power level and would be four times greater if the facility is operating at 4 MW. These doses are total EDEs and include dose from inhalation and immersion. "Off-site" means outside the site boundary rather than outside the proposed SNS facility boundary. Individual receptors are hypothetical and do not correspond to any actual person. Population receptors are based on the actual number of people residing outside the site boundary and within 50 miles (80 km) of the facility and on the number of site workers normally within 1.2 miles (2 km) of the facility and not involved in facility operation.

[b] See Table 5.2.9-2 for the numerical ranges associated with accident frequencies categories.

[c] Source terms are expressed in units that are independent of power level. Except for beyond-design-basis accidents (IDs 16a, 16b), the radioactivity released in accidents at 4 MW is four times that released at 1 MW.

[d] 40 CFR 61 limits dose to members of the public from airborne emissions from DOE facilities to 10 mrem/yr.

[e] Installation of sulfur-impregnated charcoal filters is being considered to serve as a "polishing filter" for the mercury condenser (refer to Event 17).

[f] Cryogenic charcoal absorbers are being considered as an alternative to the offgas compressor, decay storage tanks, and ambient temperature charcoal filters (refer to Events 24, 30, 31, and 32).

[g] Accidents involving tanker trucks may not be applicable for the proposed SNS facility at this site. It has not been determined how LLLW and process waste would be treated and disposed.

[h] Process waste accidental airborne releases occur at ground level. Only atmospheric dispersion factors for elevated releases were calculated for this site. Based on the radionuclide contents of LLLW, process waste source terms, and results for ORNL, doses for process waste accidents at this site are anticipated to be approximately 0.001 mrem or less for individuals and to be less than approximately 0.050 person-rem for the off-site population.

NA - Not available.

The pattern of accident doses for the proposed SNS facility at LANL is essentially the same as for the other proposed locations, but the magnitude of the doses is somewhat less. This mainly is due to the remoteness of the proposed SNS site at LANL and the lower population density.

At a power level of 1 MW, the beyond-design-basis mercury spill accident (ID 16a) would be the highest dose of the potential accidents involving the target and target system. Maximum doses to individuals would be 9 mrem for the public and 35 mrem for the uninvolved worker. The dose to the member of the public is about 3 percent of the annual dose from natural background radiation and that to the worker is about 12 percent of the dose from natural background radiation. The off-site population dose of 88 person-rem corresponds to 0.044 excess LCF.

At a power level of 1 MW, accident IDs 24 and 31 involving the offgas decay system have the highest doses of potential accidents involving waste handling systems. In these two accidents, maximum individual doses would be 2.5 mrem to the public and 3.0 mrem to an uninvolved worker. The dose of 36 person-rem to the off-site population corresponds to 0.018 LCF. Although these accidents represent a low risk of health impacts, accident ID 24, a valve sequence error in the offgas decay system, has been classified as an "anticipated" event by DOE while ID 31 is "extremely unlikely" (Appendix C). As discussed in Section 5.2.9.3.3, the likelihood of accident ID 24 could be reduced by a number of means.

The consequences of all potential accidents, except ID 16, would be four times greater at a power level of 4 MW. The "worst-case" accidents for waste-handling systems (IDs 24 and 31) would correspond to 0.071 LCF in the off-site population. The beyond-design-basis mercury spill (ID 16b) yields maximum individual doses of 590 mrem to the public and 1,100 mrem to an uninvolved worker. The off-site population dose of 8,000 person-rem in this accident corresponds to 4.0 excess LCFs (8,000 person-rem $\times$ 0.0005 LCF/person-rem = 4.0 LCFs). As discussed in Section 5.2.9.2.1, LCF values of 1.0 or greater do not mean that fatalities would actually occur in the off-site population, but they provide a quantified value for use in comparison between alternatives. In addition, there is less than a 1 in 1,000,000 chance that this accident would occur in a given year at the proposed SNS facility.

5.3.9.3.4 Hazardous Materials Accidents

Accidents involving potential exposure to toxic materials are discussed in Section 5.2.9.3.4. All involve spills of irradiated mercury. Accident IDs 2b, 16a, and 16b could result in the OSHA ceiling concentration of 0.1 mg/m^3 being exceeded for a few minutes during the initial stages of these accidents in locations accessible to workers, but it would not be exceeded at or beyond the LANL site boundary. Thus, for only a few minutes at the start of the accident, mercury concentrations at or beyond the site boundary might exceed the TEEL-1 limit (0.075 mg/m^3) but would not exceed the TEEL-2 limit (0.10 mg/m^3); individuals at the boundary at the precise occurrence of the initial emission might perceive an odor, but would not experience or develop irreversible health effects or symptoms that could impair the ability to take protective action.

The second and third stages of these accidents are conservatively assumed to last from 7 to 30 days, while in reality, administrative and emergency response actions would more probably terminate the release in a shorter time period. During these stages, airborne concentrations of mercury would remain two to three orders of magnitude below the TEEL-0 limit of 0.05 mg/m^3, and no observable detrimental effects would be expected to occur.

5.3.10 SUPPORT FACILITIES AND INFRASTRUCTURE

This section summarizes the facilities and infrastructure effects on LANL transportation and utility systems from construction and operation of the proposed SNS.

5.3.10.1 Transportation

As described in Section 3.2.5, Alternative Sites, construction of the proposed SNS, related infrastructure, and support systems would occur at LANL, located in Los Alamos County, in north-central New Mexico approximately 25 miles (40.2 km) from the City of Albuquerque, New Mexico. Only two major roads, State Highway 502 and State Highway 4, access Los Alamos County.

Construction vehicles would access the proposed SNS facility location at the LANL site from State Highway 4 via a new access road. The new access road would be for the exclusive use of the proposed SNS project and would not provide access to other LANL facilities. As such, traffic circulation effects internal to LANL are not expected. Construction employee and vehicle activity would increase during the first years of construction, peaking in the year 2002, and it would decrease significantly during the last year (2004) of construction. The estimated total of 578 construction employees in the peak construction year (2002) is expected to add approximately 466 daily round-trips and 10 material/service trucks to projected site traffic of 6,980 round-trips. This represents a 6 percent increase.

Assumptions used to evaluate the traffic impacts at LANL were based on the location of employment centers relative to the proposed SNS and the existing commuting patterns discussed in Section 4.2.10.1. Approximately 90 percent of construction vehicles would originate from areas east of LANL and travel southbound to the proposed SNS site via State Highway 4; the other 10 percent would access the site from the east on State Highway 4. State Highway 4 is currently a lightly used road. The traffic volume currently experienced on State Highway 4 between the entrance to Bandelier National Monument and State Highway 502 is approximately 1,029 with the peak hr traffic being approximately 154. The average daily trips (ADT) on State Highway 4 between State Highway 501 and the entrance to Bandelier National Monument is approximately 758 vehicle trips. The number of vehicles counted during the peak hr is 114. The expected construction vehicles associated with the proposed SNS would add 857 daily vehicle trips during the peak year of construction (45 percent increase) to the current ADT on State Highway 4 between the entrance to Bandelier National Monument and State Highway 502. An additional 93 daily vehicle trips would occur on State Highway 4 between State Highway 501 and the entrance to Bandelier National Monument (10 percent increase). Some minor traffic effects could be expected from construction of the proposed SNS facility at this location. Construction-related traffic would be near the capacity of State Highway 4 during the peak years of construction.

Operation of the proposed SNS facility would result in an additional 250 resident/visiting scientists by the year 2006, plus another 125 employees during future facility upgrades, such as a second target station. An additional 375 people and 3 service trucks/day (305 round-trips) associated with the proposed SNS project would not be expected to create traffic effects at LANL. Using current site population data (8,655 people) and associated vehicles (6,980) as a measure for comparison, the increase of 305 round-trips (4 percent increase) associated with operation of the proposed SNS facility would be minor.

Table 5.3.10.1-1 compares the No-Action Alternative with the proposed action located at the Los Alamos site. The table provides the percent increase in traffic resulting from the proposed SNS during construction and operation, as compared to the No-Action Alternative. The potential effects of any traffic increases could be reduced by having craft and non-craft workers report to work at different times, thus reducing the adverse effects on traffic flow during rush hours. Additionally, this analysis assumed there would be no transferring of personnel from within LANL. If some of the workers were previously working at LANL, the impact of the traffic would be reduced.

5.3.10.2 Utilities

This section assesses the potential environmental consequences of the proposed SNS for utilities. Although the existing utilities at LANL are extensive, the logistics of using these site services to support the proposed SNS at TA-70 would involve considerable investment in new infrastructure for all services. Since the proposed site at LANL is isolated from central site services, conventional pipeline tie-ins would not be feasible.

5.3.10.2.1 Electricity

The existing electrical power system at LANL does not have adequate capacity for significant future demands and would not meet the additional demands required by the proposed SNS. Also, future electrical distribution would not be reliable because of the age of the system. To supply power for the proposed SNS, DOE would have to pursue several regional and multistate strategies. Some of these strategies would involve bringing a new 115-kV line from the east side of the site. To provide even a 62-MW supply, other strategies in addition to the proposed line would need to be addressed. These include new regional and multistate power grid configurations and perhaps an SNS,

Table 5.3.10.1-1. LANL traffic increases compared to No-Action Alternative.

	Baseline/ No-Action	SNS Construction (Peak Year)	SNS Operation (4 MW)
Passenger Vehicle Trips/Day	6980[a]	466	302
Material Transport Trucks/Day	0	7	0
Service Trucks/Day	0	3	3
Total (% increase)	0 (0%)	476 (6%)	305 (4%)

[a]Based on 8,655 LANL employees.

site-specific, power generation station. Current capacity and reliability limitations of the electric power system would not meet the needs of the proposed SNS; significant upgrades would have to be made to meet those needs.

5.3.10.2.2 Natural Gas

Natural gas would be required to provide energy for operational functions, such as fuel for boilers and localized unit heaters in the facility heating system at the proposed SNS facility. As described in Section 4.2.10.2.2, natural gas capacity would be available to serve the needs of the proposed SNS facility. However, since no existing gas lines or distribution systems are located in the vicinity of the proposed SNS site, an expansion of natural gas infrastructure would be required to serve future needs of the proposed SNS facility. Adequate supplies of natural gas are available; therefore, environmental effects would be limited to expansion of the infrastructure needed to accommodate the proposed SNS.

5.3.10.2.3 Water Service

The proposed SNS would require 1.2 to 2.3 mgpd for the following systems: tower water cooling, deionized cooling, chilled water, building heating, process water, potable water, demineralized water, fire suppression, and target moderators.

As discussed in Section 4.2.10.2.3, based on the current demands of LANL and the surrounding communities (3.3 mgpd), the potable water system with a rated capacity of 3.85 mgpd cannot meet the anticipated demands from future needs, including the needs of the proposed SNS. Accommodating the proposed SNS facility would require delivery system upgrades, including many new lines, lift stations, and storage tanks. Significant water supply effects would be expected with implementation of the proposed SNS facility.

5.3.10.2.4 Sanitary Waste Treatment

While there is sufficient sewage treatment capacity at the existing sanitary waste system in TA-46, the waste would likely have to be trucked to the nearest lift station, located several miles from the proposed SNS site. An alternative would be installing and operating an on-site treatment and discharge system.

5.3.11 WASTE MANAGEMENT

All of the wastes generated during construction and operation of the proposed SNS would be transferred to LANL Waste Operations for processing. The existing waste management systems for hazardous wastes, solid low-level radioactive wastes, and mixed wastes would have sufficient capacity to accommodate the proposed SNS facility's wastes. There would be a minimal effect to the existing sanitary waste treatment and disposal facilities at LANL. The LANL treatment facility for liquid low-level radioactive wastes cannot accommodate wastes with accelerator-produced tritium. Because of LANL's present need for treating LLW with accelerator-produced tritium, a new facility is currently under construction (TA-53 RLW) that will be able to accept this type of waste. This new facility will also be able to handle the additional waste that the SNS facility may generate if built at LANL.

The proposed SNS facility operation and construction projections of waste streams include the following: hazardous waste, LLW, mixed waste, and sanitary/industrial waste, as listed in Table 3.2.3.7-1. A summarization of existing waste management facilities at LANL, along with facility design and/or permitted capacities and remaining available capacities, can be found in Table 5.3.11-1. Projected waste stream forecasts for LANL's individual operations, proposed SNS operations at 4 MW, and the aforementioned wastes are also included in Table 5.3.11-1. Forecasts are projected from 1998 to 2040, unless otherwise noted, and they are based on estimates provided by LANL waste management operations and waste management documentation.

The proposed SNS facility's waste streams would be certified to meet LANL TSD facilities' WAC before wastes would be accepted for TSD at the site. As mentioned earlier in Section 5.2.11, AEA, EPA, and NRC limits for LLLW treatment facility WAC would also need to be addressed for the LANL site. Currently, the LANL Radioactive Liquid Waste Treatment Facility WAC states that the facility will not accept accelerator-produced wastes with tritium for treatment. This criterion exists because the facility does not have equipment in place to treat and remove tritium from water to meet the State of New Mexico Environment Department's NPDES limit of 20,000 pCi/L in the effluent discharged from the facility. Reactor-produced tritium is expected from these requirements by the AEA. The TA-53 RLW, currently under construction, will be able to accept LLLW with accelerator-produced tritium (Moss 1998; LANL 1997a).

As shown in Table 5.3.11-1, no hazardous waste treatment or disposal facilities are located at LANL. LANL hazardous wastes are shipped off-site to DOE-approved licensed commercial facilities for treatment and disposal (LANL 1997b).

LANL waste management facilities provide treatment and disposal of LLW streams. Since facilities are present on-site for treatment and disposition, long-term storage facilities are not necessary on the site (LANL 1997b and 1997f). However, the LLW facilities do not have sufficient capacity to treat the process waste from the proposed SNS if this waste stream were classified as LLLW.

Currently, in accordance with the *LANL Mixed Waste Site Treatment Plan*, LANL ships mixed waste to DOE-approved, off-site licensed commercial treatment and disposal facilities. On-site treatment methods are being developed for processing mixed waste for which there are no commercially available treatment capabilities (LANL 1997e).

LANL has a waste certification process in place to assure wastes meet the WACs for LLW disposal. However, because of the uncertainty of the composition of LLW and mixed wastes that may be generated from operation of the SNS, the waste may not meet the current WAC for waste management facilities at LANL. DOE would take action to assure the proper disposition of these wastes. For example, pretreatment of the waste may assure they meet the WAC. DOE may be able to amend the license at current waste disposal facilities to allow acceptance of wastes from the SNS.

Excess soil, construction wastes, and sanitary wastes would be generated during construction of the proposed SNS facility. Excavated soil and rock would be used for backfill, erosion control, or other environmental purposes. Construction debris would be sent to a Class IV landfill. Liquid sanitary wastes would be transported to the LANL sanitary wastewater treatment plant at LANL. Solid sanitary waste

Table 5.3.11-1. LANL waste management facility description and capacities.

Waste Disposition	Waste Type and Facility	Total Design Capacity for LANL Site	LANL Waste Projections for 1998-2040	Total Remaining Capacity for LANL Site (Excludes Proposed SNS Operations)	Proposed SNS Waste Operations Projection for 1998-2040	Potential Effect of Waste Management on the Environment
HAZARDOUS WASTE						
TREATMENT	None					
STORAGE	Liquid/Solid a) TA-54 b) Area L	a) Liquid – 80 m^3 Treatment Tank –5,720 gal b) Solid - 749 m^3	a) 273 m^3/yr b) 669 m^3/yr	Included in Mixed Waste Capacity	Hazardous Liquid 40 m^3	Minimal effects anticipated. Standard DOE practice has been to dispose of waste at off-site, DOE-approved licensed commercial facilities. Storage facilities can be expanded via RCRA permit modification.
LOW-LEVEL WASTE						
TREATMENT	Liquid a) RLWTF TA-50 b) TA-53 RLW	a) 25,000 m^3/yr b) 340 m^3/month	a) 21,400 m^3/yr b) 40 m^3/month	a) 4,600 m^3/yr	a) 665 m^3/yr 15,700 m^3/yr Process Waste Potentially LLW	LLW with accelerator-produced tritium will not be accepted for treatment at RLWTF according to WAC. A new facility is under construction. Treatment facilities do not have the capacity to treat the process waste. Facility under construction.
	Solid a) WCRRF b) LA Super Compactor	a) WCRRF - N/A b) Compactor - 200 ton Rating – 6,794 m^3/yr Capacity		5,838 m^3/yr	1,026 m^3/yr	Minimal effect anticipated for waste stream without tritium. No effect anticipated. Waste processed through WCRRF in a batch process. Minimal effect anticipated.

Table 5.3.11-1. LANL waste management facility description and capacities (continued).

Waste Disposition	Waste Type and Facility	Total Design Capacity for LANL Site	LANL Waste Projections for 1998-2040	Total Remaining Capacity for LANL Site (Excludes Proposed SNS Operations)	Proposed SNS Waste Operations Projection for 1998-2040	Potential Effect of Waste Management on the Environment
LOW-LEVEL WASTE - continued						
DISPOSAL	Solid TA-54, Area G - Pits 15, 31, 37, 38, 39 Liquid None	150,000 m^3	2,500 m^3/yr	35,000 m^3	1,026 m^3/yr	No effect anticipated. Continued construction of Area G is under evaluation in the LANL Sitewide EIS.
MIXED WASTE						
STORAGE	Liquid TA-54 Area L	1,013 m^3	Combined Liquid/Solid Mixed waste projection at 622 m^3/yr	NA	11 m^3/yr	Minimal effects anticipated. Standard DOE practice has been to dispose of waste at off-site, DOE-approved licensed commercial facilities. Storage facilities can be expanded via RCRA permit modification.
	Solid TA-54 Area G (Dome #49)	1,864 m^3		NA	7 m^3/yr	
SANITARY/INDUSTRIAL WASTE						
TREATMENT	Liquid Sanitary Waste System Consolidation TA-46	1,060,063 m^3/yr	692,827 m^3/yr	368,000 m^3/yr	25,900 m^3/yr	No effect anticipated.
	Solid None					
DISPOSAL	Off-site landfill	NA	5,453 m^3/yr	NA	1,350 m^3/yr	No effect anticipated.

RLWTF - Radioactive Liquid Waste Treatment Facility.
WCRRF - Waste Characterization, Reduction, and Repackaging Facility.
Sources: DOE 1996c; DOE-AL 1998; LANL 1997b; LANL 1997f; LANL 1997e; (n,p) Energy, Inc. and Rogers & Associates 1995.
NA - Not applicable.

would be sent to a sanitary landfill (ORNL 1997b).

As stated in Section 5.2.11, in accordance with the *NSNS Waste Minimization and Pollution Prevention Plan,* considerations for minimizing the production of the proposed SNS facility's waste would be implemented.

5.4 ARGONNE NATIONAL LABORATORY

This section describes the potential environmental effects or changes that would be expected to occur at ANL if the proposed action were to be implemented. Included in the discussion of this section are effects on the physical environment; ecological and biological resources; existing social and demographic environment; cultural, land, and infrastructure resources; and human health.

5.4.1 GEOLOGY AND SOILS

Effects on geology and soils from construction and operation of the proposed SNS facility in the 800 Area at ANL are described in this section.

5.4.1.1 Site Stability

The proposed location for the SNS at ANL is a stable site suitable for construction of the facility. The glacial soils (sand and clays) at ANL would provide adequate foundation support for the proposed facilities. Other large-scale buildings and structures such as the Advanced Photon Source (APS), the Tandem Linac Accelerating System, and the Intense Pulsed Neutron Source have been built at ANL without encountering site stability problems.

5.4.1.2 Seismic Risk

The ANL area is a stable region in terms of seismic activity (refer to Figure 4.3.1.4-1). The closest region of significant seismic occurrences is the New Madrid fault zone along the Missouri-Tennessee border. Ground acceleration from seismic activity at New Madrid would be unlikely to significantly affect the proposed SNS facility at ANL. The proposed SNS would be constructed according to DOE Standard 1020-94 (DOE 1996a). It would be capable of withstanding maximum horizontal ground accelerations of 0.09 gravity for a return period of 500 years, 0.12 gravity for a return period of 1,000 years, 0.15 gravity for a return period of 2,000 years, and 0.26 gravity for a return period of 10,000 years. The SNS beam would be designed to shut down immediately in the event of an earthquake. As such, predictable seismicity for the 800 Area would have no impact on the construction, operation, or retirement of the proposed SNS facility.

5.4.1.3 Soils

Excavation required for construction of the proposed SNS facility would disturb the native soils. Excavated soils would be stockpiled according to soil type and horizon. If the excavated soils possess the proper characteristics, they would be used to construct the shielding berm. Otherwise, the soils would be placed in the spoils area (refer to Section 3.2.5.4). Topsoil removed during excavation would be used for grading and landscaping of the site at the finish of construction.

Construction of the SNS would require removal grading of the site and removal of vegetative cover. As a result, the potential exists for soil erosion and stream siltation especially during periodic storm events. Best management practices would be followed to minimize the impacts of erosion during construction activities. Section 3.2.2.3, Site Preparation, discusses the elements (retention basin, silt fences, temporary storm water drainages, etc.) that would follow an erosion control plan to prevent erosion and siltation of Sawmill Creek on Freund Branch.

Borrow material for construction of the berm covering on the tunnels of the proposed SNS facility would be obtained from excavation of retention ponds and from the creation of replacement wetland areas in the 800 Area (refer to Section 5.4.5.1). Any additional material would be obtained from off-site. The amount of soil required for the proposed SNS facility would not affect available supplies for other uses.

Operations of the proposed SNS at ANL would affect soils within the shielding berm surrounding the linac tunnel (refer to Section 5.2.1.3). Site-specific calculations of nuclide concentrations and transport potential have not been performed for ANL. However, the suite of activation products would not be significantly different from those at ORNL. Downward migration of contaminants at ANL would first encounter an impermeable till stratum primarily composed of clay. Retardation of nuclide migration would occur in this interval, slowing its downward movement into the primary aquifers.

No prime or unique farmlands are present on or in the vicinity of the proposed SNS site at ANL. As a result, the proposed action would have no effects on prime or unique farmlands.

5.4.2 WATER RESOURCES

Effects on water resources from construction and operation of the proposed SNS in the 800 Area at ANL are described in this section. Best management practices would be employed to minimize any effects on surface water due to erosion and siltation during construction (see Section 5.2.1.3).

5.4.2.1 Surface Water

No surface water resources within the ANL reservation would be used to supply potable water for operations at the proposed SNS facility. Demands ranging from 800 to 1,600 gpm (3,028 to 6,057 lpm) would be required to support an SNS facility that may be upgraded throughout its operational life from 1 MW to 4 MW. Potable water is currently piped to ANL from Lake Michigan. Nonpotable water suitable for cooling tower operations is available from the Canal Water Distribution System. Approximately 2 mgpd (7.6 million lpd) of capacity are available for this type of use. No effects on water resources or the distribution system for them are expected from the proposed SNS facility.

Conventional cooling tower blowdown would be discharged into Sawmill Creek, which flows into the Des Plaines River. The average flow in Sawmill Creek in 1996 was 6.7 mgpd (25.4 million lpd). By comparison, a cooling tower discharge rate for a 2-MW facility would add a daily volume of 0.36 mgpd (1.4 million lpd), and a cooling tower discharge rate for a 4-MW facility would add 0.50 mgpd (1.9 million lpd) to the Sawmill Creek flow.

Blowdown would be temporarily held within a retention basin before being released to the surface drainage system. At the conceptual design stage, the size of the retention basin required is estimated at approximately 2 acres (0.81 ha). This basin would be designed to allow sufficient residence time for the discharge to cool to ambient temperatures. If necessary, active cooling systems such as recirculating fountains may be employed. Water released into the northward flowing tributary of Sawmill Creek would exit ANL to an adjacent wetland. Characteristics of the wetlands may be affected due to the increase in flow.

Polyphosphonates for antiscaling and ozone as a biocide would be used in the cooling towers. Discharge from the towers would be regulated to contain about four times the dissolved solids content of potable water (i.e., 1,000 to 1,200 mmhos conductivity). Contributions of solids or chemical agents are not anticipated to significantly affect the stream. Discharge from the cooling towers of the proposed SNS facility would be mixed with other stream flows within ANL and would exit the ANL site at Outfall 001. Discharge at the ANL boundary is monitored under an existing NPDES permit and is required to meet permitted standards.

5.4.2.2 Flood Potential and Floodplain Activities

Executive Order 11988 requires the establishment of procedures to ensure that potential effects of flood hazards and floodplain management are considered for any DOE action undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable. Due to the low-lying nature of the area surrounding ANL, few sites are available that allow a facility the size of the proposed SNS to be constructed.

At the proposed SNS site, the eastern edge of the SNS footprint overlies a portion of the 100-yr floodplain of an unnamed tributary to Sawmill Creek. This tributary originates in the 800 Area, connecting to Sawmill Creek north of ANL. In addition, the southern tip of the footprint overlies a portion of the 100-year floodplain of an unnamed tributary to Freund Brook. This tributary originates within the footprint of the proposed SNS and flows southeast to Freund Brook. Its confluence with Freund Brook is outside the footprint of the proposed SNS. The locations of these floodplain areas are shown in Figure 6-1.

Along the unnamed tributary of Sawmill Creek, construction of the proposed SNS would include filling and stabilizing those portions of the floodplains that are required for buildings and related structures. Hence, placement of the proposed SNS facility in the 800 Area location would require an alteration of drainage patterns and construction of storm drains and canals to direct storm flow to the retention basin. There are no high hazard areas, as defined in 10 CFR 1022, within this area of the proposed project. The affected areas are within the ANL boundaries. No private homes or commercial property would be affected by flooding. If the ANL site is selected for construction of the SNS, the drainage pattern of the 800 Area would be altered. The potential effects from this would be minimized by standard construction practices, including optimizing the placement of buildings to avoid the floodplain and the location of the retention basin. The retention basin would be sized to contain a 100-year flood and would serve to control runoff to this tributary and to replace lost capacity to control floodwater due to disruption of the floodplain. Because of the relatively small area of the 100-year floodplain, estimated to be approximately 5 acres (2 ha), that would be affected by construction, compared to the total drainage area of the watershed, and the inclusion of the retention basin to control runoff from the site, no downstream effects on floodplains are predicted from construction of the proposed SNS facility.

During operation of the SNS, 0.36 to 0.5 million gallons of discharge water per day, primarily from the cooling tower, would be discharged to the unnamed tributary of Sawmill Creek. All discharges from the SNS would be directed to the retention basin, thus normalizing the discharge of cooling tower blowdown water and runoff.

Along the unnamed tributary of Freund Brook, construction of the proposed SNS would include filling and stabilizing those portions of the floodplains that are required for buildings and related structures. It would also require an alteration of drainage patterns and construction of storm drains and canals to redirect stormwater flow to Freund Brook. The potential effects of this would be minimized by standard construction practices, including optimizing the placement of buildings to avoid the floodplain. No high hazard areas are located within this area of the proposed project. Because the affected areas are within the ANL boundaries, no private homes or commercial property would be affected by flooding. Less than 1 acre (0.40 ha) of the 100-year floodplain would be affected by construction. Because of its small size compared to the total drainage of the Freund Brook watershed and the early incorporation of drainage features during construction, no downstream effects on floodplains are expected from construction of the proposed SNS facility. Operations at the facility would not affect floodplains in the southern tip of the SNS site or downstream because no SNS cooling water would be discharged into Freund Brook.

Development in the floodplains of DuPage County is regulated by the *DuPage County Countywide Stormwater and Flood Plain Ordinance* (DCSMC and ECD 1998). There is a question of the applicability of these regulations to DOE operations at ANL; however, because of the small area of floodplains involved and the minimal effects that would be expected if ANL is selected for construction of the SNS, DOE expects to be in full compliance with these regulations.

A formal floodplain/wetlands assessment document has been prepared for the proposed action at the ANL site in accordance with the DOE regulations in 10 CFR 1022.12. This document is included as Appendix H of this FEIS.

5.4.2.3 Groundwater

No groundwater resources would be used for construction or operation of the proposed SNS. Over the life of the facility, groundwater has the potential to be affected by leaching and transport of radionuclides from the berm soils (refer to Section 5.2.1.4). However, the potential effects are mitigated at ANL by natural conditions of the site. The uppermost groundwater occurs at a depth of about 65 ft (20 m) from the ground surface within a complex mixture of silts, clays, and sands (Wadsworth Till). The irregular and localized nature of shallow water sources and the extremely low permeability (1×10^{-8} cm/s) of the till renders this formation unusable as a source of drinking water. The primary aquifers for potable water occur at a depth of about 165 ft

(50 m), and the downward rate of water movement through the saturated zone of the till is only about 3 ft/yr (0.9 m/yr). In addition, the high clay content of the till would provide retardation for nuclides. Accurately predicting retardation factors in such a complex environment is difficult, and a complete evaluation of the types and amounts of radionuclides that would be generated in the soils at ANL has not been performed. Groundwater monitoring would be routinely performed (such as on a semiannual or annual basis) to ensure that no migration to the primary aquifers takes place.

5.4.3 CLIMATOLOGY AND AIR QUALITY

Effects on climate and air quality from construction and operation of the proposed SNS facility in the 800 Area at ANL are described in this section.

5.4.3.1 Climatology

Construction and operation of the proposed SNS facility would not affect regional or localized climates within the ANL area.

5.4.3.2 Air Quality

Effects on nonradiological air quality are presented in this section. Airborne radiological releases are evaluated under human health impacts (refer to Section 5.4.9). Construction activities would create temporary effects in regard to particulate matter (PM_{10}) measurements during the construction phase of the proposed SNS facility. This effect would be greatest during early clearing and excavation efforts but would decrease within a relatively short time period. Although no formal estimates of suspended particulate matter have been prepared, this level is predicted to be minimal when weighted over the usual 24-hr averaging period.

The primary nonradiological airborne release during operations at the proposed SNS facility would be combustion products from the use of natural gas. However, steam is available at ANL as an alternative heat source. If the proposed SNS facility were to employ steam heat, its usage would be at a maximum rate of about 60,000 lb/hr against available capacity of 300,000 lb/hr. Peak usage of natural gas would be during the winter months at an approximate rate of 1,447 lb/hr. Emission rates related to the maximum period of natural gas usage are listed in Table 5.3.3.2-1. The proposed SNS site is also considered to be flat, and projected air quality impacts from natural gas usage would be as shown in Table 5.4.3.2-1. Adding maximum background concentrations to maximum projected impacts from sources (a very conservative procedure because the two do not occur at the same location or time) of the proposed SNS facility also does not provide any violations of the NAAQS.

The general conformity rule (40 CFR Part 93) requires the evaluation of potential direct and indirect emissions associated with this project. According to 40 CFR 93.153(h), the project can be presumed to conform to applicable State Implementation Plan provisions if the total of direct and indirect emissions of criteria or precursor pollutant emissions are below rule-specified de minimis levels. Small quantities of direct emissions of particulates and more specifically of the criteria pollutant PM-10 can be anticipated from site preparation activities associated with the construction of project facilities. Indirect emissions can be expected from fuel combustion that will be necessary to meet the anticipated heating needs of the facilities.

Should this location be chosen for construction of the SNS, a formal comparison of site direct and indirect emission rates to the de minimis levels would be made. However, review of anticipated fuel burning hourly emission rates (Table 5.2.3.2-1) indicates, even assuming worst-case (8,760 hr/yr at full capacity) operation, the annual SNS emission rates would be well below the applicable de minimis levels as shown in Table 5.4.3.2-2. PM-10 emissions from construction activities would also be many times less than the 100 tons/yr de minimis level.

Five 200-kW diesel backup generators would be tested for short durations several times a year. Emissions from these generators are rated at 1,450 cfm at 910°F (487°C). Periodic emissions

Table 5.4.3.2-1. Impact of natural gas combustion at the proposed SNS.

NAAQS Compound	Period[a]	Estimate (μg/m³) at 984 ft (300 m)	Maximum Concentration[b]	Assumed Background (μg/m³) (Refer to Table 4.3.3.3-1)	Background + 300 m Location (μg/m³)	NAAQS Limits (μg/m³)
Sulfur dioxide (SO_2)	Annual[c]	0.03	0.05	7.9	7.9	80
	24-hr	0.30	0.60	55.8	56.1	365
	3-hr	0.70	1.40	140.7	141.4	1,300
Carbon monoxide (CO)	8-hr	21	40	2,207	2,228	10,000
	1-hr	30	57	3,602	3,632	40,000
Nitrogen dioxide (NO_2)[d]	Annual[c]	5.0	9.0	61.1	66.1	100
Particulate (PM_{10})	Annual[c]	0.60	1.10	20.0	20.6	50
	24-hr	6.80	13.30	47.0	53.8	150

[a] Factors used to convert from 1-hr averages to long periods taken from EPA 1977.
[b] Concentration at 984 ft (300 m) estimated boundary and maximum concentration [occurring at 174 ft (53 m)] estimated by EPA – Screen 3 Model (v. 96043). Maximum concentration location is expected to be "on-site."
[c] Annual concentrations reflect 33% estimated (conservative) annual usage factor.
[d] Estimated concentration in this table includes all NO_x compounds and not only NO_2 for NAAQS.

Table 5.4.3.2-2. Comparison of worst-case fuel burning emission levels to de minimis levels.

Combustion Product Pollutant	Worst-Case Emissions (tons/yr)	Deminimis Level (tons/yr)
VOCs	0.78	25
NO_x	15.28	25
SO_2	0.09	100
CO	3.20	100
PM-10	1.84	100

from these generator testings would not affect overall air quality, and effects on air quality from the construction or operation of the proposed SNS facility would be negligible.

5.4.4 NOISE

Sound emitted from construction equipment is expected to be temporary and local in nature. This type of noise is specifically exempted from compliance with the Illinois Noise Pollution Control Regulations (IPCD 1973, Rule 208-Exemption). No unusual or significant noise impacts are expected from construction of the proposed SNS facility.

Operations at the proposed SNS facility would generate some noise, caused particularly by site traffic and cooling towers. However, these facilities would be designed to satisfy Illinois State Noise Standards and DOE criteria for occupational safety and health. In general, sound levels would be characteristic of a light industrial setting. Effects on residential areas would be attenuated by the distance from the SNS [>0.4 miles (>0.6 km)] and by the forested buffer zone [at 0 to 0.4 miles (0 to 0.6 km)]. On-site, the level of noise from the proposed SNS facility would be typical of accelerator facilities, and any effects would be negligible when compared to ambient levels.

5.4.5 ECOLOGICAL RESOURCES

This section describes the potential effects construction and operation of the proposed SNS would have on ecological resources in ANL. It includes potential effects on terrestrial and aquatic resources, wetlands, and threatened and endangered species.

5.4.5.1 Terrestrial Resources

For construction of the proposed SNS facility at ANL, 110 acres (45 ha) of land would be cleared of vegetation. A large portion of this area has been disturbed, and its use by wildlife is limited. However, the area in the vicinity of the proposed SNS site has seen little recent disturbance, and the high diversity of habitats in this area supports a large number of wildlife species.

Construction and operation of the proposed SNS facility would reduce wildlife population levels on the proposed SNS site and in adjacent areas over the long term. The Waterfall Glen Nature Preserve may provide a refuge for the displaced wildlife. However, the population levels would be permanently reduced by an amount generally proportional to the amount of habitat lost (Kroodsma 1985, as cited in DOE-CH 1990).

Construction and operation activities and the associated noise and human presence would disturb wildlife occupying areas adjacent to the proposed site. This could result in emigration of some sensitive species from the surrounding area, although many of the species would adjust to the disturbance. To help minimize the disturbance to wildlife, workers would be prevented from entering undisturbed areas delineated before construction.

Except for the fallow deer, the species that would be affected are typical of the surrounding region and are not particularly rare or important as game animals. Generally, these effects on terrestrial biota would be minor.

5.4.5.2 Wetlands

Approximately 3.5 acres (1.4 ha) of wetlands on the proposed SNS site lie within the proposed footprint and would be eliminated by construction activities. This represents approximately 20 percent of the wetlands on and in the vicinity of the proposed SNS site and approximately 7.8 percent of the total area of jurisdictional wetlands on ANL property. All of the alternative sites considered for the SNS contained wetlands and streams; thus, selection of a site that would completely avoid wetland encroachment was not possible. Wetland effects are minimized to the extent that the selected site does not contain either of the two main streams on ANL land and minimizes encroachment on their associated wetlands.

These wetlands provide habitat for area wildlife, such as amphibians and wetland birds. Their primary functions, in addition to provision of wildlife habitat, most likely include flood-flow alteration, nutrient transformation, and organic material production and export. In accordance with Section 404 of the federal Clean Water Act (CWA), a permit from the USACOE would be required for construction in these wetlands. As part of this permit, DOE would consult with the USACOE on plans to mitigate this loss of wetlands. The most common mitigation for destruction of wetlands at ANL is replacement (an equivalent area of wetland habitat created, preferably in the watershed of the impacted wetlands). Because one of the wetlands that would be destroyed is relatively large, approximately 2.7 acres (1.1 ha), it would be difficult to locate a replacement wetland in the same watershed. One possibility that would be investigated would be enhancement of existing wetlands along Freund Brook.

Wetland areas in the vicinity of the proposed SNS site may be affected during construction. Proper construction techniques, including erosion and sedimentation control, would reduce the potential for indirect effects on these wetlands. In consultation with the USACOE, DOE would develop a plan for the protection of these wetlands. DOE would include details of the mitigation measures in the MAP (refer to Section 1.4).

A formal floodplain/wetlands assessment document has been prepared for the proposed action at the ANL site in accordance with the DOE regulations in 10 CFR 1022.12. This document is included as Appendix H of this FEIS.

5.4.5.3 Aquatic Resources

All precipitation runoff from the proposed SNS site would be directed to an approximate 2-acre (0.81-ha) retention basin. Cooling tower blowdown would also be released to this basin. The rate of water discharge from the basin would be up to 350 gpm (1,325 lpm) through a standpipe and into a small tributary of Sawmill Creek. The cooling tower blowdown would be elevated in temperature, and it would contain chemical biocides and antiscaling agents. The source of the makeup water for the SNS cooling towers would be the nonpotable laboratory water system; therefore, the blowdown would not contain chlorine. As described in Chapter 3, the retention basin would be designed to reduce the temperature of the water to the ambient temperature of the receiving stream.

Effluent from the retention basin would eventually be discharged to the small stream in the north end of the proposed SNS site. This stream flows through the Waterfall Glen Nature Preserve and empties into Sawmill Creek, which flows into the Des Plaines River. The addition of this discharge to the base flow of the tributary would increase water flow through the stream channel and associated wetlands. Changes in the biotic community of the tributary may result from this increased flow. Unfortunately, little information about this stream was available for inclusion in the FEIS. Consequently, the potential effects of the effluent discharge of the proposed SNS facility on the tributary could not be described fully. However, because of its location and the fact that Sawmill Creek receives effluents from ANL, the potential effects from the proposed SNS effluents would be expected to be minor.

Freund Brook would receive no operational discharges from the proposed SNS, but construction activities could increase runoff discharge and sediment loading in this stream. Without protection, this could affect the habitat within Freund Brook. Because the substrate of the brook is coarse rock and gravel, the sediments washed into it could settle on the substrate, displacing the current bottom-dwelling fauna. To avoid this potential effect, DOE would establish a 100- to 200-ft (30- to 68-m) buffer zone along Freund Brook. Vegetation within this buffer zone would not be disturbed during construction of the proposed SNS. Erosion control measures, including silt fencing and preservation of native vegetation, would minimize sediment loading in the brook during construction. As a result, effects upon Freund Brook would be minimal.

5.4.5.4 Threatened and Endangered Species

No protected species have been identified on the proposed SNS site at ANL (see Section 4.3.5.4). The great egret, black-crowned night heron, and pied-billed grebe, three state-listed endangered bird species, have been observed in the wetlands southeast of the site. However, these species are not known to breed there or elsewhere in ANL. In addition, these wetlands would not be affected by the proposed SNS project. No other protected species are known to occur in the vicinity of the proposed SNS site. Consequently, no known protected species would be affected by implementation of the proposed action on the SNS site in ANL.

A systematic survey of the proposed SNS site for protected species would be conducted prior to the start of land clearing and construction. Because definitive identification of many protected plants can only be made when they are flowering, this survey would extend over the spring, summer, and fall seasons to maximize the probability of finding them. If found, appropriate mitigation measures would be taken to protect these plants during construction and operation of the proposed SNS facility. DOE would include details of the mitigation measures in the MAP (refer to Section 1.4).

5.4.6 Socioeconomic and Demographic Environment

The socioeconomic impact section identifies whether construction and operation of the proposed project (and associated worker in-migration from outside the ROI) may adversely affect regional services and infrastructure. It also presents an estimate of the financial effects (employment, income, taxes, and economic output) that would be generated locally in the form of worker salaries, indirect effects, and induced effects. Unless otherwise noted, economic effects are described in escalated-year dollars.

The ROI associated with ANL includes Cook, DuPage, Kane, and Will counties, Illinois. This 2,600 mi² (6,734 km²) region was selected because it forms the area within which at least

95 percent of ANL workers currently reside. It is, therefore, the region within which the majority of socioeconomic effects are expected to occur. Socioeconomic effects beyond the ROI are generally expected to be minor.

The total local construction cost is estimated to be approximately $332 million (escalated dollars), and the peak construction year would be 2002, when 578 workers would be on-site (Brown 1998a). Of this total, about three-fourths (433 individuals) would likely be hired from the ROI, and 144 would come from outside the area. An approximate average of 300 SNS workers per year would be employed, including all construction, management, engineering design, and other technical and commissioning staff. Construction of the 1-MW SNS is the bounding case for analysis of construction effects. If the SNS is upgraded to 4 MW, additional construction would occur, but this would be much less than the effects associated with the initial construction of the 1-MW SNS.

Operation of the proposed SNS at 1 MW would begin in 2006 with a staff of 250 persons. Later, if the proposed SNS is upgraded to 4 MW, 375 persons would be employed. The 4-MW case is used for this analysis as the bounding case, and the effects of the proposed 1-MW SNS on the ROI would be similar but slightly less than the 4-MW case.

5.4.6.1 Demographic Characteristics

It is assumed that approximately 75 percent of all construction workers would come from the local region (Brown 1998a). Most of the construction workers would be general craft laborers, and the specialized technical components would be contracted out and fabricated in places not yet known. All locally hired construction workers would commute to the job site from existing residences and would not relocate closer to the site. The experience with past major construction projects has been that most in-migrating workers would temporarily move to the project area but would usually commute home on weekends or periodically. These individuals would generally not bring families to the ROI for the construction period. However, even if all of the in-migrating workers brought families into the ROI, the total (temporary) population increase would be less than 500 persons in the peak year, including spouses and children. This would be a temporary increase in population of much less than 0.01 percent and is, therefore, negligible.

People with the technical expertise needed to operate the proposed SNS facility currently reside in the ROI. However, it is also expected that some plant operators would come from outside the local region. It is assumed that about half of the 375-person operating workforce (for the bounding 4-MW case) would come from outside the area. It is further assumed that these households would be the same size as the national average, because it is not known from where they would in-migrate. It is conservatively estimated that in 2006 the total population increase associated with operations would be about 600 individuals, including spouses and children. The facility operators would be “permanent” residents of the ROI, and little additional in-migration would occur in subsequent years. The population increase associated with construction and operations would represent much less than 0.01 percent of the local population and is, therefore, negligible.

5.4.6.2 Housing

With about 196,000 vacant "dwelling units" (refer to Section 4.3.6.2) in the four-county ROI, workers should easily be able to find apartments to rent or houses to purchase. Some new housing would probably be constructed. However, existing vacancies and historical construction rates indicate that housing would be available for this small in-migration.

5.4.6.3 Infrastructure

Potential effects upon infrastructure are closely tied to population growth. Because the expected permanent in-migration is only 600 individuals, effects on infrastructure would be relatively minor.

There are more than 1,100 schools with an enrollment of 1.7 million students in the ROI. The addition of about 300 children to the ROI would, therefore, be minor. Even if all 300 children attended schools in Kane County, the current teacher-student ration of 1:17 would be unchanged. Effects would also be minor for police and fire protection, health care, and other services.

5.4.6.4 Local Economy

Design of the proposed SNS facility would begin in 1999, and the first construction managers and workers would begin work in FY 2000. The majority of the construction would occur from FY 2001 through FY 2004, with the peak construction employment occurring in FY 2002. Testing of the proposed SNS would be from FY 2003 through FY 2005. Operations are planned to begin by the end of FY 2005; FY 2006 would be the first full year of operations (see Figure 3.2.2-1).

Table 5.4.6.4-1 presents the results of the IMPLAN modeling for the period 1999 through 2006. Economic benefits in the form of jobs, wages, business taxes, and income would begin to accrue during the first year of the project in FY 1999. These economic benefits in the ROI would increase as construction and other associated project activities increase. Design and construction employment would be highest in FY 2002, and there would be an estimated 1,795 total (direct, indirect, and induced) new jobs created at ANL. This trend would begin to diminish in FY 2003 as design and construction employment decreased and would continue to decrease until construction is completed in FY 2004. Facility operations would begin in FY 2005. Operations would reflect substantial regional spending for operator salaries, supplies, utilities, and administrative costs.

The proposed SNS is planned to operate for 40 years. If the level of operation is the same as the 4-MW case measured in the first full year (FY 2006), it is expected that facility operation will continue to support 1,776 jobs each of the following years of operation. Other annual operations effects would include $82.9 million in local wages, $8.7 million in business taxes, $91.2 million in personal income, and $211.3 million in total output

Because of the very large regional population, construction of the facility would not be expected to lower the region's total unemployment rate of 5.2 percent. During operations, the unemployment rate may potentially decrease from 5.2 percent to 5.1 percent. The effects of operating the proposed 1-MW SNS would be similar but slightly lower.

Table 5.4.6.4-1. ANL IMPLAN modeling results—construction and operations impacts.

	1999	2000	2001	2002	2003	2004	2005	2006
Employment								
Direct	115	222	522	634	451	305	42	747
Indirect	88	158	380	475	341	234	32	354
Induced	126	231	551	684	489	334	46	676
Total	328	611	1,452	1,795	1,281	873	120	1,776
Wages								
Direct	$8,288,948	$15,673,685	$38,031,862	$48,011,602	$34,981,555	$24,326,509	$3,405,428	$44,896,760
Indirect	$3,174,669	$5,871,680	$14,351,825	$18,270,892	$13,387,061	$9,361,369	$1,313,399	$15,219,533
Induced	$3,711,096	$6,946,078	$16,868,390	$21,322,235	$15,540,350	$10,810,520	$1,512,284	$22,700,801
Total	$15,174,713	$28,491,443	$69,252,078	$87,604,730	$63,908,966	$44,498,398	$6,231,111	$82,817,092
Business Tax								
Direct	$113,558	$317,964	$701,796	$780,090	$522,183	$332,587	$46,170	$3,322,188
Indirect	$377,034	$702,723	$1,703,248	$2,147,712	$1,561,134	$1,082,963	$151,043	$1,512,655
Induced	$649,948	$1,214,170	$2,942,643	$3,711,773	$2,699,322	$1,873,469	$261,457	$3,915,033
Total	$1,140,540	$2,234,587	$5,347,687	$6,639,575	$4,782,639	$3,289,019	$458,670	$8,749,876
Income								
Direct	$9,303,482	$17,513,984	$42,548,163	$53,794,563	$39,230,485	$27,304,639	$3,822,649	$47,892,968
Indirect	$3,569,229	$6,607,919	$16,167,888	$20,604,452	$15,112,667	$10,579,212	$1,485,821	$17,998,706
Induced	$4,111,446	$7,701,094	$18,715,390	$23,673,539	$17,265,918	$12,018,978	$1,682,444	$25,271,398
Total	$16,984,158	$31,822,997	$77,431,441	$98,072,554	$71,609,070	$49,902,829	$6,990,914	$91,163,074
Output								
Direct	$23,293,804	$44,358,310	$107,435,152	$135,297,745	$98,436,491	$68,359,854	$9,568,254	$103,295,792
Indirect	$8,265,086	$15,431,175	$37,620,415	$47,742,063	$34,913,251	$24,368,507	$3,417,922	$41,430,213
Induced	$10,788,440	$20,221,876	$4,917,774	$62,248,458	$45,430,363	$31,645,379	$4,432,662	$66,623,763
Total	$42,347,330	$80,011,362	$194,233,291	$245,288,267	$178,780,104	$124,373,740	$17,418,838	$211,349,766

Source: IMPLAN Pro.

5.4.6.5 Environmental Justice

As identified in Figures 4.3.6.5-1 and 4.3.6.5-2, minority populations and low-income populations reside within 50 miles (80 km) of the proposed SNS site. For environmental justice effects to occur, there must be high and adverse human health or environmental effects that disproportionately affect minority populations or low-income populations. The human health and safety analyses show that hazardous chemical and radiological releases from normal operations of the proposed SNS facility at 1-MW and 4-MW power levels would be within regulatory limits. Annual radiological doses are given in Section 5.4.9, and the data show that normal air emissions of the proposed 1-MW SNS are negligible and would not result in adverse human health or environmental impacts off-site to the public. Therefore, operation of the proposed SNS would not have disproportionately high and adverse effects on minority or low-income populations.

Radiation doses to the public from both normal operations and accident conditions would not create high and adverse effects. Less than two (1.6) LCFs are calculated at the 4-MW power level over a 40-year operations period. If the facility operated for 10 years at 1 MW and 30 years at 4 MW, the calculated number of LCFs could be reduced (refer to Section 5.2.9.2.1). An LCF is a cumulative measure from the entire population (within a 50-mi or 80-km radius) of over 8,000,000 people used for comparing alternatives and does not necessarily indicate that a fatality would occur (refer to Section 5.2.9.2.1). Also, 25 accident scenarios would result in airborne releases. The consequences of most of these accidents would be negligible at power levels of both 1 MW and 4 MW. Four accidents are calculated to induce LCFs in the off-site population. The predominant wind direction is from the south, and wind from the southwest quadrant occurs almost 50 percent of the time (Figure 4.3.3.2-1). Figures 4.3.6.5-1 and 4.3.6.5-2 show a small concentration of minority population to the west of the proposed SNS site, but the site is mostly surrounded by non-minority, higher income population, especially in the path of the predominant wind direction. The public, including minority and low-income persons, could be in the path of an off-site airborne release. However, the analysis has shown that there would not be high and/or adverse effects on any of the population; therefore, there would be no disproportionate risk of significantly high and adverse effects on minority and low-income populations.

A number of uncertainties are associated with the evaluation of potential effects due to subsistence consumption. ANL developed an article reviewing the literature on subsistence consumption (Elliot 1994) and found that (1) "the majority of the studies that have been conducted to date are focused on site- or region-specific exposure concerns. At present, it is unclear whether the findings of these studies are representative of consumption and exposure levels among minority populations at a national level"; (2) "a large number of risk assessment studies focusing on fish and wildlife consumption examined whole populations without distinguishing between consumption and exposure patterns of specific ethnic (or other) subpopulations"; (3) "the vast majority of studies have focused on fish consumption as an exposure pathway. Few examined wildlife consumption and contamination, and even in such cases the studies were not motivated by minority exposure concerns"; and (4) "the majority populations were not significantly higher than for the population as a whole." Specific data on subsistence living are not available for the ANL region. However, DOE is unaware of any subsistence population residing in the vicinity of the proposed SNS site. Therefore, no adverse effects on such populations are expected.

In order to assemble and disseminate information on subsistence hunting and fishing, DOE began publishing *A Department of Energy Environmental Justice Newsletter: Subsistence and Environmental Health* in the spring of 1996. The newsletter is available in the public reading rooms. Three goals of the newsletter are (1) "to provide useful information about the health implications of consuming contaminated fish, wildlife, livestock products, or vegetation"; (2) "to provide information about projects and programs at DOE and other Federal and State agencies that address the problems associated with consuming contaminated fish, wildlife, livestock products, or vegetation"; and (3) "to receive relevant information from readers." In addition to the newsletter, DOE has a new project under way to identify what information is being collected on subsistence consumption by other federal agencies and to serve as a clearinghouse for such information (DOE 1996e).

No discharges of radioactive water to surface water would occur because all of the wastes generated during construction and operation of the proposed SNS facility would be transported to ANL for processing. These facilities and the management processes for these wastes are described in Section 5.4.11. All chemical releases would be regulated by NPDES permits and would be in compliance with federal and state regulations. As such, there would be no incremental effects on fish and other edible aquatic life in areas surrounding the proposed SNS site.

The analyses indicate that socioeconomic changes resulting from implementing the proposed SNS would not lead to environmental justice effects. The proposed SNS project would provide economic benefits through generating additional employment and income in the affected region (refer to Table 5.4.6.4-1). There would be increased traffic congestion; however, this effect would not disproportionately affect minority or low-income communities because traffic patterns would not be different between low-income and minority populations and the rest of the surrounding population (refer to Section 5.4.10.1). Overall, nothing from the construction and operation of the proposed SNS would pose high and adverse human health or environmental effects that would disproportionately affect minority or low-income populations.

5.4.7 CULTURAL RESOURCES

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at ANL. In addition, the locations of ancillary structures such as a retention basin and a switchyard have not been determined. As a result, the effects of the proposed action on any cultural resources that may occur in these areas cannot be assessed at this time. If the proposed SNS site at ANL were chosen for construction, a cultural resources survey and an assessment of potential effects would be conducted prior to the initiation of construction-related activities in these areas. Appropriate measures would be implemented to mitigate any identified effects on cultural resources. These measures would include avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation.

5.4.7.1 Prehistoric Resources

No prehistoric archaeological sites have been identified on the proposed SNS site at ANL, but site 11DU207 is located adjacent to the perimeter of the proposed SNS site. This location may result in disturbance or destruction of the site by construction activities from the proposed SNS. Whether or not this would represent an effect on a significant cultural resource is unknown, because the eligibility of this site for listing on the NRHP has not been assessed by ANL. If it is eligible, construction of the proposed SNS may affect a prehistoric cultural resource. If it is not eligible, construction of the proposed SNS would have no effect on prehistoric cultural resources.

The eligibility of 11DU207 for listing on the NRHP would be assessed prior to the initiation of construction-related activities on the proposed SNS site at ANL if this site is selected for construction. If the site is eligible, appropriate measures would be implemented to mitigate effects. These measures would include avoidance, if possible, or archaeological excavation. As a result of these measures, the overall effects of the proposed action on prehistoric cultural resources would be minimal.

5.4.7.2 Historic Resources

Building 829 is the only Historic Period structure remaining in the 800 Area at ANL. This building would be destroyed by site preparation activities under the proposed action. Because this building is not eligible for listing on the NRHP, its destruction would not represent an effect on a cultural resource.

5.4.7.3 Traditional Cultural Properties

DOE Chicago Operations Office (DOE-CH) has found no Native American tribal representatives in the ANL area. Consequently, it has not been possible for DOE-CH to consult with them about the potential occurrence of TCPs on the proposed SNS site and at locations in its immediate vicinity. In addition, no Native American TCPs have been identified in the ANL area, and no Native American groups have expressed an interest in the occurrence and preservation of TCPs at ANL. As a result, it has been concluded that no TCPs occur on the proposed SNS site or anywhere else on laboratory land (White, B. 1998c: 1; Wescott 1998a: 1). Therefore, implementation of the proposed action would have no effect on TCPs.

5.4.8 LAND USE

The potential effects of the proposed action on land use in the vicinity of ANL, within the boundaries of ANL, and on the proposed SNS site are assessed in this section. The assessments cover potential effects on current land uses and zoning for future land use. Furthermore, the potential effects of the proposed action on parklands, nature preserves, major recreational resources, and visual resources are assessed.

5.4.8.1 Current Land Use

Current land use in the area surrounding ANL is driven by the relationship between existing land characteristics and socioeconomic forces acting at the local and regional levels. Similarly, current land use within the ANL boundaries results from selectively using the existing characteristics of the land to meet various DOE mission requirements. The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the basic land characteristics and other forces that influence land use in these areas. Consequently, implementation of the proposed action on the proposed SNS site in ANL would have no reasonably discernible effects on land use in the vicinity of ANL and throughout most of the laboratory area. However, current uses of the land within and near the proposed SNS site would be more subject to effects.

The current land use designations within the proposed SNS site are Ecology Plots (Nos. 6, 7, and 8), Support Services (minor laboratory support services operations in the 800 Area), and undeveloped Open Space. Furthermore, several contaminated sites are located within the perimeter of the proposed SNS site. They are Area of Concern (AOC) F and Solid Waste Management Units (SWMUs) 170, 736, and 744.

Construction of the proposed SNS facility would introduce large-scale development to areas of previously undeveloped Open Space and Ecology Plot land within the proposed SNS site utility corridors, and rights-of-way. Considering the density of current development at ANL, Ecology Plot and other Open Space land are in relatively short supply (refer to Figure 4.3.8.2-1). Nonetheless, it should be emphasized that ANL has virtually no other types of land for the construction of large-scale facilities.

DOE has a federally mandated role as trustee of the natural and cultural resources on its lands. Although some undeveloped trusteeship lands would be used for the proposed SNS, this use is necessary. Previously developed lands that meet project requirements are not present in sufficient quantities to meet all project needs.

The proposed action would have no effects on the use of land by environmental research projects. The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects. The ecology plots at ANL are areas of land potentially suitable for ecological research. However, little, if any, ecological research has ever been conducted in these areas. There are no currently ongoing ecological research projects in Ecology Plot Nos. 6, 7, and 8 on the SNS site.

Construction of the proposed SNS facility would displace any remaining support services operations in the 800 Area, and it would result in demolition of the remaining buildings and features in this area. The current land use designations for the proposed SNS site would shift to a programmatic category specific to the facility or the Programmatic Mission—Other Areas category. These effects would be minimal, especially considering the long-established pattern of moving support services operations out of the 800 Area and demolishing area buildings.

Extensive earthmoving during construction of the proposed SNS would have the potential to destroy the SWMUs and AOC on the proposed SNS site. SWMUs 176 and 182, located adjacent to the proposed SNS site, could also be affected by these activities. If these areas are not remediated prior to the initiation of construction of the proposed SNS, contamination could be spread to currently uncontaminated areas (refer to Section 5.4.9.1). Realistically, site preparation and other construction activities could not be initiated on the proposed site until current environmental restoration concerns involving these AOCs and SWMUs are adequately addressed. These concerns include continuing characterization, site remediation, and dealing with already established plans to close SWMU 736 (800 Area Transformer Storage Pad) with an impermeable RCRA cap. The prospects for adequately addressing these concerns between the timing of a possible decision to construct the proposed SNS on the selected site in ANL and the scheduled start date for SNS construction remain uncertain. If they cannot be addressed in this time frame, the construction schedule for the proposed SNS would be delayed. If they can be addressed within this time frame, a beneficial effect of the proposed action would be use of a partial brownfield site for a new research facility.

5.4.8.2 Future Land Use

The proposed SNS site is zoned for future use according to the following designations: Programmatic Mission—Other Areas, Programmatic Mission—200 Area, Ecology Plot No. 8, Open Space, and Support Services. Most of the site is within the first two zones, which are dedicated to new research facilities, laboratories, and offices. Operation of the proposed SNS would be consistent with this zoning. It would appear to be inconsistent with using a portion of Ecology Plot No. 8 and the Open Space, but the expansion of other land use zones into areas currently designated as Ecology Plots and Open Space has been a guiding principle behind the current zoning of ANL land. Therefore, use of these areas for the proposed SNS may be viewed as a logical extension of this planning principle. Use of the Support Services zone for the proposed SNS is clearly at variance with current zoning, but this zone is barely within the western boundary of the proposed SNS site. As a result, the amount of Support Services land used for the proposed SNS would be negligible.

Portions of the proposed SNS site would become contaminated with pollutants from operations. Current plans call for in situ decommissioning of the SNS when its operational life cycle is completed. As a result of in situ decommissioning, some contaminated components would remain in place on the SNS site. This could limit the future use of land on the site for other purposes. Construction and operation of the SNS could also limit the future use of land areas adjacent to the SNS site.

No future uses of SNS site and vicinity land for environmental research are planned. This includes the portions of Ecology Plot Nos. 6, 7, and 8 that would be adjacent to the proposed SNS site. As a result, the effects of the proposed action on future research projects cannot be assessed.

5.4.8.3 Parks, Preserves, and Recreational Resources

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses outside ANL and within the laboratory boundaries. Consequently, implementation of the proposed action on the proposed SNS site in ANL would have no reasonably discernible effects on these specific land uses: Forest Preserve District of Cook County (recreation on Saganashkee Slough, McGinnis Slough, and small lakes); hunting and fishing in Sawmill Creek and the Des Plaines River; recreational use of an area adjacent to the southwest boundary of ANL; Waterfall Glen Nature Preserve; and ANL Park.

5.4.8.4 Visual Resources

During construction and operations, the proposed SNS facilities would not be visible from points outside the Waterfall Glen Nature preserve because the preserve is heavily forested. Their close proximity to the west perimeter of ANL, which is adjacent to the nature preserve, would make them visible from points near the ANL fence in the preserve, especially on the west side during late autumn, winter, and early spring. The proposed SNS facilities would be visible from points within the laboratory boundaries. Because the current views at these locations contain buildings and other features characteristic of development, these effects would be minimal.

5.4.9 HUMAN HEALTH

Construction and operation of the proposed SNS at ANL could pose a potential risk of adverse effects on the health of workers and of the public living in the vicinity of the facility. Potential adverse effects include

- Traffic-related fatalities and injuries to workers and the public.
- Occupational fatalities and injuries to workers.
- Exposure of workers and the public to radiation or radioactive materials.
- Exposure of workers and the public to toxic or hazardous materials.

This section evaluates the potential magnitude of these effects at ANL and the likelihood that they would occur during three phases or conditions:

- construction,
- normal operations, and
- accident conditions.

5.4.9.1 Construction

The potential effects on the health of construction workers, other ANL workers, and members of the public would be essentially the same for any of the proposed locations, because the size of the construction work force would be the same. Potential effects of construction of the SNS include construction accidents and traffic accidents.

On the basis of national traffic accident rates (1.74×10^{-8} fatalities per vehicle mile and 1.05×10^{-6} disabling injuries per vehicle mile) and the anticipated total mileage of commuting construction workers (2,074 person-years × 250 work days/person-year × 0.806 daily round-trips/worker × 20 miles/round-trip), less than one additional fatality and nine additional disabling injuries could occur as a result of increased commuter traffic during the 7-year construction period of the proposed SNS.

On the basis of national construction accident rates, 0.31 fatality (0.00015 fatalities/worker-year × 2,074 worker-years) and 110 disabling injuries (0.053 disabling injuries/worker-year × 2,074 worker-years) could occur as a result of occupational accidents during construction of the proposed SNS.

The size of the construction workforce would be the same at all of the proposed locations, and the number of traffic-related disabling injuries and fatalities would be expected to be the same; however, because the existing ANL work force is smaller than at ORNL and LANL, the relative increase would be greater. Based on data in Section 5.4.10.1, a maximum increase of approximately 9 percent could occur from the addition of the SNS construction workers to daily commuter traffic in the vicinity of ANL.

SNS construction workers at ANL would be exposed to the same risk of occupational injury or fatalities as construction workers at the other proposed locations, but ANL workers could be exposed to other additional risks. The preferred site for the proposed SNS at ANL is within the 800 Area (refer to Appendix B). A number of RCRA SWMUs are located within the 800 Area. Several of these SWMUs contain low levels of volatile organic compounds (VOC) and semi-volatile organic compounds and polychlorinated biphenyls (PCBs). Some radioactive materials may also be present. Construction activities such as excavation, grading, and filling could disturb these areas and expose workers to toxic materials.

5.4.9.2 Normal Operations

The number of SNS workers is independent of the location of the facility. The absolute number of industrial accidents and traffic-related injuries and fatalities would be expected to be essentially the same as at the other proposed locations.

On the basis of national traffic accident rates (0.0174 fatalities per million vehicle-mile and 1.05 disabling injuries per million vehicle-mile) and the anticipated total mileage of 60 million miles (375 commuting workers × 20 miles/trip × 0.806 trips/day × 250 days/year × 40 years), 1 additional fatality and 63 additional disabling injuries could occur as a result of increased commuter traffic during the 40-year operational life of the proposed SNS.

National industrial workplace accident rate data applied to the workforce for the proposed SNS would yield less than one fatality (3.4 deaths annually/100,000 workers × 375 workers × 40 years) and 500 disabling injuries (3,400 disabling injuries annually/100,000 workers × 375 workers × 40 years) occurring over the 40-year operational life of the proposed SNS.

The relative increase would be greater at ANL than at ORNL or LANL because ANL's smaller existing work force. Based on data shown in Section 5.4.10.1, the addition of the maximum of 375 SNS workers to the daily ANL traffic flow could increase the number of disabling injuries and fatalities by approximately 6 percent relative to existing rates.

The proposed SNS would generate and release direct radiation, radioactive materials, and toxic materials. Members of the public and workers at the proposed SNS facility and other adjacent facilities would be exposed to such radiation and emissions. The quantities and release rates of these materials would be the same as for other proposed locations. The impact of the ANL site-specific meteorology, distances to site boundaries, and population density and distribution are discussed in the following sections.

5.4.9.2.1 Radiation and Radioactive Emissions

This section assesses the potential effects of direct radiation and airborne emissions of radioactive materials from the proposed SNS based on the methods and dose-to-risk conversion factors discussed in Section 5.1.9.

Direct Radiation

Exposure of SNS workers to direct radiation from the proposed SNS at ANL would be expected to be the same as other proposed locations because the SNS Shielding Design Policy is applicable regardless of location.

The preferred location for the proposed SNS facility at ANL is near existing facilities that emit small amounts of direct radiation. As a result, dose to SNS workers could be slightly higher than under the LANL and ORNL alternatives. The difference, if any, would be on the order of a few mrem. The average total EDE to all ANL workers was 92 mrem in 1996 (DOE 1996f).

The preferred site for the proposed SNS facility at ANL is also relatively close to the site boundary at several points. Based on ANL monitoring results for 1996 that reflect the contributions of direct radiation from several major accelerator facilities (Golchert and Kolzow 1997), the potential increase in direct radiation levels at the ANL boundary, if any, would not be expected to be more than a few mrem/yr.

Radioactive Emissions

Radioactive emissions from routine operations of the proposed SNS would consist of releases to the atmosphere from two stacks—the Tunnel Confinement Exhaust Stack and the Target Building Exhaust Stack. Radionuclide activities in these emissions are listed in Table G-1 of Appendix G and are the same regardless of the facility location. Existing EPA-permitted commercial disposal facilities servicing ANL have sufficient capacity to accommodate LLLW and process waste from the proposed SNS, and these wastes would be processed in accordance with existing permits for these facilities.

The estimated annual doses to workers and the public from normal SNS airborne emissions are shown in Table 5.4.9.2.1-1. The methods and assumptions used in the calculation of doses are discussed in Section 5.1.9 and in greater detail in Appendix G.

Even under the conservative assumptions regarding the exposure pathways, these estimated doses would be in compliance with applicable regulations. The annual dose to the maximally exposed individual member of the public for operation at a 1-MW beam power (3.2 mrem) is 32 percent of the 10 mrem/yr limit (40 CFR Part 61) that DOE expects the facility to meet, and the maximally exposed individual annual dose for operation at a 4-MW beam power (12 mrem) is 120 percent of the dose. Compliance with 40 CFR Part 61 is determined based on dose at locations actually occupied by people. The maximally exposed individual dose at such locations from existing operations at ANL is very low, only 0.021 mrem in 1996 (Golchert and Kolzow 1997). Because the dose of 12 mrem projected for SNS operations at 4 MW is based on a hypothetical receptor much nearer to the site, ANL would remain in compliance with the addition of emissions from the proposed SNS facility.

Dose at the ANL boundary from emissions from the Tunnel Confinement Exhaust is 0.14 mrem and is dominated by radionuclides in activated concrete dust. Dose at the ANL boundary from emissions from the Target Building Exhaust is dominated by ^{3}H (57 percent) with smaller contributions from ^{14}C, ^{125}I, and ^{203}Hg. These radionuclides are listed in order of decreasing

Table 5.4.9.2.1-1. Estimated annual radiological dose from proposed SNS normal emissions at ANL.[a]

Receptor	1-MW Power Level: Target Building[b]	1-MW Power Level: Tunnel Confinement[c]	4-MW Power Level: Target Building[b]	4-MW Power Level: Tunnel Confinement[c]
Maximum Individuals (mrem)				
Off-site Public[d]	3.1	0.14	12	0.12
Uninvolved Workers[d]	0.064	0.056	0.26	0.085
Populations (person-rem)				
Off-site Public[e] (8,176,177 persons)	20	0.13	79	0.13
Uninvolved Workers[e] (3,242 persons)	0.037	0.012	0.15	0.019

[a] Doses shown include the contributions of inhalation, immersion, and "ground shine" for workers and the off-site public and ingestion for the off-site public.

[b] Target Building emissions include hot offgas exhaust, primary confinement exhaust, secondary confinement exhaust from the target building, and activated air from the beam dump buildings.

[c] Tunnel confinement emissions include activated air and concrete dust from the linac tunnel, high-energy beam transport (HEBT) tunnel(s), ring tunnel(s), and ring-to-target beam transport tunnel(s).

[d] The maximally exposed individuals are hypothetical receptors. The member of the public is assumed to occupy a position at the ANL site boundary for 8,760 hr/yr and to produce their entire food supply at this location. The maximally exposed uninvolved worker is assumed to occupy a position within 1.2 miles (2 km) of the stack for 2,000 hr/yr.

[e] The off-site population consists of all individuals residing outside the ANL site boundary within 50 miles (80 km) of the site and is assumed to be present for 8,760 hr/yr. The involved/uninvolved worker population consists of all workers normally within 1.2 miles (2 km) of the facility. These workers are assumed to be present for 2,000 hr/yr.

dose and account for 99 percent of this component of the total individual dose.

To estimate the total consequences from SNS emissions of radioactive materials over the entire life of the facility, annual population dose is multiplied by operating life of the facility and by the dose-to-risk factor of 0.0005 LCFs/person-rem. For 40 years of operation at 1 MW, 0.4 LCFs would be projected. For 40 years at 4 MW, 1.6 LCFs would be projected. If the facility operated for 10 years at 1 MW and 30 years at 4 MW, 1.3 LCFs would be projected. These projected LCFs do not mean that any actual fatalities would occur as a result of SNS operations but provide a quantified magnitude for comparison to excess LCFs estimated for the other proposed locations.

5.4.9.2.2 Toxic Material Emissions

As discussed in Section 5.2.9.2.2, elemental mercury vapor is the only toxic material expected to be released from the proposed SNS under normal conditions. Based on the continuous annual release rate of 0.0171 mg/s and atmospheric dispersion factors specific to ANL, the maximum mercury concentration in areas that could be occupied by uninvolved workers would be 3.02×10^{-6} mg/m^3 in any 2-hr period and 3.51×10^{-7} mg/m^3 in any 8-hr period. These concentrations are at least

1/100,000th of the OSHA ceiling limit (0.1 mg/m^3) and the ACGIH recommended TLV-TWA (0.05 mg/m^3) for workers. The maximum average annual airborne mercury concentration at the site boundary would be 5.09 $\times$ 10^{-8} mg/m^3, 1/6,000th of the EPA Reference concentration for members of the public (0.0003 mg/m^3).

5.4.9.3 Accident Conditions

This section assesses the affects on human health of accidents that could potentially occur during operation of the proposed SNS at ANL.

5.4.9.3.1 Accident Scenarios

The accident scenarios and source terms for accidents that could potentially occur at the proposed SNS are the same for all alternative sites and are summarized in Table G-2 (refer to Appendix G). The details of these scenarios and source terms are provided in Appendix C. Table 3.2 defines the terminology used to describe the likelihood that a given accident could occur.

5.4.9.3.2 Direct Radiation

The frequencies of occurrence and consequences of accidents involving exposure to direct radiation have not been specifically analyzed. DOE's Shielding Design Policy for the proposed SNS is such that for the worst-case design-basis accident, the dose to the maximally exposed individual in an uncontrolled area would be limited to 1 rem and for a worker in a controlled area would be limited to 25 rem. The risks of this category of accidents would be the same for all proposed sites.

5.4.9.3.3 Radioactive Materials Accidents

DOE has performed a hazard analysis of potential accidents at the proposed SNS, and for those that could result in a release of radioactive material, it has estimated source terms. The DOE analysis is included as Appendix C. Accident scenarios, estimated frequencies of occurrence, and source terms are summarized in Table G-2 and are the same for all proposed SNS alternative sites. The methods used to evaluate the consequences of these accidents are discussed in Section 5.1.9 and in more detail in Appendix G.

Doses for these accidents, should they occur at an SNS facility at ANL, are listed in Table 5.4.9.3.3-1. With the exception of accident ID 16, all doses for accidents at a 4-MW facility would be four times higher than at a 1-MW facility. This is not the case for ID 16, the beyond-design-basis mercury spill, because of differences in the source term model (refer to Exhibit F of Appendix C). At 4 MW (ID 16b), some boiling of mercury is assumed, releasing a larger quantity of mercury than at 1 MW (ID 16a), where only evaporation is assumed.

The pattern of accident doses for the proposed SNS at ANL is similar to that for the other proposed locations. However, doses to individuals reflect the relative proximity of the proposed SNS to the ANL boundary, and population doses reflect the proximity to a major metropolitan area.

At a power level of 1 MW, the beyond-design-basis mercury spill accident (ID 16a) would have the highest dose of the potential accidents

Table 5.4.9.3.3-1. Radiological dose for SNS accident scenarios at ANL.

ID	Event	Frequency[b]	Source Term[c]	Maximum Individual (mrem)[a] Off-site Public 1 MW Beam	Maximum Individual (mrem)[a] Off-site Public 4 MW Beam	Maximum Individual (mrem)[a] Uninvolved Workers 1 MW Beam	Maximum Individual (mrem)[a] Uninvolved Workers 4 MW Beam	Population (person-rem)[a] Off-site Public 1 MW Beam	Population (person-rem)[a] Off-site Public 4 MW Beam	Population (person-rem)[a] Uninvolved Workers 1 MW Beam	Population (person-rem)[a] Uninvolved Workers 4 MW Beam
A. Accidents Involving Proposed SNS Target or Target Components											
2	Major loss of integrity of Hg Target Vessel or piping (Appendix C, Section 3.3)	a) Unlikely	Percent Inventory Mercury Iodine 0.142 0.142	6.7	26.8	3.8	15.2	300	1,200	3.1	12.4
		b) Extremely Unlikely	Percent Inventory Mercury Iodine 0.243 100	21	84	9.0	36.0	1,300	5,200	7.3	29.2
8	Loss of integrity in Target Component Cooling Loop (Appendix C, Section 3.9)	a) Anticipated	Bounded by annual release limits[d]	<10	<10	NA	NA	NA	NA	NA	NA
		b) Anticipated	Gases + Mist + 150 L of D_2O	3.9	15.6	0.31	1.24	32	128	0.18	0.72
		c) Anticipated	18 L of D_2O	0.002	0.008	0.001	0.004	0.057	0.228	0.001	0.004
		d) Anticipated	Gases + Mist + 150 L of H_2O	3.6	14.4	0.27	1.08	13	52	0.15	0.6
16	Beyond-Design-Basis Hg Spill (Appendix C, Section 3.17)	a) Beyond Extremely Unlikely	1 MW Percent Inventory Mercury Iodine 1.11 100	49		28		2,100		22	
		b) Beyond Extremely Unlikely	4 MW Percent Inventory Mercury Iodine 1.28 100		3,100		880		230,000		710

Table 5.4.9.3.3-1. Radiological dose for SNS accident scenarios at ANL – (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	**Event**	**Frequency[b]**	**Source Term[c]**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**
B. Accidents Involving proposed SNS Waste Systems											
17	Hg Condenser Failure (Appendix C, Section 4.1.1)	Anticipated	13.7 g mercury	0.013	0.052	0.004	0.016	0.6	0.24	0.004	0.016
18	Hg Charcoal Absorber Failure.[e] (Appendix C, Section 4.1.2)	Unlikely	14.8 g mercury	0.004	0.016	0.003	0.012	0.12	0.48	0.002	0.008
19	He Circulator Failure (Appendix C, Section 4.2.1)	Anticipated	1 day tritium production	<0.001	<0.001	<0.001	<0.001	0.012	0.048	0.001	0.001
20	Oxidation of Getter Bed (Appendix C, Section 4.2.2)	Unlikely	1 day tritium production	<0.001	<0.001	<0.001	<0.001	<0.012	0.048	0.001	0.001
21	Combustion of Getter Bed (Appendix C, Section 4.3.1)	Extremely Unlikely	1 year tritium production, 200 g depleted uranium	5.0	20.0	0.94	3.76	430	1,720	0.77	3.08
22	Failure of Cryogenic Charcoal Absorber [f] (Appendix C, Section 4.4.1)	Unlikely	1 day production of xenon	0.21	0.214	0.018	0.072	12	48	0.015	0.06
23	Valve sequence error in Tritium Removal System (Appendix C, Section 4.5.1)	Unlikely	1 year tritium production	4.8	19.2	0.90	3.6	410	1,640	0.74	2.96
24	Valve sequence error in Offgas Decay System (Appendix C, Section 4.5.2)	Anticipated	7 days xenon accumulation (1 decay tank)	14	56	2.3	9.2	1,100	4,400	1.9	7.6

Table 5.4.9.3.3-1. Radiological dose for SNS accident scenarios at ANL – (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	**Event**	**Frequency[b]**	**Source Term[c]**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**
	B. Accidents Involving proposed SNS Waste Systems (continued)										
25	Spill during filling of tanker truck for LLLW Storage Tanks[g] (Appendix C, Section 4.5.3)	Anticipated	0.00005% of contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	0.001	0.004	<0.001	<0.001
26	Spray during filling of tanker truck for LLLW[g] (Appendix C, Section 4.5.4)	Anticipated	1.9 ml of LLLW	<0.001	<0.001	<0.001	<0.001	0.003	0.012	<0.001	0.001
27	Spill during filling of tanker truck for Process Waste Storage Tanks[g] (Appendix C, Section 4.5.5)	Anticipated	51,100 L Process Waste to surface water + 57 L to atmosphere	See footnote "h"		See footnote "h"		See footnote "h"		See footnote "h"	
28	Spray during filling of tanker truck for Process Waste[g] (Appendix C, Section 4.5.6)	Anticipated	28.4 L of Process Waste	See footnote "h"		See footnote "h"		See footnote "h"		See footnote "h"	
29	Offgas Treatment pipe break (Appendix C, Section 4.6.1)	Unlikely	24 hrs xenon production	2.2	4.4	0.14	0.56	91	364	0.12	0.48
30	Offgas Compressor Failure (Appendix C, Section 4.6.2)	Unlikely	1 hr xenon production	0.24	0.96	0.017	0.174	14	56	0.015	0.06
31	Offgas Decay Tank Failure (Appendix C, Section 4.6.3)	Extremely Unlikely	7 days xenon accumulation	14	56	2.3	9.2	1,100	4,400	1.9	7.6
32	Offgas Charcoal Filter Failure (Appendix C, Section 4.6.4)	Unlikely	7 days iodine production	0.31	1.24	0.021	0.084	3.4	13.6	0.015	0.06

Table 5.4.9.3.3-1. Radiological dose for SNS accident scenarios at ANL – (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	Event	Frequency[b]	Source Term[c]	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam
B. Accidents Involving proposed SNS Waste Systems (continued)											
33	LLLW System piping failure. (Appendix C, Section 4.6.5)	Unlikely	0.00005% of contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	0.001	0.004	<0.001	<0.001
34	LLLW Storage Tank Failure (Appendix C, Section 4.6.6)	Extremely Unlikely	0.00005% of contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	0.001	0.004	<0.001	<0.001
37	Process Waste Storage Tank Failure (Appendix C, Section 4.6.9)	Extremely Unlikely	57 L to atmosphere	See footnote "h"		See footnote "h"		See footnote "h"		See footnote "h"	

[a] Unless otherwise indicated, radiological doses are based on radiological source terms for a 1-MW power level and would be four times greater if the facility is operating at 4 MW. These doses are total EDEs and include dose from inhalation and immersion. "Off-site" means outside the site boundary rather than outside the proposed SNS facility boundary. Individual receptors are hypothetical and do not correspond to any actual person. Population receptors are based on the actual number of people residing outside the site boundary and within 50 miles (80 km) of the facility and the number of site workers normally within 1.2 miles (2 km) of the facility and not involved in facility operation.

[b] See Table 5.2.9-2 for the numerical ranges associated with accident frequencies categories.

[c] Source terms are expressed in units that are independent of power level. Except for beyond-design-basis accidents (IDs 16a, 16b), the radioactivity released in accidents at 4 MW is four times that released at 1 MW.

[d] 40 CFR 61 limits dose to members of the public from airborne emissions from DOE facilities to 10 mrem/yr.

[e] Installation of sulfur-impregnated charcoal filters is being considered to serve as a "polishing filter" for the mercury condenser (refer to Event 17).

[f] Cryogenic charcoal absorbers are being considered as an alternative to the offgas compressor, decay storage tanks, and ambient temperature charcoal filters (refer to Events 24, 30, 31, and 32).

[g] Accidents involving tanker trucks may not be applicable for the proposed SNS facility at this site. It has not been determined how LLLW and process waste would be treated and disposed.

[h] Process waste accidental airborne releases occur at ground level. Only atmospheric dispersion factors for elevated releases were calculated for this site. Based on the radionuclide contents of LLLW and process waste source terms and results for ORNL, doses for process waste accidents at this site are anticipated to be approximately 0.001 mrem or less for individuals and to be less than approximately 0.050 person-rem for the off-site population.

NA - Not available.

involving the target. The maximum dose to an individual in the off-site public would be 49 mrem and 28 mrem for the uninvolved worker. The population dose of 2,100 person-rem would correspond to 1.1 excess LCFs. There is less than a one in a million chance that this accident would occur in a given year at the proposed SNS.

At a power level of 1 MW, accidents involving the off-gas decay system (IDs 24 and 31) would result in the highest individual and population doses of any potential accidents involving waste handling systems. The potential dose to the maximally exposed member of the public for these two accidents is 14 mrem and 2.3 mrem for the maximally exposed uninvolved worker. Dose to the maximally exposed member of the public is approximately 5 percent of the 300 mrem/yr received by the average person from natural background. The worker dose is 2.5 percent of the average dose received by workers from normal operations at ANL (DOE 1996f). The population dose of 1,100 person-rem corresponds to 0.5 LCFs. The fact that accident ID 24 is "anticipated" but could easily be mitigated is discussed in Section 5.2.9.3.3

At a power level of 4 MW, the potential consequences of all accidents, except ID 16, would increase by a factor of four. For the "beyond extremely unlikely" mercury spill (ID 16b), dose to the maximally exposed member of the public would be 3,100 mrem and 880 mrem to the maximally exposed uninvolved worker. The dose to the maximally exposed member of the public is slightly more than 10 times the annual dose from natural background radiation and corresponds to a risk of LCF of about 1 in 625 chances (0.0016 LCFs).

The dose to the maximally exposed individuals from the offgas decay system accidents (ID 24 and 31) would be 55 mrem for the public individual, about 20 percent of the annual dose for natural background, and 9.3 mrem for the uninvolved worker.

Because of the large off-site population and the assumptions underlying the use of dose-to-risk factors, the quantified adverse effects are large for four accidents should they occur at a power level of 4 MW. The accident with the greatest potential consequences is the beyond-design-basis mercury spill (ID16b). The population dose of 230,000 person-rem corresponds to 120 LCFs. The probability that this accident would occur in a given year is less than one chance in a million. Another mercury spill accident (ID 2b) also has large quantified adverse health effects in the off-site population. The population dose for this accident of 5,400 person-rem corresponds to 2.7 LCFs. The probability that this "extremely unlikely" accident would occur in a given year is between 1 chance in 10,000 and 1 chance in 1,000,000.

The two accidents involving the offgas decay system (IDs 24 and 31) have the same emission source term and also would have the potential for adverse effects in the off-site population. The population dose of 4,300 person-rem corresponds to 2.1 LCFs. Accident ID 31 is "extremely unlikely," and Accident ID 24 is "anticipated." Section 5.2.9.3.3 discusses several simple actions that could be taken that would reduce the frequency of occurrence of Accident ID 24 to "unlikely."

As discussed in Section 5.2.9.2.1, LCF values of 1.0 or greater do not mean that fatalities would actually occur in the off-site population but provide a quantified value for use in comparison between alternatives.

5.4.9.3.4 Hazardous Materials Accidents

Accidents involving potential exposure to toxic materials are discussed in Section 5.2.9.3.4. All involve spills of irradiated mercury. Accident IDs 2b, 16a, and 16b could result in the OSHA ceiling concentration of 0.1 mg/m^3 being exceeded for a few minutes during the initial stages of these accidents in locations accessible to workers, but it would not be exceeded at or beyond the ANL site boundary. Thus for only a few minutes at the start of the accident, mercury concentrations at or beyond the site boundary might exceed TEEL-1 limit (0.075 mg/m^3) but would not exceed the TEEL-2 limit (0.10 mg/m^3); individuals at the boundary at the precise occurrence of the initial emission might perceive an odor but would not experience or develop irreversible health effects or symptoms that could impair the ability to take protective action.

The second and third stages of these accidents are conservatively assumed to last from 7 to 30 days, while in reality, administrative and emergency response actions would more probably terminate the release in a shorter time period. During these stages, airborne concentrations of mercury would remain two to three orders of magnitude below the TEEL-0 limit of 0.05 mg/m^3, and no observable detrimental effects would be expected to occur.

5.4.10 SUPPORT FACILITIES AND INFRASTRUCTURE

This section summarizes the facilities and infrastructure effects on ANL transportation and utility systems from construction and operation of the proposed SNS.

5.4.10.1 Transportation

As described in Section 3.2.5, Alternative Sites, construction of the proposed SNS, related infrastructure, and support systems would occur at ANL, located in DuPage County, Illinois, approximately 30 miles (48 km) from Chicago. ANL is bordered on the north by I-55, on the east by State Highway 83, and on the south by State Highway 171, which intersects with Lemont Road. Lemont Road runs north-south on the western border of the site.

Approximately 32 miles (51 km) of roadway are present within ANL, including the access roads to Cass Avenue and Lemont Road. The site is accessed via three entrances: the main (North Gate), the West Gate, and the East Gate. Westgate Road is the primary entrance for employees coming from the west. Westgate Road is a two-lane paved road that currently handles mostly automobile traffic with intermittent heavy truck traffic; it is also capable of handling construction traffic. As of 1994, no marked difficulties were apparent for on-site traffic at any location, either during peak periods of arrival and departure or during midday work hours (ANL 1994). Also, according to Illinois DOT standards, vehicle accumulation at intersections and gates is minor, even during peak hours.

In 2002, the population of the ANL site is projected to be 6,800. Only 15 percent (930 people) of current employees participate in carpools; the remainder travel in single-occupant cars (ANL 1994). Using these data, daily vehicle round-trips were calculated to be 6,290. The *1994 Laboratory Integrated Facilities Plan* *for ANL* provides the basis for the population projections in Table 5.4.10.1-1.

The 800 Area is the location within ANL that most closely matches the site for the proposed SNS. The footprint for the proposed SNS at this location, however, overlays Westgate Road. Approximately 1 mile (1.6 km) of the existing Westgate Road would be relocated to the north in order to circumvent the proposed SNS site and replace the existing Westgate Road access. For purposes of this analysis, it is assumed that the relocation of Westgate Road would precede other construction activities, thereby avoiding regular ANL employee traffic into the facility during construction of the proposed SNS. It is further assumed that the "old" Westgate Road would be dedicated to construction vehicles transporting necessary concrete, steel, and related building materials.

Construction employee and vehicular activity would increase during the first years of construction, peaking in 2002, and would decrease significantly during the last year (2004) of construction. The estimated total of 578 construction employees in the peak construction year (2002) is expected to add approximately 466 daily round-trips and 10 material/service trucks to projected site traffic of 6,290 round-trips. This seven percent increase is considered to be below a level of significance and, therefore, would not result in significant short-term (construction) traffic effects on the site and/or adjacent area. However, the nature of the construction vehicles, given their size and speed, would affect traffic composition and may affect the flow of vehicles approaching/exiting the ANL site during construction. The implementation of mitigation measures, as described in Section 5.11, would minimize such adverse effects.

After construction, operation of the proposed SNS would result in an additional 250 resident/visiting scientists by 2006, plus another 125 employees during future facility upgrades, expected approximately 5 years (2011) after operations begin. The long-term total of an additional 375 people and 3 service trucks/day (305 round-trips) is not expected to exceed the *Laboratory Integrated Facilities Plan* projection of approximately 7,500 people in 2011. Therefore, no significant, long-term effects would be expected on the transportation infrastructure from operation of the proposed SNS on the ANL site.

Table 5.4.10.1-2 compares the No-Action Alternative with the proposed action located at the ANL site. The table provides the percentage increase in traffic resulting from the proposed SNS during construction and operation as compared to the No-Action Alternative. The table also provides the percentage increase using existing site data as well as projected data for the site. The potential effects of traffic increases could be reduced by having craft and non-craft workers report to work at different times, thus reducing the adverse effects on traffic flow during rush hours. Additionally, this analysis assumed there would be no transferring of personnel from within ANL. If some of the workers were previously working at ANL, the impact of the traffic would be reduced.

5.4.10.2 Utilities

This section assesses the potential environmental consequences of the proposed SNS on utilities and utility infrastructure at ANL.

Table 5.4.10.1-1. Long-range site population projections.

	1994	1999	2004	2009	2014
ANL	5,700	6,200	6,400	6,800	7,120
DOE	500	500	500	500	500
TOTAL	6,200	6,700	6,900	7,300	7,620

Source: *1994 Laboratory Integrated Facilities Plan for ANL.*

Table 5.4.10.1-2. ANL traffic increases compared to No-Action Alternative.

	Baseline/ No-Action	(Peak Year) SNS Construction	(4 MW) SNS Operation
Passenger vehicle trips[a]/day	6,290	466	302
Material transport trucks/day	0	7	0
Service trucks/day	0	3	3
Total (% increase)	0 (0%)	476 (7%)	305 (5%)

[a]Based on 6,800 ANL employees in 2002.

5.4.10.2.1 Electrical Service

As described in Section 3.2.3.4, the proposed SNS would require large supplies of electrical power for operation. The ANL site's existing 138-kV lines would not be adequate for SNS loads (Fornek 1998a). An actual capacity of 50 MW is available from substation 549A. It is expected that this would be adequate for the 63-MW connected load for the proposed 1-MW SNS. Based on ANL's experience with the APS power requirement estimates, this would probably also satisfy the 4-MW connected case.

The location of the proposed SNS at ANL would require a 6,600-ft (2,012-m) 138-kV overhead line to connect the SNS facility to substation 549A. The route for the 138-kV line would be from substation 549A to Southwood Drive, following Outer Circle Road west to Watertower Road and west to the 800 area. If additional capacity beyond the available 50 MW is required, it would be necessary to coordinate with Commonwealth Edison to determine the best way to provide power to the site. Environmental effects of the proposed SNS on electrical supply are expected to be negligible.

5.4.10.2.2 Steam

The proposed SNS would not necessarily require steam for facility heating, but at ANL heating would be provided by steam. ANL currently uses steam for central heating and steam turbine-driven emergency generators. Approximately 1,500 ft (457 m) of additional steam piping would be required to connect the proposed SNS facility with the current steam distribution system (Fornek 1998a). APS use is approximately 60,000 lb/hr. It is expected that the proposed SNS would use about the same amount. ANL can accommodate approximately 300,000 lb/hr of additional steam demand. Therefore, environmental effects on steam supply from the proposed SNS are expected to be inconsequential.

5.4.10.2.3 Natural Gas

Natural gas would provide energy for operational equipment such as boilers and localized unit heaters in the SNS heating system. As described in Section 4.2.10.2.2, natural gas at ANL is distributed from a nearby, high-pressure main and is used in laboratory areas, boilers, and furnaces not served by the central steam heating system. Natural gas lines at the ANL site are scheduled for upgrade in 1999. It is expected that any capacity increases and/or line extensions associated with the proposed SNS could be incorporated into the upgrade (Fornek 1998a). Thus, effects on natural gas supply and distribution are expected to be minor.

5.4.10.2.4 Water Service

The proposed SNS would require water supplies for the following systems: tower water cooling, deionized cooling, chilled water, building heating, process water, potable water, demineralized water, fire suppression, and target moderators.

The potable domestic water supply at the ANL is purchased from the local water district and is capable of meeting the proposed SNS demand. The remaining capacity of nonpotable water is approximately 2 mgpd (7.6 million lpd) (Fornek 1998a). Estimated peak use of water for the proposed SNS at 1 MW and the fully upgraded facility at 4 MW is expected to be 800 gpm (3,028 lpm) and 1,600 gpm (6,057 lpm), respectively. ANL has adequate existing capacity to treat process wastewater. ANL currently treats 300,000 gpd (1,135,620 lpd) in a treatment system with over a 1-mgpd (3.8-million-lpd) capacity. It is expected that ANL would be able to meet all water requirements for the proposed SNS facility with negligible environmental effects.

5.4.10.2.5 Sewage Treatment

ANL has approximately 500,000 gpd (1,892,700 lpd) of additional sanitary waste capacity. The proposed SNS project would require 12,500 gpd (473,175 lpd) for the 1-MW facility and 18,150 gpd (68,705 lpd) for the fully upgraded 4-MW facility. Therefore, ANL would be able to provide sewage treatment for the proposed SNS. Environmental effects of the proposed SNS on sewage treatment at ANL are expected to be inconsequential.

5.4.11 WASTE MANAGEMENT

All of the wastes generated during construction and operation of the proposed SNS would be transported to ANL for processing. The existing waste management systems at ANL have sufficient capacity to accommodate the proposed SNS waste streams. Additionally, standard DOE practice has been to dispose of hazardous waste at off-site, DOE-approved licensed commercial facilities. Therefore, DOE anticipates only minimal effects on the environment from ANL from waste management activities associated with the SNS.

Projections of construction and operations waste streams that would be generated at the proposed SNS include the following: hazardous waste, LLW, mixed waste, and sanitary/industrial waste, as listed in Table 3.2.3.7-1. A summarization of existing waste management facilities located at ANL, along with facility design and/or permitted capacities and remaining capacities, can be found in Table 5.4.11-1. Waste stream forecasts for ANL's individual operations, the proposed SNS

Table 5.4.11-1. ANL waste management facility description and capacities.

Waste Disposition	Waste Type and Facility	Total Design Capacity for ANL Site	ANL Waste Projections for 1998-2040	Total Remaining Capacity for ANL Site (Excludes Proposed SNS Operations)	Proposed SNS Waste Operations Projections for 1998-2040	Potential Effect of Waste Management on the Environment
HAZARDOUS WASTE						
TREATMENT	None					
STORAGE	Solid/Liquid a) Bldg. 306 (Central Waste Management Facility) b) Bldg. 325C	Permitted Capacity a) 67 m^3 b) 6 m^3	115 m^3/yr	a) 67 m^3 new facility b) 6 m^3 new facility	40 m^3/yr	Minimal effects anticipated. Standard DOE practice has been to dispose of waste at off-site, DOE-approved licensed commercial facilities.
LOW-LEVEL WASTE						
TREATMENT	Liquid a) LLLW Treatment Facility b) Process Waste Treatment Facility (PWTF)	a) LLLW Treatment Facility has two 3.5 m^3/day evaporators. (2,500 m^3/yr) b) PWTF – 1.38E5 m^3/yr	a) LLLWTF 57 m^3/yr b) PWTF 412,600 m^3/yr	a) One 3.5 m^3/day evaporator not currently used. b) 1.0E6 m^3/yr	a) Hazardous Liquid 175,600 gal/yr b) Process Liquid potentially hazardous 4.16E06 gal/yr	a) No effect anticipated. b) No effect anticipated. Tritium discharge would increase from 0.75 Ci/yr to 40 Ci/y.
	Solid Compaction Shredding Facility	Shredder Capacity HEPA filters only, 14 filters/day. Compactor Capacity 50 drums/day	Solid Low-Level Waste Projection at 232 m^3/yr	Capacity can be expanded as necessary	Solid 1,026 m^3/yr	No effect anticipated. Treatment can be extended for greater capacity; personnel resources can be increased.
STORAGE	Solid Area 398	Permitted Capacity 30 m^3	232 m^3/yr	30 m^3	(Not compacted)	No effect anticipated. DOE has contracts in place for disposal of LLW at off-site, DOE-approved licensed commercial facilities.

Table 5.4.11-1. ANL waste management facility description and capacities (continued).

Waste Disposition	Waste Type and Facility	Total Design Capacity for ANL Site	ANL Waste Projections for 1998-2040	Total Remaining Capacity for ANL Site (Excludes Proposed SNS Operations)	Proposed SNS Waste Operations Projections for 1998-2040	Potential Effect of Waste Management on the Environment
MIXED WASTE						
TREATMENT	Liquid a) Metal Precipitation Filtration Unit b) Chemical/Photo Oxidation Unit c) Mixed Waste Immobilization/ Macro-Encapsulation Unit	Permitted Capacities a) 0.4 m^3/day b) 0.2 m^3/day c) 2 m^3/day	Combined Liquid/Solid Mixed Waste Projection at 9 m^3/yr Combined Liquid/Solid Hazardous Waste Projection at 205 m^3/yr	Capacity can be expanded as necessary	Liquid 10 m^3/yr (approximately 0.04 m^3/yr)	Minimal effects anticipated. Design capacity is much greater than anticipated volumes. If necessary, permitted volumes can be increased. Standard DOE practice has been to dispose of waste at off-site, DOE-approved licensed commercial facilities.
	Solid a) Alkali Metal Passivation Booth b) Dry Ice Pellet Decontamination unit	Permitted Capacity a) 40 pds/hr b) 500 pds/hr	0.1 m^3/yr 15,000 lb/yr		Solid 7.3 m^3/yr	
STORAGE	Solid/Liquid a) Mixed Waste Storage Facility b) Bldgs. 306, 317; 329, 374A	Permitted Capacity a) 196 m^3 b) 182 m^3	215 m^3/yr		NA	
SANITARY WASTE						
TREATMENT	Liquid Waste Water Treatment Facility	500,000 gpd	350,000 gpd	150,000 gpd	18,000 gpd	No effect anticipated.
DISPOSAL	Solid Off-site landfills	Wastes are transported to DOE approved licensed commercial facilities			1,349 m^3/yr	No effect anticipated.

Sources: DOE-CH 1995; Grandy 1997; Fornek 1998a; Fornek 1998b.
NA - Not applicable.

operations at 4 MW, and the aforementioned wastes are also included in Table 5.4.11-1. These forecasts cover the period from 1998 to 2040, unless otherwise noted. They are based on estimates provided by ANL Waste Management Operations and waste management documentation.

Before wastes from the proposed SNS facility would be accepted for TSD at ANL, they would be certified to meet the WAC of the receiving TSD facility. As mentioned earlier in Section 5.2.11, AEA, EPA, and NRC limits for LLLW treatment facility WAC would also need to be addressed for ANL.

Currently, no hazardous waste treatment or disposal facilities are located at ANL. Hazardous wastes are collected and sent quarterly to a DOE-approved licensed commercial vendor. ANL handles about 30,000 gallons of chemical waste per year, excluding asbestos. The additional 10,800 gallons of hazardous waste generated by the SNS facility would not be a problem for the facility.

No LLW disposal facilities are located at ANL. These wastes are collected, certified, and shipped to off-site, DOE-approved licensed commercial facilities or the DOE Hanford site (Fornek 1998b).

The mixed waste treatment and storage units for ANL are listed in Table 5.4.11-1. Currently, there are no mixed waste disposal facilities at ANL. Mixed wastes are collected and stored on-site pending treatment or shipment. Wastes are stored on-site until an off-site disposal facility can be determined (DOE-CH 1995).

ANL has a waste certification process in place to ensure that wastes meet the WACs for LLW disposal. However, because of the uncertainty of the composition of LLW and mixed wastes that may be generated from operation of the SNS, the waste may not meet the current WAC for waste management facilities at ANL. DOE would take action to ensure the proper disposition of these wastes. For example, pretreatment of the wastes may ensure that they meet the WAC. DOE may be able to amend the license at current waste disposal facilities to allow acceptance of wastes from the SNS.

Excess soil, construction wastes, and sanitary wastes would be generated during construction of the proposed SNS. Excavated soil and rock would be used for backfill, erosion control, or other environmental purposes. Construction debris would be sent to a Class IV landfill. Liquid sanitary wastes would be transported to the ANL sanitary wastewater treatment plant. Solid sanitary waste would be sent to a sanitary landfill (ORNL 1997b).

As stated in Section 5.2.11, in accordance with the *NSNS Waste Minimization and Pollution Prevention Plan*, considerations for minimizing the production of the SNS facility waste would be implemented.

5.5 BROOKHAVEN NATIONAL LABORATORY

This section describes the potential environmental effects or changes that would be expected to occur at BNL if the proposed action were to be implemented. Included in this discussion are the potential effects on the physical environment; ecological and biological resources; the existing social and demographic environment; cultural, land, and infrastructure resources; and human health.

5.5.1 GEOLOGY AND SOILS

Potential effects on geology and soils from construction and operation of the proposed SNS at BNL are described in this section.

5.5.1.1 Site Stability

The proposed SNS site at BNL is stable and would provide excellent foundation support for the SNS. Other large-scale buildings and structures such as the High Flux Beam Reactor (HFBR), the Alternating Gradient Synchrotron, the 200 MeV Linear Accelerator, and the National Synchrotron Light Source have been built at BNL without encountering significant site stability problems. No effects are anticipated from site stability.

5.5.1.2 Seismicity

BNL is in an area of relatively quiet seismic activity (refer to Figure 4.3.1.4-1). The proposed SNS would be constructed at BNL to meet DOE Standard 1020-94 (DOE 1996a) and would be capable of withstanding maximum horizontal ground accelerations of 0.12 gravity for a return period of 500 years, of 0.15 gravity for a return period of 1,000 years, of 0.19 gravity for a return period of 2,000 years, and of 0.30 gravity for a return period of 10,000 years. The particle beam for the proposed SNS facility would be designed to shut down immediately in the event of an earthquake. As such, predictable seismicity at BNL would have no effect on construction, operation, or retirement of the proposed SNS.

5.5.1.3 Soils

Excavation required for construction of the proposed SNS would disturb native soils. Excavated soils would be stockpiled according to soil type and horizon. If the excavated soils possess the proper characteristics, they would be used to construct the shielding berm. Otherwise the soils would be placed in the spoils area (refer to Section 3.2.5.5). Topsoil removed during excavation would be used for grading and landscaping of the site at the finish of construction.

Construction of the SNS would require removal grading of the site and removal of vegetative cover. As a result, the potential exists for soil erosion and stream siltation, especially during periodic storm events. Best management practices would be followed to minimize the impacts of erosion during construction activities. Section 3.2.2.3, Site Preparation, discusses the elements (retention basin, silt fences, temporary storm water drainages, etc.) that would follow an erosion control plan to prevent erosion and siltation of the Peconic River.

The proposed SNS at BNL would most likely be designed with a cut-and-fill approach, providing sufficient amounts of fill material for the shield from within the proposed SNS site. If additional soils are needed, then fill would be obtained from firebreak areas around BNL. Excess spoil material would be stored in the BNL transfer station area. The future supply of fill material would not be affected by construction of the proposed SNS.

Operation of the proposed SNS would affect soils within the shield berm surrounding the linac tunnel (refer to Section 5.2.1.3). Site-specific calculations of nuclide concentrations and transport potential have not been performed for BNL. Importantly, the soils at BNL are primarily composed of quartz sand (SiO_2) and possess little of the retardation capacity normally seen in clay-rich soils or soils with high organic carbon content. The resultant migration rates offer a higher potential for exposure to nuclides. No prime or unique farmlands are present on or in the vicinity of the proposed SNS site at BNL. As a result, the proposed action would have no effects on prime or unique farmlands.

5.5.2 WATER RESOURCES

Potential effects on water resources from construction and operation of the proposed SNS at BNL are described in this section. Best management practices would be employed to minimize any effects on surface water from erosion and siltation during construction (see Section 5.2.1.3).

5.5.2.1 Surface Water

No surface water resources would be used to support operations at the proposed SNS site. Potable water would be supplied by groundwater wells within BNL.

Conventional cooling tower blowdown for the proposed SNS facility would be discharged into the headwaters of the Peconic River. Because there is no sustained flow in this portion of the river, this release would be to the same headwaters reach as the sewage treatment plant (STP). Compared to an average daily contribution of 0.66 mgpd (2.5 million lpd) for the STP, the proposed SNS facility would add about 0.36 to 0.50 mgpd (1.4 to 1.9 million lpd) to the river flow depending upon the facility size (2 or 4 MW). Currently, flow within the headwaters of the Peconic River infiltrates into the subsurface before reaching the boundary of BNL. It is unlikely that the addition of SNS discharge would create sustained off-site flow.

Cooling tower discharges would be temporarily held within an approximate 2-acre (0.81-ha) retention basin before release to the Peconic River. This basin would be designed to allow sufficient residence time for the discharge to cool to ambient temperatures. If necessary, active cooling systems such as recirculating fountains may be employed. Polyphosphonates for antiscaling and ozone as a biocide would be used in the cooling towers. Discharge from the towers would be regulated to contain about four times the dissolved solids content of potable water (i.e., 1,000 to 1,200 mmhos/cm conductivity). Contributions of solids or chemical agents are not anticipated to significantly affect the stream. Flow at the BNL boundary is monitored under an existing NPDES permit and is required to meet permitted standards when it is present. Effects on surface water resources would be expected to be negligible.

5.5.2.2 Flood Potential and Floodplain Activities

The SNS at BNL would not encroach upon the 100-yr floodplain at the Peconic River. Additional flow of 0.36 to 0.50 mgpd (1.36 to 1.9 million lpd) would not affect the delineation of the floodplain within BNL. By comparison, a 1995 project to upgrade the STP would have involved the discharge of 1 mgpd (3.8 million lpd) into the on-site headwaters of the Peconic River. This project received New York State Department of Environmental Conservation (NYSDEC) approval and was found consistent with Executive Order 11988 (Floodplain Management) and all aspects of Executive Order 11990 (Protection of Wetlands). However, the project was eventually reengineered to exclude discharges to the Peconic River. This reengineering was prompted by concerns over the discharge of slightly contaminated groundwater and not floodplain delineation issues (Naidu et al. 1996: 2-45). The project has since been completed with no discharges to the Peconic River.

5.5.2.3 Groundwater

All of Long Island's drinking water supply comes from the Upper Glacial Aquifer, which underlies the island. BNL uses roughly 2,000 gpm (7,570 lpm) of groundwater to meet potable water needs plus heating and cooling requirements. Additional demands of up to 1,600 gpm (6,057 lpm) would be created by the proposed 4-MW SNS facility. Currently, three wells are in the vicinity of the proposed SNS site. Each well is capable of producing approximately 1,200 gpm (4,542 lpm). No effects on the supply or capacity of the water system at BNL are anticipated.

The SNS is proposed to be a high-energy linear accelerator potentially creating more abundant nuclides in the soil than the Alternating Gradient Synchrotron (AGS) Facility. Although transport calculations for BNL have not been performed, characteristics of the groundwater system at BNL would make this site more susceptible than the one at ORNL to effects on groundwater from radionuclide contamination. At the proposed location, the SNS would sit about 20 ft (6.1m) above the groundwater table, if built at natural grade. Using a cut-and-fill approach, the tunnel and ring structures, as well as the activated soils, would be in close proximity to the water table. Because of high permeability, vertical transport rates in these sandy soils can approach 17 ft/yr (5.2 m/yr). Thus, radionuclide contamination of groundwater would be an important potential effect of the proposed SNS facility operations.

At the AGS, only ^{3}H and ^{22}Na have sufficient half-life durations to pose a problem (DOE-BNL 1994b). Calculated dilution reduces exposure estimates to off-site receptors to below levels of concern. If comparable dilution factors can be applied to the SNS releases, then radionuclide concentrations would not be transported off-site at levels of concern. Limited effects may be expected for groundwater quality in the immediate vicinity of the proposed SNS.

Because BNL sits atop a sole source aquifer for Long Island's water supply, the construction of a multilayer shielding berm to reduce nuclide diffusion and migration (refer to Section 3.2.2.9) may be necessary. DOE would conduct site-specific studies at BNL to determine if the alternate shield design would be necessary. In addition, routine groundwater sampling at the proposed SNS facility would be implemented to ensure that radionuclide concentrations are within acceptable limits around the linac tunnel.

5.5.3 CLIMATOLOGY AND AIR QUALITY

Potential effects on the climate and air quality from construction and operation of the proposed SNS at BNL are described in this section.

5.5.3.1 Climatology

Construction and operation of the proposed SNS would not affect regional or localized climates within the BNL area.

5.5.3.2 Air Quality

Impacts on nonradiological air quality are presented in this section. Airborne radiological releases are evaluated under human health impacts (Section 5.5.9). Construction activities would create temporary effects in regard to particulate matter (PM_{10}) measurements during the construction phase of the proposed SNS project. This effect would be greatest during early clearing and excavation efforts but would decrease within a relatively short time period. This level is predicted to be minimal when weighted over the usual 24-hr averaging period.

The primary nonradiological airborne release during operations at the proposed SNS would be combustion products from the use of natural gas. Emission rates related to the maximum period of natural gas usage are listed in Table 5.2.3.2-1. This location is also considered flat, and projected air quality impacts from natural gas usage would be as shown in Table 5.5.3.2-1. Adding maximum background concentrations to maximum projected impacts from the SNS sources (a very conservative procedure because the two do not occur at the same location or time) also does not provide any violations of the NAAQS.

The general conformity rule (40 CFR 93) requires the evaluation of potential direct and indirect emissions associated with this project. According to 40 CFR 93.153(h), the project can be presumed to conform to applicable State

Table 5.5.3.2-1. Impact of natural gas combustion at the proposed SNS.

NAAQS Compound	Period[a]	Estimate (μg/m³) at 984 ft (300 m)	Maximum Concentration[b]	Assumed Background (μg/m³) (Table 4.4.3.3-1)	Background + 300 m Location (μg/m³)	NAAQS Limits (μg/m³)
Sulfur dioxide (SO_2)	Annual[c]	0.03	0.05	—	—	80
	24-hr	0.30	0.60	77.0	77.3	365
	3-hr	0.70	1.40	225.7	226.4	1,300
Carbon monoxide (CO)	8-hr	21	40	6,738	6,759	10,000
	1-hr	30	57	8,016	8,046	40,000
Nitrogen dioxide (NO_2)[d]	Annual[c]	5.0	9.0	49.6	54.6	100
Particulate (PM_{10})	Annual[c]	0.60	1.10	—	—	50
	24-hr	6.80	13.30	57.0	63.8	150

[a] Factors used to convert from 1-hr averages to long periods taken from EPA 1977.
[b] Concentration at 984 ft (300 m) estimated boundary and maximum concentration [occurring at 174 ft (53 m)] estimated by EPA – Screen 3 Model (v. 96043). Maximum concentration location is expected to be “on-site.”
[c] Annual concentrations reflect 33% estimated (conservative) annual usage factor.
[d] Estimated concentration in this table includes all NO_x compounds and not only NO_2 for NAAQS.

Implementation Plan provisions if the total of direct and indirect emissions of criteria or precursor pollutant emissions are below rule-specified de minimis levels. Small quantities of direct emissions of particulates and more specifically of the criteria pollutant PM-10 can be anticipated from site preparation activities associated with the construction of project facilities. Indirect emissions can be expected from fuel combustion that will be necessary to meet the anticipated heating needs of the facilities.

Should this location be chosen for construction of the SNS, a formal comparison of site direct and indirect emission rates to the de minimis levels would be made. However, review of anticipated fuel burning hourly emission rates (Table 5.2.3.2-1) indicates, even assuming worst-case (8,760 hr/yr at full capacity) operation, the annual emission rates would be well below the applicable de minimis levels, as shown in Table 5.4.3.2-2. PM-10 emissions from construction activities would also be many times less than the 100 tons/yr de minimis level.

Five 200-kW generators would be tested for short durations several times a year. Emissions from these generators are rated at 1,450 cfm at 910 °F (487 °C). Periodic emissions from these generator testings would not affect overall air quality, and effects on air quality from construction or operation of the proposed SNS facility would be negligible.

5.5.4 NOISE

Noise levels emitted from construction of the proposed SNS at BNL would be very similar to those currently produced by Relativistic Heavy Ion Collider (RHIC) construction. The impacts of construction noise from the proposed SNS facility would be temporary and localized. The proposed SNS would be designed to operate within New York State Noise Standards and DOE criteria for safety and health. No significant noise effects are anticipated from construction of the facility at BNL.

Operations at the proposed SNS facility would generate some noise, caused particularly by traffic and cooling towers. In general, sound levels would be characteristic of a light industrial setting. Impacts to residential areas would be attenuated by the distance from the proposed SNS facility and by existing forested areas. On-site, the level of noise from the proposed SNS facility would be typical of accelerator facilities, and any effects would be negligible when compared to ambient levels.

5.5.5 ECOLOGICAL RESOURCES

This section describes the potential effect construction and operation of the proposed SNS would have on ecological resources at BNL. It includes potential effects on terrestrial and aquatic resources, wetlands, and threatened and endangered species.

5.5.5.1 Terrestrial Resources

Construction of the proposed SNS facility would result in clearing vegetation, primarily oak and pine forest, from 110 acres (45 ha) of land at BNL. The entire proposed SNS site would be cleared during the first year of construction. The timber harvested during site preparation would be sold. Areas not immediately required for construction of proposed SNS facilities would be planted with grasses to minimize erosion.

Wildlife inhabiting the proposed SNS site includes white-tailed deer, gray squirrels, cottontail rabbits, and chipmunks. Construction of the proposed SNS would displace these species to surrounding areas. These areas have ample habitat for the displaced species, but one or more of the species populations may exceed the carrying capacity of the land because new individuals would be added to the existing off-site populations. This effect may result in a small but permanent reduction in these populations.

Clearing operations for construction of the SNS may cause the direct loss of small animals. Also, wildlife would be displaced from cleared areas and the surrounding habitat. Large mammals would be mostly excluded from controlled areas by access control fences. While additional forest-edge habitat would be created, cleared land would represent long-term loss of habitat.

Construction and operation activities and the associated noise and human presence would disturb wildlife occupying areas adjacent to the proposed site. This could result in emigration of some sensitive species from the surrounding area, although many of the species would adjust to the disturbance. To help minimize disturbance to wildlife, construction machinery would be kept in proper operating condition and workers would be prevented from entering undisturbed areas delineated before construction.

The proposed SNS site at BNL lies within the pine barrens area of Long Island, but the 110 acres (45 ha) of land on the site represents less than 2 percent of the legally established Pine Barrens Protection Area. Furthermore, the proposed SNS facility would be constructed entirely within the Compatible Growth Area rather than the more stringently protected Core Preservation Area (refer to Section 4.4.8.4). As a result, construction of the proposed SNS facility would have a minimal effect on the Pine Barrens.

The proposed SNS would operate on land where natural features have been largely removed or altered by construction activities. Consequently, the proposed SNS facility operations would have a minimal effect on terrestrial resources at this location and in immediately adjacent areas. Operation of the SNS would result in emissions to the atmosphere, composed primarily of CO_2, low levels of pollutants (see Section 5.5.3.2), and water vapor. These emissions would have no discernable effects on the surrounding Compatible Growth Area of the protected Pine Barrens.

5.5.5.2 Wetlands

No wetland areas are located within the proposed SNS site. However, three wetland areas are located in the vicinity of the site along the upper reaches of the Peconic River and at some points downstream.

The wetlands associated with the Peconic River would be protected from precipitation runoff and sedimentation during construction of the proposed SNS by establishing an uncleared zone of vegetation between the proposed SNS site and the river and by implementing erosion control measures such as silt fences. As a result, effects on wetland areas along the Peconic River would be minimal.

Runoff from most facilities and blowdown from the cooling towers would be discharged into a retention basin during operations at the proposed SNS. At the conceptual design stage, the size of the retention basin required is estimated at approximately 2 acres (0.81 ha). The outflow from the retention basin would be discharged into the Peconic River at about the same location as the current STP discharge. Therefore, none of the operational discharges from the proposed SNS facility would enter the wetland areas. Wetland areas downstream from the STP outfall would experience an increased flow of water. However, this flow would be less than that caused by a routine rain event. Consequently, construction and operation of the proposed SNS would have minimal effects on wetlands in the vicinity of the proposed SNS site.

5.5.5.3 Aquatic Resources

The proposed SNS site at BNL is adjacent to the headwaters area of the Peconic River. During land clearing and other construction activities, there would be a potential for increased surface water runoff and sediment loading in the river. A minimum 300-ft (91-m) buffer zone of uncleared vegetation would be established between the proposed SNS site and the Peconic River. This undisturbed zone would help limit runoff and preserve the vegetative cover of the river. Also, erosion control measures, including silt fencing and preservation of native vegetation, would be implemented to minimize the increased sediment load flowing to the river during construction. As a result of implementing these measures, effects on aquatic resources in the Peconic River would be minimal.

No effluents would be discharged to the upper reaches of the Peconic River during operation of the proposed SNS. All surface runoff from the site would be directed to the retention basin. Cooling tower blowdown would also be released into this basin. The basin would discharge 350 gpm (1,325 lpm) of water through a standpipe, and the discharge would be piped to the Peconic River. As previously noted, this discharge would empty into the river at about the same location as the current STP discharge. The river channel downstream from the STP outfall would experience an increased flow, but this flow would be less than that caused by a routine rain event. Thus, its effects on aquatic resources would be minimal.

The cooling tower blowdown would be elevated in temperature and contain chemical biocides and antiscaling agents. The source of the make-up water for the cooling towers would be the potable water supply system for the laboratory; therefore, the blowdown would contain chlorine. The blowdown would be dechlorinated prior to its release into the retention basin. As described in Chapter 3, the retention basin would be designed to reduce the temperature of the water to the ambient temperature of the Peconic River prior to discharge.

The foregoing assessment indicates that aquatic resources located on the proposed SNS site and in its vicinity would be minimally affected by the proposed action.

5.5.5.4 Threatened and Endangered Species

Spotted wintergreen, bayberry, and swamp azalea have been identified on the proposed SNS site at BNL (see Section 4.4.5.4). These species are protected under New York Environmental Conservation Law 9-1503 and New York State Regulation 193.3. Prior to the start of construction, DOE would consult with USFWS and the New York Department of Environmental Conservation to develop an appropriate mitigation plan to prevent adverse effects on these protected plants. Possible mitigation measures include placing a fence around the habitat containing protected plants so the construction workers and equipment could not cause damage. Consequently, the proposed action would result in minimal effects on known threatened and endangered species.

A systematic survey for protected species would be conducted in potential habitat areas prior to the start of land clearing and construction activities on the proposed SNS site. Because definitive identifications of many protected plants can only be made when they are flowering, this survey would extend over the spring, summer, and fall seasons to maximize the probability of finding them. If found, appropriate mitigation measures would be taken to protect these plants during construction and operation of the proposed SNS. DOE would include details of the mitigation measures in the MAP (refer to Section 1.4).

5.5.6 Socioeconomic and Demographic Environment

This section identifies whether construction and operation of the proposed project (and associated worker in-migration from outside the ROI) may adversely affect regional services and infrastructure. It also presents an estimate of the financial effects (employment, income, taxes, and economic output) that would be generated locally in the form of worker salaries, indirect effects, and induced effects. Unless otherwise noted, economic effects are described in escalated-year dollars.

The ROI associated with the BNL site includes Nassau and Suffolk Counties, New York. This 1,200-mi^2 region was selected because it forms the area within which at least 90 percent of BNL workers currently reside. It is, therefore, the region within which the majority of socioeconomic impacts are expected to occur. Socioeconomic effects beyond the ROI are generally expected to be minor.

The total local construction cost is estimated to be approximately $332 million (escalated dollars), and the peak construction year would be 2002, when 578 workers will be on-site (Brown 1998a). Of this total, about three-fourths (433 individuals) would likely be hired from the local area, and 144 will come from outside the ROI. An approximate average of 300 workers per year would be on-site, including all construction, management, and engineering design personnel and other technical and commissioning staff. Construction of the 1-MW SNS is the bounding case for analysis of construction effects. If the SNS is upgraded to 4 MW, additional construction would occur but this would be much less than the effects associated with the initial construction of the 1-MW SNS.

Operation of the proposed SNS facility at 1 MW would begin in 2006 with a staff of 250 persons. Later, if the proposed SNS is upgraded to 4 MW, 375 persons would be employed. The 4-MW case is used for this analysis as the bounding case, and the effects of the proposed 1-MW SNS on the ROI would be similar but slightly less than the 4-MW case.

5.5.6.1 Demographic Characteristics

It is assumed that approximately 75 percent of all construction workers would come from the local region (Brown 1998a). Most of the construction workers would be general craft laborers, and the specialized technical components would be contracted out and fabricated in places not yet known. All locally hired construction workers would commute to the job site from existing residences and would not relocate closer to the site. The experience with other past major construction projects has been that most in-migrating workers would temporarily move to the project area but would usually commute home on weekends or periodically. These individuals would generally not bring families to the ROI for the construction period. However, even if all of the in-migrating workers brought families into the ROI, the total (temporary) population increase would be less than 500 persons in the peak year, including spouses and children. This would be a temporary increase in population of much less than 0.01 percent and is, therefore, negligible.

People with the technical expertise needed to operate the proposed SNS facility currently reside in the ROI. However, it is also expected that some plant operators would come from outside the local region. It is assumed that about half of the 375-person operating workforce (for the bounding 4-MW case) would come from outside the area. It is further assumed that these households would be the same size as the national average because it is not known from where they would in-migrate. It is conservatively estimated that in 2006 the total population increase associated with operations would be about 600 individuals, including spouses and children. The facility operators would be "permanent" residents of the area, and little additional in-migration would occur in subsequent years. The population increase associated with construction and operations would represent less than 0.01 percent of the local population and is, therefore, negligible.

5.5.6.2 Housing

With about 71,000 vacant "dwelling units" (refer to Section 4.4.6.2) in the two-county ROI, workers should easily be able to find apartments to rent or houses to purchase. Some new houses would probably be constructed. However, existing vacancies and historical construction rates indicate that housing would be available for this small in-migration.

5.5.6.3 Infrastructure

Potential effects on infrastructure are closely tied to population growth. Because the expected permanent in-migration is only 600 individuals, effects on infrastructure would be relatively minor.

More than 600 schools with an enrollment of 666,000 students are located in the ROI. The addition of less than 300 children to the ROI would, therefore, be minor. Even if all 300 children attended schools in Nassau County, the current teacher-student ration of 1:13 would be unchanged. Effects would also be minor for police and fire protection, health care, and other services.

5.5.6.4 Local Economy

Design of the proposed SNS facility would begin in 1999, and the first construction managers and workers would begin work in FY 2000. The majority of the construction would occur from FY 2001 through FY 2004, with the peak construction employment occurring in FY 2002. Testing of the proposed SNS facility would be from FY 2003 through FY 2005. Operations are planned to begin by the end of FY 2005; FY 2006 would be the first full year of operations (see Figure 3.2.2-1).

Table 5.5.6.4-1 presents the results of the IMPLAN modeling for the period 1999 through 2006. Economic benefits in the form of jobs, wages, business taxes, and income would begin

Table 5.5.6.4-1. BNL IMPLAN modeling results—construction and operations impacts.

	1999	2000	2001	2002	2003	2004	2005	2006
Employment								
Direct	102	202	473	573	404	272	37	678
Indirect	77	139	334	418	300	206	28	362
Induced	90	166	396	491	351	239	33	511
Total	269	507	1,203	1,481	1,055	717	98	1,551
Wages								
Direct	$7,549,066	$14,330,179	$34,733,467	$43,790,913	$31,881,709	$22,154,595	$3,101,162	$39,667,537
Indirect	$2,573,668	$4,754,553	$11,623,660	$14,801,201	$10,845,926	$7,585,138	$1,064,148	$14,888,863
Induced	$2,636,431	$4,961,149	$12,028,197	$15,173,970	$11,045,277	$7,674,012	$1,073,164	$17,016,618
Total	$12,759,165	$24,045,880	$58,385,324	$73,766,084	$53,772,913	$37,413,746	$5,238,474	$71,573,018
Business Tax								
Direct	$186,863	$461,190	$1,047,036	$1,210,987	$833,858	$547,796	$76,291	$4,457,596
Indirect	$451,002	$836,614	$2,032,627	$2,570,126	$1,871,913	$1,301,083	$181,647	$2,070,553
Induced	$597,104	$1,122,175	$2,717,000	$3,422,671	$2,487,629	$1,725,603	$240,913	$3,813,381
Total	$1,234,969	$2,419,979	$5,796,663	$7,203,784	$5,193,400	$3,574,482	$498,852	$10,341,531
Income								
Direct	$8,238,595	$15,629,937	$37,888,677	$47,779,063	$34,789,683	$24,178,269	$3,384,471	$42,795,649
Indirect	$2,996,030	$5,534,549	$13,546,035	$17,270,440	$12,669,442	$8,870,343	$1,245,647	$18,147,646
Induced	$3,016,283	$5,678,937	$13,775,646	$17,387,412	$12,662,937	$8,802,386	$1,231,580	$19,538,272
Total	$14,250,907	$26,843,423	$65,210,358	$82,436,916	$60,122,062	$41,850,998	$5,861,698	$80,481,565
Output								
Direct	$23,274,370	$44,327,898	$107,356,711	$135,192,079	$98,356,752	$68,302,617	$9,560,201	$102,443,763
Indirect	$7,082,311	$13,147,894	$32,089,130	$40,779,464	$29,841,783	$20,841,952	$2,922,516	$42,204,013
Induced	$7,888,100	$14,863,259	$36,082,068	$45,575,617	$33,215,117	$23,104,202	$3,234,652	$51,346,502
Total	$38,244,781	$72,339,050	$175,527,908	$221,547,159	$161,413,653	$112,248,772	$15,717,369	$195,994,276

Source: IMPLAN Pro.

to accrue during the first year of the project in FY 1999. These economic benefits in the ROI would increase as construction and other associated project activities increase. Design and construction employment would be highest in FY 2002, and there would be an estimated 1,481 total (direct, indirect, and induced) new jobs created at BNL. This trend would begin to diminish in FY 2003 as design and construction employment decreased and would continue to decrease until construction is completed in FY 2004. Facility operations would begin in FY 2005. Operations would reflect substantial regional spending for operator salaries, supplies, utilities, and administrative costs.

The proposed SNS is planned to operate for 40 years. If the level of operation is the same as for the 4-MW case measured in the first full year (FY 2006), it is expected that facility operation would continue to support an estimated 1,551 jobs for each of the following years of operation, 873 of which would be indirect or induced. Other annual operations effects would include $71.6 million in local wages, $10.3 million in business taxes, $80.5 million in personal income, and $196 million in total output.

Construction of the facility would create new jobs and may potentially result in the region's unemployment rate dropping from 3.4 percent to 3.3 percent. During operations, the unemployment rate may decrease further to 3.2 percent, depending on whether construction workers and engineers (unemployed following project completion) stay in the ROI. The effects from operating the proposed 1-MW SNS would be similar but slightly lower.

5.5.6.5 Environmental Justice

As identified in Figures 4.4.6.5-1 and 4.4.6.5-2, minority populations and low-income populations reside within 50 miles (80 km) of the proposed SNS site. For environmental justice effects to occur, there must be high and adverse human health or environmental effects that disproportionately affect minority populations or low-income populations.

The human health and safety analyses show that hazardous chemical and radiological releases from normal operation of the proposed SNS at 1-MW and 4-MW power levels would be within regulatory limits. Annual radiological doses are given in Section 5.5.9, and the data show that normal air emissions from the proposed 1-MW SNS would be negligible and would not result in adverse human health or environmental effects on the public at off-site locations. Therefore, operation of the proposed SNS would not have disproportionately high and adverse effects on minority or low-income populations.

Radiation doses to the public from both normal operations and accident conditions would not create high and adverse effects. Less than two (1.5) LCFs are calculated at the 4-MW power level over a 40-year operations period. If the facility operated for 10 years at 1 MW and 30 years at 4 MW, the calculated number of LCFs would be reduced. An LCF is a cumulative measure from the entire regional population (within a 50-mi or 80-km radius) of almost 5,000,000 used for comparing alternatives and does not necessarily indicate that a fatality would occur (refer to Section 5.2.9.2.1). Twenty-five accident scenarios for the proposed SNS at BNL would result in airborne releases. The consequences of most of these accidents would be negligible at power levels of both 1 MW and 4 MW. Four accidents are calculated to result in LCFs at 4 MW. The prevailing ground-level winds are from the southwest during the summer, from the northwest during the winter, and about equal from these two directions in the spring and fall (refer to Figure 4.4.3.2-1). Figures 4.4.6.5-1 and 4.4.6.5-2 show that the closest concentrations of minority and low-income populations are southwest of the proposed site. However, the site is mostly surrounded by non-minority, higher-income populations, especially in the path of the predominant wind direction. The public, including minority and low-income persons, could be in the path of an off-site airborne release. However, the analysis has shown that there would not be high and/or adverse effects on any of the population; therefore, there would be no disproportionate risk of significantly high and adverse effects on minority and low-income populations.

A number of uncertainties are associated with the evaluation of potential effects due to subsistence consumption. ANL developed an article reviewing the literature on subsistence consumption (Elliot 1994) and found that (1) "the majority of the studies that have been conducted to date are focused on site- or region-specific exposure concerns. At present, it is unclear whether the findings of these studies are representative of consumption and exposure levels among minority populations at a national level"; (2) "a large number of risk assessment studies focusing on fish and wildlife consumption examined whole populations without distinguishing between consumption and exposure patterns of specific ethnic (or other) subpopulations"; (3) "the vast majority of studies have focused on fish consumption as an exposure pathway. Few examined wildlife consumption and contamination, and even in such cases the studies were not motivated by minority exposure concerns"; and (4) "the majority populations were not significantly higher than for the population as a whole." Specific data on subsistence living are not available for the BNL region. However, DOE is unaware of any subsistence populations residing in the vicinity of the proposed SNS site. Therefore, no adverse effects on such populations are expected.

In order to assemble and disseminate information on subsistence hunting and fishing, DOE began publishing *A Department of Energy Environmental Justice Newsletter: Subsistence and Environmental Health* in the spring of 1996. The newsletter is available in the public reading rooms. Three goals of the newsletter are (1) "to provide useful information about the health implications of consuming contaminated fish, wildlife, livestock products, or vegetation"; (2) "to provide information about projects and programs at DOE and other Federal and State agencies that address the problems associated with consuming contaminated fish, wildlife, livestock products, or vegetation"; and (3) "to receive relevant information from readers." In addition to the newsletter, DOE has a new project under way to identify what information is being collected on subsistence consumption by other federal agencies and to serve as a clearinghouse for such information (DOE 1996e).

No discharges of radioactive water to surface water would occur because all of the wastes generated during construction and operation of the proposed SNS facility would be transported to BNL facilities for processing. These facilities and the management process for these wastes are described in Section 5.5.11. All chemical releases would be regulated by NPDES permits and would be in compliance with federal and state regulations. As such, there would be no incremental effects on fish or other edible aquatic life in areas surrounding the proposed SNS site.

The analyses indicate that socioeconomic changes resulting from implementing the proposed SNS would not lead to environmental justice effects. The proposed SNS project would provide economic benefits through generating additional employment and income in the affected region (refer to Table 5.5.6.4-1). There would be increased traffic congestion; however, this effect would not disproportionately affect minority or low-income communities because traffic patterns would not be different between low-income and minority populations and the rest of the surrounding population (refer to Section 5.5.10.1). Overall, nothing from construction or operation of the proposed SNS facility would pose high and adverse human health or environmental effects that disproportionately affect minority or low-income populations.

5.5.7 CULTURAL RESOURCES

The potential effects of the proposed action on cultural resources located on and adjacent to the proposed SNS site at BNL are assessed in this section. These assessments involve prehistoric archaeological sites; structures, features, and archaeological sites dating to the Historic Period; and TCPs.

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at BNL. In addition, the locations of ancillary structures such as a retention basin and a switchyard have not been determined. As a result, the effects of the proposed action on any cultural resources that may occur in these areas cannot be assessed at this time. If the proposed SNS site at BNL were chosen for construction, a cultural resources survey and an assessment of potential effects would be conducted prior to the initiation of construction-related activities in these areas. Appropriate measures would be implemented to mitigate any identified effects on cultural resources. These measures would include avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation.

5.5.7.1 Prehistoric Resources

No prehistoric cultural resources have been identified on or adjacent to the proposed SNS site at BNL. Consequently, implementation of the proposed action would have no effect on prehistoric cultural resources listed on or eligible for listing on the NRHP.

5.5.7.2 Historic Resources

Large earthen features such as berms, linear trenches, pits, and mounds have been found at survey Stations 2, 4, 8, and 10 on the proposed SNS site at BNL. These features may have been used for trench warfare training at Camp Upton during World War I. The features at Station 2 may have been a command post associated with adjacent trenches. If these features were associated with World War I training activities, they would date to approximately 1917–1918.

The earthen features at Stations 2, 4, 8, and 10 are considered to be potentially eligible for listing on the NRHP, based on the results of the 1998 cultural resources survey of the proposed SNS site at BNL. All of these features would be destroyed by site preparation activities under the proposed action. These effects would be mitigated through data recovery operations, including detailed recording of surface features and archaeological excavation.

5.5.7.3 Traditional Cultural Properties

No Native American tribal representatives have been identified in the BNL area, and no Native American lands are located on the proposed BNL site. Because no Native American groups have been identified, it has not been possible for DOE to consult with such groups concerning the potential occurrence of TCPs on and near the proposed SNS site. A survey of the proposed site and limited surveys of other areas at BNL have encountered no evidence of prehistoric occupations. In addition, no Native American TCPs have been identified in the BNL area. Based upon these results, it has been concluded that no TCPs occur on the proposed SNS site or anywhere else on laboratory land. Therefore, implementation of the proposed action on the SNS site at BNL would have no effect on such resources.

5.5.8 LAND USE

The potential effects of the proposed action on land use in the vicinity of BNL, within the boundaries of BNL, and on the proposed SNS site are assessed in this section. The assessments cover potential effects on current land uses and zoning for future land use. Furthermore, the potential effects of the proposed action on parklands, nature preserves, major recreational resources, and visual resources are assessed.

5.5.8.1 Current Land Use

Current land use in the area surrounding BNL is driven by the relationship between existing land characteristics and socioeconomic forces acting at the local and regional levels. Similarly, current land use within the boundaries of BNL results from selectively using the existing characteristics of the land to meet various DOE mission requirements. The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the basic land characteristics and other forces that influence land use. Consequently, implementation of the proposed action on the SNS site at BNL would have no reasonably discernible effects on land use in the vicinity of BNL and throughout most of the laboratory. However, current use of the land within and near the proposed SNS site would be more subject to effects.

The current land use within the proposed SNS site is Open Space. Construction of the proposed SNS facility would introduce development to 110 acres (45 ha) of SNS site land, utility corridors, and rights-of-way. The current use of proposed SNS site land would be changed to Commercial/Industrial. Considering the large areas of undeveloped Open Space that would still be available at BNL (refer to Figure 4.4.8.2-1), these effects would be minimal.

DOE has a federally mandated role as trustee of the natural and cultural resources on its lands. The use of undeveloped trusteeship land for the SNS is proposed only because no previously developed BNL lands that meet project requirements are available.

The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects. As a result, the proposed action would have no effects on the use of land by such projects.

5.5.8.2 Future Land Use

Two versions of zoning for future land use at BNL have been developed. Each is based on the possible construction of a major scientific research facility at the laboratory in the future. One is the muon-muon collider version, and the other is the new linear accelerator version.

As much as 20 percent of the BNL land now used as Open Space is zoned for future Industrial/Commercial use. In the muon-muon collider and new linear accelerator versions, the proposed SNS site is located on land zoned as Open Space and Commercial/Industrial. In each version, most of the land within the proposed SNS site is zoned Commercial/Industrial. Construction and operation of the proposed SNS facility is consistent with this zoning. The use of Open Space would appear to be at variance with this current zoning, but one of the guiding principles behind the zoning of BNL land is to expand other land uses into Open Space.

Portions of the proposed SNS site would become contaminated with pollutants from operations. Current plans call for in situ decommissioning of the SNS when its operational life cycle is completed. As a result of in situ decommissioning, some contaminated components would remain in place on the SNS site. This could limit the future use of land on the site for other purposes. Construction and operation of the SNS could also limit the future use of land areas adjacent to the SNS site.

No future uses of proposed SNS site and vicinity land for environmental research are planned. As a result, effects of the proposed action on specific future research projects cannot be assessed.

The end-use zoning of BNL was completed before the laboratory became an alternative site for the proposed SNS facility. With the exception of a small area of Commercial/Industrial land, the land on the proposed SNS site was zoned for end use as Open Space. However, if the proposed SNS facility were eventually constructed and operated on this site, its presence would probably influence a change of end-use zoning to Commercial/Industrial for both the site and some adjacent land.

5.5.8.3 Parks, Preserves, and Recreational Resources

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses in the vicinity of BNL. Consequently, implementation of the proposed action on the proposed SNS site at BNL would have no reasonably discernible effects on the following specific land uses: Brookhaven State Park, Rocky Point State Park, Wildwood State Park, recreational use of the Peconic and Carmens rivers, Calverton Naval Weapons Plant (recreational areas), Cathedral Pines County Park, South Haven County Park, Wertheim National Wildlife Refuge, and Randall Road Hunting Station.

5.5.8.4 Visual Resources

Most of the visual panoramas in the area immediately surrounding BNL and within the laboratory contain features indicative of development. The proposed action would add the SNS facilities to this visual environment, and they would be compatible with it. Consequently, implementation of the proposed action on the proposed SNS site at BNL would have a minimal effect on visual resources.

5.5.9 HUMAN HEALTH

Construction and operation of the proposed SNS at BNL could pose a potential risk of adverse effects on the health of workers and of the public living in the vicinity of the facility. Potential adverse effects include

- Traffic-related fatalities and injuries to workers and the public.
- Occupational fatalities and injuries to workers.
- Exposure of workers and the public to radiation or radioactive materials.
- Exposure of workers and the public to toxic or hazardous materials.

This section evaluates the potential magnitude of these effects and the likelihood that they would occur during three phases or conditions:

- construction,
- normal operations, and
- accident conditions.

5.5.9.1 Construction

The potential effects on the health of construction workers, other BNL workers, and members of the public would be essentially the same for any of the proposed locations, because the size of the construction work force would be the same. Potential effects of construction of the SNS include construction accidents and traffic accidents.

On the basis of national traffic accident rates (1.74×10^{-8} fatalities per vehicle mile and 1.05×10^{-6} disabling injuries per vehicle mile) and the anticipated total mileage of commuting construction workers (2,074 person-years × 250 work days/person-year × 0.806 daily round-trips/worker × 20 miles/round-trip), less than one additional fatality and nine additional disabling injuries could occur as a result of increased commuter traffic during the 7-year construction period of the proposed SNS.
On the basis of national construction accident rates, 0.31 fatality (0.00015 fatalities/worker-year × 2,074 worker-years) and 110 disabling injuries (0.053 disabling injuries/worker-year × 2,074 worker-years) could occur as the result of occupational accidents during construction of the proposed SNS.

The existing BNL workforce of 3,100 is smaller than that at the other proposed locations, so the relative increase in traffic-related injuries and fatalities would be greater during construction of the proposed SNS facility at BNL. Based on traffic data shown in Section 5.5.10.1 and the approach described in Section 5.2.9.1, traffic-related disabling injuries and fatalities would be expected to increase by approximately 19 percent during the peak year of construction relative to existing injury and fatality rates at BNL.

No known construction activities or requirements would place SNS construction workers and the public at BNL at a different risk of occupational injury or fatalities than the risk posed to these same groups by construction at any of the proposed locations.

The previous discussion is based on construction of the 1-MW proposed SNS facility. At this stage of design, estimates of the number of workers that would be required to upgrade the facility for 4-MW operation are not available. Because the amount of construction required for upgrade to 4 MW would be less than that required for construction of the original facility, injuries and fatalities for traffic-related and construction accidents for the 4-MW facility would be less than those for construction of the original facility regardless of where the SNS is located.

5.5.9.2 Normal Operations

The number of SNS workers is independent of the location of the facility. The absolute number of industrial accidents and traffic-related injuries and fatalities would be expected to be essentially the same as at the other proposed locations.

On the basis of national traffic accident rates (0.0174 fatalities per million vehicle-mile and 1.05 disabling injuries per million vehicle-mile) and the anticipated total mileage of 60 million miles (375 commuting workers × 20 miles/trip × 0.806 trips/day × 250 days/year × 40 years), 1 additional fatality and 63 additional disabling injuries could occur as the result of increased commuter traffic during the 40-year operational life of the proposed SNS.

National industrial workplace accident rate data applied to the work force for the proposed SNS would yield less than 1 fatality (3.4 deaths annually/100,000 workers × 375 workers × 40 years) and 500 disabling injuries (3,400 disabling injuries annually/100,000 workers × 375 workers × 40 years) occurring over the 40-year operational life of the proposed SNS.

The relative increase would be greater at BNL than at the other proposed locations because of its smaller existing workforce. Based on data shown in Section 5.5.10.1, the addition of the maximum of 375 SNS workers to the daily BNL traffic flow could increase the number of disabling injuries and fatalities in traffic accidents by approximately 12 percent relative to existing rates.

The proposed SNS facility would generate and release direct radiation, radioactive materials, and toxic materials. Members of the public and workers at the proposed SNS facility and other adjacent facilities would be exposed to such radiation and emissions. The quantities and release rates of these materials would be the same as for any of the proposed locations. The impact of the BNL site-specific meteorology, distances to site boundaries, and population density and distribution are discussed in the following sections.

5.5.9.2.1 Radiation and Radioactive Emissions

This section assesses the potential effects of direct radiation and airborne emissions of radioactive materials from the proposed SNS based on the methods and dose-to-risk conversion factors discussed in Section 5.1.9.

Direct Radiation

Exposure of SNS workers to direct radiation from the proposed SNS facility at BNL would be expected to be the same as the other proposed locations because the SNS Shielding Design Policy is applicable regardless of location.

The proposed SNS at BNL is near existing facilities that emit small amounts of direct radiation. As a result, dose to SNS workers at BNL could be slightly different than at the other proposed locations. The difference, if any, would be on the order of a few mrem annually. The average total EDE to all BNL workers was 81 mrem in 1996 (DOE 1996f).

The proposed SNS site at BNL is also relatively close to the site boundary at several points. Based on BNL monitoring results for 1995 that reflect the contributions of direct radiation from several major accelerator facilities (Naidu et al. 1996), the potential increase in direct radiation levels at the BNL boundary, if any, would not be expected to be more than a few mrem/yr.

Radioactive Emissions

Radioactive emissions from routine operations of the proposed SNS facility would consist of releases to the atmosphere from two stacks: the Tunnel Confinement Exhaust Stack and the Target Building Exhaust Stack. Radionuclide activities in these emissions are listed in Table G-1 of Appendix G and are the same regardless of the facility location. Existing EPA-permitted commercial disposal facilities servicing BNL have sufficient capacity to accommodate LLLW and process waste from the proposed SNS facility, and these wastes would be processed in accordance with existing permits for these facilities.

The estimated annual doses to workers and the public from routine SNS airborne emissions are shown in Table 5.5.9.2.1-1. The methods and assumptions used in the calculation of doses are discussed in Section 5.1.9 and in greater detail in Appendix G.

Even under the conservative assumptions regarding the exposure pathways, these estimated doses would be in compliance with applicable regulations. The dose to the maximally exposed individual member of the public from operation at a 1-MW beam power (0.91 mrem) is 9 percent of the 10-mrem annual limit (40 CFR Part 61) that DOE expects the facility to meet. The maximally exposed individual dose for operation at a 4-MW beam power (3.4 mrem) is 34 percent of the annual dose limit. Because the reported annual dose from existing operations at BNL is very low, only 0.06 mrem to the maximally exposed individual and 3.2 person-rem to the off-site population in 1995 (Naidu et al. 1996), BNL would remain in compliance when the emissions from the proposed SNS are included.

Dose at the BNL boundary because of emissions from the Tunnel Confinement Exhaust is 0.024 mrem and is dominated by radionuclides in activated concrete dust. Dose at the BNL boundary because of emissions from the Target Building Exhaust is dominated by ^{3}H (55 percent) with smaller contributions from ^{14}C, ^{125}I, and ^{203}Hg. These radionuclides are listed in order of decreasing dose and account for 99 percent of this component of the total dose.

To estimate the total consequence from SNS emissions of radioactive materials over the entire life of the facility, annual population dose is multiplied by operating life of the facility and by the dose-to-risk factor of 0.0005 LCFs/ person-rem. For 40 years of operation at 1 MW, 0.4 excess LCFs would be projected. For 40 years at 4 MW, 1.5 excess LCFs would be

Table 5.5.9.2.1-1. Estimated annual radiological dose from proposed SNS normal emissions at BNL.[a]

Receptor	1-MW Power Level		4-MW Power Level	
	Target Building[b]	Tunnel Confinement[c]	Target Building[b]	Tunnel Confinement[c]
Maximum Individuals (mrem)				
Off-site Public[d]	0.89	0.024	3.4	0.029
Uninvolved Workers[d]	0.093	0.050	0.19	0.062
Populations (person-rem)				
Off-site Public[e] (4,940,116 persons)	20	0.41	76	0.41
Uninvolved Workers[e] (2,007 persons)	0.032	0.006	0.096	0.009

[a] Doses shown include the contributions from inhalation, immersion, and "ground shine" for workers and the off-site public and ingestion for the off-site public.

[b] Target Building emissions include hot offgas exhaust, primary confinement exhaust, secondary confinement exhaust from the target building, and activated air from the beam dump buildings.

[c] Tunnel Confinement emissions include activated air and concrete dust from the linac tunnel, high-energy beam transport (HEBT) tunnel(s), ring tunnel(s), and ring-to-target beam transport tunnel(s).

[d] The maximally exposed individuals are hypothetical receptors. The member of the public is assumed to occupy a position at the BNL site boundary for 8,760 hr/yr and to produce their entire food supply at this location. The maximally exposed uninvolved worker is assumed to occupy a position within 1.2 miles (2 km) of the stack for 2,000 hr/yr.

[e] The off-site population consists of all individuals residing outside the BNL site boundary within 50 miles (80 km) of the site and is assumed to be present for 8,760 hr/yr. The involved/uninvolved worker population consists of all workers normally within 1.2 miles (2 km) of the facility. These workers are assumed to be present for 2,000 hr/yr.

projected. If the facility operated for 10 years at 1 MW and 30 years at 4 MW, 1.2 excess LCFs would be projected. These projected excess LCFs do not mean that any actual fatalities would occur as the result of the proposed SNS operations but provide a quantified magnitude for comparison to excess LCFs estimated for the other alternatives.

5.5.9.2.2 Toxic Material Emissions

As discussed in Section 5.2.9.2.2, elemental mercury vapor is the only toxic material expected to be released from the proposed SNS facility under normal conditions. Based on the continuous annual release rate of 0.0171 mg/s and atmospheric dispersion factors specific to BNL, the maximum mercury concentration in areas that could be occupied by uninvolved workers would be 2.71×10^{-6} mg/m^3 in any 2-hr period and 6.05×10^{-7} mg/m^3 in any 8-hr period. These concentrations are at least 1/100,000th of the OSHA ceiling limit (0.1 mg/m^3) and the ACGIH recommended TLV-TWA (0.05 mg/m^3) for workers. The maximum average annual airborne mercury concentration at the site boundary would be 1.60×10^{-8} mg/m^3, 1/20,000th of the EPA Reference concentration for members of the public (0.0003 mg/m^3).

5.5.9.3 Accident Conditions

This section assesses the effects on human health of accidents that could potentially occur during operation of the proposed SNS at BNL.

5.5.9.3.1 Accident Scenarios

The accident scenarios and source terms for accidents that could potentially occur at the proposed SNS are the same for all alternative sites and are summarized in Table G-2 (refer to Appendix G). The details of these scenarios and source terms are provided in Appendix C. Table 3.2 in Appendix C defines the terminology used to describe the likelihood that a given accident could occur.

5.5.9.3.2 Direct Radiation

The frequencies of occurrence and consequences of accidents involving exposure to direct radiation have not been specifically analyzed. DOE's Shielding Design Policy for the proposed SNS is such that for the worst-case design-basis accident, the dose to the maximally exposed individual in an uncontrolled area would be limited to 1 rem and for a worker in a controlled area would be limited to 25 rem. The risks of this category of accidents would be the same for all alternative sites.

5.5.9.3.3. Radioactive Materials Accidents

DOE has performed a hazard analysis of potential accidents at the proposed SNS facility, and for those that could result in release of radioactive material, it has estimated source terms. The DOE analysis is included as Appendix C. Accident scenarios, estimated frequencies of occurrence, and source terms are summarized in Table G-2 and are the same for all proposed SNS alternative sites. The methods used to evaluate the consequences of these accidents are discussed in Section 5.1.9 and in more detail in Appendix G.

Doses for these accidents, should they occur at the proposed SNS facility at BNL, are listed in Table 5.5.9.3.3-1. With the exception of accident ID 16, all doses are for accidents at a 1-MW facility and would be four times higher at a 4-MW facility. This is not the case for ID 16, the beyond-design-basis mercury spill, because of differences in the source term model (refer to Exhibit F of Appendix C). At 4 MW (ID 16b), some boiling of mercury is assumed, releasing a larger quantity of mercury than at 1 MW (ID 16a), where only evaporation is assumed.

The pattern of accident doses for the proposed SNS at BNL is similar to that for the other proposed locations. That is, the same accidents and releases are postulated to occur independent of facility location. However, doses to individuals and populations reflect the relative proximity of the proposed SNS to the BNL boundary, and population doses reflect the proximity to a major metropolitan area.

At a power level of 1 MW, the design-basis mercury spill (ID 16a) has the highest dose of accidents involving the target. The maximum individual doses would be 24 mrem for the maximally exposed individual and 29 mrem for the uninvolved worker. These doses are approximately 10 percent of the 300 mrem received annually by the average person from background radiation. The off-site population dose of 1,500 person-rem corresponds to 0.75 excess LCFs.

At a power level of 1 MW, accidents involving the off-gas decay system (IDs 24 and 31) would

Table 5.5.9.3.3-1. Radiological dose for SNS accident scenarios at BNL.

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	**Event**	**Frequency[b]**	**Source Term[c]**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**	**1 MW Beam**	**4 MW Beam**
A. Accidents Involving Proposed SNS Target or Target Components											
2	Major loss of integrity of Hg Target Vessel or piping (Appendix C, Section 3.3)	a) Unlikely	Percent Inventory: Mercury 0.142, Iodine 0.142	3.4	13.6	4.0	16.0	210	840	2.9	11.6
		b) Extremely Unlikely	Percent Inventory: Mercury 0.243, Iodine 100	14	56	9.4	37.6	950	3,800	6.7	26.8
8	Loss of integrity in Target Component Cooling Loop (Appendix C, Section 3.9)	a) Anticipated	Bounded by annual release limits[d]	<10	<10	NA	NA	NA	NA	NA	NA
		b) Anticipated	Gases + Mist + 150 L of D_2O	1.5	6.0	0.26	1.04	1.9	7.6	0.13	0.52
		c) Anticipated	18 L of D_2O	<0.001	0.003	0.001	0.004	0.039	0.156	<0.001	0.004
		d) Anticipated	Gases + Mist + 150 L of H_2O	1.4	5.6	0.22	0.88	4.6	18.4	0.094	0.376
16	Beyond-Design-Basis Hg Spill (Appendix C, Section 3.17)	a) Beyond Extremely Unlikely	1 MW Percent Inventory: Mercury 1.11, Iodine 100	24		29		1,500		21	
		b) Beyond Extremely Unlikely	4 MW Percent Inventory: Mercury 1.28, Iodine 100		2,200		920		170,000		660

Table 5.5.9.3.3-1. Radiological dose for SNS accident scenarios at BNL - (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	Event	Frequency[b]	Source Term[c]	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam
B. Accidents Involving proposed SNS Waste Systems											
17	Hg Condenser Failure (Appendix C, Section 4.1.1)	Anticipated	13.7 g mercury	0.007	0.028	0.005	0.02	0.41	1.64	0.003	0.012
18	Hg Charcoal Absorber Failure.[e] (Appendix C, Section 4.1.2)	Unlikely	14.8 g mercury	0.002	0.008	0.003	0.012	0.077	0.308	0.002	0.008
19	He Circulator Failure (Appendix C, Section 4.2.1)	Anticipated	1 day tritium production	<0.001	<0.001	<0.001	<0.001	0.009	0.036	<0.001	<0.001
20	Oxidation of Getter Bed (Appendix C, Section 4.2.2)	Unlikely	1 day tritium production	<0.001	<0.001	<0.001	<0.001	<0.009	0.036	<0.001	<0.001
21	Combustion of Getter Bed (Appendix C, Section 4.3.1)	Extremely Unlikely	1 year tritium production, 200 g depleted uranium	4.0	16.0	0.99	3.96	320	1,280	0.71	2.84
22	Failure of Cryogenic Charcoal Absorber [f] (Appendix C, Section 4.4.1)	Unlikely	1 day production of xenon	0.13	0.52	0.019	0.076	8.0	32.0	0.014	0.056
23	Valve sequence error in Tritium Removal System (Appendix C, Section 4.5.1)	Unlikely	1 year tritium production	3.8	15.2	0.95	3.8	300	1,200	0.68	2.72
24	Valve sequence error in Offgas Decay System (Appendix C, Section 4.5.2)	Anticipated	7 days xenon accumulation (1 decay tank)	10	40	2.4	9.6	770	3,080	1.7	6.8

Table 5.5.9.3.3-1. Radiological dose for SNS accident scenarios at BNL - (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	Event	Frequency[b]	Source Term[c]	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam
	B. Accidents Involving proposed SNS Waste Systems (continued)										
25	Spill during filling of tanker truck for LLLW Storage Tanks[g] (Appendix C, Section 4.5.3)	Anticipated	0.00005% of contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001
26	Spray during filling of tanker truck for LLLW[g] (Appendix C, Section 4.5.4)	Anticipated	1.9 ml of LLLW	<0.001	<0.001	<0.001	<0.001	0.002	0.008	<0.001	0.001
27	Spill during filling of tanker truck for Process Waste Storage Tanks[g] (Appendix C, Section 4.5.5)	Anticipated	51,100 L Process Waste to surface water + 57 L to atmosphere	See footnote "h"		See footnote "h"		See footnote "h"		See footnote "h"	
28	Spray during filling of tanker truck for Process Waste[g] (Appendix C, Section 4.5.6)	Anticipated	28.4 L of Process Waste	See footnote "h"		See footnote "h"		See footnote "h"		See footnote "h"	
29	Offgas Treatment pipe break (Appendix C, Section 4.6.1)	Unlikely	24 hrs xenon production	1.6	6.4	0.15	0.6	4.7	18.8	0.12	0.48
30	Offgas Compressor Failure (Appendix C, Section 4.6.2)	Unlikely	1 hr xenon production	0.23	0.92	0.019	0.076	7.4	29.6	0.015	0.06
31	Offgas Decay Tank Failure (Appendix C, Section 4.6.3)	Extremely Unlikely	7 days xenon accumulation	10	40	2.4	9.6	770	3,080	1.7	6.8
32	Offgas Charcoal Filter Failure (Appendix C, Section 4.6.4)	Unlikely	7 days iodine production	0.15	0.6	0.020	0.080	1.5	6.0	0.012	0.0048

Table 5.5.9.3.3-1. Radiological dose for SNS accident scenarios at BNL - (continued).

				Maximum Individual (mrem) [a]				Population (person-rem) [a]			
				Off-site Public		Uninvolved Workers		Off-site Public		Uninvolved Workers	
ID	Event	Frequency[b]	Source Term[c]	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam	1 MW Beam	4 MW Beam
B. Accidents Involving proposed SNS Waste Systems (continued)											
33	LLLW System piping failure. (Appendix C, Section 4.6.5)	Unlikely	0.00005% of contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001
34	LLLW Storage Tank Failure (Appendix C, Section 4.6.6)	Extremely Unlikely	0.00005% of contents of LLLW Tank	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001
37	Process Waste Storage Tank Failure (Appendix C, Section 4.6.9)	Extremely Unlikely	57 L to atmosphere	See footnote "h"		See footnote "h"		See footnote "h"		See footnote "h"	

[a] Unless otherwise indicated, radiological doses are based on radiological source terms for a 1-MW power level and would be four times greater if the facility is operating at 4 MW. These doses are total EDEs and include dose from inhalation and immersion. "Off-site" means outside the site boundary rather than outside the proposed SNS facility boundary. Individual receptors are hypothetical and do not correspond to any actual person. Population receptors are based on the actual number of people residing outside the site boundary and within 50 miles (80 km) of the facility and the number of site workers normally within 1.2 miles (2 km) of the facility and not involved in facility operation.

[b] Refer to Table 5.2.9-2 for the numerical ranges associated with accident frequencies categories.

[c] Source terms are expressed in units that are independent of power level. Except for beyond-design-basis accidents (IDs 16a, 16b), the radioactivity released in accidents at 4 MW is four times that released at 1 MW.

[d] 40 CFR 61 limits dose to members of the public from airborne emissions from DOE facilities to 10 mrem/yr.

[e] Installation of sulfur-impregnated charcoal filters is being considered to serve as a "polishing filter" for the mercury condenser (refer to Event 17).

[f] Cryogenic charcoal absorbers are being considered as an alternative to the offgas compressor, decay storage tanks, and ambient temperature charcoal filters (refer to Events 24, 30, 31, and 32).

[g] Accidents involving tanker trucks may not be applicable for an proposed SNS facility at this site. It has not been determined how LLLW and process waste would be treated and disposed.

[h] Process waste accidental airborne releases occur at ground level. Only atmospheric dispersion factors for elevated releases were calculated for this site. Based on the radionuclide contents of LLLW and process waste source terms and results for BNL, doses for process waste accidents at this site are anticipated to be approximately 0.001 mrem or less for individuals and to be less than approximately 0.050 person-rem for the off-site population.

NA - Not available.

result in the highest individual and population doses of potential accidents involving the waste handling systems. The dose to the maximally exposed member of the public for these two accidents is 10 mrem and 2.4 mrem for the maximally exposed uninvolved worker. The dose to the maximally exposed member of the public is approximately 3 percent of the 300 mrem received annually by the average person from natural background. The uninvolved worker dose is 3 percent of the average dose received by workers from normal operations at BNL (DOE 1996f). The population dose of 770 person-rem corresponds to 0.4 excess LCFs.

At a power level of 4 MW, the potential consequences of all accidents, except ID 16, would increase by a factor of 4 but would still represent quantified dose of less than 10 mrem to maximally exposed individuals. For the "beyond extremely unlikely" mercury spill (ID 16b), dose to the maximally exposed member of the public would be 2,200 mrem and 920 mrem to the maximally exposed uninvolved worker. The dose to the maximally exposed member of the public is slightly more than 7 times the annual dose from natural background radiation and corresponds to an individual excess risk of LCF of about 1 in 910 chances (0.0011 LCFs).

The dose to the maximally exposed individuals from the off-gas decay system accidents (IDs 24 and 31) would be 41 mrem for the public individual, about 15 percent of the 300-mrem annual dose for natural background, and 9.6 mrem for the uninvolved worker.

Because of the large off-site population and the conservative assumptions underlying the use of dose-to-risk factors, the quantified adverse effects are large for four accidents should they occur at a power level of 4 MW. The accident with the greatest potential consequences is the beyond-design-basis mercury spill (ID 16b). The population dose of 170,000 person-rem corresponds to 85 excess LCFs. The probability that this accident would occur in a given year is less than 1 chance in 1,000,000. Another mercury spill accident (ID 2b) also has quantified adverse health effects in the off-site population. The population dose for this accident of 3,800 person-rem corresponds to 1.9 excess LCFs. The probability that this "extremely unlikely" accident would occur in a given year is between 1 chance in 10,000 and 1 chance in 1,000,000.

The two accidents involving the offgas decay system (ID 24 and ID 31) have the same emission source term and also would have the potential for adverse effects in the off-site population quantified with a magnitude greater than 1.0. The population dose from either accident of 3,100 person-rem corresponds to 1.6 excess LCFs. Accident ID 31 is "extremely unlikely"; Accident ID 24 is "anticipated." Section 5.2.9.3.3 discusses several simple mitigation actions that could be taken that would reduce the frequency of occurrence of Accident ID 24 to "unlikely."

As discussed in Section 5.2.9.2.1, LCF values of 1.0 or greater do not mean that fatalities would actually occur in the off-site population but provide a quantified value for use in comparison between alternatives.

5.5.9.3.4 Hazardous Materials Accidents

Accidents involving potential exposure to toxic materials are discussed in Section 5.2.9.3.4. All involve spills of irradiated mercury. Accident

IDs 2b, 16a, and 16b could result in the OSHA ceiling concentration of 0.1 mg/m^3 being exceeded for a few minutes in locations accessible to workers during the initial stages of these accidents, but it would not be exceeded at or beyond the BNL site boundary. Thus for only a few minutes at the start of the accident, mercury concentrations at or beyond the site boundary might exceed TEEL-1 limit (0.075 mg/m^3) but would not exceed the TEEL-2 limit (0.10 mg/m^3); individuals at the boundary at the precise occurrence of the initial emission might perceive an odor but would not experience or develop irreversible health effects or symptoms that could impair the ability to take protective action.

The secondary and tertiary stages of these accidents are conservatively assumed to last from 7 to 30 days, while in reality, administrative and emergency response actions would more probably terminate the release in a shorter time period. During these stages, airborne concentrations of mercury would remain two to three orders of magnitude below the TEEL-0 limit of 0.05 mg/m^3, and no observable detrimental effects would be expected to occur.

5.5.10 SUPPORT FACILITIES AND INFRASTRUCTURE

This section summarizes the facilities and infrastructure effects on BNL transportation and utility systems from construction and operation of the proposed SNS facility.

5.5.10.1 Transportation

As described in Section 3.2.5, Alternative Sites, construction of the proposed SNS, related infrastructure, and support systems would occur at BNL, located in Suffolk County on Long Island in the state of New York. The wooded and largely undeveloped BNL site is bordered on the south by I-495, on the west by the William Floyd Parkway, on the north by State Highway 25, and on the east by County Route 25. Primary access to BNL is provided via Princeton Avenue from the William Floyd Parkway.

A recent BNL traffic study indicated that the current site population is approximately 3,100 with approximately 2,500 daily round-trips. In 1990, a transportation master plan was completed for BNL. The transportation plan evaluated traffic circulation effects for a future site population of 3,800 employees. At that time, the BNL site population was approximately 3,400 (Vollmer Associates 1990).

Construction vehicles would transport necessary concrete, steel, and related building materials. Construction employee and vehicle activity would increase during the first years of construction, peaking in 2002, and would decrease significantly during the last year (2004) of construction. The estimated total of 578 construction employees in the peak construction year (2002) is expected to add approximately 466 daily round-trips and 10 material/service trucks. This represents a 16 percent increase. This increase is considered to be below a level of significance and, therefore, would not result in significant traffic impacts to the site or surrounding area. However, the nature of the construction vehicles, given their size and speed, would affect traffic composition, and they may affect the flow of vehicles approaching and within BNL during construction. The implementation of mitigation measures, as described in Section 5.10, would minimize such adverse effects.

After construction, operation of the proposed SNS would result in an additional 250 resident/visiting scientists by 2006 and another 125 employees during future facility upgrades. The long-term total of an additional 375 people and 3 service trucks/day (approximately 305 daily round-trips) is not expected to exceed the 1990 Traffic Master Plan's projection of 3,800 employees for the entire BNL facility. Therefore, no significant effects would be expected from operation of the proposed SNS facility at BNL.

Table 5.5.10.1-1 compares the No-Action Alternative with the proposed action at BNL. The table provides the percentage increase in traffic resulting from the proposed SNS facility during construction and operation, as compared to that of the No-Action Alternative. The table also provides the percentage increase using existing site data, as well as projected data for the site. Potential effects of these modest traffic increases could be reduced by having craft and non-craft workers report to work at different times, thus reducing the adverse effects on traffic flow during rush hours. Additionally, this analysis assumed there would be no transferring of personnel from within BNL. If some of the workers were previously working at BNL, the impact on traffic would be reduced.

5.5.10.2 Utilities

This section assesses the potential consequences of the proposed SNS on utilities and utilities infrastructure at BNL.

5.5.10.2.1 Electrical Service

As described in Section 3.2.3.4, the proposed SNS facility would require large supplies of electrical power for operation. In order to accommodate the 4-MW proposed SNS, a new 69-kV transmission line would be required. This line would extend to the Long Island Lighting Company's (LILCO) 138-kV grid, located on the southeast corner of BNL. The length of the line would be approximately 1 mile (1.6 km) and would parallel BNL's existing 69-kV transmission line. The LILCO grid would require a new 138- to 69-kV substation. Required upgrades to the electrical system would occur within existing infrastructure corridors or alignments. Therefore, environmental effects resulting from this upgrade in electrical service at BNL are expected to be minor.

Table 5.5.10.1-1. BNL traffic increases compared to No-Action Alternative.

	Baseline No-Action	(Peak Year) SNS Construction	(4 MW) SNS Operation
Passenger vehicle trips[a]/day	2,500	466	302
Material transport trucks/day	0	7	0
Service trucks/day	0	3	3
Total (% increase)	0 (0%)	476 (16%)	305 (11%)

[a]Based on BNL site population of 3,100.

5.5.10.2.2 Steam

The proposed SNS facility does not necessarily require steam for facility heating; however, steam is available at BNL. The present steam load peaks at 170,000 lb/hr. The existing steam plant has a firm capacity of 295,000 lb/hr. It would be necessary to extend the existing steam pipeline approximately 4,000 ft (1,219 m) to service the proposed SNS facility. The existing steam capacity would be sufficient to meet the 1,500 lb/hr required by the proposed SNS to deal with the Long Island climate. Environmental effects on steam resulting from the proposed SNS facility at BNL would be expected to be inconsequential.

5.5.10.2.3 Natural Gas

Natural gas would provide energy for operational equipment such as boilers and localized unit heaters in the proposed SNS facility's heating system. As described in Section 4.4.10.2.3, natural gas at BNL is distributed from an existing main located near the electrical substation at the southeast corner of the laboratory. Natural gas is distributed to the Central Steam Facility for steam production. Current usage peaks at approximately 200,000 ft^3/hr, and 40,000 ft^3/hr would be available for the proposed SNS. Thus, environmental effects on natural gas distribution to the proposed SNS facility at BNL are expected to be inconsequential.

5.5.10.2.4 Water Service

The proposed SNS facility would require water supplies for the following systems: tower water cooling, deionized cooling, chilled water, building heating, process water, potable water, demineralized water, fire suppression, and target moderators.

The water supply at BNL is obtained from six on-site wells. As described in Section 4.4.10.2.4, the total pumping capacity of the wells is approximately 7,200 gpm (27,255 lpm). Average daily water usage at BNL is approximately 1 mgpd (3.8 million lpd). Given the available supply of water, on-site water treatment, and the water storage capacity at BNL, it is expected that the laboratory can provide the proposed SNS facility with water supplies from existing sources. Environmental effects on water service resulting from the proposed SNS are expected to be minor.

5.5.10.2.5 Sewage Treatment

The STP at BNL was recently renovated, bringing the hydraulic capacity of the plant to 3 mgpd (11.4 million lpd). Its peak use during a recent 10-year storm was 2.2 mgpd (8.3 million lpd). Therefore, sufficient capacity exists to accommodate the additional flow from the proposed SNS facility. Regarding the processing of biodegradable mass, the plant capacity is 250 to 500 lb/day. Approximately 40 lb enters the sewage plant daily. The addition of biodegradable mass from the proposed SNS is expected to improve the efficiency of the existing plant. Therefore, the BNL site would be able to provide sewage treatment for the proposed SNS facility, and environmental effects are expected to be negligible.

5.5.11 WASTE MANAGEMENT

All of the wastes generated during construction and operation of the proposed SNS would be transferred to BNL waste operations for processing. The existing waste management systems for sanitary wastes and liquid low-level radioactive wastes would have sufficient capacity to accommodate wastes from the proposed SNS facility. However, storage capacity for hazardous wastes, liquid low-level and solid LLWs, and mixed wastes would have to be expanded to accommodate SNS wastes. DOE anticipates only minimal effects on the environment from waste management activities associated with the SNS.

Projections of construction and operations waste streams that would be generated at the proposed SNS facility include the following: hazardous waste, LLW, mixed waste, and sanitary/industrial waste, as listed in Table 3.2.3.7. A summarization of existing waste management facilities located at BNL, along with facility design and/or permitted capacities and remaining capacities, can be found in Table 5.5.11-1. Waste stream forecasts for BNL's individual operations, proposed SNS operation at 4 MW, and the aforementioned wastes are also included in Table 5.5.11-1. These forecasts cover the period from 1998 to 2040, unless otherwise noted. They are based on estimates given by waste management facility contacts and waste management documentation.

Before SNS wastes would be accepted for TSD at BNL, they would be certified to meet the WAC of the receiving TSD facility. As mentioned earlier in Section 5.2.11.1, AEA, EPA, and NRC limits for LLLW treatment facility WAC would also need to be addressed for BNL.

Currently, no hazardous waste treatment or disposal facilities are located at BNL. Hazardous wastes are collected, certified, and shipped to DOE-approved licensed commercial treatment or disposal facilities (Petschauer 1998a).

No LLW disposal facilities are located on-site at BNL. These wastes are collected, certified, and shipped to off-site, DOE-approved licensed commercial facilities (Petschauer 1998a).

No mixed waste treatment or disposal facilities are located at BNL. These wastes are collected, certified, and shipped to DOE-approved licensed permitted disposal facilities (Petschauer 1998a).

BNL has a waste certification process in place to ensure that wastes meet the WACs for LLW disposal. However, because of the uncertainty of the composition of LLW and mixed wastes that may be generated from operation of the SNS, the waste may not meet the current WAC for waste management facilities at BNL. DOE would take action to ensure the proper disposition of these wastes. For example, pretreatment of the waste may ensure that they meet the WAC. DOE may be able to amend the license at current waste disposal facilities to allow acceptance of wastes from the SNS.

Sanitary/industrial waste disposal facilities are not present at BNL. These wastes would be sent to a licensed disposal facility off-site (DOE 1997a).

Excess soil, construction wastes, and sanitary wastes would be generated during construction of the proposed SNS. Excavated soil and rock would be used for backfill, erosion control, or other environmental purposes. Construction debris would be sent to a Class IV landfill. Liquid sanitary wastes would be transported to the sanitary wastewater treatment plant at BNL.

Table 5.5.11-1. BNL waste management facility description and capacities.

Waste Disposition	Waste Type and Facility	Total Design Capacity for BNL Site	BNL Waste Projections for 1998-2040	Total Remaining Capacity for BNL Site (Excludes Proposed SNS Operations)	Proposed SNS Waste Operations Projection for 1998–2040	Potential Effect of Waste Management on the Environment
HAZARDOUS WASTE						
STORAGE	Liquid/Solid RCRA Hazardous Waste Storage Building	Drum storage bays (30,800 gal); chemical storage rooms (5,000 gal) 650 drums/yr	25 tons/yr (Estimate includes both liquids and solids) 100 drums/yr	No long-term storage	Hazardous Liquid 10,800 gal/yr (200 drums/yr)	Minimal effects anticipated. Standard DOE practice has been to dispose of waste at off-site, DOE-approved licensed commercial facilities.
LOW-LEVEL WASTE						
TREATMENT	Liquid Waste Concentration Facility	120,000 gal/yr	50,000 gal/yr	80,000 gal/yr	175,600 gal/yr LLLW 4.15E06 gal/yr process waste potentially LLLW	SNS volume exceeds capacity–waste can be processed at higher rate, if necessary.
	Solid None					
STORAGE	Solid Radioactive Waste Storage Building (Reclamation Building)	270 m³	283 m³/yr	270 m³ – new facility	1,026 m³/yr	Additional storage may be necessary; however, DOE has contracts in place for off-site disposal at DOE-approved licensed commercial facilities.
MIXED WASTE						
STORAGE	Solid/Liquid Mixed Waste Storage Building	22.70 m³	2 m³/yr	20.70 m³ – new facility	Liquid 10.8 m³/yr Solid 7 m³/yr	Minimal effects anticipated. Standard DOE practice has been to dispose of waste at off-site, DOE-approved licensed commercial facilities.

Table 5.5.11-1. BNL waste management facility description and capacities (continued).

Waste Disposition	Waste Type and Facility	Total Design Capacity for BNL Site	BNL Waste Projections for 1998-2040	Total Remaining Capacity for BNL Site (Excludes Proposed SNS Operations)	Proposed SNS Waste Operations Projection for 1998-2040	Potential Effect of Waste Management on the Environment
SANITARY WASTE						
TREATMENT	Liquid Waste Water Treatment Facility	2.3 mgd	800,000 gpd	1.5 mgd	18,750 gpd	No effect anticipated.
	Solid None					
DISPOSAL	Solid Off-site landfills		Trash 842.4 ton/yr Construction Waste 844 ton/yr	NA Off-site landfills	1,349 m^3/yr	No effect anticipated.

Sources: DOE 1997a; Naidu et al. 1996; Petschauer 1998a; Petschauer 1998b.
NA – Not applicable.

Solid sanitary waste would be sent to a sanitary landfill (ORNL 1997b).

As stated in Section 5.2.11, in accordance with the *NSNS Waste Minimization and Pollution Prevention Plan*, considerations for minimizing the production of SNS waste would be implemented.

5.6 NO-ACTION ALTERNATIVE

The No-Action Alternative, as described in Section 3.4, is the alternative under which the proposed SNS facility would not be constructed. This section describes the effects on the existing environment that would result from implementation of this alternative.

5.6.1 GEOLOGY AND SOILS

If the proposed SNS facility is not constructed, there would be no disturbance of geological formations or soils. In addition, there would be no possibility of soil activation. Consequently, the No-Action Alternative would have no effects on geology and soils.

5.6.2 WATER RESOURCES

If the proposed SNS facility is not constructed, there would be no effects on surface water or groundwater resources. Because no soils would be activated, there would be no chance of activation products reaching groundwater. Without operation of the proposed SNS facility, there would be no discharges of cooling water to surface waters. Consequently, implementation of the No-Action Alternative would have no effects on water resources.

5.6.3 AIR QUALITY

No excavation would occur under the No-Action Alternative; thus, there would be no increase in fugitive dust. There would be no deterioration of air quality from construction or operation of the proposed SNS. As a result, implementation of this alternative would have no effects on air quality.

5.6.4 NOISE

No increases in noise levels would occur under the No-Action Alternative because no facility construction or operations would occur. Consequently, its implementation would have no effects on the noise environment.

5.6.5 ECOLOGICAL RESOURCES

This section describes the potential effects implementation of the No-Action Alternative would have on ecological resources. It includes potential effects on terrestrial and aquatic resources, wetlands, and threatened and endangered species.

5.6.5.1 Terrestrial Resources

The proposed SNS facility would not be constructed on any area of land under the No-Action Alternative. As a result, implementation of this alternative would have no effects on terrestrial resources.

5.6.5.2 Wetlands

No area of land would be used for construction of the proposed SNS under the No-Action Alternative. As a result, no wetland areas would be filled, excavated, or otherwise disturbed.

Consequently, implementation of this alternative would have no effects on wetlands.

5.6.5.3 Aquatic Resources

The proposed SNS facility would not be constructed on any area of land under the No-Action Alternative. As a result, this alternative would have no effects on aquatic resources.

5.6.5.4 Threatened and Endangered Species

No area of land would be used for construction of the proposed SNS under the No-Action Alternative. No habitats for endangered or threatened plant or animal species would be affected. Consequently, implementation of this alternative would have no effects on endangered or threatened species.

5.6.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

This section describes the potential effects on the socioeconomic and demographic environment that would result from implementation of the No-Action Alternative.

5.6.6.1 Demographic Characteristics

Under the No-Action Alternative, there would be no in-migrating construction or operations workers. Therefore, there would be no effects on population growth trends or projections or the race or ethnicity of populations. Consequently, implementation of this alternative would have no effects on the demographic environment.

5.6.6.2 Housing

Under the No-Action Alternative, there would be no in-migrating construction or operations workers who would need housing. Therefore, there would be no effects on numbers of housing units, vacancy rates, housing sales, or apartment vacancy rates. Consequently, implementation of this alternative would have no effects on housing.

5.6.6.3 Infrastructure

Under the No-Action Alternative, there would be no in-migrating construction or operations workers who would need community services. There would be no effects on schools, health care, police protection, or fire protection services. Consequently, implementation of this alternative would have no effects on infrastructure.

5.6.6.4 Local Economy

The proposed SNS facility would not be constructed or operated under the No-Action Alternative. Therefore, no communities would receive additional benefits from increased construction or operations jobs at the proposed SNS. Consequently, the No-Action Alternative would have no effects on local economies.

5.6.6.5 Environmental Justice

Under the No-Action Alternative, there would be no proposed SNS facility, and as such, it would not cause any disproportionately high and adverse human health or environmental effects on minority populations or low-income populations, including Native Americans. Consequently, implementation of the No-Action Alternative would have no effects on environmental justice.

5.6.7 CULTURAL RESOURCES

This section assesses the potential effects on cultural resources that would result from implementation of the No-Action Alternative.

5.6.7.1 Prehistoric Resources

The No-Action Alternative would involve no disturbance of ancient archaeological sites, artifacts, structures, or features at any location. As a result, implementation of this alternative would have no effects on prehistoric cultural resources.

5.6.7.2 Historic Resources

This alternative would involve no disturbance of historic archaeological sites, artifacts, objects, structures, features, or written records. Consequently, implementation of the No-Action Alternative would have no effects on cultural resources dating to the Historic Period.

5.6.7.3 Traditional Cultural Properties

The No-Action Alternative would involve no disturbance of significant places or objects associated with the historical and cultural practices or beliefs of a living community. Consequently, its implementation would have no effects on TCPs.

5.6.8 LAND USE

This section assesses the potential effects on land use that would result from implementation of the No-Action Alternative.

5.6.8.1 Current Land Use

No existing parcel of land would be used for construction of the proposed SNS under the No-Action Alternative. Consequently, implementation of this alternative would have no effects on current land use.

5.6.8.2 Future Land Use

No existing parcel of land would be used for construction of the proposed SNS under the No-Action Alternative. Consequently, implementation of this alternative would have no effects on future land use.

5.6.8.3 Parks, Preserves, and Recreational Resources

No existing parcel of land would be used for construction of the proposed SNS under the No-Action Alternative. Consequently, implementation of this alternative would have no effects on parks, nature preserves, or recreational resources.

5.6.8.4 Visual Resources

No existing parcel of land would be used for construction of the proposed SNS under the No-Action Alternative. Consequently, implementation of this alternative would have no effects on visual resources.

5.6.9 HUMAN HEALTH

This section assesses the potential effects on human health that would result from implementation of the No-Action Alternative.

5.6.9.1 Construction

There would be no risk of adverse effects on the health of SNS workers or the public due to injury or exposure to radioactive or toxic materials since no construction would take place. Consequently, implementation of the No-Action Alternative would have no effects on the health of construction workers or the public.

5.6.9.2 Normal Operations

There would be no risk of adverse effects on the health of workers or the public from exposure to direct radiation or to emissions of radioactive or toxic materials during normal operations of the proposed SNS facility since the SNS would not operate. Consequently, the No-Action Alternative would have no effects on the health of workers or the public.

5.6.9.3 Accident Conditions

There would be no risk of adverse effects on the health of workers or the public from exposure to direct radiation or to emissions of radioactive or toxic materials as the result of accidents during operations of the proposed SNS since the SNS would not operate. Consequently, implementation of the No-Action Alternative would have no effects on the risk of accidents for workers or the public.

5.6.10 SUPPORT FACILITIES AND INFRASTRUCTURE

There would be no additional demands on support facilities and infrastructure because the proposed SNS facility would not be constructed or operated. Consequently, implementation of the No-Action Alternative would have no effects on support facilities or infrastructure.

5.6.11 WASTE MANAGEMENT

No wastes would be generated under the No-Action Alternative. Consequently, this alternative would have no effects on waste management.

5.7 CUMULATIVE IMPACTS OF THE ALTERNATIVES

The Council on Environmental Quality (CEQ) regulations that implement the procedural provisions of the National Environmental Policy Act (NEPA) define cumulative impacts as effects on the environment that result from the addition of the incremental effect of the proposed action to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes the other actions (40 CFR 1508.7). This chapter describes cumulative impacts for geology and soils, water resources, air quality, ecological resources, socioeconomic and demographic characteristics, cultural resources, land use, human health, infrastructure, and waste management facilities.

In the earlier discussions in this chapter, the potential environmental effects of the proposed SNS facility were evaluated with respect to existing conditions or “background.” This takes into account past and present actions on the alternative sites and in the vicinity of the alternative sites. Therefore, discussions in this section will center on the potential effects of reasonably foreseeable future actions in the vicinity of the alternative sites in conjunction with the potential effects from construction and operation of the proposed SNS. The reasonably foreseeable future actions included in the discussions for each alternative site were determined from planning documents and through communications with each site to identify potential actions that may contribute to cumulative impacts on or in the vicinity of the laboratory.

No reasonably foreseeable future actions by nonfederal agencies or persons that might contribute to cumulative impacts were identified.

5.7.1 ORNL ALTERNATIVE (PREFERRED ALTERNATIVE)

The actions that DOE considers reasonably foreseeable and pertinent to the analysis of cumulative impacts for the ORNL Alternative are described in this section. The proposed locations of these actions are shown in Figure 5.7.1-1. These actions are as follows.

Parcel ED-1. DOE completed an environmental assessment (DOE-ORO 1996) for the proposed lease of 957.16 acres of land within the ORR to the East Tennessee Economic Council, a non-profit organization, for a period of 10 years with an option for renewal. The East Tennessee Economic Council proposes to develop an industrial park on the leased site to provide employment opportunities for DOE and contractor employees affected by decreased federal funding. DOE has determined that this action is not a major federal action that would significantly affect the quality of the human environment. However, Parcel ED-1 is included in the discussions of cumulative impacts.

Upgrades to the High Flux Isotope Reactor. DOE is planning several upgrades to the High Flux Isotope Reactor (HFIR) at ORNL. These upgrades include a new Users Facility, a Neutron Science Support Building, and Accelerator and Reactor Improvements and Modifications. Based on the NEPA documentation for these actions (Hall 1989; Hall 1996; and Hall 1997), no environmental effects that would contribute to cumulative impacts with the proposed SNS are anticipated.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Waste Disposal Facility. DOE has published a Remedial Investigation/Feasibility Study for the disposal of ORR CERCLA wastes (DOE-ORO 1998). Alternatives in the Remedial Investigation/Feasibility Study include disposal of CERCLA wastes off-site and in a new disposal facility to be constructed on the ORR. Three alternative sites on the ORR have been considered; two just north of Bear Creek Road and the third along State Highway 95 at the interchange with State Highway 58. The Proposed Plan and Record of Decision (ROD) for the CERCLA Waste Disposal Facility have not been published, so no decisions concerning the construction of this facility on the ORR have been made.

Joint Institute for Neutron Science. This is a facility being funded by the State of Tennessee. It would be constructed near the intersection of Bethel Valley Road and Chestnut Ridge Road on the ORR. Because this would be a state-funded project, Joint Institute for Neutron Science (JINS) would not be a DOE facility. The facility would provide accommodations, including hotel rooms, offices, and meeting rooms, for scientists visiting the neutron science facilities at ORNL. The Division of Facilities Planning, University of Tennessee, is designing the facility. Construction is expected to begin in the summer

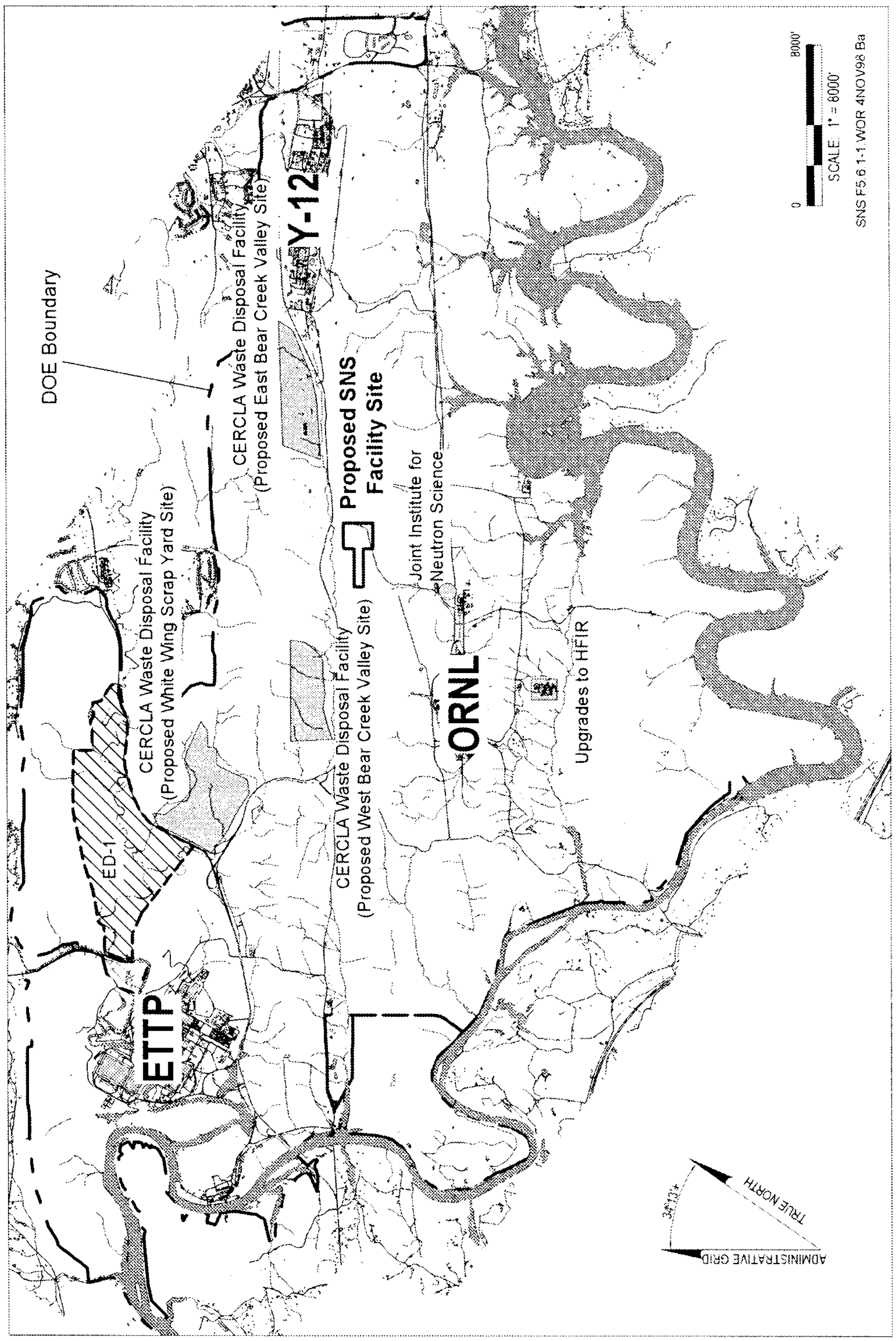

Figure 5.7.1-1. Locations of actions used in the ORNL cumulative impacts analysis.

of 1999, and occupancy would begin in the summer of 2000. NEPA documentation for this facility would be completed in 1999.

Remediation of Contaminated Areas in the Melton Valley Watershed

Contamination in the Melton Valley Watershed originated from operations of ORNL and other facilities over a 50 year period. Numerous active and inactive waste management facilities used by operations at ORNL are located in Melton Valley. ORNL's historic missions of plutonium production and chemical separation during World War II and development of nuclear technology during the postwar era produced a diverse legacy of contaminated inactive facilities, research areas, and waste disposal areas throughout the Melton Valley Watershed that are potential candidates for remediation. A feasibility study has been prepared that documents the development, screening, and detailed evaluation of alternative remedial actions for contaminated areas in the Melton Valley (Jacobs 1997).

5.7.1.1 Geology and Soils

Construction and operation of the proposed SNS facility would not contribute to the cumulative impact on the geology or soils of the ORR or surrounding communities. The proposed SNS would be designed as a stand-alone facility that is physically removed from the main plant area of ORNL. No significant problems have been identified in regard to site stability, seismic risk, the soil medium, or prime or unique farmlands that would constitute impacts by themselves (refer to Section 5.2.1) or combine with existing or future conditions to create cumulative impacts.

5.7.1.2 Water Resources

Construction and operation of the proposed SNS would not contribute to the cumulative impact on the surface water and groundwater of the ORR or surrounding communities. Increased surface water flow due to the discharge from the proposed SNS facility would have temporary effects on the erosion patterns of White Oak Creek and would increase the flow over White Oak Dam by a small amount (refer to Section 5.2.2). However, information to date shows no future activities within ORNL that would add to the current or proposed SNS discharge to further increase flows within White Oak Creek, thereby creating cumulative impacts.

The primary effect of the proposed SNS facility operations on the groundwater of the site would be the activation and leaching of radionuclides (refer to Section 5.2.2.3.2). Since no other radiological source exists in close proximity to the proposed SNS site and radionuclides from the SNS linac tunnel would decay prior to significant transport away from the site, no cumulative impacts would occur. Similarly, no current or planned activities would affect the groundwater supply at the proposed SNS site on Chestnut Ridge.

5.7.1.3 Air Quality

Potential cumulative impacts on air quality are discussed with reference to the air quality in Roane County. Table 5.2.3.2-2 provides collective effects of the ten small boiler stacks at the proposed SNS facility by adding the model-projected maximums for those stacks for each pollutant to an assumed background concentration developed from ambient monitoring maximums measured near the site. These values were then compared to appropriate NAAQS, and no exceedances were noted.

Table 5.7.1.3-1 indicates total hourly emission rates from the ten stacks and compares these values to county-wide average hourly emission rates. The very small percentage increase attributed to the proposed SNS facility is also shown.

No effects from the emission of air pollutants were identified in the NEPA documentation for the development of Parcel ED-1, the CERCLA Waste Disposal Facility, JINS, or the upgrades to HFIR. Similarly, the emissions from the proposed SNS would have a minimal effect on air quality because they would not exceed regulatory standards. The addition of these low SNS emissions to those of the other facilities would be expected to result in a minimal cumulative impact on the air quality of the ORR.

5.7.1.4 Noise

The anticipated future actions would generate additional levels of noise, especially during construction periods. However, these projects would be constructed at different time periods and on different ORR locations. As such, the noise levels would only be additive to existing background noises. Noise effects from the proposed SNS at ORNL are described in Section 5.2.4. It is anticipated that the highest levels would occur during construction and would approach a typical noise level of approximately 86 dBA for such activities. However, the proposed SNS at ORNL would be located in a remote portion of the ORR and would not contribute to other noise sources to increase the overall noise amplitude at the site. Hence, no cumulative impacts are predicted for noise on the ORR.

5.7.1.5 Ecological Resources

This section presents the potential cumulative impacts on ecological resources at ORNL.

5.7.1.5.1 Terrestrial Resources

The ORR has a total of 34,516 acres (13,794 ha) of land. About 80 percent of this land is covered with forest. Approximately 110 acres (45 ha) of forest would be cleared for the proposed SNS. The other planned actions for the ORR would also require the clearing of forests. Parcel ED-1 would require clearing of approximately 500 acres (202 ha) of land (Medley 1998:1). The site for the CERCLA Waste Disposal Facility has not been selected; however, the largest area of land that would have to be cleared is approximately 126 acres (51 ha), if the White

Table 5.7.1.3-1. Comparison of SNS boiler emission rates to county-wide emission totals.

	SNS Emissions (lb/hr)[a]	Roane County Total Average Emission Rate (lb/hr)	% Increase from SNS Emissions
SO_2	0.02	26,947	0.000074
NO_x	3.49	8,634	0.04
CO	0.73	394	0.18
Particulate matter (PM_{10})	0.42	246 (TSP)[b]	0.17

[a] Based on cumulative output of 10 boilers at the proposed SNS with total heat load of 34,870,000 Btu/hr. Boilers do not operate at total heat load continuously.
[b] TSP - total suspended particulates

Wing Scrap Yard site is selected (Jacobs 1998). Construction of the JINS would require clearing approximately 4 acres (1.6 ha). The HFIR upgrades would occur in developed areas; no forests would be cleared. Thus, the total amount of forest to be cleared, including forest on the proposed SNS site, would be 740 acres (300 ha). This would reduce the total acreage of forest on the ORR by approximately 2.5 percent.

This reduction in forested land may reduce the overall population of terrestrial wildlife utilizing the forest habitat. However, this reduction would be minimal, as the reduction in forest habitat is minimal.

5.7.1.5.2 Wetlands

The proposed SNS facility would cause an incremental impact to wetlands on the ORR. Currently proposed projects on the ORR include the CERCLA Waste Disposal Facility, which may result in the destruction of up to 10 acres (4 ha) of wetlands, and the Melton Valley Remediation Project, which could result in up to almost 45 acres (18 ha) of wetland excavation and fill. No impacts on wetlands were identified for construction of the JINS at ORNL or in the environmental assessment for development of Parcel ED-1, a tract leased by DOE to the Community Reuse Organization of East Tennessee for development of an industrial park. Thus, a cumulative total of approximately 56 acres (22 ha) of wetlands may be disturbed or destroyed on the ORR under currently proposed projects. The actual amount of wetland disturbance would depend on the final plans selected for each of these projects. Most of the wetlands that would be affected in the Melton Valley remediation area have contaminated substrates. Thus, excavation and/or fill of these areas would be unavoidable if environmental cleanup is to be completed. However, in all cases, DOE would develop and secure regulator approval of mitigation plans to avoid or minimize impacts and to restore wetland functions through wetland creation, restoration, or enhancement in the same watershed or elsewhere on the ORR. Successful compensatory mitigation would reduce or eliminate the cumulative impacts on the wetland resources of the ORR.

5.7.1.5.3 Aquatic Resources

As stated in Section 5.2.5.3, construction of the proposed SNS on the Chestnut Ridge site would have minimal effects on White Oak Creek. None of the other projects proposed for the foreseeable future would impact White Oak Creek; thus, no cumulative impacts are anticipated.

5.7.1.5.4 Threatened and Endangered Species

As stated in Section 5.2.5.4, the effects of construction of the proposed SNS on the Chestnut Ridge site can be mitigated and would be expected to be minimal. The CERCLA Waste Disposal Facility is also expected to have minimal effects on protected species at any of the three alternative sites (Jacobs 1998). Areas within Parcel ED-1 that may contain protected species or habitat for protected species would be protected during the development of this parcel (DOE-ORO 1996). No effects on protected species have been identified for the HFIR upgrade projects, and enough flexibility exists in siting of the JINS to avoid effects on protected species. Therefore, cumulative impacts on protected species on the ORR would be expected to be minimal.

5.7.1.6 Socioeconomic and Demographic Characteristics

Service sector businesses, government operations (federal, state, and local), retail trade, and manufacturing dominate the economics of the ORNL ROI. Activities included in operation of the ORR are estimated to account for more than 7 percent of the employment, wage and salary, and business activities in the four-county ROI. The effects from upgrades to the HFIR and construction and operation of the JINS would be minimal. The existing on-site workforce would accomplish construction of the upgrades to HFIR, and the current operations staff would operate it. No new jobs would be created, and there would be no effects on housing or community services. JINS is a small facility that would be constructed in less than one year and would be operated by a few people. Construction and operations jobs are expected to be filled by current residents, and there would be no additional effects on housing or community infrastructure.

The goal of the Parcel ED-1 project is to create 1,500 new jobs over the next 10 years. Given the number of persons displaced by DOE downsizing at the ORR facilities in the past five years and the number of unemployed persons in the ROI, it is likely that almost all the direct and indirect jobs created by the development of Parcel ED-1 would be filled by current residents of the ROI. Thus, it is expected that worker in-migration resulting from the proposed action and the effects on housing and community services would be insignificant (DOE-ORO 1996).

The incremental effects from locating the proposed SNS facility on the economy and community infrastructure of the ROI would be minimal. There would be some positive economic benefits in the form of new jobs created by construction and operation of the proposed SNS. Construction of the proposed SNS facility would require 578 full-time employees during the peak year and from 250 to 375 (1 MW to 4 MW) during operations. Most of the construction workforce and about half of the operations workforce would come from the ROI, and as such, the effects on housing and community services would be minimal. The details of these effects are given in Section 5.2.6.

No effects to environmental justice were identified from the upgrades to the HFIR, the construction and operation of the JINS, the construction of a CERCLA Waste Disposal Facility, or the development of Parcel ED-1. The proposed SNS facility would also not have any effects on environmental justice at ORNL. Therefore, there would be no cumulative impacts on environmental justice.

5.7.1.7 Cultural Resources

The cumulative impacts of the proposed action and other actions on the cultural resources of the ORR are assessed in this section.

5.7.1.7.1 Prehistoric Resources

No prehistoric sites listed on or considered to be eligible for listing on the NRHP have been identified on the proposed SNS site at ORNL or in its vicinity. As a result, the proposed action would have no effects on prehistoric cultural resources. Therefore, the proposed action would not contribute to cumulative impacts on the prehistoric cultural resources of the ORR.

5.7.1.7.2 Historic Resources

No Historic Period sites, structures, or features listed on or considered to be eligible for listing on the NRHP have been identified on the proposed SNS site at ORNL or in its vicinity. As a result, the proposed action would have no effect on Historic Period cultural resources. Therefore, the proposed action would not contribute to cumulative impacts on the Historic Period cultural resources of the ORR.

5.7.1.7.3 Traditional Cultural Properties

No TCPs of special sensitivity or concern to the Cherokee are known to exist on the proposed SNS site at ORNL or anywhere else on the ORR. As a result, no TCPs would be affected by implementation of the proposed action. Therefore, the proposed action would not contribute to cumulative impacts on the TCPs of the ORR.

5.7.1.8 Land Use

The cumulative impacts of the proposed action and other actions on ORR land use are assessed in this section.

5.7.1.8.1 Current Land Use

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the basic characteristics of the land that influence land use in the vicinity of the ORR and on most of the ORR. This would also be true of the effects from industrial development of Parcel ED-1, the CERCLA Waste Disposal Facility, upgrades to HFIR, JINS, and the Melton Valley Remediation Project. Therefore, these would have no reasonably discernible cumulative impacts on current land use outside the ORR or throughout most of the reservation.

The proposed action would introduce large-scale development to approximately 110 acres (45 ha) of proposed SNS site land on the ORR. The Parcel ED-1 industrial park would introduce development to about 500 acres (202 ha) of ORR land (Medley 1998: 1). If the White Wing Scrap Yard is selected for the on-site CERCLA Waste Disposal Facility, 126 acres (51 ha) of undeveloped land would be affected by the project (Jacobs 1998: 7-14 and 8-17). The JINS would introduce development to no more than 4 acres (1.6 ha) of ORR land. The HFIR upgrades would occur in developed and disturbed areas of the 7900 complex at ORNL (Hall 1989: 1; Hall 1996: 1 and 3; Hall 1997: 1 and 4). The Melton Valley Remediation Project would also occur in an area of ORNL that is largely developed and disturbed as a result of waste management activities.

The ORR has approximately 22,490 acres (8,903 ha) of undeveloped land (Medley 1998: 1). Cumulatively, the foregoing facilities would introduce development to about 740 acres (294 ha), which is only 3.3 percent of the undeveloped land on the ORR. Therefore, this cumulative impact on undeveloped ORR land would be minimal.

The proposed action would effectively change the current use of 110 acres (45 ha) of land on the proposed SNS site from Mixed Research/Future Initiatives to Institutional/ Research. The current use of CERCLA Waste Disposal Facility land [White Wing Scrap Yard (high-end scenario)] is Mixed Research/Future Initiatives. If this new waste management facility is built at the scrap yard location, the use of approximately 126 acres (51 ha) of land would change to the Industrial use designation. If JINS is built, approximately 4 acres (1.6 ha) of current Mixed Research/Future Initiatives land would change to Institutional/Research. Current use of the 500 acres (202 ha) slated for development in Parcel ED-1 would have been designated as Mixed Research/Future Initiatives at one time, but, in anticipation of industrial development, its current designation has become Mixed Industrial. No changes in current land use would result from the HFIR upgrades or the Melton Valley Remediation Project.

The current use of approximately 20,000 acres (8097 ha) of ORR land is Mixed Research/Future Initiatives. In addition, approximately 957 acres (387 ha) of land on Parcel ED-1 would have been designated as Mixed Research/Future Initiatives prior to its reclassification in anticipation of industrial development. For the purposes of this cumulative impacts assessment, these figures are summed to obtain a total of 20,957 acres (8,485 ha) of Mixed Research/Future Initiatives land. Cumulatively, the facilities in the foregoing paragraph would change the current use of about 740 acres (300 ha) of Mixed Research/Future Initiatives land. This is only 3.5 percent of the Mixed Research/Future Initiatives land on the ORR. Therefore, this cumulative impact on current land use would be minimal.

National Environmental Research Park

Pollutant emissions from the proposed SNS facility (CO_2 and possibly H_2O vapor) would adversely affect the NOAA TDFCMP and ORNL-ESD ecological research projects in the nearby Walker Branch Watershed (refer to Section 5.2.8.1.1). Construction and operation of the SNS would reduce the current environmental research potential on the approximately 241 acres (98 ha) of land that comprise the Walker Branch Watershed research area (Hanson 1998: 1). Construction of the proposed SNS facility would reduce the current environmental research potential of a minimum 110 acres (45 ha) of NERP land on the proposed SNS site. The CERCLA Waste Disposal Facility [White Wing Scrap Yard (high-end scenario)] would effectively reduce the current environmental research potential of 126 acres (51 ha) of NERP land. The CERCLA documentation for this project indicates that NERP activities, such as research, could be affected by this facility but does not specify any particular environmental monitoring or research projects that would be clearly affected by this facility (Jacobs 1998: 8-32). Industrial construction and operations on Parcel ED-1 would reduce the current environmental research potential of up to 500 acres (202 ha) of NERP land. However, the NEPA documentation for this project does not indicate specific, current environmental monitoring or research projects that would be affected (DOE-ORO 1996: F-3 and 4-1). The HFIR upgrades would have no effect on the current use of ORR land for environmental monitoring or research. JINS would reduce the current environmental research potential of 4 acres (1.6 ha) of NERP land. However, it is not expected to affect current environmental monitoring or research projects on ORR land. The Melton Valley Remediation Project would reduce the current environmental research potential of approximately 69 acres of NERP land in SWSA 6. However, the CERCLA documentation for this project (Jacobs 1997) does not specify any current environmental monitoring or research projects that would be affected.

The ORR NERP contains approximately 21,980 acres (8,899 ha) of land. Cumulatively, the proposed action, CERCLA Waste Disposal Facility, Parcel ED-1, JINS, and the Melton Valley Remediation Project would reduce the current environmental research potential of 1050 acres (425 ha) of NERP land. However, this would be only 4.8 percent of the NERP land on the ORR. Therefore, this cumulative impact on the current research potential of NERP land would be minimal. The cumulative impacts of the foregoing actions on environmental research projects would be uncertain.

5.7.1.8.2 Future Land Use

The proposed action would be compatible with DOE zoning of ORR land on the proposed SNS site. Therefore, it would not contribute to cumulative impacts involving the future use of land for purposes other than those for which it is zoned.

Walker Branch Watershed

Future operation of the proposed SNS facility over a 40-year period would have continuing adverse effects on CO_2 and possibly H_2O vapor monitoring under the TDFCMP in the Walker Branch Watershed unless effective mitigation measures are implemented to minimize these effects. Future ORNL-ESD ecological research projects in this area would also be adversely affected by CO_2 and H_2O vapor emissions from the proposed SNS. However, the NEPA/ CERCLA documentation for the CERCLA Waste Disposal Facility, Parcel ED-1, HFIR upgrades, and Melton Valley Remediation Project does not indicate effects from these actions on future environmental research projects. No such effects are anticipated from JINS. Therefore, the cumulative impacts of the foregoing actions on future environmental research projects would be uncertain.

Common Ground Process and End Uses of ORR Land

The proposed action and CERCLA Waste Disposal Facility [White Wing Scrap Yard (high-end scenario)] would be cumulatively at variance with the Common Ground recommendations for future land use on the ORR (refer to Section 4.1.8.3). They are within areas designated for Conservation Area Uses.

The siting of the proposed action on a greenfield site would appear to be at variance with the End Use Working Group recommendation to locate new DOE facilities on brownfield sites. However, as noted in Section 5.2.8.2.2, use of the proposed SNS site would be necessary because no brownfield sites of the required size and configuration could be available by the proposed start date for SNS construction. The other actions considered in this cumulative impacts analysis would not clearly be at variance with the End Use Working Group recommendation. Two of the alternative locations for the CERCLA Waste Disposal Facility would include brownfield sites. However, the White Wing Scrap Yard (high-end scenario) would also contain a large greenfield area. The HFIR upgrades would occur in a developed area of the ORR that could be technically defined as a brownfield. The Melton Valley Remediation Project would result in the installation of various remediation features such as impermeable caps, groundwater diversion trenches, and cryogenic barriers, as opposed to new DOE facilities in the conventional sense. By its very nature, most of the project area is a brownfield. The private sector industrial facilities in Parcel ED-1 would not be DOE facilities. Because JINS would be constructed using State of Tennessee funds, it would not be a DOE facility

5.7.1.8.3 Parks, Preserves, and Recreational Areas Resources

The proposed action would have minimal effects on the following parks, preserves, and recreational resources on and in the vicinity of the ORR: University of Tennessee Arboretum, University of Tennessee Forest Experiment Station, TVA recreation areas on Melton Hill Lake and Watts Bar Lake, and Clark Center Recreation Park. The NEPA/CERCLA documentation for the CERCLA Waste Disposal Facility, Parcel ED-1, and the HFIR upgrades do not identify effects on these specific land uses. JINS would not be expected to affect these uses of the land. The cumulative effect of these actions on parks, preserves, and recreational land use is uncertain, however, it is expected that construction and operation of the SNS would not contribute to cumulative impacts on parks, preserves, or recreational land uses on or in the vicinity of the ORR.

The proposed action would reduce the area of ORR land open to hunting by approximately 110 acres (45 ha). Industrial development of Parcel ED-1 could reduce the area open to recreational hunting by approximately 500 acres (202 ha) (DOE-ORO 1996: 4-18). JINS would reduce the area open to hunting by up to 4 acres (1.6 ha). The NEPA/CERCLA documentation for the CERCLA Waste Disposal Facility and the HFIR upgrades does not identify any effects of these actions on recreational hunting.

Recreational hunting is restricted on approximately 8,000 acres (3,238 ha) of the 34,516 acres (13,968 ha) of land on the ORR (DOE-ORO 1996: 4-18). Thus, approximately 26,516 acres (10,731 ha) are open for hunting. Cumulatively, the proposed action, development of Parcel ED-1, and JINS would reduce the ORR land open to deer hunting by 614 acres (248 ha), or 2.3 percent. Therefore, the cumulative impact of these actions on recreational hunting would be minimal.

5.7.1.8.4 Visual Resources

The SNS, CERCLA Waste Disposal facility (three proposed locations), industrial development on Parcel ED-1, JINS, or HFIR upgrades would not be visible to the public from one vantage point. This would result from a combined function of the distance between facilities, restricted public access to reservation land, topography, and vegetation cover. Therefore, the proposed action would not contribute to cumulative impacts on visual resources.

5.7.1.9 Human Health

None of the reasonably foreseeable actions on the ORR have effluents containing radioactive materials. Therefore, they would not contribute to cumulative impacts with the proposed SNS facility. During normal operations, all SNS effluents containing radioactive or toxic materials would be gaseous. The dose from all ORR airborne emissions in 1996 was 9.9 person-rem to the off-site population and 0.45 mrem to a hypothetical maximally exposed individual. If it is conservatively assumed that the ORR and proposed SNS maximally exposed individuals are in the same location, SNS emissions at 1-MW power would increase these doses to 0.84 mrem for the maximally exposed individual and 26 person-rem for the off-site population. The cumulative dose to the maximally exposed individual would be only 8 percent of the applicable limit. At a power level of 4 MW, these doses would become 2.0 mrem for the maximally exposed individual and 36 person-rem for the off-site population. The cumulative dose to the maximally exposed individual would be 20 percent of the applicable limit. If the same population received these doses for 40 years, 0.52 LCFs could occur from operations on the ORR with a 1-MW SNS facility and 0.72 LCFs could occur for operations on the ORR with a 4-MW SNS facility. LCFs of 1.0 or greater do not mean that any actual deaths would occur. Rather, LCFs provide a common and conservative basis for comparisons of alternatives.

Airborne concentrations of mercury would be approximately 10,000 times less than applicable standards for workers and the public and would not contribute to cumulative toxic health impacts.

5.7.1.10 Infrastructure

This section discusses the cumulative impacts on transportation and utility systems from the upgrades to HFIR, development of Parcel ED-1, and construction and operation of JINS and the proposed SNS facilities on the ORR.

5.7.1.10.1 Transportation

No effects on traffic would result from upgrading the HFIR because the construction upgrades and operation would be performed by the existing workforce. There would be a small increase in traffic during the construction of JINS, but this would only be for less than 1 year. The operation of JINS would add only a few automobiles to the local traffic, and the effects would be minimal.

The development of Parcel ED-1 could eventually generate as many as 7,000 trips per day. The development of this industrial park is intended to provide employment opportunities for DOE and contractor employees affected by decreased federal funding. As such, the vast majority of these employees would be expected to already live in the region and utilize the roads. Therefore, no significant change in levels of service on or nearby roads is expected. The LOS for some roadway segments nearby the proposed SNS site would also be expected to be marginally reduced, especially during construction.

5.7.1.10.2 Utilities

Incremental increases in utilities usage by addition of the reasonably foreseeable future projects would be minimal. Utilities required for the HFIR are not expected to increase noticeably after the upgrades are made. There would be a small incremental increase in the utilities used by JINS but this would be minimal. The development of Parcel ED-1 would occur over a 10-year period. These developments would gradually require more electric power, water, and wastewater treatment, but the DOE water treatment and City of Oak Ridge sewer system are currently operating at about 50 percent capacity. Electrical energy consumption for the whole ORR is about 726,000 MW hr/yr, and availability from the TVA is 13,880,000 MW hr/yr. The proposed SNS facility would require substantial electric power (62 MW for the 1-MW beam and 90 MW for the 4-MW beam), but there is sufficient excess capacity to accommodate the demand. Capacities for other utilities needed to support the proposed SNS are well above the required demands. Details on the impacts to utilities are given in Section 5.2.10.2.

5.7.1.11 Waste Management Facilities

All of the waste generated during construction and operation of the proposed SNS facility would be transferred to ORNL for processing. The existing waste management facilities at ORNL have sufficient capacity to accommodate the known waste streams from the proposed SNS facility (refer to Section 5.2.11). DOE would take the appropriate action necessary to dispose of any waste streams that have unknown composition. The evaluation of potential effects on the waste management systems include projected volumes of waste. These projections include wastes from future activities; thus minimal cumulative impacts on ORNL wastes systems would be anticipated.

Wastes generated by the development of Parcel ED-1 would not enter the ORNL Waste Management system. These wastes would remain the responsibility of the companies utilizing Parcel ED-1. Small volumes of wastes that do not meet the WAC for the CERCLA Waste Disposal facility may enter the ORNL waste system. Small amounts of solid low-level radioactive wastes, hazardous wastes, and mixed wastes would be generated during modifications to HFIR. These wastes have been accounted for in the waste projections used to evaluate the potential cumulative impacts of the SNS wastes.

5.7.2 LANL ALTERNATIVE

DOE recently published the *Draft Site-Wide Environmental Impact Statement for Continued Operations of the Los Alamos National Laboratory* (DOE-AL 1998). This site-wide analysis in large measure is, by its scope, an analysis of cumulative impacts. This document formed the basis for analyzing the cumulative environmental impacts of constructing the proposed SNS at LANL.

The site-wide EIS addresses several proposed alternative actions that are pertinent to the analysis of cumulative impacts. The locations of these actions are shown in Figure 5.7.2-1. These actions are as follows.

Expansion of Low-Level Waste Disposal Capacity. The existing disposal capacity for low-level radioactive waste at LANL is projected to be filled by 2000. Five alternatives for expanding this disposal capacity are described in the LANL site-wide EIS. In the EIS, they are included under the Expanded Operations Alternative for continued LANL operations. They are as follows: (1) develop Zone 4 at TA-54, (2) develop Zone 6 at TA-54, (3) develop both Zones 4 and 6 at TA-54 in stepwise fashion (preferred alternative), (4) develop the north site at TA-54, and (5) develop an undisturbed site at another LANL TA (TA-67) [DOE-AL 1998: Vol. II, 1-8]. The proposed locations for implementation of these alternatives are shown in Figure 5.7.2-1.

Road Construction to Support Pit Production. The Expanded Operations Alternative for continued LANL operations includes construction of a proposed road between TA-55 (Plutonium Facility) and TA-3 (Chemical and Metallurgy Research Building). This road would support pit production operations at the laboratory. Approximately 7 acres (3 ha) of LANL land would be used for this project (DOE-AL 1998:5-99).

In addition to the site-wide EIS, the EIS for the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility (DOE-AL 1995a) was also

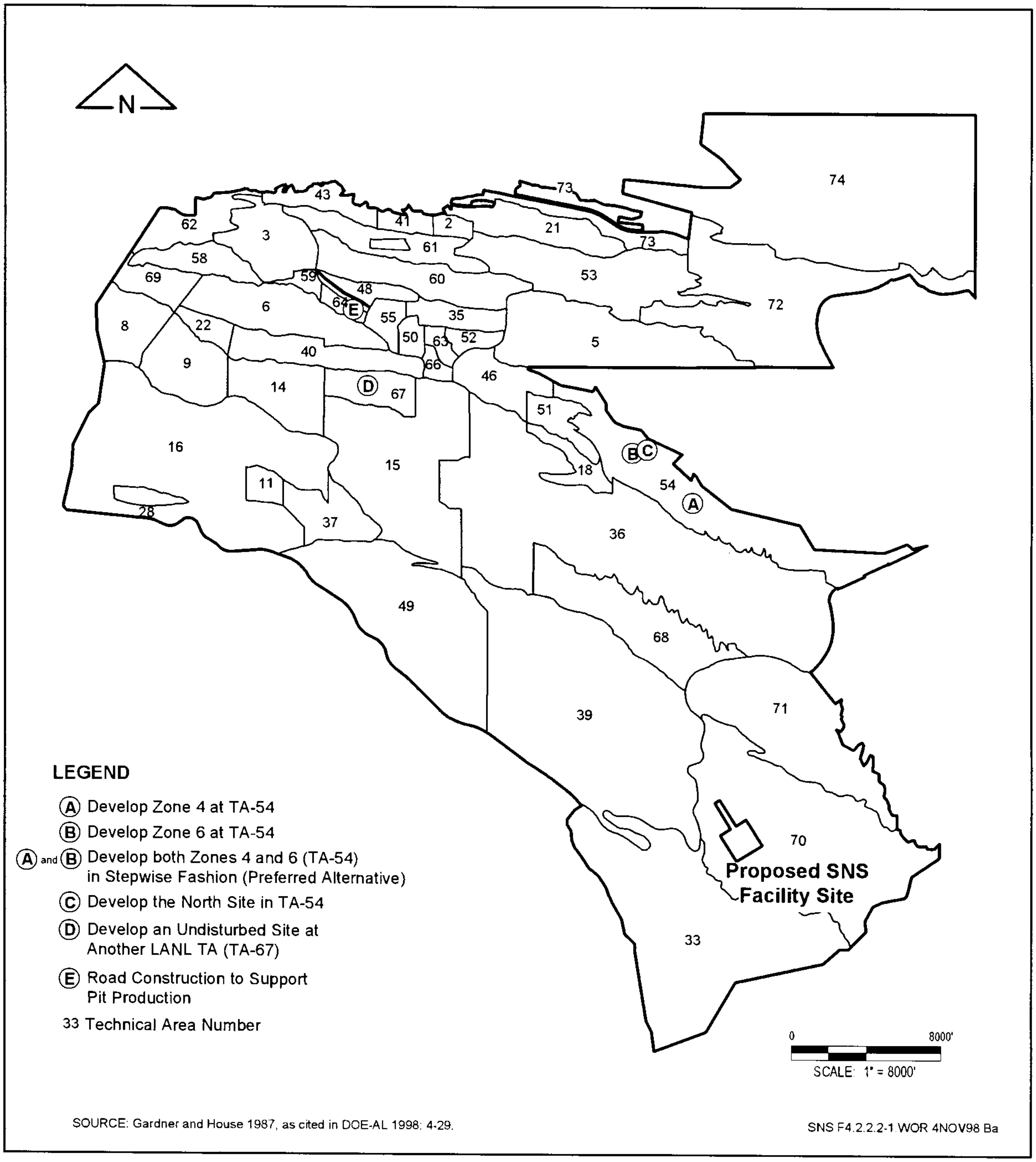

Figure 5.7.2-1. Locations of actions used in the LANL cumulative impacts analysis.

examined. The construction of the DARHT facility is nearing completion. The DARHT facility would provide dual-axis, multiple-exposure radiographs for the study of devices and materials under hydrodynamic conditions. This facility would be used primarily in support of DOE's Stockpile Stewardship and Management Programs. For the most part, the environmental effects discussed in the DARHT EIS are included in the discussion in the LANL site-wide EIS. However, specific information from the DARHT EIS is included in the following discussion when necessary for clarity.

5.7.2.1 Geology and Soils

The proposed SNS facility would not contribute to the cumulative impact on the geology and soils of LANL or surrounding communities. The proposed SNS would be designed as a stand-alone facility at TA-70, which is physically removed from the main area of LANL. No significant problems have been identified in regard to site stability, seismic risk, the soil medium, or prime or unique farmlands that would constitute impacts by themselves (refer to Section 5.3.1) or combine with existing or future conditions to create cumulative impacts.

5.7.2.2 Water Resources

Surface water discharge by the proposed SNS facility would enter a dry arroyo and infiltrate into the arid soils of the site. No other discharges are planned for this area; hence, no cumulative impacts on surface water would occur at the TA-70 site.

LANL and the surrounding local communities are dependent on groundwater for their water supply. The main aquifer in the area is the only groundwater source capable of serving as a municipal water supply. Although not classified as such, it could be considered a sole-source aquifer. An additional 1.2 to 2.3 mgpd (4.5 to 8.7 million lpd) above current demand would be required to support the proposed SNS operations. Water supply studies specific to SNS demand have not been conducted, but it can be reasonably predicted that increased production of 36 to 70 percent from the main aquifer would impact water levels and create competition with private and local users for water resources.

5.7.2.3 Air Quality

Table 5.3.3.2-1 provides collective effects of the ten small boiler stacks at the proposed SNS facility by adding the model-projected maximums for those stacks for each pollutant to an assumed background concentration developed from ambient monitoring maximums measured near the site. These values were then compared to appropriate NAAQS, and no exceedances were noted.

Table 5.7.2.3-1 indicates total hourly emission rates from the ten stacks and compares these values to county-wide average hourly emission rates. The percentage increase to this total from addition of the SNS minimal sources is also shown.

If future facilities were to be located near the proposed SNS, they would have a cumulative impact on air quality in the immediate vicinity of the SNS. The potential cumulative impact of incremental emissions from such facilities would be evaluated and permitted on a case-by-case basis by the state and federal air quality agencies at the appropriate juncture in order to protect public health and welfare.

Table 5.7.2.3-1. Comparison of SNS boiler emission rates to county-wide emission totals.

	SNS Emissions (lb/hr)[a]	Los Alamos County Total Average Emission Rate (lb/hr)	Increase from SNS Emissions (%)
SO_2	0.02	2.1	0.95
NO_x	3.49	84.3	4.1
CO	0.73	22.1	3.3
Particulate matter (PM_{10})	0.42	8.5	4.9

[a] Based on cumulative output of 10 boilers at the proposed SNS facility with total heat load of 34,870,000 Btu/hr. Boilers do not operate at total heat load continuously.

5.7.2.4 Noise

Noise impacts of the proposed SNS facility at LANL are described in Section 5.3.4. It is anticipated that the highest levels would occur during construction and would approach a typical noise level of approximately 86 dBA for such activities. However, the proposed SNS facility would be located in a remote portion of LANL and would not combine with other noise sources to increase the overall amplitude of the laboratory. Hence, no cumulative impacts are predicted for noise at LANL.

5.7.2.5 Ecological Resources

This section presents the potential cumulative impacts to ecological resources at LANL.

5.7.2.5.1 Terrestrial Resources

A total of 12,770 acres (5,108 ha) of piñon-juniper woodland is present at LANL, representing 46.2 percent of the total land area at LANL. The proposed SNS facility would remove approximately 110 acres (45 ha), or less than 1 percent, of piñon-juniper woodland. LANL is relatively large and undeveloped. Therefore, construction and operation of the proposed SNS facility at LANL would have a minimal contribution to cumulative impacts on terrestrial resources.

5.7.2.5.2 Wetlands

No wetlands are located on or near the proposed site for the SNS, and no cumulative impacts on wetlands were identified in the LANL site-wide EIS. Thus, the SNS would not be expected to contribute to cumulative impacts on wetlands at LANL.

5.7.2.5.3 Aquatic Resources

No aquatic resources are located on or near the proposed SNS site in TA-70. Construction and operation of the proposed SNS would not be expected to affect aquatic resources. Thus, the proposed SNS would not contribute to cumulative impacts on these resources at LANL.

5.7.2.5.4 Threatened and Endangered Species

Impacts on protected species are identified in the LANL site-wide EIS. DOE will soon complete the Threatened and Endangered Species Habitat Management Plan. This plan provides long-range planning information for all future projects at LANL, and develops long-range mitigation actions to protect the habitat of protected species at LANL. This plan will be integrated with the LANL Natural Resource Management Plan, providing policies, methods, and recommendations for long-term management of LANL facilities, infrastructure, and natural resources (DOE-AL 1998). Construction and operations activities associated with the proposed SNS facility would be subject to the restrictions and protective measures defined in these plans, thus minimizing any cumulative impacts on threatened and endangered species at LANL.

5.7.2.6 Socioeconomic and Demographic Characteristics

Government operations (federal, state, local, and tribal) and service sector businesses dominate the economics of the LANL ROI. Activities included in the continued operation of LANL are estimated to directly and indirectly account for more than one third of the employment, wage and salary, and business activity in the three county ROI. In addition to continued operations covered under the LANL site-wide EIS, the DARHT facility is estimated to add about 253 new jobs to the economy. About 106 of these new jobs would be directly supported by project construction and operating expenditures. There would be no impacts to housing or community infrastructure (DOE-AL 1995b). The majority of the new jobs would most likely be filled by existing residents.

The incremental effects of the proposed SNS facility on the economy and community infrastructure of the ROI would be minimal. There would be some positive economic benefits in the form of new jobs created by construction and operation of the proposed SNS. Construction of the proposed SNS facility would require 578 full-time employees during the peak year and from 250 to 375 (1 MW to 4 MW) during operations. Most of the construction workforce and about half of the operations workforce would come from the ROI. As such, the effects on housing and community services would be minimal. The details of these effects are given in Section 5.3.6.

No effects on environmental justice would result from continued operation of LANL or the construction or operation of the DARHT or the proposed SNS facilities. Therefore, there would not be any cumulative effects to environmental justice.

5.7.2.7 Cultural Resources

This section assesses the cumulative impacts of the proposed action and other actions on the cultural resources at LANL.

5.7.2.7.1 Prehistoric Resources

The proposed action would result in the destruction of five prehistoric archaeological sites on the 65 percent of the proposed SNS site and adjacent buffer zone that have been surveyed for cultural resources. These sites are eligible for listing on the NRHP. In the unsurveyed area of the proposed SNS site, any prehistoric sites listed on or eligible for listing on the NRHP would also be destroyed. However, the remaining 35 percent of the proposed SNS site and buffer zone have not been surveyed for prehistoric cultural resources. As a result, the potential effects of the proposed action on specific cultural resources in this unsurveyed area cannot be assessed at this time. Therefore, the contribution of such effects to cumulative impacts on prehistoric cultural resources at LANL cannot be accurately assessed. If the proposed SNS site at LANL were selected for construction of the SNS, this area would be surveyed for prehistoric cultural resources. The effects of the proposed action on specific prehistoric cultural resources, including contributions to cumulative impacts, would be assessed prior to the initiation of construction-related activities within this area.

The alternative to construct a new Low-Level Waste Disposal Facility in TA-67 at LANL could potentially destroy 15 prehistoric archaeological sites. All of these sites are eligible for listing on the NRHP. The effects on these cultural resources would be mitigated through archaeological data recovery (DOE-AL 1998: 5-118). The other alternatives for expanding LLW disposal capacity and the road construction to support pit production are not expected to affect prehistoric cultural resources.

Cumulatively, 20 prehistoric cultural resources at LANL would be impacted by the foregoing actions. This is approximately 3 percent of the 770 prehistoric sites at LANL that are eligible for listing on the NRHP. This percentage would probably be much smaller in light of another 322 prehistoric sites that are considered potentially eligible for listing on the NRHP. These low percentages and the mitigation of impacts through archaeological data recovery indicate that the cumulative impacts of the proposed action (65 percent survey area only) and the Area G LLW disposal facility on prehistoric cultural resources at LANL would be minimal.

5.7.2.7.2 Historic Resources

No archaeological sites, structures, or features dating to the Historic Period have been identified within the 65 percent survey area at the proposed SNS site. As a result, the proposed action would have no effect on Historic Period cultural resources within this area. None of the other LANL actions considered in this analysis would affect historic cultural resources. Therefore, implementation of the proposed action within the surveyed area would not contribute to cumulative impacts on Historic Period cultural resources at LANL.

Site preparation activities in the unsurveyed portion of the proposed SNS site would destroy any historic sites, structures, or features listed on or eligible for listing on the NRHP. However, the remaining 35 percent of the proposed SNS site and an adjacent buffer zone have not been surveyed for Historic Period cultural resources. As a result, the potential effects of the proposed action on specific historic resources in this area cannot be assessed at this time. Therefore, the potential contribution of these effects to cumulative impacts on Historic Period cultural resources at LANL cannot be accurately assessed at this time. If the proposed SNS site at LANL were selected for construction of the SNS, this area would be surveyed for specific Historic Period cultural resources. The effects of the proposed action on Historic Period cultural resources, including contributions to cumulative impacts, would be assessed prior to the initiation of construction-related activities within this area.

5.7.2.7.3 Traditional Cultural Properties

Five prehistoric archaeological sites have been identified within the 65 percent survey area on and adjacent to the SNS site at LANL. These TCPs would be destroyed by site preparation activities associated with construction of the SNS. If any prehistoric archaeological sites are located within the unsurveyed 35 percent of the proposed SNS site, these TCPs would also be destroyed by site preparation. However, because the occurrence of such TCPs in this area is unknown, such potential effects cannot be reasonably factored into the analysis of cumulative impacts.

Fifteen prehistoric archaeological sites would be destroyed by expansion of the LLW disposal facility in TA-54. Cumulatively, construction of the SNS and the new LLW disposal facility would affect 20 prehistoric archaeological sites eligible for listing on the NRHP. Although these 20 sites are only 1.5 percent of the 1,295 prehistoric archaeological sites identified at LANL, any losses or damage involving these TCPs would probably be viewed by tribal groups as an adverse cumulative effect.

Some tribal groups have identified the water resources at LANL as TCPs. Sections 5.7.2.2 and 5.7.2.10.2 discuss cumulative effects on water resources at LANL. The cumulative effects identified in these sections would probably be viewed by tribal groups as adverse cumulative effects on water resource TCPs.

The specific identities and locations of other TCPs on and adjacent to the SNS site are not known and cannot be reasonably estimated (refer to Section 4.2.7.3). As a result, the specific effects of the proposed action on such TCPs would be uncertain. The expansion of LLW disposal capacity at LANL and the road construction to support pit production could affect TCPs, but this is uncertain due to a lack of specific information on TCPs at the alternative construction sites and other locations on laboratory land. Therefore, the potential cumulative effects of these proposed actions on TCPs would be uncertain.

5.7.2.8 Land Use

This section assesses the cumulative impacts of the proposed action and other actions on land use at LANL.

5.7.2.8.1 Current Land Use

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the basic characteristics of the land that influence land use in the vicinity of LANL or across the laboratory as a whole. The same would be true of the alternatives for future expansion of LLW disposal capacity and the proposed road construction to support pit production. Therefore, these actions would have no reasonably discernible cumulative impacts on current land use outside LANL or throughout most of the laboratory.

The proposed action would introduce development to approximately 110 acres (45 ha) of undeveloped land in TA-70. Construction of a new LLW Disposal Facility in TA-67 (worst-case alternative for area of land used) would introduce development to approximately 60 acres (24 ha) of land at LANL (DOE-AL 1998: 5-99). Under the Expanded Operations Alternative for continuing LANL operations, a new road would be constructed to support pit production (DOE-AL 1998: 5-99). This would introduce development to 7 acres (3 ha) of land.

The proposed action and the other foregoing actions would introduce development to about 177 acres (72 ha) of LANL land. This would be only 1.1 percent of the approximately 16,000 acres (6,478 ha) of undeveloped land within the laboratory boundaries. However, only about 2,000 acres (810 ha) out of these 16,000 acres (6,478 ha) of undeveloped land are considered to be suitable for development. The proposed action and other actions would consume about 8.8 percent of the currently undeveloped land that is considered to be suitable for development. However, future building on LANL land that has been previously developed would reduce additional effects on undeveloped land. Therefore, the overall cumulative impacts on undeveloped land at LANL would be minimal.

The proposed action would change the current use of approximately 110 acres (45 ha) of proposed SNS site land from Environmental Research/Buffer to Experimental Science. Construction of the road to support pit production would change 7 acres (3 ha) of Environmental Research/Buffer land to another land use category. The alternatives for expanding LLW disposal capacity would not appear to involve changes in the current use of Environmental Research/Buffer land.

The proposed action and the road construction would reduce the current Environmental Research/Buffer land at LANL by approximately 117 acres (47 ha). Considering the extremely large areas of LANL in current use as Environmental Research/Buffer land (see Figure 4.2.8.2-2), this cumulative impact on current land use would be minimal.

The proposed action, construction of a new LLW Disposal Facility in TA-67, and construction of a new road to support pit production would reduce the environmental research potential of 177 acres of NERP land. This cumulative impact would be minimal because only 0.6 percent of the NERP land at LANL would be affected.

The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects. As a result, the proposed action would not contribute to cumulative impacts on the use of land by such projects.

5.7.2.8.2 Future Land Use

The proposed action would be compatible with DOE zoning for the land on the proposed SNS site at LANL. Therefore, it would not contribute to cumulative impacts involving the future use of land for purposes other than those for which it is zoned.

No future uses of proposed SNS site and vicinity land for environmental research are planned. As a result, the cumulative impacts of the proposed action on specific future research projects cannot be assessed.

5.7.2.8.3 Parks, Preserves, and Recreational Resources

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics or other factors that support park, nature preserve, or recreational land uses outside the LANL boundaries. Consequently, implementation of the proposed action on the proposed SNS site would have minimal effects on the use of Santa Fe National Forest and Bandelier National Monument as recreational areas. However, on LANL land, the public use of hiking trails near the proposed SNS site could be potentially restricted or eliminated. The draft EIS covering the continued operation of LANL does not identify potential effects of the considered alternatives on parks, preserves, or recreational land uses. Thus, the cumulative effect of these actions on parks, preserves, and recreational land use is uncertain. However, it is expected that construction and operation of the SNS would not contribute to cumulative impacts on parks, preserves, or recreational land uses on and in the vicinity of LANL.

5.7.2.8.4 Visual Resources

Construction and operation of the proposed SNS facility on the TA-70 site would change views in the area of the site from that of an undeveloped piñon-juniper woodland to industrial development. During the night hours, facility lighting would be visible to travelers on State Route 4 and the access road to the proposed SNS site. No other large, lighted facilities would be present in this remote area of the laboratory. Under the Expanded Operations Alternative for continuing LANL operations, the alternative involving construction of a new LLW Disposal Facility in TA-67 would change views of the Pajarito mesa top in its area from forest to industrial development (DOE-AL 1998: 5-99). Nighttime lighting of this facility would be potentially noticeable to off-site viewers because there are currently no areas along the mesa that are similarly lit (DOE-AL 1998: 5-100). If the proposed action, one of the alternatives for expanding LLW disposal capacity, and the road construction to support pit production were implemented, a slight increase in overall levels of light pollution from LANL could occur. However, from a cumulative impacts perspective, the proposed action and these other actions would have a minimal impact in terms of expanding the overall daytime and nighttime visibility of LANL across the Rio Grande Valley.

5.7.2.9 Human Health

During normal operations, all SNS effluents containing radioactive or toxic materials would be gaseous. Doses from the airborne pathways for the alternatives considered in the LANL site-wide EIS range from lows of 1.88 mrem/yr for the maximally exposed individual and 11 person-rem/yr for the off-site population for the reduced operations alternative to highs of 5.44 mrem/yr for the maximally exposed individual and 33 person-rem/yr for the off-site population for the expanded operations alternative. The annual doses for airborne pathways for the DARHT facility are estimated to be 0.02 mrem for the maximally exposed individual and 0.9 person-rem for the off-site population. The annual doses for the proposed SNS facility would be 0.47 mrem for the maximally exposed individual and 2.0 person-rem for the off-site population for a 1-MW facility and 1.8 mrem for the maximally exposed individual and 5.3 person-rem for the off-site population for a 4-MW facility.

If it is conservatively assumed that (1) the MEI is in the same location for each case; (2) LANL implements the expanded operations alternative as described in the site-wide environmental impact statement (SWEIS); (3) the DARHT is operational; and (4) the SNS operates for 40 years at the 4-MW power level, the maximum cumulative radiological impacts of these activities would be 7.26 mrem/yr for the maximally exposed individual and 39.2 person-rem/yr for the off-site population. Based on a risk conversion factor of 0.0005 LCFs, 0.78 LCFs could occur if all of these facilities operated together for 40 years. LCFs of 1.0 or greater do not mean that any actual deaths would occur. Rather, LCFs provide a common and conservative basis for comparisons of alternatives.

Airborne concentrations of mercury would be approximately 10,000 times less than applicable standards for workers and the public and would not contribute to cumulative toxic health impacts.

5.7.2.10 Infrastructure

This section discusses the cumulative impacts on transportation and utility systems from the continued operation of LANL and construction and operation of the DARHT and proposed SNS facilities.

5.7.2.10.1 Transportation

Continued operation of LANL is not expected to increase the population of Los Alamos significantly, although future land transfers could potentially increase traffic. The construction of the DARHT facility is now nearing completion, and there would not be much of an increase in traffic once the facility is operational. The effects of SNS construction and operation are discussed in Section 5.3.10.1. No other planned activity would result in increased traffic on this road. Thus, minimal cumulative impacts would be expected.

5.7.2.10.2 Utilities

Within the electric power pool that serves LANL, direct use by LANL is about 80 percent of the total. The system serving LANL is near capacity, and projections of future electric power use by LANL under continued operations indicate that demand would exceed capacity. Some solutions are being evaluated, but no specific proposals have been fully developed to remedy this situation. The operation of the DARHT facility would be expected to add another 2,500 MW hr/yr of demand to the existing system. The incremental addition of the proposed SNS facility to the current electric system would be significant. In addition to bringing in a new 115-kV line, strategies for supplying 62 MW to meet the demands for a 1-MW beam and the 90 MW for the 4-MW beam would have to be addressed.

Current and future natural gas capacities would be able to meet the needs for continued operation of LANL, the DARHT, and the proposed SNS facilities. However, there are no existing gas lines or distribution systems in the vicinity of the proposed SNS site, and this infrastructure would have to be installed.

Under the current 3.3 mgpd (12.5 million lpd) demand for potable water from LANL and the surrounding communities, it would be difficult to meet the additional demands of 1.2 to 2.3 mgpd from the proposed SNS facility. Moreover, accommodating the proposed SNS facility would require delivery system upgrades, including many new lines, lift stations, and storage tanks to increase the existing 3.86-mgpd capacity of the system.

Sanitary sewage treatment capacity is more than adequate to meet the current and projected future demands from the continued operation of LANL, DARHT, and the proposed SNS facilities. However, there is no infrastructure in place at the proposed SNS site; the waste would likely have to be trucked to the nearest lift station, which is several miles away, or a treatment and discharge system would have to be installed. The details of the effects on utilities are given in Section 5.3.10.2.

5.7.2.11 Waste Management Facilities

All of the waste generated during construction and operation of the proposed SNS facility would be transferred to LANL for processing. The existing waste management facilities for hazardous wastes, solid low-level radioactive waste, mixed waste, and sanitary waste at LANL have sufficient capacity to accommodate the waste streams from the proposed SNS. The LANL treatment facility for liquid low-level radioactive waste cannot accommodate wastes with tritium. An alternative disposal method would be necessary for these wastes from the proposed SNS facility (refer to Section 5.3.11). The evaluation of potential effects on the waste management systems include projected volumes of waste. These projections include wastes from future activities. Thus, minimal cumulative impacts on LANL waste systems would be anticipated.

5.7.3 ANL ALTERNATIVE

DOE did not identify any reasonably foreseeable future actions at ANL for inclusion in the analysis of cumulative impacts. However, DOE did include the NEPA documentation for the APS in the analysis of cumulative impacts, although this facility has been completed and is operating. The APS (Figure 5.7.3-1) provides high-brilliance X-rays for use by researchers from industry, universities, and national laboratories. The bright X-ray beams are produced by accelerating positrons (particles like electrons, but positively charged) in a circular path to nearly the speed of light. When the beam is bent by magnets, it emits energy in the form of X-rays.

5.7.3.1 Geology and Soils

Construction and operation of the proposed SNS facility would not contribute to the cumulative impact on the geology or soils of ANL or surrounding communities. The proposed SNS facility will be designed as a stand-alone facility in the 800 Area, which is adjacent to the main portion of the proposed SNS site. No significant problems have been identified with regard to site stability, seismic risk, the soil medium, or prime or unique farmlands (refer to Section 5.4.1), and no existing or future conditions would provide cumulative impacts.

5.7.3.2 Water Resources

Construction and operation of the proposed SNS facility would not contribute to the cumulative impact on the surface water and groundwater at ANL or in surrounding communities. A portion of the proposed SNS facility would encroach on portions of the 100-year floodplains associated with two unnamed tributaries of Sawmill Creek and Freund Brook. As indicated in Section 5.4.2.2, construction of the proposed SNS would result in the filling and stabilization of small portions of these floodplains for SNS buildings and related structures. In the affected area along the unnamed tributary of Sawmill Creek, drainage patterns would be altered, and storm drains and canals would be constructed. These storm drains and canals would direct stormwater flow to the retention basin, which would control the discharge of stormwater and cooling water from SNS operations to the unnamed tributary of Sawmill Creek. In the affected area along the unnamed tributary of Freund Brook, construction of the proposed SNS would also require alteration of drainage patterns and construction of storm drains and canals to redirect stormwater flow to Freund

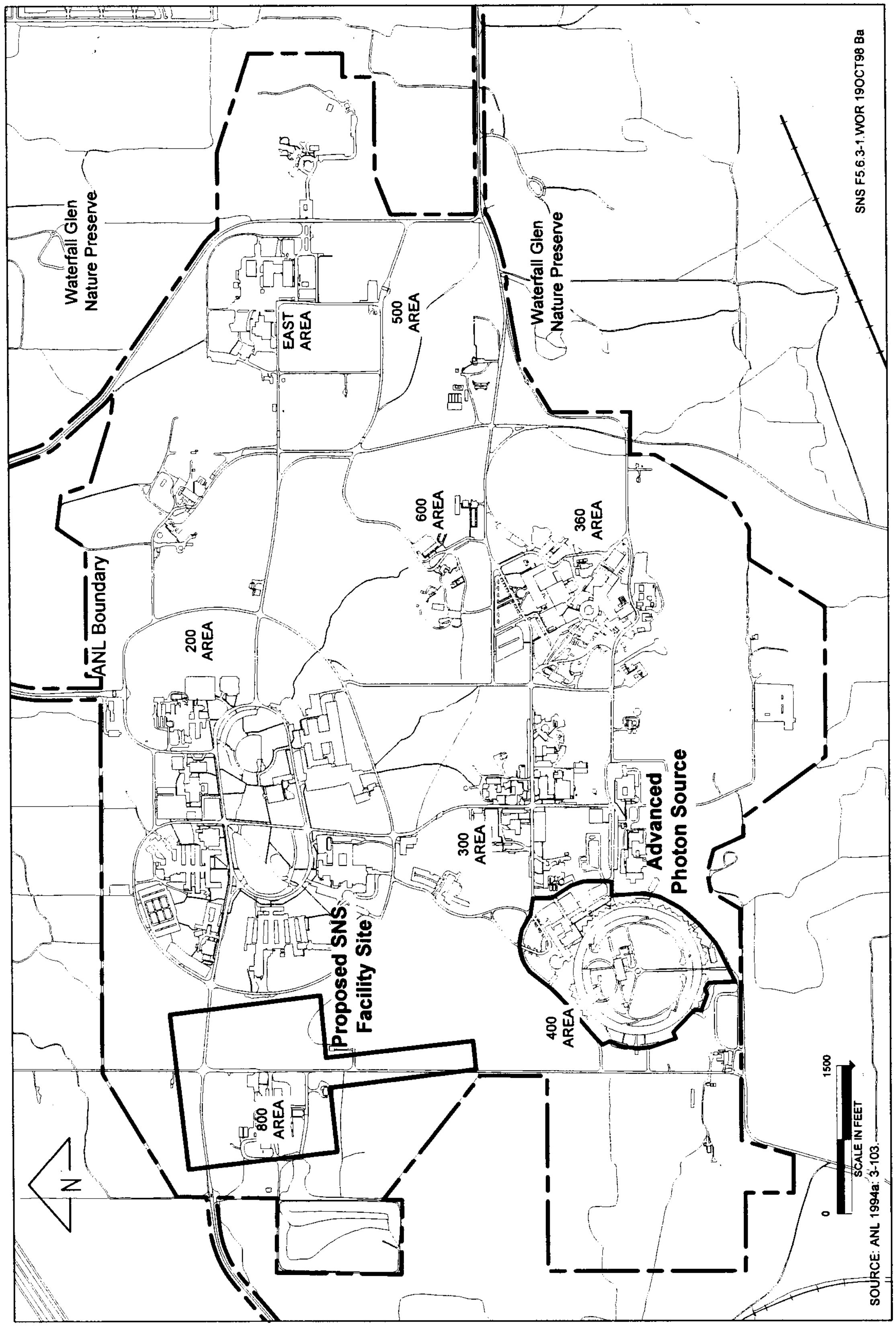

Figure 5.7.3-1. Locations of ANL actions used in the ANL cumulative impacts analysis.

Brook. As a result, construction and operation of the proposed SNS are not expected to have downstream effects on floodplains. The 100-year floodplains would not extend above the proposed SNS site, and no cumulative impacts involving nearby facilities would occur.

The primary effect of SNS operations on groundwater at the site would be the activation and leaching of radionuclides. This impact would be localized to an area immediately adjacent to the proposed SNS facility and limited to the upper soil horizon. Potable aquifers that occur at depths of over 100+ feet in this region would not be impacted. No other radiological sources exist in close proximity to the proposed SNS site, and radionuclides generated at the SNS linac tunnel would decay prior to transport from the site. Therefore, no cumulative impacts would occur. Similarly, no current or planned activities would affect groundwater resources from the potable aquifers since Lake Michigan currently supplies water for ANL.

5.7.3.3 Air Quality

Information on the emission of air pollutants from specific facilities included in this discussion was not available. Therefore, potential cumulative impacts on air quality are discussed with reference to the air quality in DuPage County. Table 5.4.3.2-1 provides collective effects of the ten small boiler stacks at the proposed SNS facility by adding the model-projected maximums for those stacks for each pollutant to an assumed background concentration developed from ambient monitoring maximums measured near the site. These values were then compared to appropriate NAAQS, and no exceedances were noted.

Table 5.7.3.3-1 indicates total hourly emission rates from the ten stacks and compares these values to county-wide average hourly emission rates. The very small percentage increase attributed to the proposed SNS facility is also shown.

If future facilities were to be located near the proposed SNS, they would have a cumulative impact on air quality in the immediate vicinity of the SNS. The potential cumulative impacts from such facilities would be evaluated and permitted on a case-by-case basis by the state and federal air quality regulatory agencies at the appropriate juncture in order to protect public health and welfare.

Table 5.7.3.3-1. Comparison of SNS boiler emission rates to county-wide emission totals.

	SNS Emissions (lb/hr)[a]	DuPage County Total Average Emission Rate (lb/hr)	% Increase from SNS Emissions
SO_2	0.02	100.4	0.02
NO_x	3.49	406.8	0.86
CO	0.73	195.7	0.37
Particulate Matter (PM_{10})	0.42	27.2	1.54

[a] Based on cumulative output of 10 boilers at the proposed SNS facility with total heat load of 34,870,000 Btu/hr. Boilers do not operate at total heat load continuously.

5.7.3.4 Noise

Noise impacts of the proposed SNS facility at ANL are described in Section 5.4.4. It is anticipated that the highest levels would occur during construction and would approach a typical noise level of approximately 86 dBA for such activities. There are no other large construction activities in the vicinity of the proposed SNS site. Thus, no cumulative impacts on noise levels are anticipated. Both the proposed SNS and the APS would be in operation at the same time. Both facilities generate noise from their mechanical draft cooling towers. However, there would be sufficient distance between the two sources of noise to prevent a cumulative impact.

5.7.3.5 Ecological Resources

This section presents the potential cumulative impacts on ecological resources at ANL.

5.7.3.5.1 Terrestrial Resources

The construction of APS required the clearing of 70 acres (28 ha) of land. The total undeveloped land area that would be affected by both the APS and the proposed SNS would be approximately 160 acres (65 ha). This represents approximately 15 percent of the undeveloped land on ANL. This total decrease in undeveloped land would cause a decrease in terrestrial wildlife inhabiting ANL proper. The Waterfall Glen Nature Preserve may provide a refuge for the displaced wildlife. However, applying the argument of Kroodsma (refer to Section 5.4.5.1), the population levels would be permanently reduced by an amount generally proportional to the amount of habitat lost. As stated in Section 5.4.5.1, this would be a minor effect because, except for the fallow deer, the species that would be affected are typical of the surrounding region and are not particularly rare or important as game animals.

5.7.3.5.2 Wetlands

During 1993, a site-wide wetlands delineation was completed for ANL in accordance with the *1987 U.S. Army Corps of Engineers Wetlands Delineation Manual.* This delineation identified 45 acres (18 ha) of natural and man-made wetlands (ANL 1994a). These range from small stormwater ditches that are overgrown with cattails to natural depressions, beaver ponds, and man-made ponds. One of these wetland areas on Freund Brook has partially reverted to upland due to the natural breaching of an old beaver dam.

Construction of the APS resulted in the destruction of 1.8 acres (0.73 ha) of wetlands. The current DOE policy is for no net decrease in the amount of wetlands as a result of DOE activities. Therefore, DOE obtained a permit for construction in wetlands from the USACOE in accordance with Section 404 of the CWA. The lost wetlands were replaced with an equivalent amount of wetland habitat created in the vicinity of the APS facility within the same watershed of the impacted wetlands.

Construction of the proposed SNS facility at ANL would result in the destruction of approximately 3.5 acres (1.4 ha) of wetlands (refer to Section 5.4.5.2). This represents 7.8 percent of the wetland area on ANL land and approximately 0.5 percent of the wetlands in and around ANL. The Waterfall Glen Nature Preserve, which surrounds and is in the same watershed (Des Plaines River) as ANL, contains 601 acres (243 ha) of emergent, swamp, and riverine marsh wetlands. The filling of the wetlands on the proposed SNS site would result in an incremental loss of wetlands in this portion of the Des Plaines River watershed.

DOE would obtain a permit for construction in the wetlands. Creation of replacement wetlands or enhancement of existing wetlands would be the most likely mitigation for this loss of wetland acreage and functions. At a minimum, these replacement wetlands would be designed to replace the structural (vegetation and hydrologic regime) and functional aspects of the wetlands that would be filled. Thus, the unavoidable wetland encroachment on the proposed SNS site is not expected to contribute to cumulative impacts on the wetland resources of the area in and around ANL.

5.7.3.5.3 Aquatic Resources

No permanent streams are located on the site of the APS. Only temporary effects on surface water biota were identified in the Environmental Assessment for the APS. As presented in Section 5.4.5.3, construction of the proposed SNS facility at ANL is expected to cause minimal effects on surface waters. Sawmill Creek currently receives many of the discharges from ANL. However, because of the nature of the aquatic discharges from the proposed SNS, these discharges would be expected to result in minimal contributions to cumulative impacts on Sawmill Creek.

5.7.3.5.4 Threatened and Endangered Species

Construction and operation of the proposed SNS facility would not affect known protected species at ANL. Therefore, there would be no contribution to cumulative impacts on threatened and endangered species at ANL.

5.7.3.6 Socioeconomic and Demographic Characteristics

Service sector businesses constitute one third of the economics of the ANL ROI. Activities included in the operation of ANL account for much less than one percent (0.01) of the employment, wage and salary, and business activity in the four-county ROI. The APS facility created up to 250 jobs during peak construction. As this number decreases, as it has done during the last three years of construction, the APS technical and administrative staff were projected to gradually increase to a stable operations work force of about 300 persons. Some of these new workers could be expected to have in-migrate with their families from outside the ROI, but the effects on housing and community infrastructure would have been minimal.

The incremental effects from the proposed SNS facility on the economy and community infrastructure of the ROI would be minimal. There would be some positive economic benefits in the form of new jobs created by the construction and operation of the proposed SNS. Construction of the proposed SNS facility would require 578 full-time employees during the peak year and from 250 to 375 (1 MW to 4 MW) during operations. Most of the construction workforce and about half of the operations workforce would come from the ROI, and as such, the effects on housing and community services would be minimal. The details of these effects are given in Section 5.4.6.

No effects on environmental justice were identified from the operation of ANL or the construction and operation of the APS. The proposed SNS would also have no effects on environmental justice at ANL. Therefore, there would be no cumulative impacts on environmental justice.

5.7.3.7 Cultural Resources

The cumulative impacts of the proposed action and other actions on cultural resources at ANL are assessed in this section.

5.7.3.7.1 Prehistoric Resources

One prehistoric archaeological site (40DU207), which might be eligible for listing on the NRHP, may be disturbed or destroyed by construction of the proposed SNS facility (refer to Section 5.4.7.1). After the Environmental Assessment for the proposed APS was completed, the remains at 40DU189 (formerly ANL-6) were assessed as ineligible for listing on the NRHP (DOE-CH 1990: 80-81; Wescott 1998b). As a result, the APS would have no impact on prehistoric cultural resources. Therefore, the proposed SNS would not contribute to cumulative impacts on prehistoric cultural resources at ANL.

5.7.3.7.2 Historic Resources

Building 829 is the only Historic Period structure remaining in the 800 Area at ANL. This building is not eligible for listing on the NRHP. As a result, the proposed action would have no effect on Historic Period cultural resources. Therefore, the proposed action would not contribute to cumulative impacts on Historic Period cultural resources at ANL.

5.7.3.7.3 Traditional Cultural Properties

No TCPs are known to exist on the proposed SNS site at ANL or anywhere else on laboratory land. As a result, no TCPs would be affected by implementation of the proposed action. Therefore, the proposed action would not contribute to cumulative impacts on TCPs at ANL.

5.7.3.8 Land Use

The cumulative impacts of the proposed action and other actions on land use at ANL are assessed in this section.

5.7.3.8.1 Current Land Use

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the basic characteristics of the land that influence land use in the vicinity of ANL and throughout most of the laboratory. This would also be true of the effects from construction and operation of the APS. Therefore, these actions would have no reasonably discernible cumulative impacts on land use outside ANL and throughout most of the laboratory.

The proposed action would introduce development to approximately 90 acres (36 ha) of undeveloped Open Space and Ecology Plot land on the proposed SNS site. Construction of the APS resulted in the development of 70 acres (28 ha) of previously undeveloped land. Cumulatively, these two actions would introduce development to 160 acres (65 ha) of undeveloped ANL land. This would represent an approximately 15 percent reduction in the combined Open Space and Ecology Plot land available for additional development. Considering the already limited space available for development at ANL, this would be a fairly substantial cumulative impact.

Construction of the proposed SNS would displace any remaining support services operations in the 800 Area at ANL, and it would result in demolition of the remaining buildings and features in this area. The current use designations for land on the proposed SNS site (Ecology Plots 6, 7, and 8; Support Services; and Open Space) would change to a programmatic use category specific to the new facility or the Programmatic Mission-Other Areas category. Construction of the APS resulted in a current land use change from Open Space to Programmatic Mission-APS Project. These changes in current land use would involve approximately 75 (30 ha) acres of Open Space land on the proposed SNS site and 70 acres (28 ha) of Open Space land on the APS site. Cumulatively, the proposed action and the APS would reduce the Open Space land at ANL by approximately 145 acres (59 ha). This would represent an approximately 15 percent reduction in the Open Space land available for additional development at ANL. Considering the already limited space available for development, this would be a fairly substantial cumulative impact.

No NERP land is present at ANL. Consequently, the proposed action would not reduce the environmental research potential of NERP land.

The land on and in the vicinity of the proposed SNS site, including Ecology Plot Nos. 6, 7, and 8, is not being used by environmental research projects. As a result, the proposed action would not contribute to cumulative impacts on the use of land by such projects.

5.7.3.8.2 Future Land Use

An extremely small area of land zoned for future use in Support Services is located barely inside the west boundary of the proposed SNS site at ANL. The remainder of the proposed SNS site would be compatible with DOE zoning of this land for future use. The APS site does not contain Support Services zoning and is already dedicated to APS facilities. Therefore, the proposed action would not contribute to cumulative impacts involving the future use of land for purposes other than those for which it is zoned.

No future uses of proposed SNS site and vicinity land for environmental research are planned. This includes Ecology Plot Nos. 6, 7, and 8. As a result, the cumulative impacts of the proposed action on specific future research projects cannot be assessed.

5.7.3.8.3 Parks, Preserves, and Recreational Resources

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses outside the ANL boundaries. Consequently, implementation of the proposed action would have minimal effects on the following land uses on and in the vicinity of ANL: Forest Preserve District of Cook County (recreation on Saganashkee Slough, McGinnis Slough, and small lakes), hunting and fishing in Sawmill Creek and the Des Plaines River, recreational use of an area adjacent to the southwest boundary of ANL, Waterfall Glen Nature Preserve, and ANL Park. The NEPA environmental assessment covering construction and operation of the APS indicates that these actions would have no significant, long-term effects on the Waterfall Glen Nature Preserve (DOE-CH 1990: 65). The environmental assessment does not identify effects on the other previously listed land uses. Thus, the cumulative effect of these actions on these other uses would be uncertain. However, it is expected that construction and operation of the SNS would not contribute to cumulative impacts on these uses.

5.7.3.8.4 Visual Resources

The proposed SNS site is located in close proximity to the west perimeter of ANL, and the currently operating APS site is similarly located near the proposed SNS site and the west perimeter of the laboratory. These facilities would not be visible from points outside the surrounding Waterfall Glen Nature Preserve because the preserve is heavily forested. However, the APS and the proposed SNS would be simultaneously visible from points within ANL. They would also be visible from points near the ANL fence in the Waterfall Glen Nature Preserve, especially on the west side during late autumn, winter, and early spring. Because current views in these areas already contain buildings and other features characteristic of development, the cumulative impacts of the SNS and APS on visual resources would be minimal.

5.7.3.9 Human Health

During normal operations, all SNS effluents containing radioactive or toxic materials would be gaseous. Based on 1996 emissions for all existing ANL facilities, the hypothetical maximally exposed individual received a dose of 0.053 mrem via air pathways, while the off-site population received a dose of 2.64 person-rem. DOE includes the APS in the analysis of cumulative impacts for the proposed SNS facility at ANL. The principal potential health impact from the APS would be exposure to direct radiation. Estimated dose at the ANL site boundary would be 6 mrem/hr due to direct radiation plus an additional 0.06 mrem/yr from the emission of activated air.

Estimates of direct radiation are not available for the proposed SNS, and analysis of cumulative impacts is based on the air pathways. For the proposed 1-MW SNS facility, the air pathway dose to the maximally exposed individual would be 3.1 mrem/yr and 20 person-rem/yr to the off-site population. For the proposed 4-MW SNS facility, the corresponding doses are 12 mrem/yr for the maximally exposed individual and 79 person-rem/yr for the off-site population. The ingestion component of the air pathway dose for the proposed SNS has been conservatively estimated based on the inhalation component of the air pathways. The maximum cumulative dose at the site boundary for the 4-MW facility is 12.1 mrem/yr. Maximally exposed individuals for determining compliance with the 10-mrem/yr limit for exposures based on the air pathway are receptors located only where people actually reside. Maximally exposed individuals in this FEIS are hypothetical receptors located at the site boundary and, at ANL, are much closer to the site than the nearest actual resident. The cumulative affects of SNS emissions at locations where people actually reside would not exceed to limit of 10 mrem/yr. The limit for all pathways including air and direct radiation is 100 mrem/yr.

Based on a risk conversion factor of 0.0005 LCFs/person-rem, the cumulative impacts of ANL emissions with the proposed SNS could result in fatalities at both 1 MW (0.45 LCFs) and 4 MW (1.6 LCFs). LCFs of 1.0 or greater do not mean that any actual deaths would occur. Rather, LCFs provide a common and conservative basis for comparisons of alternatives.

Airborne concentrations of mercury would be approximately 10,000 times less than applicable standards for workers and the public and would not contribute to cumulative toxic health impacts.

5.7.3.10 Infrastructure

This section discusses the cumulative impacts on transportation and utility systems from construction and operation of the APS and proposed SNS facilities at ANL.

5.7.3.10.1 Transportation

ANL is bordered on the north by I-55, on the east by State Highway 83, and on the south by State Highway 171. As of 1994, no marked difficulties were apparent for on-site traffic at any location, either during peak periods of arrival and departure or midday (ANL 1994b). Also, according to Illinois DOT standards, vehicle accumulation at intersections and gates is minimal, even during peak hours. Operating the APS was projected to increase traffic by about 240 trips per day. Locating the proposed SNS at ANL would increase traffic by 466 round-trips during the peak construction year and by 302 round-trips during operations. The addition of the SNS to the existing APS would increase traffic, but the existing transportation infrastructure could accommodate this increase. However, the location within ANL that most closely matches the siting criteria for the SNS overlays Westgate Road. Approximately 1 mile (1.6 km) of the existing Westgate Road would be relocated to the north in order to circumvent the proposed SNS site and replace the existing Westgate Road access. The details of the effects from the proposed SNS are given in Section 5.4.10.1.

5.7.3.10.2 Utilities

Electric power was provided from an existing substation to the APS by two 13-kV feeder circuits that originally serviced the ANL Zero Gradient Synchrotron accelerator facility, which was shut down in 1979 (DOE-CH 1990). ANL's existing 138-kV lines would not be adequate for the SNS loads. A new 138-kV overhead line would be needed to connect the proposed SNS facility to substation 549A to meet the power requirements of the SNS. If additional capacity beyond the available 50 MW is required, it would be necessary to coordinate with Commonwealth Edison to determine the best way to provide power to the site.

The APS was expected to use approximately 60,000 lb/hr of steam. It is expected that the proposed SNS facility would use about the same amount. ANL can accommodate approximately 300,000 lb/hr of additional steam demand.

The potable domestic water supply at ANL is purchased from the local water district. The APS was estimated to use an average of 30,000 gpd (113,562 lpd) of domestic water. The proposed SNS facility would probably use about the same amount, which is four percent of the excess capacity at ANL. Cooling tower water demand for the APS was projected to average 400,000 gpd (1,514,160 lpd) and would come from the Chicago Sanitary and Ship Canal. The proposed SNS is expected to use 800 gpm (3,028 lpm) for the 1-MW beam and 1,600 gpm (6,057 lpm) for the 4-MW beam. ANL has the capacity to provide approximately 2 mgpd (7.6 million lpd), and it is expected that ANL would be able to meet the APS and proposed SNS water requirements with minimal environmental effects. The details of the effects on utilities are given in Section 5.4.10.2.

5.7.3.11 Waste Management Facilities

All of the waste generated during construction and operation of the proposed SNS facility would be transferred to ANL for processing. The existing waste management facilities have sufficient capacity to accommodate the SNS waste streams (refer to Section 5.4.11). The evaluation of potential effects on the waste management systems included projected volumes of waste. Since the APS is an operational facility, wastes from this facility are included in these projections, thus minimal cumulative impacts on ANL wastes systems would be anticipated.

5.7.4 BNL ALTERNATIVE

The actions that DOE considers reasonably foreseeable and pertinent to the analysis of cumulative impacts for the BNL alternative are described in this section. The locations of these actions are shown in Figure 5.7.4-1. These actions are as follows:

Programmed Improvements of the Alternating Gradient Synchrotron (AGS) Complex. DOE prepared an Environmental Assessment for the proposed action to improve the efficiency of the AGS and upgrade the environment, safety, and health systems of the facility. The AGS began operation in 1960 as a proton accelerator supporting research in high-energy physics. The AGS was adapted to accelerate heavy ions in 1986.

Relativistic Heavy Ion Collider. DOE prepared an environmental assessment for the construction and operation of the Relativistic Heavy Ion Collider (RHIC) facility at BNL. The proposed action is to utilize existing facilities at BNL and construct new facilities to complete the RHIC. The RHIC facility would provide a unique, world-class heavy ion research facility.

CERCLA Actions at BNL. In 1980, the BNL site was placed on the New York Department of Environmental Conservation's List of Inactive Hazardous Waste Disposal Sites. In 1989, the laboratory was included on the EPA's National Priorities List of Superfund sites. The inclusion of BNL on both lists was due primarily to the effects of past operations, which posed a potential threat to Long Island's sole source aquifer.

There are 29 Areas of Concern on the BNL site. To ensure effective management, these areas were grouped into five distinct Operable Units. Areas of Concern refer to specific locations of contamination on BNL. The footprint of the proposed SNS at BNL overlies portions of Operable Units III and V.

Operable Unit III was created to address site-specific Areas of Concern, concentrating on groundwater plumes originating from the western portion of BNL. There is a total of 16 Areas of Concern within Operable Unit III; however, none of them are in the vicinity of the SNS footprint (BNL, 1999a).

Operable Unit V is located in the eastern-central portion of BNL. The area includes the Sewage Treatment Plant, an active facility used to process sewage from BNL facilities. There are two Areas of Concern within this Operable Unit. Neither of them is in the vicinity of the SNS footprint (BNL, 1999b).

5.7.4.1 Geology and Soils

The SNS would be designed and constructed as a stand-alone facility. Because of its relative

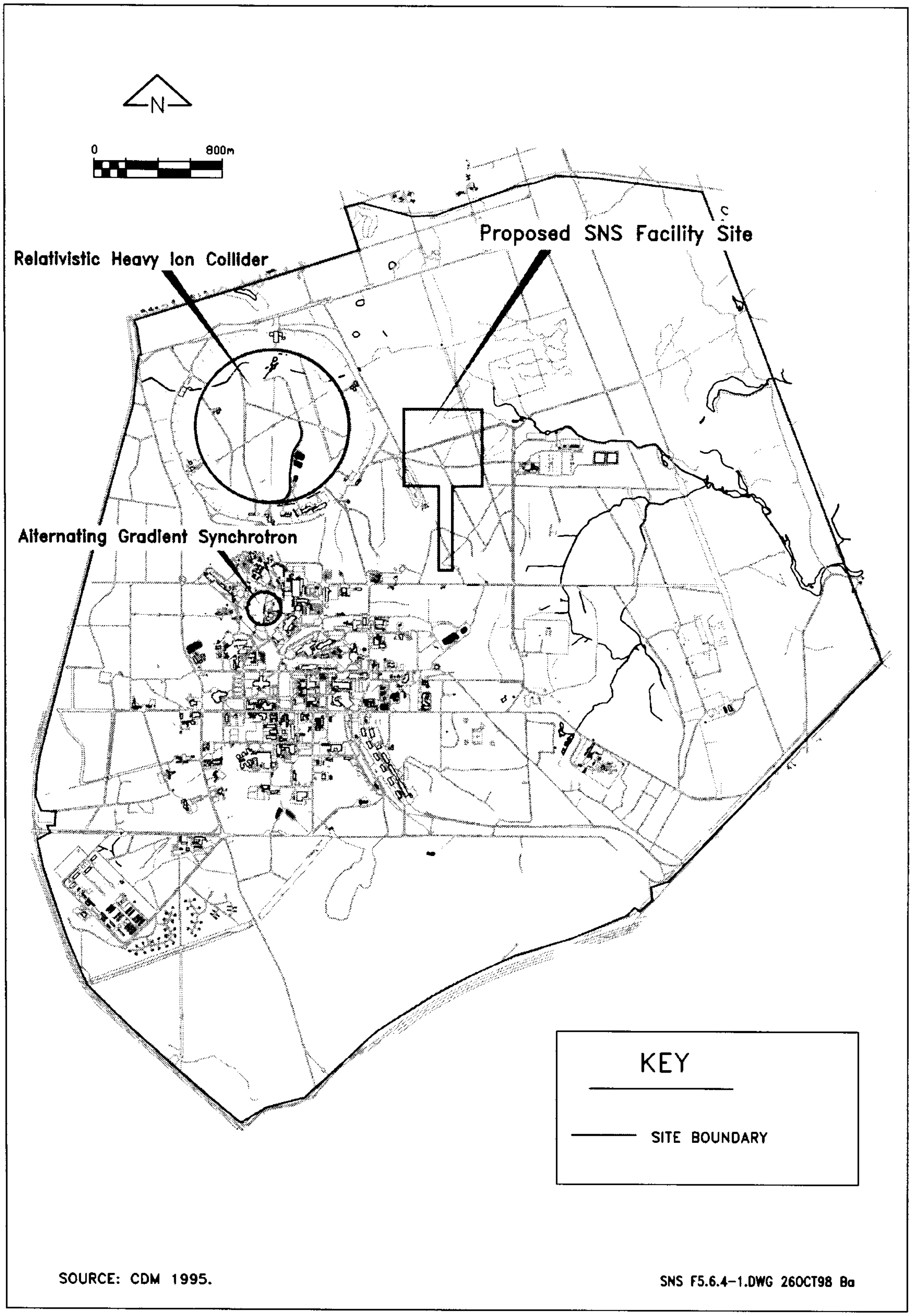

Figure 5.7.4-1. Locations of actions used in the BNL cumulative impacts analysis.

isolation from other BNL facilities, activated soil around the linac tunnel would not combine with other radioactively contaminated soils to create cumulative impacts. No potential conditions have been identified in regard to site stability, seismic risk, or prime or unique farmlands that would constitute impacts by themselves (refer to Section 5.5.1) or combine with existing or future conditions to create cumulative impacts. Therefore, construction and operation of the SNS would not contribute to cumulative impacts on the soils and geology of BNL or the surrounding area.

5.7.4.2 Water Resources

Operation of the proposed SNS facility would create limited amounts of radionuclides in the soils and groundwater surrounding the linac tunnel. Site-specific studies have not been conducted to determine the specific concentrations of radionuclides that would be produced at BNL, but the types of nuclides would be very similar to those predicted for ORNL.

Any SNS contribution of radionuclides would add to those from currently operating and planned radiological sources at BNL. These potential sources include the Brookhaven LINAC Isotope Production Facility, the Alternating Gradient Synchrotron, and the National Synchrotron Light Source. In addition, the HFBR is reported to have released ^{3}H to the groundwater at BNL, and RHIC is predicted to add quantities of several radionuclides, including ^{3}H and ^{22}Na, to the groundwater.

Similar to the SNS, a study (DOE-CH 1991) of the RHIC (currently under construction at BNL) has indicated that secondary particles created by beam interactions would escape into the soil surrounding the tunnel on all sides. From the interaction with the silicon and oxygen atoms in the soil, RHIC is predicted to produce the following radionuclides: ^{3}H, ^{22}Na, ^{7}Be, ^{11}C, ^{13}N, and ^{15}O.

Since the leaching and transport of nuclides is relatively slow, only the longer-lived isotopes such as ^{3}H and ^{22}Na would exist for potential human exposure. An annual total of 11 mCi of ^{3}H and 14 mCi of ^{22}Na are expected to be produced by RHIC. These concentrations would yield a human exposure through the water pathway several orders of magnitude below the Safe Drinking Water Act (SDWA) limit of 4 mrem per year. Assuming a person's intake would consist of 100 percent of water at the BNL boundary, the maximum off-site dose to an individual would be about 0.07 mrem per year.

Due to the proximity of the proposed SNS site and RHIC, the potential exists for commingling of radionuclides from the two facilities. Cumulative impacts, however, would be minimal because of the small amounts generated by each facility, the natural dilution by groundwater, and the isotopic decay over time.

BNL has also identified a groundwater ^{3}H plume derived from the Spent Fuel Pool at the HFBR (BNL 1998). This plume, located in Operable Unit III, has been the focus of a remedial investigation/feasibility study under the CERCLA process, and immediate remedial actions are being taken to remove the ^{3}H sources, mitigate the plume's migration, and characterize the human health exposure at the BNL boundary. The plume trends roughly south from HFBR about 4,200 ft and is approximately 750-ft wide at its greatest dimension. The leading edge of the plume (20,000-pCi/L contour line) would require about 16.4 years to reach the BNL boundary. By that time, natural radioactive decay alone would reduce the ^{3}H concentration to less than half of its current level. Considering the combined effects of groundwater flow, nuclide dispersion, and radioactive decay, groundwater modeling indicates that ^{3}H concentrations above the SDWA level of 20,000 pCi/L would never cross the BNL boundary.

The SNS site is located about 1,500 to 2,000 ft northeast of the HFBR. Due to the configuration of the groundwater gradient within BNL (refer to Figure 4.4.2.2-3), any migration of radionuclides from the SNS site would not intersect the HFBR plume. Hence, cumulative groundwater impacts from the SNS and HFBR would not occur.

The overall picture of cumulative groundwater impacts that might result from operation of the SNS and all the foregoing BNL facilities remains somewhat unclear. However, it is possible that localized groundwater conditions may be affected at BNL, while minimal effects would occur at the laboratory boundary due to the dilution and decay of radionuclides.

It is possible that localized groundwater conditions may be affected at BNL, while minimal effects would occur at the laboratory boundary due to the dilution and decay of radionuclides.

5.7.4.3 Air Quality

Information on the emission of air pollutants from the specific facilities included in this discussion was not available. Therefore, potential cumulative impacts on air quality are discussed with reference to the air quality in Suffolk County. Table 5.5.3.2-1 provides the collective effects of the ten small boiler stacks at the proposed SNS facility by adding the model-projected maximums for those stacks for each pollutant to an assumed background concentration developed from ambient monitoring maximums measured near the site. These values were then compared to appropriate NAAQS, and no exceedances were noted.

Table 5.7.4.3-1 indicates total hourly emission rates from the ten stacks and compares these values to county-wide average hourly emission rates. The very small percentage increase attributed to the proposed SNS facility is also shown.

If future facilities were to be located near the proposed SNS, they would have a cumulative impact on air quality in the immediate vicinity of the SNS. The potential cumulative impacts from such facilities would be evaluated and permitted on a case-by-case basis by the state and federal air quality regulatory agencies at the appropriate juncture in order to protect public health and welfare.

5.7.4.4 Noise

Noise impacts of the proposed SNS facility at BNL are described in Section 5.5.4. It is anticipated that the highest levels would occur during construction and would approach a typical noise level of approximately 86 dBA for such activities. However, the proposed SNS facility would be located west of the main BNL office complex and would be removed from any discernable source of noise produced by that area. No cumulative noise impacts are expected from the two sources.

Table 5.7.4.3-1. Comparison of SNS boiler emission rates to county-wide emission totals.

	SNS Emissions (lb/hr)[a]	Suffolk County Total Average Emission Rate (lb/hr)	% Increase from SNS Emissions
SO_2	0.02	4,350.0	0.00046
NO_x	3.49	2,123.9	0.16
CO	0.73	481.5	0.15
Particulate Matter (PM_{10})	0.42	107.4	0.39

[a] Based on cumulative output of 10 boilers at the proposed SNS facility with total heat load of 34,870,000 Btu/hr. Boilers do not operate at total heat load continuously.

5.7.4.5 Ecological Resources

This section presents the potential cumulative impacts on ecological resources at BNL.

5.7.4.5.1 Terrestrial Resources

As presented in Section 5.5.5.1, the proposed SNS site at BNL lies within the pine barrens area of Long Island. However, the 110 acres (45 ha) of land on the site represents less than 2 percent of the Pine Barrens protection area and lies entirely within the Compatible Growth Area rather than the more stringently protected Core Preservation Area. Cumulative impacts to the Pine Barrens would be minimal. Construction associated with the Programmed Improvements of the AGS complex is limited to areas within existing facilities or existing utility rights-of-way. No land would be cleared.

The Pine Barrens Protection Act was enacted in 1993 after the environmental assessment for RHIC was completed. The land occupied by the RHIC facilities was included in the Compatible Growth Area. The construction of RHIC is utilizing facilities that already existed for the ISABELLE/CBA project at BNL, plus other facilities and components that already were built and operational at BNL. Thus, very little undisturbed land was cleared for RHIC.

5.7.4.5.2 Wetlands

Wetlands occur in the headwaters of the Peconic River. However, construction and operation of the proposed SNS facility would have minimal effects on these wetlands.

Construction-associated improvements to the AGS is limited to areas within existing facilities or existing utility rights-of-way. No land would be cleared.

No construction activities for the RHIC facility occurred in a wetland. However, there was a potential for indirect effects on wetlands. By implementing appropriate mitigation measures, such as immediate mulching and reseeding of disturbed areas and the use of standard erosion control practices adjacent to wetlands, these secondary effects were expected to be minimal. The NYSDEC issued a Notice of Determination of Non-Significance in response to the request for authorization to construct, submitted by DOE to the NYSDEC in accordance with Article 24 of the Environmental Conservation Law, Protection of Freshwater Wetlands. Thus, cumulative impacts on wetlands from the foregoing facilities would be minimal.

5.7.4.5.3 Aquatic Resources

Cumulative impacts on aquatic resources at BNL would be expected to be minimal. The proposed site for the SNS project and the existing RHIC facilities are located within an area designated as "scenic" under the New York State Wild, Scenic, and Recreational River Act. The ISABELLE/CBA facilities, to be used by RHIC, were constructed prior to the 1987 designation of the portion of the Peconic River flowing through BNA as "scenic." The general public does not have open access for use and enjoyment of the river within the BNL boundary, but the New York State Wild, Scenic, and Recreational River Act applies. At the RHIC location, the Peconic River is an intermittent stream. No impacts on the scenic nature of the river resulting from RHIC activities were identified in the environmental assessment.

The 300-ft (91-m) buffer zone of natural vegetation that would be established between the Peconic River and the proposed SNS would protect the scenic nature of the river.

The only potential effect on the Peconic River identified by the RHIC EA is increased sediment loading during construction. Construction activities at RHIC would be completed prior to the start of construction on the proposed SNS facility. The potential for increased sediment loading in the Peconic River during construction of the proposed SNS also exists. Effective erosion control measures are standard practice at DOE construction sites. This, coupled with the fact that construction activities for these projects would not be concurrent, would result in minimal cumulative impacts on the Peconic River.

5.7.4.5.4 Threatened and Endangered Species

No effects on threatened and endangered species were identified in the EA for the RHIC. Construction and operation of the proposed SNS facility would be expected to result in minimal or no effects on known threatened and endangered species. Thus, the cumulative effects on potential species would be uncertain but would be expected to be minimal.

5.7.4.6 Socioeconomic and Demographic Characteristics

Government operations (federal, state, and local), service sector businesses, and retail trade dominate the economics of the BNL ROI. Activities included in the operation of BNL account for much less than one percent (0.02) of the employment, wage and salary, and business activity in the two-county ROI. The proposed programmed improvements of the AGS would upgrade existing facilities, and the construction and operation would be performed by the current workforce. This proposed action would not create any jobs or cause population changes. Therefore, it would not affect ROI housing demand or community infrastructure. The construction of RHIC would also involve upgrades to existing facilities by the current workforce. However, RHIC would add 200 new jobs during operations. Some of these new workers would in-migrate with their families from outside the ROI, but the effects on housing and community infrastructure would be minimal.

The incremental effects from the proposed SNS facility on the economy and community infrastructure of the ROI would be minimal. There would be some positive economic benefits in the form of new jobs created by construction and operation of the proposed SNS. Construction of the proposed SNS facility would require 578 full-time employees during the peak year and from 250 to 375 (1 MW to 4 MW) during operations. Most of the construction workforce and about half of the operations workforce would come from the ROI, and as such, the effects on housing and community services would be minimal. The details of these effects are given in Section 5.5.6.

No effects on environmental justice were identified from the operation of BNL or the construction and operation of the AGS or RHIC. The proposed SNS facility would also have no effects on environmental justice at BNL. Therefore, there would be no cumulative effects on environmental justice.

5.7.4.7 Cultural Resources

This section assesses the cumulative impacts of the proposed action and other actions on the cultural resources at BNL.

5.7.4.7.1 Prehistoric Resources

No prehistoric sites listed on or considered to be eligible for listing on the NRHP have been identified on the proposed SNS site at BNL or in its vicinity. As a result, the proposed action would have no effect on prehistoric cultural resources. Therefore, the proposed action would not contribute to cumulative impacts on prehistoric cultural resources at BNL.

5.7.4.7.2 Historic Resources

The footprint for the ISABELLE/CBA facility was surveyed and archaeologically tested for cultural resources to support the NEPA process in 1977. These efforts resulted in the location of 14 Historic Period archaeological sites dating to World War I. Subsequently, the New York State Historic Preservation Officer (SHPO) indicated that construction of ISABELLE/CBA could proceed as a result of compliance with requirements under the National Historic Preservation Act (NHPA) and Executive Order 11593 (DOE-CH 1991: 14). After extensive construction had already occurred, the project was cancelled. The RHIC was later proposed for construction entirely within the footprint of the partially constructed ISABELLE/CBA facility. In an opinion issued on January 2, 1991, the SHPO indicated that RHIC would have no effect on cultural resources listed on or eligible for listing on the NRHP (Miltenberger et al. 1990; DOE-CH 1991: 14). This would include Historic Period cultural resources at BNL.

With respect to the other project included in this cumulative impacts analysis, the absence of Historic Period cultural resources in the AGS complex indicates that proposed improvements to the AGS would not affect Historic Period cultural resources at BNL (DOE-CH 1994: 14). Considering the absence of cultural resources impacts from RHIC and AGS, the destruction of potentially NRHP-eligible World War I features at Stations 2, 4, 8, and 10 on the proposed SNS site would not contribute to cumulative impacts on Historic Period cultural resources at BNL.

5.7.4.7.3 Traditional Cultural Properties

No TCPs are known to exist on the proposed SNS site at BNL or anywhere else on laboratory land. As a result, no TCPs would be affected by implementation of the proposed action. Therefore, the proposed action would not contribute to cumulative impacts on TCPs at BNL.

5.7.4.8 Land Use

This section assesses the cumulative impacts of the proposed action and other actions on land use at BNL.

5.7.4.8.1 Current Land Use

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the basic characteristics of the land that influence land use in the vicinity of BNL and throughout most of the laboratory. This would also be true of the effects from RHIC and improvements to the AGS. Therefore, these actions would have no reasonably discernible cumulative impacts on land use outside BNL and throughout most of the laboratory.

The proposed action would introduce development to approximately 110 acres (45 ha) of land on the proposed SNS site. Because of its location on the site of a previous construction project, RHIC would involve very little disturbance of previously undeveloped land (DOE-CH 1991: 27). The AGS improvements would occur within a previously developed area of the laboratory. Therefore, the proposed action would not contribute to cumulative impacts on undeveloped land at BNL.

The proposed action would change the current use of 110 acres (45 ha) of land on the proposed SNS site from Open Space to Industrial/Commercial. The construction of RHIC would occur in the previously developed area associated with ISABELLE/CBA, and the AGS improvements would occur within another Industrial/Commercial land use area. As a result, no changes in current land use would be associated with RHIC and improvements to the AGS. Therefore, the proposed action would not contribute to cumulative impacts on current land use at BNL.

No NERP land is present at BNL. Consequently, the proposed action would not reduce the environmental research potential of NERP land.

The land on and in the vicinity of the proposed SNS site is not being used by environmental research projects. As a result, the proposed action would not contribute to cumulative impacts on the use of land by such projects.

5.7.4.8.2 Future Land Use

The RHIC and AGS improvements would be compatible with the Industrial/Commercial zoning of their sites. Therefore, the proposed action would not contribute to cumulative impacts involving the future use of land for purposes other than those for which it is zoned.

No future uses of proposed SNS site and vicinity land for environmental research are planned. As a result, the cumulative impacts of the proposed action on specific future research projects cannot be assessed.

5.7.4.8.3 Parks, Preserves, and Recreational Resources

The effects of the proposed action would not be of sufficient scope, magnitude, or duration to alter the key land characteristics that support park, nature preserve, and recreational land uses outside the ANL boundaries. Consequently, implementation of the proposed action would have minimal effects on the following land uses in the vicinity of BNL: Brookhaven State Park, Rocky Point State Park, Wildwood State Park, recreational use of the Peconic and Carmens Rivers, Calverton Naval Weapons Plant (recreational areas), Cathedral Pines County Park, South Haven County Park, Wertheim National Wildlife Refuge, and Randall Road Hunting Station. The NEPA documentation for RHIC and the AGS improvements does not identify potential effects on these land uses (DOE-CH 1991; 1994). Thus, the cumulative effect of these actions on parks, preserves, and recreational land use would be uncertain. However, it is expected that construction and operation of the SNS would not contribute to cumulative impacts on parks, preserves, and recreational land uses in the vicinity of BNL.

5.7.4.8.4 Visual Resources

Most of the visual panoramas in the area immediately surrounding BNL and within the laboratory contain features indicative of development. Cumulatively, the proposed action, RHIC, and AGS improvements would be compatible with the existing visual environment of the area. Therefore, the cumulative impact of these actions on visual resources at BNL would be minimal.

5.7.4.9 Human Health

During normal operations, all SNS effluents containing radioactive or toxic materials would be gaseous. Based on 1995 emissions for all existing BNL facilities, the hypothetical maximally exposed individual received a dose of 0.06 mrem via air pathways, while the off-site population received a dose of 3.2 person-rem. DOE includes the RHIC and the programmed improvements of the AGS in the analysis of cumulative impacts for a proposed SNS facility at BNL. Operation of the RHIC and other facilities supporting it would result in an additional dose from air pathways of 0.016 mrem/yr to the hypothetical maximally exposed individual and 6 mrem/yr to the off-site population. Operation of the improved AGS and other facilities in tandem with these improvements would add 0.29 mrem/yr to the maximally exposed individual. No estimate of the increment in dose to the off-site population is available.

For the proposed 1-MW SNS facility, the increment in air pathway dose to the maximally exposed individual would be 0.89 mrem/yr and 20 person-rem/yr to the off-site population. For the proposed 4-MW SNS facility, the corresponding doses are 3.4 mrem/yr for the maximally exposed individual and 76 person-rem/yr for the off-site population. The ingestion component of the air pathway dose for the proposed SNS has been conservatively estimated based on the inhalation component of the air pathways. In spite of this conservatism and the conservatism of assuming that the maximally exposed individual is at the same location in each case, the cumulative dose via air pathways of 3.8 mrem/yr based on the proposed 4-MW SNS facility is still below the applicable limit of 10 mrem/yr.

Based on a risk conversion factor of 0.0005 LCFs/person-rem, the cumulative impacts of BNL emissions with those from the proposed SNS facility could result in fatalities at both 1 MW (0.46 LCFs) and 4 MW (1.6 LCFs). LCFs of 1.0 or greater do not mean that any actual deaths would occur. Rather, LCFs provide a common and conservative basis for comparisons of alternatives.

Airborne concentrations of mercury would be approximately 10,000 times less than applicable standards for workers and the public and would not contribute to cumulative toxic health impacts.

5.7.4.10 Infrastructure

This section discusses the cumulative impacts on transportation and utility systems from the construction and operation of the proposed SNS, programmed improvements on the AGS, and RHIC.

5.7.4.10.1 Transportation

BNL is accessed by three major four-lane, divided highways. Currently, about 2,500 vehicles per day enter and exit BNL. In 1990, a transportation master plan was developed for BNL that evaluated traffic circulation impacts. The results of the study indicate that the transportation infrastructure in and around BNL could adequately service predicted traffic of 3,060 round-trips per day. The programmed improvements on the AGS would not increase traffic because the existing workforce would construct the upgrades and operate the facilities. The existing workforce would also construct the upgrades to existing facilities needed for RHIC. The operation of RHIC would increase traffic by about 160 round-trips per day. Locating the proposed SNS facility at BNL would increase traffic by 466 round-trips during the peak construction year and by 302 round-trips during operations. The addition of all these facilities would increase traffic, but the existing transportation infrastructure could accommodate this increase. The details of the effects from the proposed SNS are given in Section 5.5.10.1.

5.7.4.10.2 Utilities

BNL's current electrical demand is 52 MW. RHIC is projected to require 27.7 MW of electrical power with the injector system (AGS, Booster, LINAC, etc.) using another 16.8 MW strictly for accelerating ions that would be injected into RHIC. The proposed SNS facility would require 62 MW for the 1-MW beam and 90 MW for the 4-MW beam. Approximately 84 percent of BNL's energy demands are met by the New York Power Authority. They have 75,000 kW available for industrial use and would seriously consider requests for additional allocation from BNL for RHIC (DOE-CH 1991). The proposed SNS facility would require a new 69-kV transmission line to the LILCO's 138-kV grid located on the southeast corner of the BNL site. Required upgrades to the electrical systems for all of these facilities would occur within existing infrastructure corridors or alignments. Therefore, cumulative environmental impacts would be expected to be minimal.

The AGS used 1.37 mgpd (5.2 million lpd) of water for operations in 1992. However, the AGS is serviced with a closed-loop cooling system, and essentially all of the water pumped for AGS cooling purposes is returned to the aquifer through recharge basins. RHIC's requirements of 144,000 gpd (545,098 lpd) represent about 3 percent of the margin-of-safe-yield volume of 5.2 mgpd (19.7 million lpd) available to BNL. RHIC would require 450 gpm (1,703 lpm) for cooling purposes. This is a small increment of the 4,500 gpm (17,034 lpm) that BNL withdraws and the 2,250 gpm (8,517 lpm) it returns to recharge basins. The proposed SNS facility would require 800 gpm (3,028 lpm) for the 1-MW beam and 1,600 gpm (6,057 lpm) for the 4-MW beam. BNL has the capacity to pump 7,200 gpm (27,255 lpm) and would be able to accommodate all of these facilities. The details of the effects of the proposed SNS facility on utilities are given in Section 5.5.10.2.

5.7.4.11 Waste Management Facilities

All of the waste generated during construction and operation of the proposed SNS facility would be transferred to BNL for processing. The existing BNL waste management facilities for sanitary wastes and for treatment of liquid low-level radioactive wastes have sufficient capacity to accommodate the waste streams from the proposed SNS. However, current storage capacity for hazardous wastes, low-level radioactive wastes, and mixed wastes would not be able to accommodate the projected volumes of SNS wastes (refer to Section 5.5.11). These projections include wastes from future activities. The current storage facilities would have to be expanded to increase RCRA-permitted storage capacity to accommodate the storage of these future wastes. Considering that BNL recently finished construction of a new waste management facility, a requirement to expand this facility in the future would incur additional resources. Consequently, SNS operations would have an effect on waste management operations at BNL.

5.7.5 No-Action Alternative

The proposed SNS facility would not be constructed, operated, or closed at any location under the No-Action Alternative. Consequently, implementation of this alternative would not contribute to cumulative impacts.

5.8 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

The impact assessment conducted in this FEIS has identified potential adverse impacts along with mitigation measures that could be implemented to either avoid or minimize these effects. The residual adverse impacts are unavoidable and are discussed below.

5.8.1 ORNL Alternative (Preferred Alternative)

The unavoidable adverse environmental impacts that would result from implementation of the proposed action at ORNL are as follows:

- Neutron activation of soils in the berm used to shield the linac tunnel.

- Site runoff and the SNS cooling water collected in the approximately 2-acre (0.81-ha) retention basin would be discharged to White Oak Creek at a point south of Bethel Valley Road. The discharge rate would be 0.36 to 0.50 mgpd (1.36 to 1.9 million lpd), increasing stream velocity and channel erosion in White Oak Creek. Potential changes in water parameters, such as an increase in temperature, would occur. As a result of the increased water flow out of

White Oak Lake, radionuclide releases at White Oak Dam would potentially increase by minimal amounts.

- Potential localized increase in groundwater radionuclide concentrations due to leaching of neutron-activated soil in the shielding berm for the linac tunnel. Exceedance of drinking water limits for a human receptor would be highly unlikely.

- Removal of vegetation, primarily of oak-hickory forest and planted pine stands, from 110 acres (45 ha) of land on the proposed SNS site. Vegetation would also be removed within new utility corridors and rights-of-way. Vegetation would be removed from approximately 20 percent of NERP Natural Area 52.

- A total of 0.23 acres (0.09 ha) of wetland, comprising portions of three separate wetlands, would be destroyed to allow for upgrading of Chestnut Ridge Road, the primary access road to the proposed SNS site. DOE, in consultation with USACOE and the State of Tennessee, would develop a plan to mitigate these effects either by constructing new wetland habitat or by enhancing existing wetland habitats.

- Introduce large-scale development to the undeveloped proposed SNS site, utility corridors, and new rights-of-way.

- Near-term and future adverse effects of emissions from the SNS boiler stacks on CO_2 monitoring under the TDFCMP in the Walker Branch Watershed. The CO_2 output from the proposed SNS would include exhaust emissions from construction equipment and from personal vehicles driven to the site by operations employees beginning in FY 2005. Two ORNL ecological research projects would be adversely affected by these CO_2 emissions. The CO_2 effects could be mitigated, which would result in minimal effects. The effects of NO_x on TDFCMP monitoring would be minimal. After SNS operations begin in late FY 2005, water vapor emitted by the SNS cooling towers may affect TDFCMP monitoring and eight ORNL ecological research projects, including a continuation of some current projects and several planned projects. In all cases, the effects from emissions would be loss of data quality and data comparability over time.

- Approximately 26,516 acres (10,735 ha) of ORR land are open to the public for recreational deer hunting. Construction of the SNS would reduce the total open to the public for recreational deer hunting by 110 acres (45 ha). This restriction would continue during the operational life cycle of the SNS.

- The proposed SNS facilities would come into view along the upper reaches of Chestnut Ridge Road and the southwest access road to the proposed SNS site. During construction these roads would be traveled by DOE and ORNL personnel, construction workers, and service providers. During operations, they would be traveled by DOE personnel, SNS employees, service providers, and visitors to the SNS facilities, including visiting scientists.

- During normal operations, releases of small amounts of radiation from the proposed SNS facility in the form of direct radiation and airborne emissions would be unavoidable. The potential for adverse effects due to these releases is based on the very conservative assumptions used to estimate ingestion dose to the public based on inhalation dose. The highest doses to maximally exposed individuals and populations from airborne emissions would occur during operations at 4 MW. A member of the public could receive a dose of 1.5 mrem/yr, and an uninvolved worker could receive a dose of 0.37 mrem/yr. Based on the assumption that the proposed SNS operates at 1 MW for 10 years and at 4 MW for 30 years, a total of 0.84 LCFs could occur in the off-site population over the entire 40-year life of the facility.

- Construction and operation of the proposed SNS would increase traffic on the roads leading to the proposed SNS site. The resulting increases in traffic congestion and accidents would be unavoidable and could require upgrading the affected roads to accommodate increased traffic and minimize accidents.

5.8.2 LANL ALTERNATIVE

Implementation of the proposed action at LANL would result in the following unavoidable adverse environmental impacts:

- Neutron activation of soils in the berm used to shield the linac tunnel.

- Site runoff and the SNS cooling water collected in the approximate 2-acre (0.81-ha) retention basin would be discharged to intermittent drainages in TA-70. The discharge rate would be 0.36 to 0.50 mgpd (1.36 to 1.9 million lpd), increasing stream velocity and channel erosion in these intermittent streams. Potential changes in water parameters, such as an increase in temperature, would occur when water is present in the streams.

- Potential localized increase in groundwater radionuclide concentrations due to leaching of neutron-activated soil in the shielding berm for the linac tunnel. Groundwater effects would be minimal because of the low soil infiltration rate and great depth [820 ft (250 m)] to the main aquifer.

- Sustained groundwater pumping over 40 years to serve the needs of the proposed SNS facility could lower water levels in area wells and reduce the long-term productivity of the main aquifer that serves the LANL area.

- Removal of vegetation, primarily piñon-juniper woodlands and scattered juniper savannas, from 110 acres (45 ha) of land on the proposed SNS site. Vegetation would also be removed within new utility corridors and rights-of-way.

- Five NRHP-eligible prehistoric archaeological sites within the 65 percent survey area on and adjacent to the SNS site would be destroyed by site preparation activities under the proposed action. In the unsurveyed 35 percent of the proposed SNS site, any prehistoric sites listed on or eligible for listing on the NRHP would also be destroyed during site preparation.

- Thirty-five percent of the proposed SNS site has not been surveyed for historic cultural resources. However, site preparation activities in this area would destroy any historic sites, structures, or features listed on or eligible for listing on the NRHP.

- Five TCPs (all prehistoric archaeological sites in the 65 percent survey area on and adjacent to the SNS site) would be destroyed by site preparation activities under the proposed action. If any prehistoric archaeological sites are located within the unsurveyed 35 percent of the proposed SNS site, these TCPs will also be destroyed by site preparation. The unavoidable adverse impacts on water resources listed in this section would also be unavoidable adverse impacts on TCPs.

- Introduction of large-scale development to the undeveloped proposed SNS site, utility corridors, and new rights-of-way.

- Potential restriction or ending of public hiking trail use near the proposed SNS site in TA-70.

- The proposed action would change views in its vicinity from undeveloped piñon-juniper woodlands to industrial development. During construction and operations, the SNS facilities would be visible to travelers along State Route 4 and the access road to the SNS. These facilities would also be visible from points on the proposed SNS site. During the night hours, facility lighting would be highly noticeable to viewers because no other large, lighted facilities are present in this remote area of LANL. However, the SNS facilities would not be visible from White Rock or popular public use areas in Bandelier National Monument.

- Potable water demand for the proposed SNS facility during operations would exceed the groundwater-based distribution system's capacity by 1.75 mgpd (6.62 million lpd).

- During normal operations, releases of small amounts of radiation from the proposed SNS facility in the form of direct radiation and airborne emissions would be unavoidable. The potential for adverse effects due to these releases is based on the very conservative assumptions used to estimate ingestion dose to the public based on inhalation dose. The highest doses to maximally exposed individuals and populations from airborne emissions would occur during operations at 4 MW. A member of the public could receive a dose of 1.2 mrem/yr, and an uninvolved worker could receive a dose of 0.23 mrem/yr. Based on the assumption that the proposed SNS operates at 1 MW for 10 years and at 4 MW for 30 years, a total of 0.15 LCFs could occur in the off-site population over the entire 40-year life of the facility.

- The proposed SNS site is isolated from the other facilities at LANL and would require a considerable investment in new infrastructure to provide the necessary utilities to the SNS. Moreover, the existing electrical power system at LANL does not have adequate electrical capacity to meet significant future demands such as those required by the proposed SNS. New ways of getting more power to the site would have to be pursued, and there are no pending strategies to do that at this time.

5.8.3 ANL ALTERNATIVE

The unavoidable adverse environmental impacts that would result from implementation of the proposed action at ANL are as follows:

- Neutron activation of soils in the berm used to shield the linac tunnel.
- Site runoff and the SNS cooling water collected in the approximate 2-acre (0.81-ha) sediment retention basin would be discharged to an unnamed tributary of Sawmill Creek. The discharge rate would be 0.36 to 0.50 mgpd (1.36 to 1.9 million lpd), increasing stream velocity and channel erosion in the tributary. Potential changes in water parameters, such as an increase in temperature, would occur.
- Potential localized increase in groundwater radionuclide concentrations due to leaching of neutron-activated soil in the shielding berm for the linac tunnel. A potable groundwater aquifer lies at a depth of 165 ft (50 m). The downward rate of water movement through the saturated zone of the Wadsworth Till is only 3.0 ft/yr (0.9 m/yr). High clay content of the till would retard radionuclide migration, but accurate prediction of migration rates and the potential for aquifer contamination would be difficult because of the complex deposits.
- Construction in small areas on the 100-year floodplains of two unnamed tributaries of Sawmill Creek and Freund Brook. The areas of floodplain that would be affected are, respectively, approximately 5 acres (2 ha) and <1 acre (0.40 ha).
- A total of 3.5 acres (1.4 ha) of wetland habitat would be destroyed to allow construction of the proposed SNS facility. DOE, in consultation with the USACOE and the State of Illinois, would develop a plan to mitigate this effect, either by constructing new wetland habitat or by enhancing existing wetland habitats.
- Removal of vegetation from Ecology Plots 6, 7, and 8 and Open Space land on the proposed SNS site. Vegetation would also be removed within new utility corridors and rights-of-way.
- Introduction of large-scale development to Ecology Plots 6, 7, and 8, Open Space land on the proposed SNS site, utility corridors, and new rights-of-way.
- The proposed SNS site would be located in proximity to the west perimeter fence of ANL. This fence would be adjacent to the Waterfall Glen Nature Preserve. During construction and operations, the SNS facilities would be visible from points near the ANL fence in the preserve, especially on the west side during late autumn, winter, and early spring.
- During normal operations, releases of small amounts of radiation from the proposed SNS facility in the form of direct radiation and airborne emissions would be unavoidable. The potential for adverse effects due to these releases is based on the very conservative assumptions used to estimate ingestion dose to the public based on inhalation dose. The highest doses to maximally exposed individuals and populations from airborne emissions would occur during operations at 4 MW. A member of the public could

receive a dose of 6.8 mrem/yr, and an uninvolved worker could receive a dose of 0.15 mrem/yr. Based on the assumption that the proposed SNS operates at 1 MW for 10 years and at 4 MW for 30 years, a total of 3.1 LCFs could occur in the off-site population over the entire 40-year life of the facility.

- The proposed SNS site is within the 800 Area at ANL, and the footprint for this site would overlay Westgate Road. Approximately 1 mile (1.6 km) of the existing Westgate Road would have to be relocated to replace the existing ANL site access.

5.8.4 BNL ALTERNATIVE

Implementation of the proposed action at BNL would result in the following unavoidable adverse environmental impacts:

- Neutron activation of soils in the berm used to shield the linac tunnel.

- Site runoff and the SNS cooling water collected in the approximate 2-acre (0.81-ha) retention basin would be discharged to the headwaters of the Peconic River. The discharge rate would be 0.36 to 0.50 mgpd (1.36 to 1.9 million lpd), increasing stream velocity and channel erosion in the river. Potential changes in water parameters, such as an increase in temperature, would occur.

- Potential increase in groundwater radionuclide concentrations due to leaching of neutron-activated soil in the shielding berm for the linac tunnel. The sole source aquifer for Long Island would lie only 20 ft (6.1 m) below the proposed SNS site. High permeability of the soils [17 ft/yr (5.2 m/yr)] would allow unacceptably high levels of radionuclides in the aquifer in the immediate vicinity of the proposed SNS site. Exceedance of drinking water limits for a human receptor at an off-site location would be unlikely.

- Removal of vegetation from 110 acres (45 ha) of Open Space land on the proposed SNS site. This vegetation would be primarily oak and pine forest in the Compatible Growth Area of the established Pine Barrens Protection Area. Vegetation would also be removed within new utility corridors and rights-of-way.

- A number of potentially NRHP-eligible earthen features at Stations 2, 4, 8, and 10 on the proposed SNS site may have been associated with World War I trench warfare training at Camp Upton. They would be destroyed by construction activities under the proposed action.

- Introduction of large-scale development to the undeveloped proposed SNS site, utility corridors, and new rights-of-way.

- The proposed action would add the SNS facilities to an existing visual environment indicative of development.

- During normal operations, releases of small amounts of radiation from the proposed SNS facility in the form of direct radiation and airborne emissions would be unavoidable. The potential for adverse effects due to these releases is based on the very conservative assumptions used to estimate ingestion dose to the public based on inhalation dose. The highest doses to maximally exposed individuals and populations from airborne emissions would occur during operations at 4 MW. A member of the public could receive a dose of 2.6 mrem/yr, and an uninvolved worker could receive a dose of 0.13 mrem/yr. Based on the assumption that the proposed SNS operates at 1 MW for 10 years and at 4 MW for 30 years, a total of 2.1 LCFs could occur in the off-site population over the entire 40-year life of the facility.

5.8.5 NO-ACTION ALTERNATIVE

The proposed SNS would not be constructed, operated, or retired at any location under the No-Action Alternative. Consequently, no unavoidable adverse environmental impacts would result from implementation of this alternative.

5.9 SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

The proposed action is projected to last for a minimum period of 40 years on the alternative site selected for construction and operation of the SNS. The effects of this short-term use of the environment and the No-Action Alternative on the long-term productivity of the environment are assessed in this section.

5.9.1 ORNL ALTERNATIVE (PREFERRED ALTERNATIVE)

DOE has no current plans to return the proposed SNS site to environmental conditions approaching those of a greenfield at the end of its operational life cycle, although this option has not been totally eliminated from consideration. If such an option were implemented, the proposed SNS site environment would be available for productive uses commensurate with the cleanup levels achieved during site remediation.

Two possible options for decommissioning of the proposed SNS are being actively considered: in situ decommissioning and limited decontamination combined with in situ decommissioning. As a result, use of the 110-acre (45-ha) SNS site and adjacent land for other productive purposes could be limited for an indeterminate number of years beyond the operational life cycle of the SNS. The proposed SNS site represents less than one half percent of the total forested area on the ORR.

Impacts would occur on the development of groundwater in the immediate vicinity of the SNS site due to the release of radionuclides. The impact on groundwater productivity would be localized and insignificant in terms of unaffected groundwater resources within the surrounding watershed that would be available for development.

5.9.2 LANL ALTERNATIVE

The primary source of potable water for LANL and the Los Alamos area is a groundwater aquifer. This aquifer is not officially designated as a sole source aquifer, but it essentially functions as one. Operation of the proposed SNS would require 1.2 to 2.3 mgpd (4.5 million lpd) of groundwater from this aquifer. If the continuous daily demand for SNS operations were only half of what would actually be required to operate the proposed 4-MW SNS facility, pumping of water from the main aquifer would have to increase by 25 percent to meet this demand. Sustained pumping at this magnitude over much of the minimum 40-year operational life cycle of the proposed SNS facility could lower water levels in nearby wells and ultimately affect the long-term productivity of the main aquifer. Lower water levels would occur if water withdrawal rates from the main aquifer exceed natural recharge in the arid climate of the Los Alamos area. This possibility would place water demands for the proposed SNS facility in competition with future growth demands by commercial, industrial, and residential users. These potential limitations on aquifer productivity could persist for an indeterminate period beyond the operational life cycle of the proposed SNS.

Impacts would occur on the development of groundwater in the immediate vicinity of the SNS site due to the release of radionuclides. The impact on groundwater productivity would be localized and insignificant in terms of unaffected groundwater resources within the surrounding watershed that would be available for development.

DOE has no current plans to return the proposed SNS site to environmental conditions approaching those of a greenfield at the end of its operational life cycle, although this option has not been totally eliminated from consideration. If such an option were implemented, the proposed SNS site environment would be available for productive uses commensurate with the cleanup levels achieved during site remediation.

Two possible options for decommissioning of the proposed SNS are being actively considered: in situ decommissioning and limited decontamination combined with in situ decommissioning. As a result, use of the 110-acre (45-ha) SNS site and adjacent land for other productive purposes could be limited for an indeterminate number of years beyond the operational life cycle of the SNS. The proposed SNS site represents approximately 10 percent of the piñon-juniper habitat in TA-70.

5.9.3 ANL Alternative

DOE has no current plans to return the proposed SNS site to environmental conditions approaching those of a greenfield at the end of its operational life cycle, although this option has not been totally eliminated from consideration. If such an option were implemented, the proposed SNS site environment would be available for productive uses commensurate with the cleanup levels achieved during site remediation.

Two possible options for decommissioning of the proposed SNS are being actively considered: in situ decommissioning and limited decontamination combined with in situ decommissioning. As a result, use of the 110-acre (45-ha) SNS site and adjacent land for other productive purposes could be limited for an indeterminate number of years beyond the operational life cycle of the SNS.

Impacts would occur on the development of groundwater in the immediate vicinity of the SNS site due to the release of radionuclides. The impact on groundwater productivity would be localized and insignificant in terms of unaffected groundwater resources within the surrounding watershed that would be available for development.

5.9.4 BNL Alternative

Operation of the proposed SNS facility would result in some neutron activation of the soils in the linac berm, even with specially engineered, multilayer shielding. The minimal ability of proposed SNS site soils to retard the transport of contaminants in groundwater and their high permeability would allow for the leaching of contaminated soils and rapid migration of radionuclides to the sole source aquifer that lies only 20 ft (6.1 m) beneath the proposed SNS site. Radionuclide accumulations in this aquifer could reach unacceptable levels, although contaminant migration to off-site locations in concentrations of concern to local drinking water quality would be improbable.

Impacts would occur on the development of groundwater in the immediate vicinity of the SNS site due to the release of radionuclides. The impact on groundwater productivity would be localized and insignificant in terms of unaffected groundwater resources within the surrounding watershed that would be available for development.

DOE has no current plans to return the proposed SNS site to environmental conditions approaching those of a greenfield at the end of its operational life cycle, although this option has not been totally eliminated from consideration. If such an option were implemented, the proposed SNS site environment would be available for productive uses commensurate with the cleanup levels achieved during site remediation.

Two possible options for retirement of the proposed SNS facility are being actively considered: in situ decommissioning and limited decontamination combined with in situ decommissioning. As a result, use of the 110-acre (45-ha) SNS site and adjacent land for other productive purposes could be limited for an indeterminate number of years beyond the operational life cycle of the SNS. The proposed site lies within the Pine Barrens area of Long Island. The 110 acres (45-ha) represent less than two percent of the Pine Barrens Protection Area. The proposed SNS would be constructed entirely within the Compatible Growth Area of the Pine Barrens, not within the more stringently Protected Core Preservation Area (refer to Section 4.4.8.4).

5.9.5 No-Action Alternative

The proposed SNS facility would not be constructed, operated, or closed at any location under the No-Action Alternative. No short-term use of the environment would occur under this alternative. Consequently, such use would have no effect on the long-term productivity of the environment.

5.10 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The irreversible and irretrievable commitment of resources associated with the proposed action (SNS siting alternatives) and the No-Action Alternative are presented in Table 5.10-1.

Table 5.10-1. Irreversible and/or irretrievable commitment of resources (proposed SNS facility at 1 MW for 40 years).

Factor	No-Action	ORNL Alternative	LANL Alternative	ANL Alternative	BNL Alternative
Land use					
Land (ac)	0	110	110	110	110
Forested (ac)	0	75±	50±	50±	75±
Construction					
Concrete (yd^3)	0	50,000	50,000	50,000	50,000
Steel Shielding (tons)	0	4,000	4,000	4,000	4,000
Utilities					
Electricity[a] (gWh)	0	10,183	10,183	10,183	10,183
Water[b] (gals)	0	9.4E+09	9.4E+09	9.4E+09	9.4E+09
Steam[c] (lb)	0	0	4.8E+09	4.8E+09	0
Natural Gas (bcf)[d]	0	1.73	NA	NA	2.67
Workforce					
Direct (persons)	0	275	275	275	275
Indirect	0	1,314	1,314	1,314	1,314
Construction	0	2,349	2,349	2,349	2,349

[a] Assume full power for 240 days/yr for 40 yrs at 85%.
[b] Assume continuous 800 gpm (3,028 lpm) use for 240 days/yr for 40 yrs at 85%.
[c] Energy required to produce steam based on APS usage at ANL, adjusted for degree days.
[d] Billion cubic feet - based on 23.565 mcf/hr at ORNL in January, adjusted for degree days.
NA - Not available.

5.11 MITIGATION MEASURES AND MONITORING PLAN

One of the major functions of an EIS is to specify measures that could be taken to mitigate adverse environmental impacts identified through the impact analysis. Mitigation measures may be classified according to three basic categories: (1) measures required by law or regulations; (2) measures that are built into a project from the start to avoid effects; and (3) measures that are developed in response to adverse impacts identified in the environmental impact analyses.

This section summarizes the mitigation measures that may be applied to potential effects associated with each of the alternatives analyzed in this FEIS. Mitigation measures required by law or regulation are not discussed in this section. The applicable laws and regulations that embody such requirements are described in Chapter 6. Also, routine mitigation measures that would be implemented as part of standard practices for construction or operation are not included in the summary. These measures would include practices such as installing silt fences to minimize soil erosion and sediment transport during construction.

When necessary, DOE would implement mitigation measures to minimize the impacts caused by construction and operation of the SNS. DOE would prepare a MAP that will address mitigation commitments expressed in the ROD. The MAP would present details concerning the planning and implementation of the mitigation measures designed to lessen the impacts associated with the proposed action. DOE would complete the MAP before taking any action directed by the ROD that is subject to a mitigation commitment.

5.11.1 ORNL ALTERNATIVE (PREFERRED ALTERNATIVE)

Measure designed to avoid adverse environmental impacts that would result from implementing the proposed action on the SNS site at ORNL would be incorporated in SNS construction. DOE is committed to implementation of the following avoidance measures:

- A retention basin (approximately 2 acres or 0.81 ha) would be constructed to collect surface water runoff from the proposed SNS site. It would be used to settle sediment particles entrapped in the runoff and to control the rate of water discharge from the basin into White Oak Creek. As a result, effects on stream characteristics and flow, water quality, and aquatic resources downstream from the outfall into White Oak Creek would be minimized.

- Water from the cooling towers would be temporarily collected in the retention basin. The basin would be committed to lowering the temperature of the cooling water prior to its discharge into White Oak Creek. This reduction would minimize the potential effects of elevated water temperatures on the ambient temperature of the creek and temperature-sensitive aquatic resources.

- The cooling water effluent from the proposed SNS facility would be dechlorinated prior to discharge into the retention basin to minimize effects on aquatic resources downstream from the outfall to White Oak Creek.

- The discharge from the retention basin would be routed by pipeline to a White Oak Creek outfall point south of Bethel Valley Road. This pipeline would avoid effects on baseline NPDES monitoring activities, including the ORNL Biological Monitoring and Abatement Program (BMAP), and other ORNL research activities involving the headwaters of White Oak Creek.

- The shielding design of the proposed SNS facility would be modified to minimize neutron activation of the linac berm soils, leaching of radionuclides by groundwater, and subsurface migration of radionuclide contamination. This design would include a crushed limestone interval covered by a geomembrane liner to protect the groundwater and inhibit its flow.

- A continuously forested pathway would be retained along Chestnut Ridge during vegetation clearing to minimize effects on terrestrial wildlife movements.

- A 100- to 200-ft (34- to 68-m) buffer zone of uncleared vegetation would be retained along the headwaters of White Oak Creek near the proposed SNS site to minimize the effects of solar radiation on water temperature and cool water aquatic resources (for example, fish species such as the banded sculpin and blacknose dace).

A number of measures would be taken to mitigate adverse environmental impacts that would result from implementing the proposed action on the SNS site at ORNL. DOE is committed to implementation of the following mitigation measures:

- The effects of elevated continuous noise from the cooling towers and other sources on SNS site personnel and visitors would be minimized with landscape barriers to the extent possible. Such barriers would include the use of trees as sound baffles.

- A small area of wetlands [0.23 acres (0.09 ha)] would be eliminated for the upgrade of Chestnut Ridge Road and areas of other wetlands may be indirectly affected during construction and operation of the proposed SNS. Effects of the proposed action on wetlands would be mitigated by implementing measures to prevent their damage, repair unpreventable damage, or replace eliminated wetlands with an equal or greater amount of man-made wetlands. These man-made wetlands would be as much like the original wetlands as possible and would be placed onsite or in the same watershed. Such mitigative actions would meet the current federal policy calling for no net loss of wetlands as a result of U.S. government activities.

- Appropriate measures would be implemented to protect identified specimens of pink lady's slipper and American ginseng during implementation of the proposed action. On a case-by-case basis, appropriate measures would be taken to protect any other specimens of threatened and endangered species identified during a systematic biological survey of the proposed SNS site that would occur prior to implementation of the proposed action.

- Traffic impacts would be mitigated by improvements to eastbound segments of Bethel Valley Road and southbound segments of State Road 62.

- If radioactive mixed waste generated by the SNS were to exceed the capacity of current storage facilities at ORNL, mitigation measures would have to be taken. Increasing the RCRA-permitted storage capacity at the laboratory would mitigate this.

DOE is considering the following mitigation measures at ORNL but has not yet committed to their implementation:

- Emissions of CO_2 during construction and operation of the SNS would affect TDFCMP measurements by NOAA/ATDD and susceptible ORNL-ESD ecological research projects in the Walker Branch Watershed. The TDFCMP monitoring and ecological research projects may also be affected by water vapor emissions from the cooling towers at the proposed SNS. These effects could be mitigated by relocating the NOAA/ATDD meteorological monitoring tower to a Walker Branch Watershed location less susceptible to the effects of the CO_2 emissions or by building a new tower at this different location.

- Emissions of CO_2 from natural gas boiler stacks during operation of the SNS would affect TDFCMP measurements and susceptible ORNL-ESD ecological research projects in the Walker Branch Watershed. These effects could be mitigated by installing electric heat pumps in the SNS heating system instead of natural gas boilers. This would eliminate CO_2 emissions from the heating system.

The prevention of future impacts after implementation of the proposed action on the SNS site at ORNL would be dependent upon plans for monitoring of the environment. DOE is committed to implementation of the following environmental monitoring measures:

- The groundwater at the proposed SNS site would be routinely monitored for radionuclide contamination.

- Emissions of airborne radioactivity and direct radiation would be routinely monitored throughout the life of the facility. Data gathered over approximately 10 years of operation at 1 MW would be used to evaluate and modify design and operating procedures, as necessary, prior to operation at 4 MW.

5.11.2 LANL ALTERNATIVE

Measures designed to avoid adverse environmental impacts that would result from implementing the proposed action on the SNS site at LANL would be incorporated into SNS construction. DOE is committed to implementation of the following avoidance measures:

- The shielding design of the proposed SNS would be modified to minimize neutron activation of the linac berm soils, leaching of radionuclides by groundwater, and subsurface migration of the radionuclide contamination. This design would include a crushed limestone interval covered by a geomembrane liner to protect the groundwater and inhibit its flow.

A number of measures would be taken to mitigate adverse environmental impacts that would result from implementing the proposed action on the SNS site at LANL. DOE is committed to implementation of the following mitigation measures:

- The effects of elevated continuous noise from the cooling towers and other sources on SNS site personnel and visitors would be minimized with landscape barriers to the extent possible.

- Appropriate measures would be taken on a case-by-case basis to protect specimens of threatened and endangered (T&E) species identified during a systematic biological survey of the proposed SNS site that would occur prior to implementation of the proposed action.

- Five prehistoric archaeological sites, all eligible for listing on the NRHP, are located on the proposed SNS site. In addition, these sites would be considered to be TCPs by local tribal groups. These sites are within the 65 percent of the proposed SNS site that has been surveyed for cultural resources. These sites would be destroyed during construction of the proposed SNS. This destruction would be mitigated through data recovery operations, consisting primarily of archaeological excavations and detailed architectural recording of the prehistoric structures at the five sites. The remaining 35 percent of the proposed SNS site and a 100-ft (30.5-m) buffer zone around it would be surveyed for cultural resources prior to implementation of the proposed action, if the site at LANL were selected for construction of the proposed SNS facility. Any NRHP-eligible prehistoric or historic cultural resources identified in this area would be subject to the same types of mitigation measures or other more appropriate measures determined on a case-by-case basis.

- DOE-AL has not consulted with Native American and Hispanic groups about the occurrence of other specific TCPs on the proposed SNS site or in its vicinity at LANL. If this site were chosen for construction of the proposed SNS facility, these consultations would be made prior to implementation of the proposed action. Appropriate measures to mitigate effects on any TCPs that may be identified through these consultations would be implemented on a case-by-case basis.

- The solid LLW generated by the SNS would cause a minimal effect on LANL's waste treatment facilities. Alternative treatment methods would have to be considered.

- The sanitary waste generated by the SNS would cause a minimal effect on LANL's waste treatment and disposal capabilities. Alternative treatment and disposal methods would have to be found.

DOE is considering the following mitigation measures at LANL but has not yet committed to their implementation:

- Construction of a dry cooling tower to recycle process water used at the site in an effort to reduce aquifer drawdown.

- Construction of new utility infrastructure would be necessary to support the electrical power demands of the SNS. Additionally, it would be necessary to pursue several regional and multistate strategies to provide a 62-MW supply. These include a new regional (multistate) power grid configuration or possibly an SNS site-specific power generation station.

The prevention of future impacts after implementation of the proposed action on the SNS site at LANL would be dependent upon plans for monitoring of the environment. DOE is committed to implementation of the following environmental monitoring measures:

- Emissions of airborne radioactivity and direct radiation would be routinely monitored throughout the life of the facility. Data gathered over approximately 10 years of operation at 1 MW would be used to evaluate and modify design and operating procedures, as necessary, prior to operation at 4 MW.

5.11.3 ANL ALTERNATIVE

Measures designed to avoid adverse environmental impacts that would result from implementing the proposed action on the SNS site at ANL would be incorporated into SNS construction. DOE is committed to implementation of the following avoidance measures:

- The eastern edge of the proposed SNS site in ANL overlies a portion of the 100-year floodplain along an unnamed tributary of Sawmill Creek. The eastern edge of the proposed SNS site at ANL would overlie a portion of the 100-year floodplain along an unnamed tributary of Sawmill Creek. In addition, the southern tip of the site would encroach on the 100-year floodplain along an unnamed tributary of Freund Brook. Potential effects from flooding would be mitigated in several ways, including filling and stabilization of those portions of the floodplains required for buildings and related structures, alteration of drainage patterns, construction of drainage features (storm drains and canals), and optimizing the placement of buildings and the retention basin to avoid floodplains. With regard to the unnamed tributary of Sawmill Creek, the retention basin would be sized to contain a 100-year flood, replace lost capacity to control floodwater due to disruption of the floodplain, and control runoff to the tributary.

- A retention basin (approximately 2 acres or 0.81 ha) would be constructed to collect surface water runoff from the proposed SNS site. It would be used to settle sediment particles entrapped in the runoff and to control the rate of water discharge from the basin into a small tributary of Sawmill Creek. As a result, effects on stream characteristics and flow, water quality, and aquatic resources downstream from the outfall would be minimized.

- Water from the cooling towers would be temporarily collected in the retention basin. The basin would be committed to lowering the temperature of the cooling water prior to its discharge into the tributary of Sawmill Creek. This reduction would minimize the potential effects of elevated water temperatures on the ambient temperature of the creek and aquatic resources.

- The shielding design of the proposed SNS facility would be modified to minimize neutron activation of the linac berm soils, leaching of radionuclides by groundwater, and subsurface migration of the radionuclide contamination. This design would include a crushed limestone interval covered by a geomembrane liner to protect the groundwater and inhibit its flow.

- A 100 to 200-ft (30 to 68-m) buffer zone of uncleared vegetation would be retained around Freund Brook to minimize surface water runoff and the effects of sediment loading on bottom-dwelling fauna.

A number of measures would be taken to mitigate adverse environmental impacts that would result from implementing the proposed action on the SNS site at ANL. DOE is committed to implementation of the following mitigation measures:

- The effects of elevated continuous noise from the cooling towers and other sources on SNS site personnel and visitors would be minimized with landscape barriers to the extent possible. Such barriers would include the use of trees as sound baffles.

- Approximately 3.5 acres (1.4 ha) of wetlands would be eliminated during construction of the proposed SNS. These wetlands are located on the proposed SNS site in ANL. Additional wetlands in the vicinity of the proposed SNS site would be temporarily affected during construction. These effects would be mitigated by implementing measures to prevent their damage, repair unpreventable damage, or replace eliminated wetlands with an equal or greater amount of man-made wetlands.

These man-made wetlands would be as much like the original wetlands as possible. Such mitigative actions would meet the current federal policy calling for no net loss of wetlands as a result of U.S. government activities.

- Appropriate measures would be taken on a case-by-case basis to protect specimens of threatened and endangered species identified during a systematic biological survey of the proposed SNS site that would occur prior to implementation of the proposed action.

- The eligibility of 11DU207 for listing on the NRHP has not been assessed by ANL. If the proposed SNS site at ANL were chosen for construction of the SNS, this assessment would be made prior to the initiation of construction-related activities on the site. If the assessment indicates that 11DU207 is an NRHP-eligible cultural resource, appropriate measures would be implemented to mitigate effects from the proposed SNS facility. These measures would include avoidance, if possible, or archaeological excavation.

- The remaining support services operations in the 800 Area would be displaced by construction of the proposed SNS. This land use effect would be mitigated by transferring these operations to another area of ANL.

- The footprint for the SNS overlays Westgate Road. Approximately 1 mile (1.6 km) of this road would be relocated to the north to circumvent the proposed SNS site and replace the existing Westgate Road access.

The prevention of future impacts after implementation of the proposed action on the SNS site at ANL would be dependent upon plans for monitoring of the environment. DOE is committed to implementation of the following environmental monitoring measures:

- The groundwater at the proposed SNS site would be routinely monitored for radionuclide contamination.

- Emissions of airborne radioactivity and direct radiation would be routinely monitored throughout the life of the facility. Data gathered over approximately 10 years of operation at 1 MW would be used to evaluate and modify design and operating procedures, as necessary, prior to operation at 4 MW.

5.11.4 BNL ALTERNATIVE

Measures designed to avoid adverse environmental impacts that would result from implementing the proposed action on the SNS site at BNL would be incorporated into SNS construction. DOE is committed to implementation of the following avoidance measures:

- A retention basin (approximately 2 acres or 0.81 ha) would be constructed to collect surface water runoff from the proposed SNS site. It would be used to settle sediment particles entrapped in the runoff and to control the rate of water discharge from the basin into the Peconic River. As a result, effects on stream characteristics and flow, water quality, and aquatic resources downstream from the outfall into the river would be minimized.

- Water from the cooling towers would be temporarily collected in the retention basin. The basin would be committed to lowering the temperature of the cooling water prior to its discharge into the Peconic River. This reduction would minimize the potential effects of elevated water temperatures on the ambient temperature of the creek and temperature-sensitive aquatic resources.

- The cooling water effluent from the proposed SNS facility would be dechlorinated prior to discharge into the retention basin to minimize effects on aquatic resources downstream from the discharge outfall to the Peconic River.

- The discharge from the retention basin would be routed by pipeline to an outfall point on the Peconic River. This outfall would be located near the current outfall for the STP. Routing the discharge to this location would avoid effects on wetlands located upstream from the outfall.

- A minimum 300-ft (91-m) buffer zone of uncleared vegetation would be retained between the proposed SNS site and the Peconic River to minimize surface water runoff, sediment loading, and effects on aquatic resources.

A number of measures would be taken to mitigate adverse environmental impacts that would result from implementing the proposed action on the SNS site at BNL. DOE is committed to implementation of the following mitigation measures:

- The effects of elevated continuous noise from the cooling towers and other sources on SNS site personnel and visitors would be minimized with landscape barriers to the extent possible. Such barriers would include the use of trees as sound baffles.

- Appropriate measures would be implemented to protect identified specimens of spotted wintergreen, bayberry, and swamp azalea (state-protected species) during implementation of the proposed action. On a case-by-case basis, appropriate measures would be taken to protect any specimens of threatened and endangered species identified during a systematic biological survey of the proposed SNS site that would occur prior to implementation of the proposed action.

- A number of earthen features at Stations 2, 4, 8, and 10 on the proposed SNS site at BNL may have been used for World War I trench warfare training at Camp Upton. These features are potentially eligible for listing on the NRHP. They would be destroyed during construction of the proposed SNS facility. This effect would be mitigated through data recovery, which would consist of archaeological excavation.

- Hazardous waste generated by the proposed SNS facility would exceed the capacity of current RCRA storage facilities at BNL. This exceedance would be mitigated by increasing the permitted storage capacity for hazardous waste at the laboratory.

- Solid and liquid low-level radioactive waste generated by the proposed SNS facility would exceed the capacity of current storage facilities at BNL. This would be mitigated by increasing the permitted storage capacity for these wastes at the laboratory.

- Mixed waste generated by the proposed SNS facility would exceed the capacity of current RCRA storage facilities at BNL. This would be mitigated by increasing the permitted storage capacity for mixed waste at the laboratory.

- The liquid and solid hazardous wastes generated by the SNS would exceed BNL's current storage capacity. Storage facility capabilities must be expanded to increase RCRA-permitted storage capacity to accommodate the storage of these future wastes.

- The liquid and solid low-level radioactive wastes generated by the SNS would exceed BNL's current storage capacity. Storage facility capabilities must be expanded to increase RCRA-permitted storage capacity to accommodate the storage of these future wastes.

- The liquid and solid mixed wastes generated by the SNS would exceed BNL's current storage capacity. Storage facility capabilities must be expanded to increase RCRA-permitted storage capacity to accommodate the storage of these future wastes.

DOE is considering the following mitigation measures at BNL but has not yet committed to their implementations:

- The constructed proposed SNS facility at BNL would sit only 20 ft (6.1 m) above the sole source aquifer for Long Island. The sandy soils on the proposed SNS site are highly permeable, forming a rapid vertical migration route from a contaminated area of soil to the aquifer. Because of the potential for neutron activation of linac berm soil during SNS operations, a complex multilayer shielding design would be implemented on the proposed SNS site. This shielding would minimize neutron activation of the berm soils, leaching of radionuclides by groundwater, and subsurface migration of the radionuclide contamination.

The prevention of future impacts after implementation of the proposed action on the SNS site at BNL would be dependent upon plans for monitoring of the environment. DOE is committed to implementation of the following environmental monitoring measures:

- The groundwater at the proposed SNS site would be routinely monitored for radionuclide contamination.

- Emissions of airborne radioactivity and direct radiation would be routinely monitored throughout the life of the facility. Data gathered over approximately 10 years of operation at 1 MW would be used to evaluate and modify design and operating procedures, as necessary, prior to operation at 4 MW.

5.11.5 NO-ACTION ALTERNATIVE

The proposed SNS facility would not be constructed or operated at any location under the No-Action Alternative. Consequently, no environmental effects would occur as a result of this alternative, and no mitigation measures would be required.

CHAPTER 6: PERMITS AND CONSULTATIONS

The major laws, regulations, executive orders, and Department of Energy (DOE) orders that would apply to the proposed action are discussed in this chapter. This discussion includes the federal and state environmental permits required to construct and operate the proposed Spallation Neutron Source (SNS). In addition, it describes the consultations and actions required to protect cultural resources, endangered species, and migratory birds located on and in the vicinity of the alternative proposed SNS sites.

6.1 FEDERAL AND STATE REQUIREMENTS

The federal laws, executive orders, and state environmental laws that would be applicable to construction and operation of the proposed SNS are described in this section, along with the regulations that are used to implement the laws. The laws are presented according to whether they were passed by the U.S. Congress (federal) or the state legislatures in Tennessee, New Mexico, Illinois, or New York. The executive orders are all federal requirements issued by the President of the United States.

All of these requirements are presented in short tables under major subject headings, such as air quality, water quality, and waste management. The names of the laws and the formal numerical designations for the executive orders are presented in the second column. The third column contains the locations of the laws in the federal and state statutory codes. All of the indicated laws are considered to include subsequent amendments to them. The titles of the executive orders are also presented in this column. The fourth column contains the beginning citation numbers or a citation number range for the regulations that were developed to implement the laws.

The tables are followed by brief descriptions of the laws, executive orders, and regulations. Although some state environmental laws and regulations can be more stringent than their federal counterparts, their contents, especially at the regulatory level, must be at least as rigorous as the federal requirements. As a result, their content is mostly federal in origin. For this reason, the laws and regulations in this section are largely described at the federal level.

Many of the environmental laws and regulations require permits for performing certain activities that could be harmful to the environment. In addition, some require formal consultations with state and federal agencies about the potential effects of proposed actions on particular aspects of the environment. The permitting and consultation requirements applicable to the proposed action being assessed in this environmental impact statement (FEIS) are included within the descriptions of the laws that mandate them. The required permits and consultations are summarized in Table 6.1-1.

The Environmental Protection Agency (EPA) has primary, umbrella responsibility for enforcement of the environmental laws and regulations that apply to the proposed action, but other federal agencies such as the U.S. Army Corps of Engineers (USACOE) and the U.S. Fish and Wildlife Service (USFWS) are charged with consultation, permitting, or enforcement responsibilities that apply to specific aspects of the proposed action. The federal regulations

Table 6.1-1. Environmental permit and consultation requirements.

Activity/ Subject	Law	Requirements	Agency
Site Preparation	Clean Water Act (Section 404)	Section 404 Permit; State Aquatic Resource Alteration Permit (wetlands filling and stream alteration)	USACOE, TDEC, NMED, IEPA, NYSDEC
Stormwater Discharges	Clean Water Act	NPDES General Permit for Construction Activity; NPDES General Permit for Industrial Storm Water	EPA Region VI, TDEC, IEPA, NYSDEC
Wastewater Discharges	Clean Water Act	NPDES Permit for Industrial Activity (cooling water; groundwater interceptor system water)	EPA Region VI
Nonradioactive Air Emissions	Clean Air Act	Permits to construct new emissions sources; operating permits (natural gas boiler vents; laboratory hood vents; concrete batch plant)	TDEC, NMED, IEPA, NYSDEC
Radioactive Air Emissions	Clean Air Act	Permit to construct new emissions sources; NESHAP permit (Target Building and tunnel vent system stacks)	EPA Regions II, V, and VI; TDEC
Structures over 200 ft (61 m) in height	Federal Aviation Act	Permit for structures over 200 ft (61 m) in height (construction cranes, water tower)	FAA
Cultural Resources	Archaeological Resource Protection Act	Excavation or removal permit data recovery at LANL or BNL	DOE
	National Historic Preservation Act	Section 106 consultation	SHPO
Endangered Species	Endangered Species Act	Consultation	USFWS
Migratory Birds	Migratory Bird Treaty Act	Consultation	USFWS

FAA - Federal Aviation Administration; TDEC – Tennessee Department of Environment and Conservation; NMED – New Mexico Environment Department; IEPA – Illinois Environmental Protection Agency; NYSDEC – New York State Department of Environmental Conservation; SHPO - State Historic Preservation Officer.

relating to worker safety are enforced by the Occupational Safety and Health Administration (OSHA). Other requirements potentially applicable to the proposed action are administered by the Federal Aviation Administration (FAA).

The EPA has delegated most of its authority to enforce regulations to the states, although authority for some regulatory areas in some states is retained by the agency. Most of the state enforcement authority is lodged with the primary state environmental regulatory agencies. In Tennessee, New Mexico, Illinois, and New

York, these agencies are, respectively, the Tennessee Department of Environment and Conservation (TDEC), New Mexico Environment Department (NMED), Illinois Environmental Protection Agency (IEPA), and New York State Department of Environmental Conservation (NYSDEC). Some enforcement authority, especially with regard to public water supplies and sanitary waste, is lodged with the state and local health departments.

6.1.1 AIR QUALITY

Jurisdiction	Statute	Citation: Statutes	Citation: Regulations
Federal	Clean Water Act	33 USC 1251 et seq.	40 CFR 110-136, 433-459
Tennessee	Tennessee Water Quality Control Act	TCA 69-3-101 et seq.	TCRR 1200-4-1 to 5, 7, 10-11
New Mexico	New Mexico Water Quality Control Act	NMSA 1978, Sections 74-6-4 et seq.	20 NMAC 6.1
Illinois	Environmental Protection Act	415 ILCS 5/11-13	35 Ill. Adm. Code 301
New York	New York State Environmental Conservation Law	Article 17	6 NYCRR 700-758

The Clean Air Act (CAA) is intended to protect and enhance the quality of the nation's air resources. Section 118 of the CAA places requirements on each federal agency that has jurisdiction over properties and facilities that might result in the discharge of air pollutants. Under this section, the agency must comply with all federal, state, interstate, and local requirements with regard to the control and abatement of air pollution.

This law requires the EPA to establish National Ambient Air Quality Standards (NAAQS), as necessary, to protect public health from any known or anticipated adverse effects of a regulated pollutant (42 USC 7409), while allowing an adequate margin of safety. It also requires the establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 USC 7411) and requires the evaluation of specific emission increases to prevent a significant deterioration in air quality (42 USC 7470). Hazardous air pollutants, including radionuclides, are regulated separately (42 USC 7412). Air emissions are regulated by the EPA in 40 CFR 50 through 99. In particular, radionuclide emissions are regulated under the National Emission Standards for Hazardous Air Pollutants (NESHAP) program (see 40 CFR 61).

The EPA has overall regulatory authority under the CAA, but this authority has been delegated to states that have established air pollution control programs approved by EPA. The state environmental regulatory agencies in Tennessee, New Mexico, Illinois, and New York have approved air programs. However, this approval does not extend to all the air regulations applicable to the national laboratories.

The EPA has retained regulatory authority over the new emission source performance standards (40 CFR 60, Subpart Db) in New York. In addition, EPA has retained regulatory authority over the NESHAP for radionuclides in New Mexico, Illinois, and New York. In Tennessee, EPA has delegated this authority to the Tennessee Department of Environment and Conservation (TDEC). Furthermore, in Tennessee and New Mexico, EPA has retained regulatory authority relating to the stratospheric ozone protection provisions in Title VI of the CAA amendments of 1990.

Permits to construct and operate new air emissions sources would be required for new nonradiological sources used during construction and operation of the proposed SNS. These new sources would potentially include the vents for seven natural gas boilers in the building heating system, laboratory hood vents (nonradioactive use), and a concrete batch plant. These permits would contain operating conditions and emissions limitations for air pollutants.

Permits for construction of new radioactive emission sources and NESHAP permits for radionuclide emissions would be required for the target building and the linac tunnel ventilation stacks at the proposed SNS. In addition, such permits would be required for any laboratory hood vents that have the potential to emit radionuclides to the atmosphere during operation of the proposed SNS. As described in 40 CFR 61.96, if the effective dose equivalent caused by all emissions from facility operations is projected to be greater than one percent of the 10 mrem per year NESHAP standard, an application for approval to construct under 40 CFR 61.07 would have to be filed. With prior EPA approval, 40 CFR 61.96 allows DOE to use methods other than the standard EPA methods for estimating the radionuclide source terms used in calculating the projected dose. The current annual NESHAP report for the site selected in the Record of Decision for construction of the SNS would be modified to include radioactive emissions from the SNS.

6.1.2 WATER QUALITY

		Citation	
Jurisdiction	Statute	Statutes	Regulations
Federal	Clean Air Act	42 USC 7401 et seq.	40 CFR 50-99
Tennessee	Tennessee Air Quality Act	TCA 53-3408 et seq.	TCRR 1200-3
New Mexico	New Mexico Air Quality Control Act	NMSA 1978, Sections 74-1-1 et seq.	20 NMAC 2.1
Illinois	Environmental Protection Act	415 ILCS 5/10, 27, 39, and 39.5	35 Ill. Adm. Code 201
New York	New York State Environmental Conservation Law	Article 19	6 NYCRR 200 and 380

The Clean Water Act (CWA) was enacted to restore and maintain the chemical, physical, and biological integrity of the nation's water. It prohibits the discharge of toxic pollutants in toxic amounts to navigable waters of the United States. (Section 101). Section 313 of the CWA requires all branches of the federal government engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with federal, state, interstate, and local requirements. In addition to setting water quality standards for the nation's waterways, the CWA sets guidelines and limitations (Sections 301–303) for effluent discharges from point sources and provides authority (Sections 401–402) for the EPA to implement the National Pollutant Discharge Elimination System (NPDES) permitting program under 40 CFR 122.

The EPA has delegated primary enforcement authority for the CWA and the NPDES permitting program to the state environmental regulatory agencies in Tennessee, Illinois, and New York. In New Mexico, EPA has not delegated full CWA enforcement authority to the state environmental regulatory agency. The NPDES permits for the Los Alamos National Laboratory (LANL) are issued by EPA Region VI in Dallas, Texas. However, NMED does perform limited compliance auditing and monitoring at LANL through a Section 106 water quality agreement with EPA.

The foregoing state and federal agencies have issued NPDES permits covering current industrial wastewater discharges at Oak Ridge National Laboratory (ORNL), LANL, Argonne National Laboratory (ANL), and Brookhaven National Laboratory (BNL). These permits establish effluent limitations for specific chemical pollutants, limitations on physical parameters such as water temperature and flow, and monitoring requirements. The cooling water discharge from the proposed SNS would need to be included under the laboratory NPDES permit for discharges associated with industrial activities.

Process wastewater from the proposed SNS would be treated in on-site waste treatment facilities, and the effluent from the treatment process would be discharged to surface waters. The Atomic Energy Act of 1954 (AEA) regulates the discharge to surface waters of radionuclides from source, by-product, and special nuclear materials. However, the proposed SNS is an accelerator facility, and the discharge of accelerator-produced radionuclides to surface waters is not regulated under this statute. These discharges are regulated by EPA [CWA (40 CFR 122) and NPDES program] or authorized state programs under the CWA. The proposed SNS wastewater containing accelerator-produced radionuclides would be treated in facilities that also treat radionuclides from source, by-product, or special nuclear materials, such as reactor waste. At the outfalls for these treatment facilities, it would be impossible to determine whether a particular radionuclide in the discharge came from an accelerator or a reactor, which raises the issue of whether the discharge would be regulated under the AEA or the CWA. A possible approach would be to comply with the more restrictive discharge limits under the CWA, which are administered by EPA and the states.

There is no limit on the quantity or concentrations of radionuclides that can be discharged to surface waters under the current AEA requirements, as long as it can be shown that such discharges do not result in radiation doses in excess of established limits. The CWA and state rules establish limits on concentrations of radionuclides in effluents discharged to unrestricted areas and quantity limits on discharges to certain types of systems, such as sanitary sewer systems. However, DOE and ORNL have historically questioned the State of Tennessee's authority to regulate AEA-exempt radionuclide discharges to surface waters. This approach to compliance with respect to the proposed SNS waste treatment discharges would bring this controversy into sharper focus at ORNL and potentially at the other three national laboratories (DeVore 1997:1).

Another approach to this regulatory issue would be to proceed with compliance under a radionuclide-by-radionuclide scenario. Radionuclides from source, by-product, and special nuclear materials (for example, ^{137}Cs and ^{90}Sr) would be regulated under the AEA discharge rules. Accelerator-produced radionuclides, such as ^{7}Be, would be regulated under EPA or state rules. Radionuclides produced by both accelerator and nonaccelerator sources would be regulated under EPA or state rules. This regulation of common products in the treatment plant discharges would be the only departure from current practice (DeVore 1997:2).

Section 402(p) of the CWA authorizes the establishment of regulations to control the issuance of NPDES permits for stormwater discharges. These permits apply to discharges of stormwater from construction activities and point source discharges of stormwater associated with industrial activity. An NPDES general permit covering stormwater discharges from construction activity would be required for construction of the proposed SNS. In addition, an approved stormwater pollution prevention and erosion control plan specific to the construction activity would be required. An NPDES general permit for point-source stormwater discharges associated with industrial activity would be required for operation of the proposed SNS. The national laboratory selected for construction of the proposed SNS would be required to revise its site-wide Storm Water Pollution Prevention Plan to include the new stormwater point source on the sediment retention basin at the proposed SNS.

Section 316(a) of the CWA authorizes the Regional Administrator of EPA to set alternative effluent limitations on the thermal component of industrial discharges, if the owner/operator demonstrates that the proposed thermal effluent limitations are more stringent than necessary to ensure the protection and propagation of a balanced population of fish, shellfish, and wildlife in or on a body of water into which the discharge is to be made. In support of its request for a Section 316(a) exception, the owner/operator must submit with its NPDES permit application scientific documentation showing that the expected heated effluent will not result in appreciable harm to the indigenous aquatic community of the receiving water body. This scientific documentation is called a Section 316(a) Demonstration.

A Section 316(a) Demonstration may be required for the thermal component of the proposed SNS cooling water discharge. If required at ORNL, ANL, or BNL, this satisfactory demonstration would be made to the state environmental regulatory agencies. If required at LANL, the demonstration would be made to EPA Region VI. In all cases, demonstration oversight would be provided by EPA.

Section 404 of the CWA requires the issuance of a Section 404 permit for discharge of dredge or fill material into the waters of the United States. This includes the filling of wetland areas by construction projects. The authority to implement these requirements and issue the permits has been given to the USACOE. In addition, a state environmental regulatory agency may require a state permit to physically alter waters of the state, which usually include streams and wetlands. For example, in Tennessee, TDEC requires an Aquatic Resource Alteration Permit (ARAP) to alter the waters of the state. Section 401 of the CWA requires certification that discharges from construction or operation of facilities, including discharges of dredge and fill material into navigable waters, will comply with applicable water quality standards. This certification is normally granted by the state regulatory agencies and is a prerequisite for receiving a Section 404 permit and state permits such as the Tennessee ARAP.

When a federal construction project would result in the filling of a wetland area, the issuance of a Section 404 permit is usually contingent upon approval of a wetlands mitigation plan by the USACOE.

Construction activities would result in the partial filling of a wetland area overlapping the site of the sediment retention basin associated with the proposed SNS at ORNL. If the site in ANL were selected for construction of the proposed SNS, several wetland areas in ANL would be filled. These actions would require a Section 404 permit and a Tennessee ARAP or a similar state permit from IEPA. Furthermore, Section 404 and state permitting may be required for wastewater discharge conveyances, outfall structures, and the bridging of small streams, especially with regard to road improvements and the piping of retention basin discharge to White Oak Creek at ORNL and the Peconic River at BNL.

The primary objective of the Safe Drinking Water Act (SDWA) is to protect the quality of public water supplies and all sources of drinking water. The implementing regulations are administered by EPA or authorized state environmental regulatory agencies, and they establish standards applicable to public water systems. These standards include maximum contaminant levels (chemicals and radioactivity) in public water systems, which are defined as water systems that serve at least 15 service connections used by year-round residents or regularly serve at least 25 year-round residents. Other programs established by the SDWA include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program.

		Citation	
Jurisdiction	Statute	Statutes	Regulations
Federal	Safe Drinking Water Act	42 USC 300(F) et seq.	40 CFR 141-143
Tennessee	Tennessee Safe Drinking Water Act	TCA 68-221-701 et seq.	TCRR 1200-4-6, 1200-4-9, and 1200-5-1
New Mexico	Environmental Improvement Act	NMSA 1978, Section 74-1-8	20 NMAC 7.1
Illinois	Environmental Protection Act	Ill. Rev. Stat. 1981, ch 111 1/2, pars. 1001 et seq.	35 Ill. Adm. Code 601
New York	New York State Public Health Law	Sections 201, 206, and 225	10 NYCRR 5

EPA has delegated regulatory enforcement authority under the SDWA to state regulatory agencies in Tennessee, New Mexico, Illinois, and New York. In most cases, compliance with public water supply and contaminant monitoring requirements is overseen by state and local health departments. During operation of the proposed SNS, the levels of specific radioactive and chemical contaminants in the potable water system would have to be monitored on a regular basis to ensure cross-connection control and protection of human health.

Jurisdiction	Order No.	Title
Federal	Executive Order 12903	Energy Efficiency and Water Conservation at Federal Facilities

Executive Order 12903 requires federal agencies to develop and implement a program for the conservation of energy and water resources.

6.1.3 HAZARDOUS MATERIALS STORAGE AND HANDLING

Jurisdiction	Statute	Citation	
		Statutes	Regulations
Federal	See Section 6.2.2		
New York	New York State Environmental Conservation Law	Article 40	6 NYCRR 595-599

Improper storage and handling of hazardous materials poses serious risks to human health, public safety, and the environment. The federal and state requirements for hazardous materials storage and handling are aimed at minimizing these risks by identifying materials considered to be hazardous and establishing standards for hazardous materials storage facilities, storage and handling operations, response to releases, release reporting, and corrective action. The hazardous materials storage and handling activities conducted during construction and operation of the proposed SNS would be required to comply with the applicable portions of these requirements.

6.1.4 WASTE MANAGEMENT

The treatment, storage, or disposal (TSD) of hazardous and nonhazardous solid waste is governed by the Resource Conservation and Recovery Act (RCRA). Under Section 3006, a state that seeks to administer and enforce a hazardous waste program pursuant to RCRA may apply for EPA authorization of its program. The environmental regulatory agencies in the potential host states for the proposed SNS have received authorization from EPA to implement hazardous waste management programs.

Jurisdiction	Statute	Citation	
		Statutes	Regulations
Federal	Resource Conservation and Recovery Act	42 USC 6901 et seq.	40 CFR 240-282
Tennessee	Tennessee Hazardous Waste Management Act	TCA 68-212-101 et seq.	TCRR 1200-1-11
New Mexico	New Mexico Hazardous Waste Act	NMSA 1978, Section 74-1-6 et seq.	20 NMAC 4.1
Illinois	Environmental Protection Act	415 ILCS 5/13. 22.4, and 27	35 Ill. Adm. Code 700
New York	New York State Environmental Conservation Law	Article 27	6 NYCRR 370

RCRA and state hazardous waste regulations contain criteria for identifying hazardous wastes, requirements for hazardous waste transportation and handling, and requirements for the TSD of hazardous waste. The regulations imposed on a generator or TSD facility vary according to the types of hazardous waste generated, quantities of waste generated, characteristics of the TSD methods applied, and the attributes of the facilities used to manage the wastes. A RCRA permit is required for facilities that store hazardous waste on-site for more than 90 days, treat it, or dispose of it. Generators may be allowed to treat hazardous wastes on-site without a RCRA permit, provided that all applicable requirements are met.

The construction and operation of the SNS would generate hazardous waste and mixed waste. Mixed waste is a waste that is both hazardous and radioactive. Hazardous wastes would be accumulated at the SNS site for up to 90 days. The 90-day hazardous waste accumulation areas would be managed in compliance with applicable federal (RCRA) and state hazardous waste regulations. Hazardous waste would be transported to a permitted hazardous waste storage or treatment facility at the host site within the 90-day accumulation time limit.

Jurisdiction	Title	Statute Citation
Federal	The Federal Facility Compliance Act	42 USC 6921 et seq.

The Federal Facility Compliance Act (FFCA) was enacted on October 6, 1992. This legislation made federal facilities liable for federal/state fines and penalties for the illegal management of mixed waste, particularly its storage beyond established time limits. However, this law temporarily postpones the imposition of fines and penalties for mixed waste storage violations at DOE sites because sufficient treatment capacity for these wastes does not exist on a national scale. The postponement allows DOE to prepare plans for developing treatment capacity for the mixed waste generated or stored at each of its facilities. After consultation with other affected states, each plan must be approved by a facility's host state or the EPA, and the responsible regulatory agency must issue a consent order requiring compliance with the plan. Under the FFCA, DOE is not subject to fines and penalties for storage prohibition violations as long as it is in compliance with an approved plan and consent order and meets all other applicable regulations.

The FFCA would apply to any new mixed waste stream generated during construction or operation of the proposed SNS. DOE would be required to provide the state environmental regulatory agencies with information on the generation of these new mixed waste streams, and the mixed wastes in these streams would have to be managed in compliance with all applicable requirements.

Jurisdiction	Title	Statute Citation
Federal	Pollution Prevention Act	42 USC 13101 et seq.
Tennessee	Tennessee Hazardous Waste Reduction Act	TCA 68-212-301
New York	New York State Environmental Conservation Law	Article 27

The Pollution Prevention Act establishes a national policy for waste management and pollution control that focuses first on source reduction, followed sequentially by environmentally safe recycling, treatment, and disposal. Disposal or releases to the environment should occur only as a last resort. In response, DOE has committed to participation in the U.S. EPA 33/50 Pollution Prevention Program (Superfund Amendments and Reauthorization Act, Section 313). The goal for facilities already involved in Section 313 compliance was to achieve a 33 percent reduction in the release of 17 priority chemicals by 1997, using 1993 baseline quantities. On August 3, 1993, President Clinton issued Executive Order 12856 (see below), which resulted in expansion of the 33/50 Pollution Prevention Program. Under the expanded program, DOE must reduce its total releases of all toxic chemicals 50 percent by December 31, 1999. In addition, DOE is requiring each of its sites to establish site-specific goals to reduce the generation of all waste types.

Jurisdiction	Order Number	Title
Federal	Executive Order 12856	Right-to-Know Laws and Pollution Prevention Requirements

Executive Order 12856 requires all federal agencies to reduce the toxic chemicals entering any waste stream. This order also requires federal agencies to (1) report toxic chemicals entering waste streams; (2) improve emergency planning, response, and accident notification; and (3) encourage clean technologies and the testing of innovative pollution prevention technologies.

Jurisdiction	Order Number	Title
Federal	Executive Order 13101	Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition

Executive Order 13101 states a national policy preference for pollution prevention (reducing the generation of waste at its source) over waste recycling, treatment, and disposal. If pollution prevention is not feasible, wastes should be recycled or treated in an environmentally safe manner. Disposal should be used only as a last resort.

The Secretary of Energy is required to incorporate waste prevention and recycling into daily DOE operations. Markets for recovered materials must be expanded through greater DOE preference and demand for products made from such materials. In addition, DOE must implement cost-effective procurement programs that favor the purchase of environmentally preferable products and services. These are products and services with a lesser or reduced effect on human health and the environment compared to competing products and services used for the same purposes.

This executive order would require the incorporation of waste prevention and recycling into construction and operation of the proposed SNS, consistent with the demands of efficiency and cost-effectiveness. Procurement programs would be implemented to favor the purchase of environmentally preferable products and services, which would include products made from recovered materials.

Jurisdiction	
Tennessee	Potential Rulemaking on Accelerator-Produced Radioactive Wastes and Products

Although no such rules have been formally proposed, TDEC has indicated to DOE that the State of Tennessee intends to eventually promulgate regulations applicable to the management of radioactive products and wastes produced by accelerator facilities. Because the proposed SNS facility would be an accelerator-based neutron research facility, many of these potential regulations would be applicable to its operations. If the ORNL site is selected for construction of the SNS, DOE will meet all state regulatory requirements applicable to radioactive products and wastes produced by accelerator facilities such as the proposed SNS.

6.1.5 FLOODPLAINS AND WETLANDS

Jurisdiction	Order Number	Title
Federal	Executive Order 11988	Floodplain Management

Executive Order 11988 requires federal agencies to establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for any action undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable.

Jurisdiction	Order Number	Title
Federal	Executive Order 11990	Protection of Wetlands

Executive Order 11990 requires government agencies to avoid any short- and long-term adverse impacts on wetlands wherever there is a practicable alternative. It requires federal agencies to identify potential impacts to wetlands resulting from proposed activities and to minimize these impacts. Where impacts cannot be avoided, action must be taken to mitigate the damage by repairing or replacing the wetlands with an equal or greater amount of a man-made wetland as much like the original wetland as possible. The current federal policy is for no net loss of wetlands as a result of federal activities.

Jurisdiction	
Federal	See Sections 6.1.2 and 6.2.1

The discharge of dredge or fill material into wetlands is regulated at the federal level under Section 404 of the CWA and at the state level. The relevant requirements and permits are discussed in Section 6.1.2. In addition, DOE has promulgated its own regulations pertinent to floodplains and wetlands management. These regulations are cited in Section 6.2.1.

6.1.6 WILDLIFE AND ECOSYSTEMS

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Endangered Species Act	16 USC 1531 et seq.	50 CFR 17, 23–24, 81, 217, 220–222, 225–227, 402, 424, 450–453

The Endangered Species Act is intended to prevent the further decline of endangered and threatened species and to restore these species and their habitats. The Act is jointly administered by the U. S. Department of Commerce (National Marine Fisheries Service) and the U.S. Department of the Interior (DOI) (USFWS). Section 7 requires consultation with the USFWS and the National Marine Fisheries Service to determine if endangered and threatened species or their critical habitats are in the vicinity of a proposed federal action.

The states also have various laws and regulations aimed at protecting endangered species, threatened species, other species of concern, and their habitats. Under these requirements, the states have issued lists of protected species that are state-level counterparts of the federal lists, but often with additional protection and concern categories that reflect state priorities.

The alternative proposed SNS sites and adjacent lands have been surveyed at the reconnaissance level for endangered, threatened, and special-concern floral and faunal species. These surveys encompassed species listed by the federal government, Tennessee, New Mexico, Illinois, and New York. In addition, the survey areas were evaluated for the presence or absence of potential habitats for these species. DOE has initiated informal consultations with the USFWS.

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Migratory Bird Treaty Act	16 USC 703 et seq.	50 CFR 20

The Migratory Bird Treaty Act is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the harvest of migratory birds by specifying the mode of harvest, hunting seasons, bag limits, and other requirements. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill . . . any migratory bird."

DOE would be required to consult with the USFWS about potential impacts of the proposed

SNS on migratory birds. In accordance with the USFWS Mitigation Policy, DOE would be required to evaluate ways to avoid or minimize any such impacts during construction and operation of the proposed SNS.

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Bald and Golden Eagle Protection Act	16 USC 668-668d	50 CFR 21-22

The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald and golden eagles, their nests, or their eggs anywhere in the United States (Sections 668, 668c). A permit must be obtained from the DOI to relocate a nest that interferes with resource development or recovery operations.

No evidence of bald or golden eagle activity has been encountered on the four alternative proposed SNS sites. If bald or golden eagles, their nests, or their eggs appear on the chosen proposed SNS site prior to the initiation of construction-related activities, DOE would be required to obtain a permit for their disturbance or relocation.

6.1.7 CULTURAL AND HISTORIC RESOURCES

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	National Historic Preservation Act	16 USC 470 et seq.	36 CFR 60-61, 63, and 800-812

The National Historic Preservation Act (NHPA) authorizes the Secretary of the Interior to maintain the National Register of Historic Places (NRHP). Under this statute, federal agencies must consider the potential effects of proposed projects on properties listed on or eligible for listing on the NRHP. Section 106 of the NHPA requires the formal review of a proposed action to determine its effects on historic properties. Under this review process, the federal agency must consult with the State Historic Preservation Officer (SHPO) in the state where the action would be implemented as part of an effort to locate possible historic properties and evaluate their NRHP eligibility. If an eligible or listed historic property is identified, the federal agency continues consultation with the SHPO to assess the effect of the proposed action on the property. If the action is determined to have an adverse effect on the property, consultation with the SHPO and Advisory Council on Historic Preservation will usually generate a Memorandum of Agreement containing stipulations that must be followed to mitigate the adverse effects.

The Section 106 review process has been initiated for each of the four alternative proposed SNS sites. It began with reconnaissance-level surveys for cultural resources on and in the vicinity of three alternative sites. Sufficient survey data on the proposed SNS site at ANL already existed prior to the beginning of the EIS process. The surveys at ORNL and BNL have been completed. Only 65 percent of the proposed SNS site and an associated buffer zone at LANL have been surveyed. DOE has initiated required consultations with the SHPOs in Tennessee, New Mexico, Illinois, and New York.

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Archaeo-logical Resource Protection Act	16 USC 470 et seq.	18 CFR 1812, 32 CFR 299, 36 CFR 296, and 43 CFR 7

The Archaeological Resource Protection Act requires a permit for any excavation or removal of archaeological resources from public or Native American lands. Excavations must be undertaken for the purpose of furthering archaeological knowledge in the public interest. Any resources that are removed must remain the property of the United States. If a resource is on land owned by a Native American tribe, then consent must be obtained from the tribe before a permit is issued, and the permit must contain terms or conditions requested by the tribe.

Potential cultural resources dating to the Historic Period (World War I) have been identified on the proposed SNS site at BNL. Prehistoric archaeological resources eligible for listing on the NRHP have been identified on the proposed SNS site at LANL. If the proposed SNS site at BNL is chosen for construction, Phase II archaeological test excavations may be necessary to definitively assess the presence of Historic Period resources eligible for listing on the NRHP. Any necessary mitigation of potentially adverse impacts on NRHP-eligible resources at a proposed SNS site would likely be done through archaeological data recovery operations. These operations would involve the excavation and removal of artifacts. The archaeological testing, excavation, and removal operations would require a permit under the Act. This permit would be issued by DOE.

6.1.8 NATIVE AMERICANS

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Native American Graves Protection and Repatriation Act	25 USC 3001	43 CFR 10

This law directs the Secretary of the Interior to assume responsibilities for repatriation of federal archaeological collections and collections held by museums that are culturally affiliated with Native American tribes and are receiving federal funding. Major actions to be taken under this law include (1) establishing a review committee with monitoring and policy-making responsibilities, (2) developing regulations for repatriation, including procedures for identifying the lineal descent or cultural affiliation needed for claims, (3) overseeing museum programs designed to meet the inventory requirements and deadlines of this law, and (4) developing procedures to handle unexpected discoveries of graves or grave goods during activities on federal or tribal lands.

The provisions of this law would apply to the disposition of artifacts and human remains recovered during data recovery mitigation on the proposed SNS site at LANL, if this site is chosen for construction of the SNS. Remains from the Classic Period sites would be ancestral to the Native Americans at the Pueblo of San Ildefonso. Furthermore, if any inadvertent discoveries of Native American archaeological materials or human remains were to occur during construction or operation of the proposed SNS, their disposition would also be subject to the provisions of this law.

Jurisdiction	Statute	Citation
Federal	American Indian Religious Freedom Act	42 USC 1996

The provisions of the American Indian Religious Freedom Act reaffirm the religious freedom of American Indians under the first amendment to the constitution. The Act establishes a national policy to protect and preserve the inherent and constitutional right of American Indians to believe, express, and exercise their traditional religions. The Act requires that federal actions avoid interfering with access to sacred locations and traditional resources that are integral to the practice of religion.

Prehistoric cultural resources eligible for listing on the NRHP have been identified on the proposed SNS site at LANL. In addition, traditional cultural properties (TCPs) may occur on and adjacent to the site. If this site is chosen for construction of the proposed SNS, DOE would consult with the four accord tribes in the area (Pueblos of Cochiti, Jemez, Santa Clara, and San Ildefonso) concerning the occurrence of TCPs and cultural resources, mitigation of potential impacts on these resources, and other issues relating to the American Indian Religious Freedom Act.

Jurisdiction	Statute	Citation
Federal	Indian Sacred Sites	Executive Order 13007

Executive Order 13007 applies to agencies within the executive branch of the federal government that have statutory or administrative responsibility for managing federal lands that may contain American Indian sacred sites. A sacred site is defined as "…any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site."

To the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, DOE must accommodate access to and ceremonial use of Indian sacred sites on DOE lands by Indian religious practitioners. In addition, DOE must avoid adversely affecting the physical integrity of sacred sites and, where appropriate, maintain the confidentiality of such sites. Section 2 of this executive order requires the implementation of procedures to meet these requirements. Where practicable and appropriate, these procedures must ensure reasonable notice of proposed actions or land management policies that may restrict future access to or ceremonial use of sacred sites or adversely affect the physical integrity of such sites.

This executive order would be applicable to any sacred sites that might be identified on the proposed SNS site at LANL through consultations with American Indian tribal groups. No such sites are known to be present on the proposed SNS sites at ORNL, ANL, and BNL.

6.1.9 NOISE

Jurisdiction	Statute	Citation
Federal	Noise Control Act	42 USC 4901 et seq.

Section 4 of the Noise Control Act directs all federal agencies to carry out their programs in ways that promote an environment free of noise that jeopardizes human health and welfare.

6.1.10 HEALTH AND SAFETY

Jurisdiction	Statute	Citation	
		Statute	Regulation
Federal	Occupational Safety and Health Act	29 USC 651 et seq.	29 CFR 1910

The Occupational Safety and Health Act establishes standards to enhance safe and healthful working conditions in places of employment throughout the United States. The Act is administered and enforced by the OSHA, an agency under the U.S. Department of Labor. While both OSHA and EPA have a mandate to reduce exposures to toxic substances, the OSHA jurisdiction is limited to safety and health conditions that exist in the workplace. The Act requires each employer to furnish its employees with a workplace free from recognized hazards likely to cause death or serious physical harm. Employees have a duty to comply with the OSHA standards and all rules, regulations, and orders issued under the Act.

The OSHA regulations establish specific standards that inform employers what must be done to achieve a safe and healthful working environment. This set of regulations establishes OSHA requirements for employee safety in a variety of working environments. It addresses employee emergency and fire prevention plans (29 CFR 1910.38), hazardous waste operations and emergency response (29 CFR 1910.120), and hazard communications (29 CFR 1910.1200). These rules enable employees to be aware of the dangers they face from hazardous materials in their workplace.

DOE emphasizes compliance with these regulations at facilities such as the proposed SNS. The contractor and subcontractor employees who work at such facilities must comply with the regulations applicable to their work, as prescribed through DOE orders. DOE keeps and makes available the various records of minor illnesses, injuries, and work-related deaths required by the OSHA regulations.

Jurisdiction	Statute	Citation	
		Statute	Regulation
Federal	Federal Aviation Act of 1958	49 USC 1504	14 CFR 77

The FAA requires a permit for any structure greater than 200 ft (61 m) in height that would affect navigable airspace. A permit would be required for structures at the proposed SNS site greater than 200 ft (61 m) in height. Construction cranes used at the proposed SNS site could require a permit.

Jurisdiction	Order Number	Order Title
Federal	Executive Order 12898	Environmental Justice

Executive Order 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

6.1.11 ENVIRONMENTAL PROTECTION

Jurisdiction	Statute	Citation	
		Statute	Regulation
Federal	National Environmental Policy Act	42 USC 4321 et seq.	40 CFR 1500–1508

The National Environmental Policy Act (NEPA) establishes a national policy promoting awareness of the consequences of human activity on the environment and consideration of environmental impacts during the early planning and decision-making stages of federal projects.

Under the provisions of NEPA, federal agencies are required to assess the potential effects of their major proposed actions on the environment.

This FEIS has been prepared in response to NEPA policies, regulatory requirements established by the Council on Environmental Quality (CEQ), and the DOE regulations for implementing the procedural provisions of NEPA. It discusses reasonable alternatives and their potential environmental consequences.

Jurisdiction	Statute	Citation: Statute	Citation: Regulation
Federal	Toxic Substances Control Act	USC 2601 et seq.	40 CFR 761-763

The Toxic Substances Control Act (TSCA) regulates the manufacture, use, treatment, storage, and disposal of certain toxic substances not regulated by RCRA or other statutes. These substances include polychlorinated biphenyls (PCBs) (40 CFR 761) and asbestos (40 CFR 763).

It is expected that the use of these materials in the proposed SNS would be limited or not occur at all. However, if they should be used, compliant programs and procedures would need to be implemented to address appropriate management and disposal of waste generated as a result of their use.

Jurisdiction	Order Number	Order Title
Federal	Executive Order 11514	Protection and Enhancement of Environmental Quality

Executive Order 11514 requires federal agencies to monitor and control their activities continually to protect and enhance the quality of the environment. In addition, it requires the development of procedures to ensure the fullest practicable provision of timely public information and understanding of federal plans and programs with environmental impacts.

6.1.12 EMERGENCY PLANNING AND RESPONSE

Jurisdiction	Statute	Citation: Statute	Citation: Regulation
Federal	Emergency Planning and Community Right-To-Know Act	42 USC 11001 et seq.	40 CFR 350-372

The Emergency Planning and Community Right-To-Know Act is also referred to as Title III of the Superfund Amendments and Reauthorization Act. This statute requires the owners and operators of facilities with hazardous substances to engage in emergency planning. In addition, they must notify their communities and government agencies about the storage, use, and release of hazardous substances at their facilities. Under Subtitle A of this statute, owners and operators must develop and maintain inventories of hazardous substances stored and used at their facilities. These inventories and information on releases of the substances must be reported to state emergency response authorities and the Local Emergency Planning Committee. This reporting is designed to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances.

Hazardous substances may be used and stored at the proposed SNS. The host national laboratory for the proposed SNS would be required to fold the inventory and release information on these substances into its Emergency Planning and Community Right-to-Know Act reporting processes.

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Comprehensive Environmental Response, Compensation, and Liability Act	42 USC 9601 et seq.	40 CFR 300-302

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its implementing regulations provide the needed general authority for federal and state governments to respond directly to hazardous substance incidents. The regulations require reporting of spills, including releases of radioactive materials, to the National Response Center.

DOE would be required to comply with these regulations if hazardous materials spills occur during construction and operation of the proposed SNS. Programs for the development of internal procedures to implement the CERCLA regulations are generally set forth in DOE orders.

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Hazardous Materials Transportation Act	49 USC 5101 et seq.	49 CFR 172

The requirements for marking, labeling, placarding, and documenting shipments of hazardous materials are presented in these regulations under the Hazardous Materials Transportation Act. In addition, they specify the requirements for providing hazardous materials information and training. Any hazardous materials shipped from the proposed SNS would be required to comply with these regulations.

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Atomic Energy Act of 1954	42 USC 2011 et seq.	10 CFR 30.72, Schedule C

This regulation is used by the public and private sector to determine if an emergency response plan must exist for unscheduled releases of radiological materials. It is one of the threshold criteria documents for DOE Emergency Preparedness Hazards Assessments required by DOE Order 151.1, *Comprehensive Emergency Management System*. An emergency response plan addressing the proposed SNS operations would need to be prepared in accordance with this regulation.

		Citation	
Jurisdiction	Statute	Statute	Regulation
Federal	Reorganization Plan No. 3 of 1978, Public Health and Welfare	42 USC 5121 et seq.	44 CFR 1-399

These regulations set forth the policies, procedures, and responsibilities of DOE, the Federal Emergency Management Agency, and the Nuclear Regulatory Commission (NRC) for implementing a Federal Emergency Preparedness Program, including radiological planning and preparedness. An emergency response plan, including radiological planning and preparedness for proposed SNS operations, would need to be prepared and implemented at the SNS in accordance with these requirements.

6.2 DOE REQUIREMENTS

DOE controls its operations through various sets of federal regulations and DOE orders covering a wide range of subjects. The regulations and DOE orders applicable to construction and operation of the proposed SNS are described in this section.

6.2.1 REGULATIONS

DOE regulations address wide-ranging areas such as environmental management, administrative requirements and procedures, energy conservation, nuclear safety, and classified information. For the purposes of this FEIS, regulations relevant to the proposed action include 10 CFR 20, *Dose Limits for Individual Member of the Public*; 10 CFR 820, *Procedural Rules for DOE Nuclear Facilities*; 10 CFR 830, *Nuclear Safety Management—Contractor and Subcontractor Activities*; 10 CFR 835, *Occupational Radiation Protection*; 10 CFR 1021, *Compliance with NEPA*; and 10 CFR 1022, *Compliance with Floodplains/Wetlands Environmental Review Requirements*.

DOE has established occupational radiation protection standards to protect DOE personnel and contractor employees. These standards are set forth in the regulations under 10 CFR 835. These regulations establish standards, limits, and program requirements to protect individual workers from ionizing radiation that may be generated by DOE activities. These activities include, but are not limited to, the construction and operation of DOE facilities. The requirements under 10 CFR 835 would apply to construction and operation of the proposed SNS. The radioactive material storage and handling operations at the proposed SNS would be required to comply with these regulations.

6.2.2 DOE ORDERS

DOE orders contain statements of departmental policies, as well as the procedures and requirements necessary for implementing them.

A large number of DOE orders apply to implementation of the proposed action described in this FEIS.

Hazardous materials storage and handling operations conducted under the proposed action would be required to comply with DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards,* and DOE Order 5480.7A, *Fire Protection*. These two orders require DOE and its contractors to comply with the National Fire Protection Association codes and standards, the OSHA regulations in 29 CFR 1910, and the DOE Explosives Safety Manual.

Additional DOE orders applicable to construction and operation of the proposed SNS are listed in Table 6.2.2-1.

Table 6.2.2-1. DOE orders applicable to the proposed action.

DOE Order	Title
151.1	Comprehensive Emergency Management System
225.1	Accident Investigations
231.1	Environment, Safety, and Health Reporting
232.1	Occurrence Reporting and Processing of Operations Information
420.1	Facility Safety
430.1	Life-Cycle Asset Management
440.1	Worker Protection Management for DOE Federal and Contractor Employees
441.1	DOE Radiological Health and Safety Policy
441.2	Extension of DOE Order 441.1
451.1A	National Environmental Policy Act Compliance Program
460.1A	Packaging and Transportation Safety
460.2	Departmental Materials and Packaging Management
470.1	Safeguards and Security Program
471.1	Identification and Protection of Unclassified Controlled Nuclear Information
471.2A	Information Security Program
472.1B	Personnel Security Activities
1300.2A	Department of Energy Technical Standards Program
1360.2B	Unclassified Computer Security Program
3790.1B	Federal Employee Occupational Safety and Health Program
4330.4B	Maintenance Management Program
4700.1	Project Management System
5400.1	General Environmental Protection Program
5400.3	Hazardous and Radioactive Mixed Waste Program
5400.5	Radiation Protection of the Public and the Environment
5480.17	Site Safety Representatives
5480.19	Conduct of Operations Requirements for DOE Facilities
5480.21	Unreviewed Safety Requirements
5480.22	Technical Safety Requirements
5480.23	Nuclear Safety Analysis Reports
5480.25	Safety of Accelerator Facilities
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5630.12A	Safeguards and Security Inspection and Evaluation Program
5632.1C	Protection and Control of Safeguards and Security Interests
5700.6C	Quality Assurance
5820.2A	Radioactive Waste Management
6430.1A	General Design Criteria

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GLOSSARY

Absorbed dose: The energy imparted by ionizing radiation per unit mass of irradiated material at the place of interest in that material. Expressed in units of radiation absorbed dose or grays, where 1 radiation absorbed dose equals 0.01 gray.

Accelerator: An apparatus for imparting high velocities to charged particles.

Accident: An unexpected or undesirable event that leads to the release of hazardous material within a facility or into the environment exposing workers or the public to hazardous materials or radiation.

Accumulator ring: A circular band that, when injected with particles, strips the electrons from the H^- ions leaving protons. When a sufficient amount of proton bunches are accumulated in the ring they are then released from the ring as a pulse.

Air pollutant: Any substance in the air that could, if in high enough concentration, harm humans, other animals, or vegetation.

Air quality standards: The level of pollutants in the air prescribed by regulations that may not be exceeded during a specified time in a defined area.

Alloy: A substance made from a mixture of a metal and one or more other metals or nonmetallic elements.

Alluvium: Clay, silt, sand, and/or gravel deposits found in a stream channel or in low parts of a stream valley that is subject to flooding.

Alpha particle: A positively charged particle, consisting of two protons and two neutrons, given off by the radioactive decay of many elements, including uranium, plutonium, and radon.

Ambient air: That portion of the atmosphere, external to buildings, to which the general public is exposed.

Ambient water quality standards: The level of pollutants in water, prescribed by regulations, that may not be exceeded during a specified time in a defined area.

Antiscaling agent: A chemical added to cooling water to prevent buildup on interior surfaces of cooling water systems.

Aqueous: Containing or dissolved in water.

Aquifer: Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to conduct groundwater.

Aquitard: A less-permeable geologic unit in a stratigraphic sequence. The unit is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

Archaeological site: Any location where humans have altered the terrain or discarded artifacts during either prehistoric or historic times.

Area of concern: Any site that has been identified as needing corrective action but for which there are no Resource and Conservation and Recovery Act or Comprehensive Environmental Response, Compensation, and Liability Act remediation requirements.

Arroyos: A watercourse (as a creek) in an arid region.

Artifact: An object produced or shaped by human workmanship of archaeological or historical interest.

As low as reasonably achievable (ALARA): The approach to manage and control exposures (both individual and collective) to the workforce and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit but a process that has the objective of attaining doses as far below the applicable limits as is reasonably achievable (10 CFR 835.2).

Beam scattering: Beams of molecules are directed toward a surface and various properties are studied as a result of the beam/surface interaction. The scattered beam, desorbed reaction products, or adsorbed species can be detected.

Benthic: Occurring at the bottom of a body of water.

Beryllium: An extremely lightweight, strong metal used in weapons systems.

Beta particle: A negatively charged particle emitted during the radioactive decay of many radionuclides. A beta particle is identical to an electron. It has a short range in air and a small ability to penetrate other materials.

Biocides: A substance that is destructive to many different organisms.

Biodiversity: Biological diversity in an environment as indicated by numbers of different species of plants and animals.

Biodiveristy significance ranking (BSR): A system that ranks the importance of biological variety within an environment; ranks are from a high of 1 for outstanding significance to a low of 5 for general biodiversity interest.

Biota: Living organisms including plants and animals.

Brownfield: Previously developed land or contaminated land that has been remediated to accommodate certain uses.

Caldera: A volcanic crater that has a diameter many times that of the vent and is formed by collapse of the central part of a volcano or by explosions of extraordinary violence.

Cesium: A silver-white alkali metal. A radioisotope of cesium, cesium-137, is a common fission product.

Chert: A rock resembling flint and consisting essentially of a large amount of fibrous chalcedony with smaller amounts of cryptocrystalline quartz and amorphous silica.

Climatology: The science that deals with climates and investigates their phenomena and causes.

Code of Federal Regulations (CFR): A U.S. government publication containing the full range of federal regulations in codified form.

Cold neutrons: Neutrons with wavelengths >0.4 nanometers.

Cold War period: The historic period from 1949 to 1989, characterized by international tensions and nuclear armament buildup, especially between the United States and the U.S.S.R. The era began approximately at the end of World War II when the Atomic Energy Act was passed, establishing the Atomic Energy Commission, and ended with the dissolution of the U.S.S.R. into separate republics and the ending of large-scale nuclear weapons production in the United States.

Committed effective dose equivalent: The sum of the products of the committed dose equivalent to an organ or tissue and the weighting factor applicable to each organ or tissue irradiated. The committed dose equivalent is the dose equivalent that will be received from an intake of radioactive material during the 50-year period following the intake.

Common Ground Process: This process is the response of the Oak Ridge Reservation to the 1993 mandate by the Assistant Secretary of Environmental Restoration and Waste Management and the Acting Associate Deputy Secretary for Facilities and Management (both within the Department of Energy) to identify stakeholder preferred alternatives for the future use of land and buildings at Department of Energy sites.

Community (biotic): All plants and animals occupying a specific area under relatively similar conditions.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): Provides a federal "Superfund" to clean up uncontrolled or abandoned hazardous waste sites, as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through the Act, the Environmental Protection Agency was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.

Contamination: The deposition or discharge of chemicals, radionuclides, or particulate matter above a given threshold, usually associated with an effects level onto or into environmental media, structures, areas, objects, personnel, or nonhuman organisms.

Cretaceous Age: Geologic time making up the end of the Mesozoic Era, dating from approximately 144 million to 66 million years ago.

Criteria pollutant: Six air pollutants [sulfur dioxide, nitric oxides, carbon monoxide, ozone, particulate matter-10 (smaller than 10 microns in diameter), and lead] for which National Ambient Air Quality Standards are established by the U.S. Environmental Protection Agency.

Cultural resource: Any prehistoric or historic site, building, structure, district, or other place or object (including biota of importance) considered to be important to a culture, subculture, or community for scientific, traditional, or religious purposes or for any other reason.

Cumulative impacts: In an Environmental Impact Statement, the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal), private industry, or individual undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Curie: The conventional unit of activity in a sample of radioactive material. The curie is equal to 37 billion disintegrations per second; which is approximately the rate of decay of 1 gram of radium; also a quantity of any nuclide or mixture of nuclides having 1 curie of radioactivity.

Decay (radioactive): The decrease in the amount of radioactive material with the passage of time due to the spontaneous transformation of an unstable nuclide into a different nuclide or into a different energy state of the same nuclide; the emission of nuclear radiation (alpha, beta, or gamma radiation) is part of the process.

Decontamination: The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive or chemical contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

Deoxyribonucleic acid (DNA): Any of various nucleic acids that are usually the molecular basis of heredity, are localized especially in cell nuclei, and are constructed of a double helix held together by hydrogen bonds between purine and pyrimidine bases, that project inward from two chains containing alternate links of deoxyribose and phosphate.

Deposition: In geology, the laying down of potential rock-forming materials; sedimentation. In atmospheric transport, the settling out on ground and building surfaces of atmospheric aerosols and particles (“dry deposition”) or their removal from the air to the ground by precipitation (“wet deposition”).

Derived air concentrations: Airborne concentration of a radionuclide that, if inhaled for a work year, would result in a dose to an individual worker corresponding to the applicable dose limit.

Derived concentration guide (DCG): The concentration of a radionuclide in air or water that under conditions of continuous exposure for 1 year by one exposure mode (e.g., ingestion of water, submersion in air, or inhalation of air) would result in an effective dose equivalent equal to the annual dose limit for the group exposed. For the public, this would be a dose of 100 millirem to a reference human who inhales 8,400 cubic meters of air and ingests 730 liters (771 quarts) of water in a year.

Dispersion: The downwind spreading of a plume by turbulence and meander in wind direction, resulting in a plume of lower concentration over a larger area.

Disposal: The process of placing waste in a final repository.

Dose: A generic term that expresses the energy absorbed by a unit mass of material exposed to ionizing radiation (absorbed dose in units of rad or gray) or the product of a quality factor and the energy absorbed by human tissue exposed to ionizing radiation (dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent). In this Environmental Impact Statement, dose means effective dose equivalent, committed effective dose equivalent, or total effective dose equivalent as defined in this glossary.

Dose conversion factor: For internal exposures, the dose received per unit activity inhaled or ingested. For external exposures, the dose received per unit time exposed to a unit activity concentration.

Dose equivalent: The dose equivalent is the product of the absorbed dose and a quality factor that depends on the type of ionizing radiation.

Dose rate: The radiation dose delivered per unit time (e.g., rad/h).

Drainage basin: An aboveground area that supplies the water to a particular stream.

Drawdown: The subsurface difference in elevation between the natural water level in a formation and the reduced water level in the formation caused by the withdrawal of groundwater.

Drinking water standard: The prescribed level of constituents or characteristics in a drinking water supply that cannot be legally exceeded.

Ecology: The science dealing with the relationship of all living things with each other and with the environment.

Ecosystem: Living organisms and their nonliving (abiotic) environment functioning together as a community.

Effective dose equivalent (EDE): The sum of the products of the dose equivalent to an organ or tissue and the weighting factor applicable to each organ or tissue irradiated.

Effluent: Liquid or gaseous waste streams discharged into the environment.

Endangered species: Plants and animals that are threatened with extinction, serious depletion, or destruction of critical habitat. Requirements for declaring a species endangered are contained in the Endangered Species Act.

Environment: The sum of all external conditions and influences affecting the life, development, and ultimately the survival of an organism.

Environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or environmental hazards due to a lack of political or economic strength.

Environmental Impact Statement (EIS): A document required of federal agencies by the National Environmental Policy Act for proposals for legislation or major federal actions significantly affecting the quality of the human environment. A tool for decision-making, it describes the positive and negative environmental impacts of the proposed action and alternative actions.

Environmental Restoration Integrated Water Quality Program: A program established in 1996 in an attempt to integrate the various biological, physical, and chemical monitoring activities that were being conducted across the Oak Ridge Reservation. The program uses data collected by other programs and additionally supplements these data with its own sampling. Monitoring data deemed most important to evaluating long-term trends and assessing off-site export are included in the program's scope.

Epicenter: The point on Earth's surface directly above the focus of an earthquake.

Erosion: A general term for the natural processes by which earth materials are loosened, dissolved, or worn away and moved from one place to another. Typical processes are wind and water as they carry away soil.

Fallout: Radioactive material that has been produced and distributed through the atmosphere as a result of above-ground testing of nuclear devices.

Fault: A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred.

Floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas including at a minimum that area inundated by a 1 percent or greater chance of flood in any given year.

Formation: In geology, the primary unit of formal stratigraphic mapping or description. Most formations possess certain distinctive features.

Fusion: Nuclear reaction in which light nuclei are fused together to form a heavier nucleus, accompanied by the release of immense amounts of energy and fast neutrons.

Gamma rays: High-energy, short-wavelength, electromagnetic radiation accompanying fission and emitted from the nucleus of an atom during radioactive decay. Gamma rays are very penetrating and can be effectively stopped only by dense materials (such as lead) or a thick layer of shielding materials.

Geology: The science that deals with Earth: the materials, processes, environments, and history of the planet, including the rocks and their formation and structure.

Geotechnical systems: The utilization of rocks or geological formations as a group of objects forming a network that serves a common purpose.

Greenfield: A site not previously developed or contaminated.

Groundwater: Water found beneath the Earth's surface.

Group: The geological term for the rock layer next in rank above formation.

Habitat: The part of the physical environment in which a plant or animal lives.

Half-life: The time in which half the atoms of a radioactive substance disintegrate to another nuclear form. Half-lives vary from millionths of a second to billions of years.

Hazardous material: A material, including a hazardous substance defined by 49 CFR 171.8, that poses a risk to health, safety, and property when transported or handled.

Hazardous waste: A solid waste that, because of its quantity, concentration, physical, chemical, or infectious characteristics, may significantly contribute to an increase in mortality: or may pose a potential hazard to human health or the environment when improperly treated, stored, or disposed. The Resource Conservation and Recovery Act defines a "solid waste" as including solid, liquid, semisolid, or contained gaseous material. By definition, hazardous waste has no radioactive components.

Heavy metals: Metallic or semimetallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations.

High efficiency particulate air (HEPA) filter: A disposable, extended media, dry-type filter with a rigid casing enclosing the full depth of the pleats. The filter exhibits a minimum efficiency of 99.97 percent when tested with an aerosol of essentially monodispersed 0.3-mm diameter test aerosol particles.

Historic resources: The sites, districts, structures, and objects considered limited and nonrenewable because of their association with historic events, persons, social, or historic movements.

Holocene: The current epoch of geologic time, which began approximately 10,000 years ago.

Human Genome Sequencing Project: The ultimate goal of the Human Genome (genetic material of an organism) Project is to determine the deoxyribonucleic acid (DNA) sequence of the entire human genome and to elucidate the genetic information by analyzing the structure and function of all the genes of humans and other organisms.

Hydric: Requiring an abundance of moisture.

Hydrology: The science dealing with the properties, distribution, and circulation of natural water systems.

In-situ decommissioning: To remove (as a ship or nuclear power plant) from service without completely dismantling.

Ion: An atom or molecule that has gained or lost one or more electrons to become electrically charged.

Ionizing radiation: Radiation with sufficient energy to displace electrons from atoms or molecules, thereby producing ions.

Isotope: An alternate form of an element that has the usual number of protons but a nonstandard number of neutrons; the fewer or additional neutrons give the isotope a different atomic weight than the regular element and may make the isotope radioactive.

Karst: An irregular limestone region with sinkholes, underground streams, and caverns.

Klystron: An electron tube used for the generation of ultra-high-frequency current.

Linac: Linear accelerator.

Linear accelerator (linac): A device in which charged particles are accelerated in a straight line by successive impulses from a series of electric fields.

Lithic: The description of rocks on the basis of such characteristics as color, mineralogic composition, and grain size.

Lithology: A rock formation having a particular set of characteristics.

Loam: A soil composed of a mixture of clay, silt, sand, and organic matter.

Low-income population: Community in which 25 percent or more of the population is characterized as living in poverty.

Low-level radioactive waste: All radioactive waste that is not classified as high-level waste, transuranic waste, spent nuclear fuel, or "11e(2) by-product material," as defined by DOE Order 5820.2A, *Radioactive Waste Management*. By-product material includes the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

Maximum contaminant level : The maximum permissible level of a contaminant in water that is delivered to any user of a public water system, as measured within the system or at entry points, depending upon the contaminant (40 CFR 141).

Migration: The movement of a material through the soil or groundwater.

Mitigation: The alleviation of adverse impacts on resources; by avoidance, by limiting the degree or magnitude of an action, by repair or restoration, by preservation and maintenance that reduces or eliminates the impact, or by replacing or providing substitute resources or environments.

Mixed waste: Mixed waste contains both hazardous waste [as defined by the Resource Conservation and Recovery Act (RCRA) and its amendments] and radioactive waste (as defined by the Atomic Energy Act and its amendments). It is jointly regulated by the Nuclear Regulatory Commission (NRC) or NRC's Agreement States and the Environmental Protection Agency (EPA) or EPA's RCRA-Authorized States.

Moderator: A substance (as water) used for slowing down neutrons in a nuclear reactor.

Modified Mercalli intensity: A level on the modified Mercalli scale. A measure of the perceived intensity of earthquake ground shaking with 12 divisions, from I (not felt by people) to XII (damage nearly total).

Moraine: An accumulation of earth and stones carried and finally deposited by a glacier.

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act*, as amended. The primary NAAQS are intended to protect the public health with an adequate margin of safety, and the secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants (NESHAP): A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These standards were implemented in the Clean Air Act Amendments of 1977.

National Environmental Research Park (NERP): An outdoor laboratory set-aside for ecological research to study the environmental impacts of energy developments. NERPs were established by the Department of Energy to provide protected land areas for research and education in the environmental sciences and to demonstrate the environmental compatibility of energy technology development and use.

National Historic Preservation Act (NHPA): Congress passed the NHPA in 1966. The law established a national policy for the protection of historic and archaeological sites and outlined the responsibilities of federal and state governments in preserving our nation's history.

National Oceanic and Atmospheric Administration (NOAA): The organization within the Department of Commerce responsible for describing and predicting changes in Earth's environment and for conserving and managing the nation's coastal and marine resources.

National Pollutant Discharge Elimination System (NPDES) permit: The NPDES is a regulatory program (regulated through the Clean Water Act, as amended) of either the Environmental Protection Agency or state EPA-authorized agency that is designed to control all discharges of pollutants from point sources to U.S. waterways. NPDES permits regulate discharges into navigable waters from all point sources of pollution, including industries, municipal treatment plants, large agricultural feed lots, and return irrigation flows. Federal and State regulations (40 CFR Parts 122 and 125) require one of these permits for the discharge of pollutants from any point source into the waters of the United Stated regulated through the Clean Water Act, as amended.

National Register of Historic Places (NRHP): A list of districts, sites, buildings, structures, and objects of prehistoric or historic local, state, or national significance maintained by the Secretary of the Interior. The list is expanded as authorized by Section 2(b) of the Historic Sites Act of 1935 (16 U.S.C. 462) and Section 101(a)(1)(A) of the National Historic Preservation Act of 1966, as amended.

Native American: For purposes of this document, a Native American is defined as a tribe, people, or culture that is indigenous to the United States. Also referred to as American Indians.

Net primary productivity: The net creation of organic matter by green plants.

Neutron: An elementary atomic particle that has no charge and a mass that is approximately the same as that of a proton. Neutrons are found in all atoms except the lightest isotopes of hydrogen.

Neutron activation analysis: Use of neutrons for the detection and quantification of trace amounts of substances within a larger sample.

Neutron flux: The number of neutrons passing through a unit area per second.

Neutron sources: The facilities and equipment used to produce neutrons.

Nuclear criticality: A state in which a self-sustaining nuclear chain reaction is achieved.

Nuclide: A species of atom characterized by its nuclear constitution (number of protons and number of neutrons).

Off-site: As used in this draft Environmental Impact Statement, the term denotes a location, facility, or activity occurring outside the boundary of the Oak Ridge Reservation, Los Alamos National Laboratory, Argonne National Laboratory, and Brookhaven National Laboratory sites.

On-site: As used in this draft Environmental Impact Statement, the term denotes a location or activity occurring somewhere within the boundary of the Oak Ridge Reservation, Los Alamos National Laboratory, Argonne National Laboratory, and Brookhaven National Laboratory sites.

Open space: A land use category applied to areas that exist in a predominantly natural, undeveloped state.

Oral reference dose: The daily oral intake per unit body weight that would be likely to be without appreciable risk of adverse health effects during a lifetime.

Organic compounds: Carbon compounds, which are, or are similar to, compounds produced by living organisms.

Outfall: Place where liquid effluents enter the environment and are monitored.

Oxide: A compound in which an element chemically combines with oxygen.

Ozone: A molecule of oxygen in which three oxygen atoms are chemically attached to each other.

Paleozoic Era: Geologic time dating from 570 million to 245 million years ago when seed-bearing plants, amphibians, and reptiles first appeared.

Particulates: Solid particles and liquid droplets small enough to become airborne.

Perched groundwater: A body of groundwater of small lateral dimensions lying above a more extensive aquifer.

Perched aquifer: A body of groundwater separated from an underlying body of groundwater by an unsaturated zone.

Perennial: Acting or lasting throughout the year or through many years (perpetual).

Perennial stream: A stream that contains water at all times except during extreme drought.

Permeability: Ability of liquid to flow through rock, groundwater, soil, or other substances.

Person-rem: Unit of radiation dose to a given population; the sum of the individual doses received by a collection of individuals.

pH: A measure of the hydrogen ion concentration in aqueous solution. Pure water has a pH of 7, acidic solutions have a pH less then 7, and basic solutions have a pH greater than 7.

Physiographic: Pertaining to the physical features of Earth's surface, such as land forms or bodies of water.

Pleistocene Epoch: Geologic time that occurred approximately 11,000 to 2 million years ago.

Plutonium: A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombardment of uranium with neutrons and is used in the production of nuclear weapons.

Polychlorinated biphenyl (PCB): Any of several compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine, have various industrial applications, and are poisonous environmental pollutants that tend to accumulate in animal tissues.

Potable: Suitable for drinking.

Potentiometric water level: Surface of the groundwater table or height to which the water level would rise in a confined aquifer.

Prehistoric: Of, relating to, or existing in times antedating written history.

Proton: An elementary atomic particle with a positive charge and a mass of approximately 1 amu (atomic mass unit).

Pueblo: The communal dwelling of an American Indian village of Arizona, New Mexico, or adjacent areas consisting of contiguous, flat-roofed stone or adobe houses in groups, sometimes several stories high; an American Indian village of the southwestern United States, a member of a group of American Indian peoples of the southwestern United States.

Radiation: The particles or electromagnetic energy emitted from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor.

Radioactive waste: Materials from nuclear operations that are radioactive or are contaminated with radioactive materials and for which there is no practical use or for which recovery is impractical.

Radioactivity: The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

Radioisotope: An isotope of an element that undergoes spontaneous decay with the release of radioactive particles.

Radionuclide: Any radioactive element.

Reactor: An apparatus in which a chain reaction in fissionable material is initiated and controlled.

Record of Decision (ROD): A document prepared in accordance with the requirements of 40 CFR 1505.2. It provides a concise public record of DOE's decision on a proposed action for which an EIS was prepared. A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative(s), factors balanced by DOE in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why they were not.

Reference concentration (RfC): The concentration of a toxic material in air that, if inhaled daily, would be likely to be without appreciable risk of adverse health effects during a lifetime.

Reference dose: The dose associated with a reference concentration.

Region of Influence (ROI): For the purpose of this document, a site-specific geographic area that includes the counties that would be potentially affected by the proposed action.

Rem (Roentgen equivalent man): The conventional unit or radiation dose equivalent. A unit of individual dose of absorbed ionizing radiation used to measure the effect on human tissue. The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of X-ray or gamma ray exposure.

Remediation: The process, or a phase in the process, of rendering radioactive, hazardous, or mixed waste environmentally safe, whether through processing, entombment, or other methods.

Rift: An elongated valley formed by the depression of a block of Earth's crust between two faults or groups of faults of approximately parallel strike.

Riparian: On or around rivers and streams.

Rip-rap: A foundation or sustaining wall of stones or chunks of concrete thrown together without order usually on an embankment slope to prevent erosion.

Roentgen: A unit of exposure to ionizing X-ray or gamma radiation equal to 2.58×10^{-4} coulomb per kilogram. (A coulomb is a unit of electrical charge.) A roentgen is approximately equal to 1 rad.

Runoff: The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and may eventually enter streams.

Sanitary waste: Liquid or solid (includes sludge) wastes that are not hazardous or radioactive and that are generated by industrial, commercial, mining, or agricultural operations or from community activities.

Saprolite: Disintegrated rock that lies in its original place.

Seismic: Pertaining to any earth vibration, especially an earthquake.

Seismicity: Occurrence of earthquakes in space and time.

Shield: Material used to reduce the intensity of radiation that would irradiate personnel or equipment.

Short-lived: A designation for radionuclides with relatively short half-lives.

Silt: A sedimentary material consisting of fine mineral particles intermediate in size between sand and clay.

Slope factor: External exposure slope factors are central to the estimate of lifetime attributable radiation cancer incidence risk for each year of exposure to external radiation from photon-emitting radionuclides distributed uniformly in a thick layer of soil and are expressed as risk/yr per pCi/gram of soil.

Socioeconomic: The social and economic conditions in a study area.

Solid waste: As defined under the Resource Conservation and Recovery Act, any solid, semisolid, liquid, or contained gaseous materials discarded from industrial, commercial, mining, or agricultural operations and from community activities. Solid waste includes garbage; construction debris; commercial refuse; sludge from water supply facilities, or waste treatment plants, or air pollution control facilities; and other discarded materials. Solid waste does not include solid or dissolved materials in irrigation return flows or industrial discharges that are point sources subject to permits under section 402 of the Clean Water Act or source, special nuclear, or by-product material as defined by the Atomic Energy Act.

Solid waste management unit (SWMU): Any unit from which hazardous constituents may migrate, as defined by the Resource Conservation and Recovery Act. A designated area that is or is suspected to be the source of a release of hazardous material into the environment that will require investigation and/or corrective action.

Source term: The quantity of material released and parameters such as exhaust temperature that determine the downwind concentration, given a specific meteorological dispersion condition.

Stabilization: The action of making a nuclear material more stable by converting its physical or chemical form or placing it in a more stable environment.

Strata: Layers of rock, usually in a sequence.

Stratum: A single layer of rock, usually one of a sequence.

Stratigraphy: The science of rock strata or the characteristics of a particular set of rock strata.

Strontium: A soft, malleable, ductile metallic element of the alkaline-earth group.

Superconductor: A substance in which electrical resistance completely disappears, especially at very low temperatures.

Surface water: Water on Earth's surface, as distinguished from water in the ground (groundwater).

Thermal neutrons: Neutrons with a wavelength distribution peaked around 1.6 angstroms (one ten-billionth of a meter).

Threatened and endangered species: Animals, birds, fish, plants, or other living organisms in jeopardy of extinction by human-produced or natural changes in their environment. Requirements for declaring species threatened or endangered are contained in the Endangered Species Act of 1973.

Till: Unstratified glacial drift consisting of clay, sand, gravel, and boulders intermingled.

Total effective dose equivalent (TEDE): The sum of the committed effective dose equivalent for internal exposures (committed EDE) and the effective dose equivalent (EDE) for external exposures.

Traditional cultural property (TCP): A significant place or object associated with historical and cultural practices or beliefs of a living community that is rooted in that community's history and is important in maintaining the continuing cultural identity of the community.

Treatment: Any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize it, render it nonhazardous or less hazardous, or recover it, make it safer to transport, store or dispose of, or amenable for recovery, storage, or volume reduction.

Treatment, storage, or disposal (TSD) facility: A site, regulated by the Environmental Protection Agency and the state under the Resource Conservation and Recovery Act, where a hazardous substance is treated, stored, or disposed.

Tritium: A radioisotope of the element hydrogen with two neutrons and one proton. Common symbols for the isotope are H-3 and T.

Tuff: A rock composed of the finer kinds of volcanic detritus usually fused together by heat.

Uranium: A heavy, silvery-white metallic element (atomic number 92) with many radioisotopes. ^{235}Uranium is most commonly used as a fuel for nuclear fission. Another isotope, ^{238}uranium, can be transformed into fissionable ^{239}plutonium by its capture of a neutron in a nuclear reactor.

Vadose zone: A region in a porous medium in which the pore space is not filled with water.

Volatile organic compounds (VOCs): A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures. They include compounds such as benzene, chloroform, and methyl alcohol.

Waste acceptance criteria (WAC): Requirements established by treatment, storage, and disposal facilities for the acceptance of waste into a facility.

Water table: Water under the surface of the ground occurs in two zones, an upper unsaturated zone and the deeper saturated zone. The boundary between the two zones is the water table.

Wave guides: A quadrangular tube designed for the transfer of microwaves.

Weir: A dam in a stream or river to raise the water level or divert its flow.

Wetland: Land or areas exhibiting hydric (requiring considerable moisture) soil concentrations, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions.

Wind rose: A depiction of wind speed and direction frequency for a given period of time.

X-ray: A penetrating electromagnetic radiation, which may be generated by accelerating electrons to high velocity and suddenly stopping them by collision with a target material.

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