DOE/EIS-0240

Office of
Fissile Materials Disposition

United States Department of Energy

Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement

Volume I

June 1996

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Department of Energy
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June 1996

Dear Interested Party:

The *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* is enclosed for your information. This document has been prepared in accordance with the National Environmental Policy Act, and reflects comments received on an earlier draft released in October 1995 for review by the public. The document presents the analyses of the environmental impacts of alternatives for the disposition of weapons-usable highly enriched uranium (HEU) that has been declared surplus to national defense needs.

The Department proposes to eliminate the proliferation threat of surplus HEU by blending it down to low enriched uranium (LEU), which is not weapons-usable. The EIS assesses the disposition of a nominal 200 metric tons of surplus HEU. The Preferred Alternative is, where practical, to blend the material for sale as LEU and use over time, in commercial nuclear reactor fuel to recover its economic value. Material that cannot be economically recovered would be blended to LEU for disposal as low-level radioactive waste.

In addition to the "No Action" Alternative, the HEU EIS analyzes four alternatives that represent different proportions of the resulting LEU being used in commercial reactor fuel or disposed of as waste. It analyzes the blending of HEU using three different processes at four potential sites. The transportation of materials is also analyzed.

A public comment period for the HEU Draft EIS was held from October 27, 1995 to January 12, 1996. Comments were received by letter, fax, electronic mail, and telephone recording. In addition, public workshops on the EIS were held in Knoxville, Tennessee and Augusta, Georgia in November, 1995. All comments were considered by the Department in preparing the Final EIS and are presented along with responses in Volume II of the document. A Record of Decision on surplus HEU disposition will be issued no sooner than 30 days following publication of the Notice of Availability of the HEU Final EIS in the Federal Register.

The Department appreciates the participation of outside organizations and the general public in the review of this document.

Sincerely,

J. David Nulton, Director
Office of NEPA Compliance and Outreach
Office of Fissile Materials Disposition

COVER SHEET

Lead Federal Agency: U.S. Department of Energy (DOE)
Cooperating Federal Agency: U.S. Environmental Protection Agency

TITLE:

Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement–Summary
(DOE/EIS-0240-S)

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ABSTRACT:

This document assesses the environmental impacts that may result from alternatives for the disposition of U.S.-origin weapons-usable highly enriched uranium (HEU) that has been or may be declared surplus to national defense or defense-related program needs. In addition to the No Action Alternative, it assesses four alternatives that would eliminate the weapons-usability of HEU by blending it with depleted uranium, natural uranium, or low-enriched uranium (LEU) to create LEU, either as commercial reactor fuel feedstock or as low-level radioactive waste. The potential blending sites are DOE's Y–12 Plant at the Oak Ridge Reservation in Oak Ridge, Tennessee; DOE's Savannah River Site in Aiken, South Carolina; the Babcock & Wilcox Naval Nuclear Fuel Division Facility in Lynchburg, Virginia; and the Nuclear Fuel Services Fuel Fabrication Plant in Erwin, Tennessee. Evaluations of impacts at the potential blending sites on site infrastructure, water resources, air quality and noise, socioeconomic resources, waste management, public and occupational health, and environmental justice are included in the assessment. The intersite transportation of nuclear and hazardous materials is also assessed. The Preferred Alternative is blending down as much of the surplus HEU to LEU as possible while gradually selling the commercially usable LEU for use as reactor fuel. DOE plans to continue this over an approximate 15- to 20-year period, with continued storage of the HEU until blend down is completed.

PUBLIC INVOLVEMENT:

The Department of Energy issued a HEU Draft EIS on October 27, 1996, and held a formal public comment period on the HEU Draft EIS through January 12, 1996. In preparing the HEU Final EIS, DOE considered comments received via mail, fax, electronic bulletin board (Internet), and transcribed from messages recorded by telephone. In addition, comments and concerns were recorded by notetakers during interactive public hearings held in Knoxville, Tennessee, on November 14, 1995, and Augusta, Georgia, on November 16, 1995. These comments were also considered during preparation of the HEU Final EIS. Comments received and DOE's responses to those comments are found in Volume II of the EIS.

DOE/EIS-0240

Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement

Volume I

United States Department of Energy
Office of Fissile Materials Disposition

June 1996

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LIST OF ACRONYMS AND ABBREVIATIONS

ABB-CE	Asea Brown-Boveri Combustion Engineering
ALARA	as low as reasonably achievable
AQCR	Air Quality Control Region
ASTM	American Society of Testing Materials
B&W	Babcock & Wilcox
BEIR	Biological Effects of Ionizing Radiation
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CNFP	Commercial Nuclear Fuel Plant
CRT	cargo restraint transportation
CSXT	CSX Transportation
CWA	*Clean Water Act*
DNL	day/night average sound levels
DOE	Department of Energy
DOT	Department of Transportation
DU	depleted uranium
EA	environmental assessment
EIS	environmental impact statement
EPA	Environmental Protection Agency
ES&H	Environmental, Safety, and Health
FEMA	Federal Emergency Management Agency
FFCA	*Federal Facility Compliance Agreement*
FONSI	Finding of No Significant Impact
GE	General Electric
HEPA	high-efficient particulate air
HEU	highly enriched uranium
HEU EIS	*Disposition of Surplus Highly Enriched Uranium Environmental Impact Statement*
HI	Hazard Index
HLW	high-level waste
HQ	Hazard Quotient
I	Interstate highways
IAEA	International Atomic Energy Agency
IDLH	Immediately Dangerous to Life or Health
INEL	Idaho National Engineering Laboratory
IP	implementation plan
IRIS	Integrated Risk Information System
LANL	Los Alamos National Laboratory
LEU	low-enriched uranium
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
MEI	maximally exposed individual
MOU	memorandum of understanding
NAAQS	National Ambient Air Quality Standards
NEPA	*National Environmental Policy Act* of 1969
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFS	Nuclear Fuel Services

NNFD	Naval Nuclear Fuel Division
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NS	Norfolk Southern Railroad
NTS	Nevada Test Site
NU	natural uranium
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
PEIS	programmatic environmental impact statement
POTW	Publicly Owned Treatment Works
PSD	Prevention of Significant Deterioration
RCRA	*Resource Conservation and Recovery Act*
REA	regional economic area
RFI	Remedial Feasibility Investigation
ROD	Record of Decision
ROI	region of influence
SAR	Safety Analysis Report
SNL	Sandia National Laboratories
SR	State Route highways
SRS	Savannah River Site
SRS IMNM EIS	*Savannah River Site Interim Management of Nuclear Materials Environmental Impact Statement*
SST	safe secure trailer
STEL	Short-Term (15-minute) Exposure Limits
SWU	Separative Work Unit
TDEC	Tennessee Department of Environment and Conservation
TDS	total dissolved solids
TLV	Threshold Limit Values
TRU	transuranic
TSCA	*Toxic Substance Control Act*
TSP	total suspended particulates
TWA	Time (8-hour) Weighted Average
USEC	United States Enrichment Corporation
VOC	volatile organic compounds
VRM	Visual Resource Management
Y–12 EA	*Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y–12 Plant, Oak Ridge, Tennessee*

CHEMICALS AND UNITS OF MEASURE

Al_2O_3	aluminum oxide
BeO	beryllium oxide
BGY	billion gallons per year
Bq	becquerel
BTU	British Thermal Units
°C	degrees Celsius
Ci	curie
cm	centimeter
cm^3	cubic centimeter
CO	carbon monoxide
CO_3	carbonate
dBA	decibel A-weighted
°F	degrees Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
F_2	fluorine
g	gram
gal	gallon
GPD	gallons per day
ha	hectare
H_2	hydrogen
H_2O	water
HCO_3	bicarbonate
HF	hydrogen fluoride
HNO_3	nitric acid
hr	hour
in	inch
kg	kilogram
km	kilometer
km^2	square kilometer
l	liter
lb	pound
m	meter
m^2	square meter
m^3	cubic meter
mCi	millicurie
mg	milligram
MGD	million gallons per day
MGY	million gallons per year
mi	mile
mi^2	square mile
mrem	millirem (one thousandth of a rem)
MTU	metric ton uranium
MWe	megawatt electric

MWh	megawatt hour
N_2	nitrogen
NaOH	sodium hydroxide
nCi	nanocurie (one-billionth of a Curie)
NO_2	nitrogen dioxide
NO_3	nitrogen trioxide
O_3	ozone
Pb	lead
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
pCi	picocurie (one-trillionth of a Curie)
PM_{10}	particulate matter (less than 10 microns)
ppm	parts per million
Pu	plutonium
Pu-238	plutonium-238
Pu-239	plutonium-239
Ra-226	radium-226
rem	roentgen equivalent man
Rn-222	radon-222
s	second
SO_2	sulfur dioxide
t	metric ton
Tc-99	technetium-99
Th-230	thorium-230
Th-234	thorium-234
TCE	trichloroethylene
U	uranium
U/Al	uranium-aluminum
U-232	uranium-232
U-234	uranium-234
U-235	uranium-235
U-236	uranium-236
U-238	uranium-238
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
UNH	uranyl nitrate hexahydrate
UO_2	uranium dioxide
UO_3	uranium trioxide
U_3O_8	triuranic octaoxide
yr	year
µCi	microcurie (one-millionth of a curie)
µg	microgram (one-millionth of a gram)
µohms/cm	resistance per centimeter

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					
sq. inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.40469	hectares	hectares	2.471	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. 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
Force					
dynes	.00001	newtons	newtons	100,000	dynes
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

The numbers (estimated by models or calculated, not those obtained from references) in this document have been rounded using engineering judgment to facilitate reading and understanding of the document. Because numbers have been rounded, converting these numbers from metric to English using the conversion table above will give answers not consistent within the text.

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}
deka-	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}

Chapter 1
Introduction, Purpose of, and Need for the Proposed Action

1.1 INTRODUCTION

The Department of Energy (DOE) is the Federal agency responsible for the management, storage, and disposition of weapons-usable fissile materials from U.S. nuclear weapons production and dismantlement activities. Highly enriched uranium (HEU) is a weapons-usable fissile material; in certain forms and concentrations, it can be used to make nuclear weapons.[1] In accordance with the *National Environmental Policy Act* of 1969 (NEPA), the Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500–1508), and DOE's NEPA Implementation Procedures (10 CFR Part 1021), DOE has prepared this environmental impact statement (EIS) to evaluate alternatives for the disposition of U.S.-origin HEU that has been or may be declared surplus to national defense or national defense-related program needs by the President.

This EIS consists of two volumes. Volume I contains the main text and the technical appendices that provide supporting details for the analyses contained in the main text. Volume II contains the comments received on the HEU Draft EIS during the public review period and the DOE responses to those comments. A summary of the *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (HEU EIS) is also available as a separate document. Changes to the HEU Draft EIS are shown by side bar notation (vertical lines adjacent to text) in this HEU Final EIS for both the text and tables. Deletion of one or more sentences is indicated by the phrase "text deleted" in brackets. Similarly, where a table or figure has been removed, the phrase "table deleted" or "figure deleted" is shown.

[1] Plutonium (Pu) is the other major weapons-usable fissile material. This document covers the disposition of surplus HEU. The storage of nonsurplus Pu and the storage and disposition of surplus Pu, as well as the storage of nonsurplus HEU and surplus HEU before disposition (or continued storage of surplus HEU if no action is selected in the Record of Decision for this HEU EIS), are analyzed in the *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement*, which was issued (in draft form) in February 1996.

Acting as lead agency, DOE requested the participation of agencies and organizations that have jurisdiction or expertise in the proposed action (40 CFR 1501.6). The Environmental Protection Agency (EPA) and United States Enrichment Corporation (USEC) have established frameworks for technical cooperation and each has signed a memorandum of understanding (MOU) with DOE concerning the development of the EIS for the disposition of surplus HEU (Appendix H). The EPA, which has authority under NEPA and under Section 309 [42 U.S.C. 7609] of the *Clean Air Act* and Amendments to review the proposed action, is a cooperating agency.

1.1.1 BACKGROUND

The end of the Cold War created a legacy of weapons-usable fissile materials both in the United States and the former Soviet Union. Further agreements on disarmament between the two nations may increase the surplus quantities of these materials. The global stockpiles of weapons-usable fissile materials pose a danger to national and international security in the form of potential proliferation of nuclear weapons, and the potential for environmental, safety, and health consequences if the materials are not properly safeguarded and managed.

[Text deleted.]

In September 1993, President Clinton issued the Nonproliferation and Export Control Policy (Appendix A) in response to the growing threat of nuclear proliferation. Further, in January 1994, President Clinton and Russia's President Yeltsin issued a joint statement between the United States and Russia on nonproliferation of weapons of mass destruction and the means of their delivery (Appendix B). In accordance with these policies, the focus of the U.S. nonproliferation efforts in this regard is five-fold: to secure nuclear materials in the former Soviet Union; to assure safe, secure, long-term storage and disposition of surplus fissile materials; to establish transparent and irreversible nuclear reductions; to strengthen the nuclear nonproliferation regime; and to control nuclear exports.

Highly Enriched Uranium—A Weapons-Usable Fissile Material

Fissile materials are capable of undergoing nuclear fission, the splitting of an atom that results in the release of a large amount of energy. Plutonium (Pu) and highly enriched uranium (HEU) are the primary fissile materials used as the explosive components of nuclear warheads. Uranium (U) in nature consists of a combination of isotopes, chemically identical elements with the same number of protons (the same atomic number) but different numbers of neutrons (different atomic weights). Natural uranium consists of, by weight, about 99.3-percent uranium-238 (U-238) (the isotope with an atomic weight of 238) and about 0.7-percent U-235 (the isotope with an atomic weight of 235). [Text deleted.]

Through technically complex, costly, energy-intensive, and time-consuming processes that exploit the slightly different sizes of the atoms of the different isotopes, uranium can be "enriched" in the U-235 isotope, which is the primary fissile isotope of uranium. (Because the isotopes are chemically identical, no simple chemical process can be used to effect enrichment.) Uranium that has been enriched from the natural level of 0.7 percent to the range of 3- to 5-percent U-235 can be used to fuel light water nuclear reactors that are used to generate electricity around the world. Uranium that has been enriched to 20-percent or greater U-235 is called "highly enriched" and can be used in nuclear weapons (it is a weapons-usable fissile material).

Whereas enriching uranium is difficult, reversing the process to reduce its enrichment is a relatively simple matter of dilution. Simply blending HEU with slightly enriched (1 to 2 percent), natural (0.7 percent), or depleted (0.2 to 0.7 percent) uranium by one of several available processes reduces the enrichment of the resulting mixture. By blending a product to less than 20-percent enrichment (low-enriched uranium [LEU]), the material is made unusable in nuclear weapons. The resulting LEU cannot be made weapons-usable without going through the difficult enrichment process again. [Text deleted.]

To demonstrate the United States' commitment to these objectives, the President announced on March 1, 1995, that approximately 200 metric tons (t) of fissile materials, 165 t of which are HEU, had been declared surplus to U.S. defense needs.[2] Continuing arms control processes may result in the dismantlement of additional weapons and result in further increases in surplus fissile materials, including HEU.

1.1.2 THE PROPOSED ACTION

The Department of Energy proposes to blend down surplus HEU to low-enriched uranium (LEU) to eliminate the risk of diversion for nuclear proliferation purposes and, where practical, to reuse the resulting LEU in peaceful, beneficial ways that recover its commercial value.[3] Unlike plutonium (Pu), of which most isotopes are weapons-usable, only uranium that has been enriched to 20 percent or more in the uranium-235 (U-235) isotope could be used for weapons. The isotope most abundant in nature is U-238. Therefore, the weapons-usability of HEU can be eliminated by blending it with material that is low in U-235 and high in U-238 to create LEU. This isotopic blending process can be performed by blending HEU with depleted uranium (DU), natural uranium (NU), or LEU blendstock. Once HEU is blended down to LEU, it is no more weapons-usable than existing, abundant supplies of LEU. It would need to be re-enriched to be useful in weapons, which is a costly, technically demanding, and time-consuming process. Therefore, blending to LEU is the most timely and effective method for eliminating the proliferation threat of surplus HEU.

[2] The Secretary of Energy's *Openness Initiative* announcement of February 6, 1996, declared that the United States has about 213 t of surplus fissile materials, including the 200 t the President announced in March 1995. Of the 213 t of surplus materials, the *Openness Initiative* indicated that about 174.3 t (hereafter referred to as approximately 175 t) are HEU, including 10 t previously placed under International Atomic Energy Agency (IAEA) safeguards in Oak Ridge, Tennessee. The HEU Draft EIS, which identified the current surplus as 165 t, did not include the IAEA-safeguarded material.

[3] Low-enriched uranium has commercial value because at appropriate enrichment levels and in appropriate forms, it can be used as fuel for the generation of electricity in nuclear power plants.

The Department of Energy's inventory of surplus HEU consists of a variety of chemical, isotopic, and physical forms. If blended down, much of the resulting LEU will be suitable for commercial use in the fabrication of fuel for nuclear power plants. Other portions of the resultant LEU would contain uranium isotopes, such as U-234 and U-236, that would make them less desirable for commercial use. To the extent that they could not be commercially used, these portions would need to be disposed of as low-level waste (LLW). Some of the material, the "off-spec" material[4], may or may not be suitable for commercial use because its isotopic composition would not meet current industry specifications for commercial nuclear reactor fuel. Nonetheless, it could be used as fuel under certain circumstances, as explained later in this EIS.

[Text deleted.]

[Figure deleted.]

All of the materials covered in the HEU EIS may be subject to international and/or bilateral inspection. All of the surplus fissile materials and the unclassified material forms may be subject to inspection by the International Atomic Energy Agency (IAEA) pursuant to the U.S./IAEA Safeguard Agreement or based on agreements between the United States and Russia to increase transparency of nuclear weapons dismantlement. Currently, 10 t of HEU is under IAEA safeguards in a storage vault at the Y–12 Plant. Future plans are to maximize the amount of surplus HEU under IAEA safeguards (pursuant to Presidential Decision Directives 13 and 41) in either static storage or down-blending operations. Facilities for surplus HEU disposition would need to accommodate inspection requirements. Other modifications to facility design might be needed should new treaties such as the *Open Skies Treaty* and the protocols for the *Biological and Chemical Warfare Conventions* become effective.

Because of the multiplicity of existing material forms and potential end products (commercial reactor fuel or LLW), disposition of the entire inventory of surplus HEU is likely to involve multiple processes, facilities, and business arrangements. As described in Section 1.4.2, DOE has established a Preferred Alternative in this EIS. The Preferred Alternative is to gradually blend down surplus HEU, sell the resulting LEU for commercial use, and eventually blend and dispose of the non-usable LEU as LLW.

1.2 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The Department of Energy proposes to blend down surplus HEU from the weapons program to LEU to eliminate the risk of diversion for nuclear proliferation purposes and, where practical, to reuse the resulting LEU in peaceful, beneficial ways that recover its commercial value. The purpose of the proposed action is to reduce the threat of nuclear weapons proliferation worldwide in an environmentally safe manner by reducing stockpiles of weapons-usable fissile materials, setting a nonproliferation example for other nations, and allowing peaceful, beneficial reuse of the material to the extent practical. [Text deleted.]

Comprehensive disposition actions are needed to ensure that surplus HEU is converted to proliferation-resistant forms consistent with the objectives of the President's nonproliferation policy. These proposed actions would essentially eliminate the potential for reuse of the material in nuclear weapons and would demonstrate the U.S. commitment to dispose of surplus HEU and encourage other nations to take similar actions toward reducing stockpiles of surplus HEU. [Text deleted.] The proposed actions would begin to reduce DOE's HEU inventory and costs associated with storage, accountability, and security rather than depending upon indefinite storage of all such material.

[4] Off-spec material is material that, when blended to LEU, would not meet industry standard (American Society for Testing and Materials) specifications for isotopic content of commercial nuclear reactor fuel. The ultimate disposition of the off-spec material will depend on the ability and willingness of nuclear fuel fabricators and nuclear utilities to use and the Nuclear Regulatory Commission to license the use of off-spec fuel. (For instance, fuel with a higher than usual proportion of the isotope U-236, which inhibits the fission process that is needed for reactors to produce heat and electricity, can still be used in nuclear fuel if the fuel is at a somewhat higher enrichment level. High levels of U-234 can have implications for worker radiation exposures in fuel fabrication.) Utilities have expressed some interest in the use of such material, but the practical extent of that interest will depend upon cost and market conditions, among other things.

1.3 SCOPE OF THIS ENVIRONMENTAL IMPACT STATEMENT

This EIS assesses environmental impacts of reasonable alternatives identified for the disposition of surplus HEU. This EIS considers HEU that has already been declared surplus (175 t, Section 1.1.1), as well as additional HEU (not yet identified) that may be declared surplus in the future. This EIS assesses the disposition of a nominal 200 t of surplus HEU. This surplus HEU includes materials with enrichment levels of 20 percent or greater by weight of the isotope U-235. The material, which is in a variety of forms, is currently located at facilities throughout DOE's nuclear weapons complex. As a result of the Secretary of Energy's *Openness Initiative* announcement of February 6, 1996, DOE is now able to provide additional unclassified details about the locations, forms, and quantities of surplus HEU, which are shown in Figure 1.3–1. This EIS also addresses the transfer of title to 7,000 t of NU now owned by DOE to USEC. This material is part of a large quantity that is in storage at DOE's Portsmouth and Paducah gaseous diffusion plants.

The screening process for fissile materials disposition concluded that all the reasonable alternatives for surplus HEU disposition involve blending the HEU down to LEU to remove its potential for use in nuclear weapons. This EIS assesses potential environmental impacts associated with the four sites where HEU conversion and blending could occur: DOE's Y–12 Plant at the Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee; DOE's Savannah River Site (SRS) in Aiken, South Carolina; the Babcock & Wilcox (B&W) Naval Nuclear Fuel Division facility in Lynchburg, Virginia; and the Nuclear Fuel Services (NFS) facility in Erwin, Tennessee. Three blending technologies are analyzed; uranyl nitrate hexahydrate (UNH) blending would be used to produce either commercial reactor fuel or LLW, whereas uranium hexafluoride (UF_6) and metal blending would only be used to produce commercial reactor fuel and LLW, respectively. This EIS also assesses the environmental impacts of transportation of materials. Because of the variety of existing material forms and the different end products that result (commercial reactor fuel or LLW), multiple paths and multiple disposition actions are likely to be pursued for the surplus inventory.

Until recently, DOE was authorized to market LEU, including LEU derived from HEU, only with USEC acting as its marketing agent.[5] [Text deleted.] On April 26, 1996, the President signed Public Law 104-134, the *Balanced Budget Down Payment Act*, which included provisions (in Sections 3101-3117, the *USEC Privatization Act*) providing for the privatization of USEC (see Appendix J). This legislation provides that once USEC is privatized, DOE is not required to sell through USEC, but places several conditions on the sale or transfer of DOE's uranium inventory (Public Law 104-134, Section 3112(d), 3116(a)(1)). Thus, once USEC is privatized, DOE will have numerous business options for selling LEU derived from surplus HEU and could pursue a number of different methods for undertaking or contracting blending services and LEU sales over time. The HEU EIS addresses the potential impacts associated with the various alternatives regardless of the commercial arrangements.

The exact quantity of future discrete "batches" of surplus HEU and the exact time at which such batches would be subject to disposition would depend on a number of factors, including the rate of weapons dismantlement; the rate at which the HEU is declared surplus; market conditions; work orders for commercial fuel feed; legislative restrictions on sales (see Public Law 104-134); and available throughput capacities and capabilities of the blending facilities. This EIS analyzes the blending of surplus HEU at the facilities and using technologies that exist and are available today or that could be added without new construction. It analyzes the transportation of necessary materials from their likely places of origin to the potential blending sites, and from blending sites to the likely or representative destinations for nuclear fuel fabrication or waste disposal. Decisions about the timing and details of specific disposition actions (which facility or process to use) might be made in part by DOE, USEC, the private successor to USEC, or other private entities acting as marketing agents for DOE.

[5] The *Energy Policy Act* of 1992, Public Law 102-486, created USEC as a wholly Government-owned corporation to take over uranium enrichment functions from DOE. The legislation made USEC the Government's exclusive marketing agent for enriched uranium (42 U.S.C. 2297c(a)).

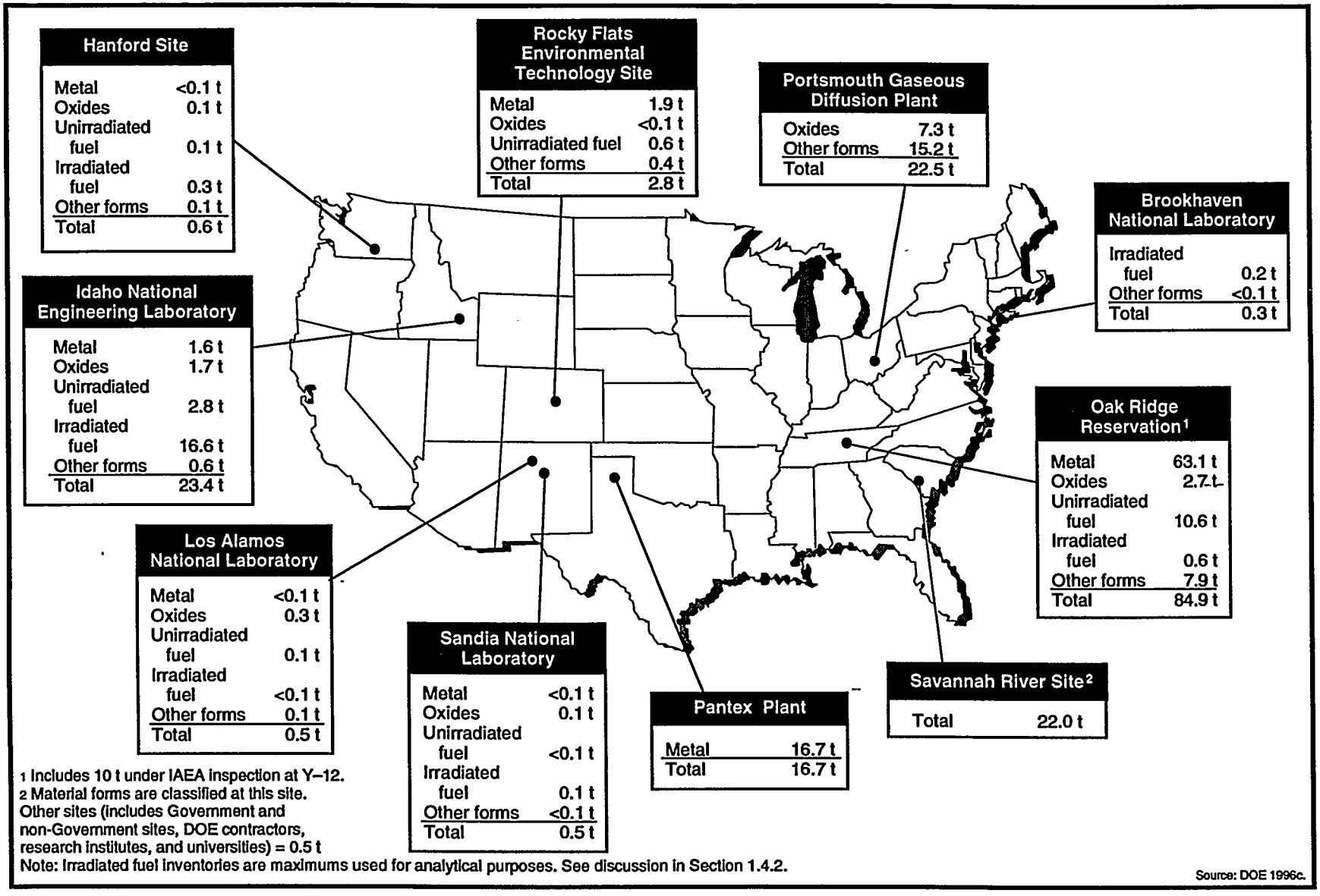

Figure 1.3–1. Locations, Forms, and Amounts of Surplus Highly Enriched Uranium, as of February 6, 1996.

1.4 ALTERNATIVES

1.4.1 ALTERNATIVES CONSIDERED

Several representative, reasonable alternatives are described in Chapter 2, and their impacts are assessed in Chapter 4. In addition to the No Action Alternative, there are four alternatives that represent different ratios of blending to commercial use versus blending to waste (fuel/waste ratios). Alternative 1 is No Action (continued storage). Alternative 2 is No Commercial Use and represents blending all 200 t of surplus HEU to waste (the fuel/waste ratio is 0/100) using all four sites. Alternative 3 is Limited Commercial Use and includes transferring 50 t of HEU to USEC for commercial use[6] and blending 150 t of surplus HEU to waste. Alternative 3 assumes the 50 t of commercial material would be blended at the two commercial sites, but the waste material would be blended at all four sites. Alternative 4 is Substantial Commercial Use and represents blending about 65 percent of the material to fuel and about 35 percent to waste. Alternative 5 is Maximum Commercial Use and represents blending about 85 percent of the material to fuel and about 15 percent of the material to waste. As with Alternative 3, both Alternatives 4 and 5 include the proposal to transfer 50 t of surplus HEU to USEC. Alternatives 4 and 5 each have four site variations: two DOE sites only, two commercial sites only, all four sites, and each site alone.

The alternatives as described are not intended to represent exclusive choices among which DOE must choose, but rather are analyzed to represent reasonable points in a matrix of possible reasonable choices. Section 4.5 explains how impacts would change over the life of the campaign if the exact fuel/waste ratio or division among sites were different.

[6] The proposal to transfer 50 t of HEU and 7,000 t of NU to USEC is specifically authorized by Section 3112(c) of Public Law 104-134. Those proposed transfers are components of each of the commercial use alternatives (3, 4, and 5). The delivery to commercial end users of the surplus uranium transferred to USEC could not begin before 1998, pursuant to the statute. Because the proposed transfer of 7,000 t of NU from DOE to USEC is part of the same proposed transaction as the transfer of 50 t of HEU, the environmental impacts of that transfer are assessed in Section 4.9 of the HEU EIS. DOE may propose to sell additional remaining inventories of NU, and those decisions will be considered in separate NEPA reviews, as appropriate.

1.4.2 PREFERRED ALTERNATIVE

The Department of Energy has identified a Preferred Alternative that satisfies the purpose and need described in Section 1.2. The Preferred Alternative is as follows:

- To gradually blend down surplus HEU and sell as much as possible (up to 85 percent) of the resulting commercially usable LEU (including as much "off-spec" LEU as practical) for use as reactor fuel (including 50 t of HEU that are proposed to be transferred to USEC over a 6-year period), using a combination of four sites (Y–12, SRS, B&W, and NFS) and two possible blending technologies (blending as UF_6 and UNH) that best serves programmatic, economic, and environmental needs, beginning following the Record of Decision (ROD) and continuing over an approximate 15- to 20-year period, with continued storage of the HEU until blend down

- To eventually blend down surplus HEU that has no commercial value using a combination of four sites (Y–12, SRS, B&W, and NFS) and two blending technologies (blending as UNH and metal) that best serves programmatic, economic, and environmental needs, to dispose of the resulting LEU as LLW, and to continue to store the HEU until blend down occurs

Thus, the Preferred Alternative is Alternative 5, which would result in the blend down and eventual commercial use of up to 85 percent of the surplus HEU, with the remaining 15 percent being blended down for disposal as waste. As a portion of the surplus HEU is in forms, such as residues and weapons components, that would require considerable time to make available for blending, it is anticipated that no more than 70 percent of the surplus HEU could be blended down and commercialized in the near term (over the next 10- to 15-year period).

A portion of the surplus HEU is in the form of irradiated fuel (the total quantity of which remains

classified). The irradiated fuel is not directly weapons-usable, is under safeguards and security, and poses no proliferation threat. Therefore, DOE is not proposing to process the irradiated fuel to separate the HEU for down blending as part of any of the alternatives in this EIS. There are no current or anticipated DOE plans to process irradiated fuel solely for the purposes of extracting HEU. However, activities associated with the irradiated fuel for purposes of stabilization, facility cleanup, treatment, waste management, safe disposal, or environment, safety, and health reasons could result in the separation of HEU in weapons-usable form that could pose a proliferation threat and thus be within the scope of this EIS. Under the Preferred Alternative, DOE would recycle any such recovered HEU and blend it to LEU pursuant to this EIS.[7] (If the No Action Alternative were selected in the ROD for this EIS, such "recovered" HEU would continue to be stored pursuant to the *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* [Storage and Disposition PEIS] or other appropriate NEPA analyses.) To provide a conservative analysis presenting maximum potential impacts, this EIS includes such HEU (currently in the form of irradiated fuel) in the material to be blended to LEU, as if such HEU had been separated from the irradiated fuel pursuant to health and safety, stabilization, or other non-defense activities. However, such HEU may actually remain in its present form (without the HEU ever being separated) and be disposed of as high level waste in a repository or alternative pursuant to the *Nuclear Waste Policy Act*.[8]

The Department of Energy anticipates that the blending will most likely be done at some combination of commercial and DOE sites (site Variation c in Table 2.1.2–1). With respect to the HEU that could be blended to commercial fuel feed for commercial power reactors, including the 50 t of HEU proposed to be transferred to USEC, the decisions and associated contracts concerning 1) which facility(ies) would blend the material, and 2) marketing of the fuel, may be made by USEC, or by a private corporation as successor to USEC, or by other private entities acting as marketing agents for DOE, or by DOE.

The Department of Energy has concluded that the Preferred Alternative would best serve the purpose and need for the HEU disposition program for several reasons. DOE considers all of the action alternatives (2 through 5) to be roughly equivalent in terms of serving the nonproliferation objective of the program. Both 4-percent LEU in the form of commercial spent nuclear fuel and 0.9-percent LEU oxide for disposal as LLW—and any allocation between them—fully serve the nonproliferation objective, as both processing of the spent fuel and re-enrichment of the 0.9-percent LEU to make new weapons-usable material would be technologically difficult and expensive. However, the alternatives that include commercial use better serve the economic recovery objective of the program by allowing for peaceful, beneficial reuse of the material. Commercial use would reduce the amount of blending that would be required for disposition (a 14 to 1 blending ratio of blendstock to HEU as opposed to 70 to 1 for waste) and minimize Government waste disposal costs that would be incurred if all (or a greater portion of) the material were blended to waste. The sale of LEU derived from surplus HEU would yield returns on prior

[7] For example, weapons-usable HEU is anticipated to be recovered from dissolving and stabilizing targets and spent fuel at SRS pursuant to the analysis and decisions in the EIS (October 1995) and ROD (December 1995 and February 1996) on the *Final Interim Management of Nuclear Materials* at SRS, and from the proposed demonstration of electrometallurgical treatment at Argonne National Laboratory-West pursuant to the analysis in the *Environmental Assessment for Electrometallurgical Treatment Research and Demonstration Project in the Fuel Conditioning Facility at Argonne National Laboratory - West* (May 1996) (Finding of No Significant Impact, May 15, 1996). As part of the proposed electrometallurgical treatment demonstration, HEU derived from the demonstration would be down-blended to LEU at Argonne National Laboratory-West; therefore, such material would not be blended down as part of this HEU EIS.

[8] If HEU currently in irradiated fuel remains in its current form, it would be managed pursuant to the analyses and decisions in the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement* (April 1995) and the associated RODs (60 FR 28680, June 1, 1995, amended by 61 FR 9441, March 8, 1996), and subsequent, project-specific or site-specific NEPA documentation. Such spent fuel could be disposed of as high level waste in a repository pursuant to the *Nuclear Waste Policy Act* (42 U.S.C. 10101 *et seq.*). DOE is in the process of characterizing the Yucca Mountain Site in Nevada as a potential repository under that Act.

investments to the Federal Treasury. Finally, the analysis in this EIS indicates that commercial use of LEU derived from surplus HEU would minimize overall environmental impacts because blending for commercial use involves generally lower impacts, and because adverse environmental impacts from uranium mining, milling, conversion, and enrichment would be avoided by using this material rather than mined uranium to produce nuclear fuel.

An indirect impact of the Preferred Alternative would be the creation of spent nuclear fuel (through the use of commercial LEU fuel derived from surplus HEU in power reactors). However, since the LEU nuclear fuel derived from surplus HEU would replace nuclear fuel that would have been created from newly mined uranium without this action, there would be no additional spent fuel generated. Because LEU derived from surplus HEU supplants LEU from NU, the environmental impacts of uranium mining, milling, conversion, and enrichment to generate an equivalent amount of commercial reactor fuel would be avoided (see Section 4.7). The domestic spent fuel would be stored and potentially disposed of in a repository or other alternative, pursuant to the *Nuclear Waste Policy Act* as amended (42 U.S.C. 10101 *et seq.*).

[Text deleted.]

With respect to the ultimate disposal of LLW material, certain DOE LLW is currently disposed of at commercial facilities, and other DOE LLW is stored or disposed of at DOE sites. A location where LLW derived from DOE's surplus HEU can be disposed of has not been designated. Disposal of DOE LLW would be pursuant to DOE's *Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE/EIS-0200-D, draft issued in August 1995) (Waste Management PEIS) and associated ROD(s), and any subsequent NEPA documents tiered from or supplementing the Waste Management PEIS. Waste material derived from surplus HEU would be required to meet LLW acceptance criteria of DOE's Office of Environmental Management. For purposes of analysis of LLW transportation impacts only, this EIS assumes the use of the existing LLW facility at the Nevada Test Site (NTS) as a representative facility. Other sites being analyzed in the Waste Management PEIS for disposal of LLW include ORR, SRS, and the Hanford Site. No LLW would be transferred to NTS (or any alternative LLW facility) until completion of the Waste Management PEIS (or other applicable project or site-specific NEPA documentation, such as the NTS Site-Wide EIS) and in accordance with decisions in the associated ROD(s). [Text deleted.] Additional options for disposal of LLW may be identified in other documents.

Continued storage of surplus HEU prior to blending may be required for some time. The storage, pending disposition (for up to 10 years) of surplus HEU at the Y–12 Plant (where most of the HEU is stored or destined to be stored), is analyzed in the *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y–12 Plant, Oak Ridge, Tennessee* (DOE/EA-0929, September 1994) (Y–12 EA). Impacts from storage, as analyzed in the Y–12 EA and incorporated by reference herein, are briefly summarized in this EIS (see Section 4.2). Should the surplus HEU disposition actions continue beyond 10 years, subsequent storage of surplus HEU pending disposition will be pursuant to and consistent with the ROD associated with the Storage and Disposition PEIS or tiered NEPA documents.[9]

1.5 THE FISSILE MATERIALS DISPOSITION PROGRAM AND THE *NATIONAL ENVIRONMENTAL POLICY ACT*

1.5.1 PROGRAM DEVELOPMENT FOR FISSILE MATERIALS DISPOSITION

In partial response to the President's nonproliferation policy, Secretary of Energy Hazel O'Leary created the Fissile Materials Disposition Project on January 24, 1994, which later that year became the Office of Fissile Materials Disposition by statute (Public Law 103-337). This office is charged with developing departmental recommendations and directing implementation of decisions concerning disposition

[9] Under the No Action Alternative for the Storage and Disposition PEIS, if storage of surplus HEU pending disposition (or no action) continued beyond 10 years, storage facilities at Y–12 would be maintained to ensure safe facility operation, or surplus HEU material might be moved out of the Y–12 Plant at the end of this 10-year period with the completion of the relocation within the following 5 years. Subsequent NEPA review would be conducted as required.

of excess weapons-usable fissile materials. Its primary focus is to examine and implement options for placing fissile materials in a form or condition that is substantially and inherently more difficult to use in nuclear weapons. This arms control/nonproliferation objective must be achieved in a safe, environmentally sound, cost-effective manner.

The Department of Energy has determined that the long-term storage and disposition of weapons-usable fissile materials represents a major Federal action and could have a significant impact on the environment. On June 21, 1994, DOE published a Notice of Intent (NOI) in the *Federal Register* (59 FR 31985) to prepare a PEIS for weapons-usable fissile materials, including both surplus and nonsurplus HEU. The purpose of the NOI was to inform the public of the proposed scope of the Storage and Disposition PEIS, to solicit public input, and to announce that public scoping meetings would be conducted from August through October 1994. The extensive scoping process for the Storage and Disposition PEIS included options for the disposition of surplus HEU.

At the scoping meetings, the Department of Energy also received input on proposed screening criteria to be used to determine reasonable alternatives that should be further evaluated in the Storage and Disposition PEIS. The screening process specifically addressed HEU as well as other fissile materials. The screening criteria were based on the President's September 1993 nonproliferation policy, the January 1994 summit meeting in Moscow between Presidents Clinton and Yeltsin, and the analytical framework established by the National Academy of Sciences in a 1994 report. A summarized listing of the screening criteria as they apply to HEU disposition follows (the order does not reflect relative evaluation importance):

- **Resistance to Theft or Diversion by Unauthorized Parties.** Each step in the process must be capable of providing for comprehensive protection and control of weapons-usable fissile materials.

- **Resistance to Retrieval, Extraction, and Reuse by the Host Nation.** The surplus material must be made highly resistant to potential reuse in weapons to reduce the reliance on institutional controls and demonstrate that arms reductions will not be easily reversed.

- **Technical Viability.** There should be a high degree of confidence that the disposition alternative will be technically successful.

- **Environmental, Safety and Health (ES&H) Compliance.** High standards of public and worker health and safety and environmental protection must be met, and significant new burdens should not be created.

- **Cost-Effectiveness.** The option should be accomplished in a cost-effective manner.

- **Timeliness.** The time that the materials remain in weapons-usable form should be minimized.

- **Fostering Progress and Cooperation With Russia and Other Countries.** The options must establish appropriate standards for the disposition of international weapons-usable material inventories, support negotiations for bilateral or multi-lateral reductions in these materials, and allow for international verification.

- **Public and Institutional Acceptance.** An alternative should be able to muster a broad and sustainable consensus.

[Text deleted.]

The disposition of surplus HEU was originally considered within the scope of the single Storage and Disposition PEIS also dealing with Pu. In the course of the PEIS public scoping process, DOE realized that it might be more appropriate to analyze the impacts of surplus HEU disposition in a separate EIS. DOE held a public meeting on November 10, 1994, to obtain comments on the subject of considering HEU disposition separately from the Storage and Disposition PEIS. While both pro and con views were expressed, DOE subsequently concluded that a separate EIS would be appropriate. Scoping for

surplus HEU disposition had already occurred as part of the scoping process for the Storage and Disposition PEIS.

The decision to separate analysis of HEU from the Storage and Disposition PEIS was made for a number of reasons, including the following. The disposition of surplus HEU could use existing technologies and facilities in the United States, in contrast to the disposition of surplus Pu. The disposition of surplus HEU would involve different timeframes, technologies, facilities, and personnel than those required for the disposition of surplus Pu. Decisions on surplus HEU disposition are independently justified; would not impact, trigger, or preclude other decisions that may be made regarding the disposition of surplus Pu; and would not depend on action taken or decisions made pursuant to the Storage and Disposition PEIS. In addition, a separate action is the most rapid path for neutralizing the proliferation threat of surplus HEU, is consistent with the President's nonproliferation policy, would demonstrate the U.S. nonproliferation commitment to other nations, and is consistent with the course of action now underway in Russia to reduce Russian HEU stockpiles.

Accordingly, DOE published a notice in the *Federal Register* (60 FR 17344) on April 5, 1995, to inform the public of the proposed plan to prepare a separate EIS for the disposition of surplus HEU. Four comments (one pro and three con) were received on the proposal. For the reasons explained above, DOE concluded that disposition of HEU should be treated separately.

In accordance with DOE regulations implementing NEPA, 10 CFR 1021.312, DOE published an implementation plan (IP) for this EIS in June 1995. The IP recorded the issues identified during the scoping process, indicated how they would be addressed in the HEU EIS, and provided guidance for the preparation of this EIS. DOE issued the HEU Draft EIS for public comment in October 1995, and provided a public comment period from October 27, 1995 until January 12, 1996. Public workshops on the HEU Draft EIS were held in Knoxville, Tennessee, on November 14, 1995, and in Augusta, Georgia, on November 16, 1995.

1.5.2 Major Comments Received on the *Disposition of Surplus Highly Enriched Uranium Draft Environmental Impact Statement*

During the 78-day public comment period on the HEU Draft EIS, DOE received comments on the document by mail, fax, telephone recording, electronic mail, and orally at the two public workshops. Altogether, DOE received 468 written or recorded comments from 197 individuals or organizations, plus 220 oral comments provided by some of the 134 individuals who attended the public workshops. All of the comments have been entered into a database and are presented in Volume II of the HEU Final EIS, the *Comment Analysis and Response Document.*

The major themes that emerged from public comments on the HEU Draft EIS were as follows:

- There was broad support for the fundamental objective of transforming surplus HEU from the weapons program to non-weapons-usable form by blending it down to LEU (for either fuel or waste). However, a few commentors argued that surplus HEU should be retained in its present form for possible future use, either in weapons or breeder reactors.

- Among those who submitted comments, there was substantial opposition to commercial use of LEU fuel derived from surplus HEU because the commentors believed that such use increases proliferation risk by creating commercial spent nuclear fuel, which includes Pu. Commentors who opposed commercial use generally supported blending surplus HEU to LEU for disposal as waste.

- Substantial concern was expressed by elements of the uranium fuel cycle industry that the entry into the market of LEU fuel derived from surplus HEU from Russian and U.S. weapons programs would depress uranium prices and possibly lead to the closure of U.S.

uranium mines, conversion plants, or enrichment plants.

- Several electric utilities that operate nuclear plants and one uranium supplier expressed the belief that LEU fuel derived from surplus HEU would enter the market at a time when worldwide production is expected to fall considerably short of demand and prices are expected to be rising substantially, which in fact has occurred over the course of completing this EIS. These commentors believed that the likely impact of market sales of LEU fuel derived from surplus HEU would be to moderate sharp price escalation.

- Several commentors argued that "blend and store" options should have been evaluated in the EIS.

- Many commentors expressed support for or opposition to the use of particular facilities for surplus HEU disposition actions.

- A few commentors expressed concern regarding the projected worker latent cancer fatality consequences for facility accidents.

- Numerous commentors wanted to see a formal economic analysis of the alternatives included in the EIS.

1.5.3 CHANGES IN THE *DISPOSITION OF SURPLUS HIGHLY ENRICHED URANIUM FINAL ENVIRONMENTAL IMPACT STATEMENT* IN RESPONSE TO COMMENTS

In response to comments received on the HEU Draft EIS as well as other changes in circumstances, the HEU Final EIS has been modified in the following respects:

- The discussion of potential impacts on the uranium industry (Section 4.8) has been augmented to reflect the enactment of the *USEC Privatization Act* (Public Law 104-134), and to better reflect the cumulative impacts in light of the U.S.-Russian Agreement to purchase Russian HEU blended down to LEU.

- The discussion of the rates of disposition actions that could result in commercial sales of LEU has been modified in Table 2.1.2–1 and throughout the document to better reflect the most current assessment of the time required for DOE to make surplus HEU available for disposition, and the legislative requirement to avoid adverse material impacts on the domestic uranium mining, conversion, or enrichment industries (Public Law 104-134, Section 3112(d)(2)(B)).

- The assessment of impacts to noninvolved workers and the public from accidental releases (radiological) was revised to improve realism in the calculation of doses and the results were incorporated into Chapters 2 and 4 of the HEU Final EIS. Accidental radiological releases of uranium were remodeled using the MELCOR Accident Consequence Code System (MACCS) computer code with more detailed site-specific information to better estimate noninvolved worker (and public) cancer fatalities at each candidate site. The results revealed substantial reductions in projected cancer fatalities for all the blending alternatives at each site. DOE believes that these results reflect more realistic consequences since MACCS offers better capabilities in terms of modeling accident conditions and uses detailed site-specific information.

- The HEU Final EIS has been modified to reflect the fact that SRS has effectively lost the ability to engage in metal blending and currently lacks the ability to solidify and crystallize material at the 4-percent enrichment level. SRS is now assessed only for UNH blending, and the fact that other arrangements must be made for crystallization of commercial-enrichment material is reflected.

- A separate Floodplain Assessment (and Proposed Statement of Findings) has been added to this Final EIS (see Section 4.13) pursuant to 10 CFR Part 1022. This assessment is based, in large part, on information that was presented in the water resources sections of the HEU Draft EIS. The discussion of potential flooding at the NFS site has been expanded in response to comments.

- Several changes have been made to the cumulative impacts section (see Section 4.6) to reflect changes in the status of other projects and their associated NEPA documents.

- Numerous other minor technical and editorial changes have been made to the document.

1.5.4 Unchanged Department of Energy Policy Positions

Some DOE policy positions have remained unchanged between the Draft and HEU Final EISs notwithstanding significant comments that counseled a different approach:

- A substantial number of comments opposed commercial use of LEU fuel derived from surplus HEU. These commentors maintained that commercial use increases proliferation risks by creating Pu-containing spent nuclear fuel. DOE does not agree, however, that spent nuclear fuel poses proliferation risks.[10] Furthermore, reactors that might use LEU fuel derived from surplus HEU would simply use other fuel obtained from NU if the LEU fuel derived from surplus HEU did not exist, so there would be no increase in spent fuel and no increase in Pu created in that spent fuel.

- Most of the comments that opposed commercial use of LEU derived from surplus HEU also expressed opposition to commercial nuclear power in general. Because of the rate that LEU derived from surplus HEU would be made available (due to market prices, market supply, DOE's ability to make the material available, and legislative requirements), the proposed HEU disposition would be neutral in its impacts on commercial nuclear power. The program would not depend on or require any resurgence in the construction of nuclear power plants in the United States.[11] Furthermore, commercial use of LEU (derived from surplus HEU) would make beneficial use of a valuable resource, offset the costs of disposition actions, and minimize adverse environmental impacts (when compared to down-blending to waste, for example).

- Numerous commentors expressed a wish to participate in all aspects of DOE's decisionmaking, including the evaluation of economic considerations. An economic analysis of the alternatives has been prepared to aid the decisionmaker, and is available for public comment separately from this HEU Final EIS. (This analysis has been disseminated to all commentors who expressed an interest in it.)

- The Department of Energy received comments suggesting that the alternative of blending some or all of the HEU to 19-percent LEU and storing it should be evaluated. This option was considered by the screening committee for fissile materials disposition as a specific option (the screening process is explained in Chapter 2). However, this alternative is not reasonable because it would delay

[10] Although spent fuel contains Pu, which if separated is a weapons-usable fissile material, spent fuel is extremely radioactive and hazardous to handle and, thus, it is difficult and costly to separate Pu from spent fuel. In accordance with recommendations of the National Academy of Sciences, it is the policy of the United States to make weapons-usable fissile materials at least as proliferation-resistant as commercial spent fuel.

[11] Discussion of the merits of commercial nuclear power production is beyond the scope of this document.

final disposition, present criticality concerns (for transportation and storage before down-blending) that would need to be accommodated, delay recovery of the economic value of the material, and add storage costs. Furthermore, this option would be practically applicable to only a small portion (20 t or about 40 t if an SRS crystallization facility is subsequently proposed and constructed) of the current surplus HEU inventory.

1.5.5 Office of Fissile Materials Disposition Responsibilities for Highly Enriched Uranium

The Office of Fissile Materials Disposition has responsibility for implementation of the program for the disposition of surplus HEU by:

- Analyzing disposition options for the surplus HEU in terms of cost-effectiveness, timeliness, technological availability, and policy goals
- Conducting environmental analyses of impacts related to the proposed action
- Integrating and documenting the results of the environmental, technical, cost, schedule, and policy analyses for the decisionmaker to support a ROD for DOE actions regarding surplus HEU disposition
- Overseeing the implementation of decisions on the disposition of the surplus HEU

[Text deleted.]

1.5.6 Related *National Environmental Policy Act* Actions

Other NEPA EAs and EISs that are related to, but are not part of or connected with, the scope of this EIS include the following:

- EA/Finding of No Significant Impact (FONSI) for the proposed interim storage of enriched uranium above the maximum historical storage level at the Y–12 Plant, Oak Ridge, Tennessee (DOE/EA-0929, September 1994)
- EA/FONSI on the disposition of HEU obtained from the Republic of Kazakhstan (DOE/EA-1063, May 1995)
- EIS on interim management of nuclear materials at SRS (DOE/EIS-0220, October 1995) (ROD issued, 60 FR 65300)
- PEIS on the storage and disposition of weapons-usable fissile materials (DOE/EIS-0229-D) (draft issued, February 1996)
- PEIS on stockpile stewardship and management (DOE/EIS-0236) (draft issued, February 1996)
- PEIS on waste management (DOE/EIS-0200-D) (draft issued, August 1995)
- EIS for the disposition of depleted UF_6 (in preparation)
- EIS for Nevada Test Site (DOE/EIS-0243) (draft issued, January 1996)
- EA/FONSI for the purchase of Russian LEU derived from the dismantlement of nuclear weapons in the former Soviet Union (DOE/EA-0837, USEC/EA-94001, January 1994)

The relationships of these documents to this HEU EIS are discussed at appropriate locations throughout this document.

Chapter 2
Description of the Proposed Action and Alternatives

2.1 DEVELOPMENT OF SURPLUS HIGHLY ENRICHED URANIUM DISPOSITION ALTERNATIVES

The HEU EIS evaluates reasonable alternatives for blending U.S.-owned surplus HEU into LEU. These alternatives evaluate the blending of HEU to LEU at various enrichment levels so that the material can either be used to fabricate fuel for use in commercial reactors or be disposed of as waste.

The Department of Energy used a screening process along with public input to identify a range of reasonable alternatives for the disposition of surplus HEU.[1] The process was conducted by a screening committee that consisted of five DOE technical program managers, assisted by technical advisors from DOE's National Laboratories and other support staff. The committee was responsible for identifying the reasonable alternatives to be evaluated. It compared alternatives against screening criteria, considered input from the public, and used technical reports and analyses from the National Laboratories and industry to develop a final list of alternatives.

The initial phases of the scoping and screening processes consisted of planning meetings that were attended by technical experts from DOE's National Laboratories, industry, and academia that culminated in public meetings on May 4 and 5, 1994, in Washington, D.C. The planning meetings helped DOE introduce the objectives of the program to the public and served as a forum to solicit input on the scope of the Storage and Disposition PEIS proposal. During August, September, and October 1994, 12 workshops were held throughout the United States to solicit public comment on the scope of the Fissile Materials Disposition Program. The workshops were designed to achieve four objectives: 1) comply with NEPA; 2) help identify a range of reasonable alternatives so that their potential impacts on the affected environment could be evaluated; 3) solicit relevant input from the public; and 4) continue the ongoing public participation efforts of DOE with the goal of reaching all interested parties.

The first step in the screening process was to develop criteria against which to judge potential alternatives. The criteria were developed for the screening process based on the President's nonproliferation policy of September 1993, the January 1994 *Joint Statement by the President of the Russian Federation and the President of the United States of America on Non-proliferation of Weapons of Mass Destruction and the Means of Their Delivery,* and the analytical framework established by the National Academy of Sciences in its 1994 report, *Management and Disposition of Excess Weapons Plutonium.* These criteria reflect domestic and policy interests of the United States, including nonproliferation; security; environment, safety, and health; timeliness and technological viability; cost-effectiveness; international cooperation, and additional benefits. A summarized listing of the screening criteria as they apply to HEU disposition is presented in Section 1.5.1. The criteria were discussed at the public scoping workshops, and participants were invited to further comment using questionnaires. The questionnaires allowed participants to rank criteria based on relative importance, comment on the appropriateness of the criteria, and suggest new criteria.

The revised criteria were used in a two-step screening process. First, alternatives were evaluated against potential disqualifiers to rule out alternatives that were unable to satisfy any of the screening criteria. For example, an alternative would be considered unreasonable if the resistance to retrieval, extraction, and reuse by the host nation is no better than that of continued storage (no action). The second step involved evaluation of each remaining alternative against the screening criteria. Alternatives that rated low for multiple criteria and/or were clearly dominated by similar, more attractive alternatives in the same category were eliminated as unreasonable. Details on how the screening process was developed

[1] As previously explained in Section 1.5.1, the disposition of surplus HEU was originally within the scope of the Storage and Disposition PEIS. Separate analyses were conducted for Pu, HEU, and other fissile materials during the screening process to identify reasonable alternatives for each. Therefore, the results of the screening process are not affected by the separation of the disposition of surplus HEU from the Storage and Disposition PEIS.

and applied and how the results were obtained are published in the *Summary Report of the Screening Process to Determine Reasonable Alternatives for Long-Term Storage and Disposition of Weapons-Usable Fissile Materials* (DOE/MD-0002, March 29, 1995).

The Department of Energy began with nine potential alternatives for disposition of surplus HEU. These alternatives were evaluated in the screening process to identify those reasonable alternatives that merited further evaluation in this EIS. [Text deleted.]

Two factors significantly influenced the evaluation of disposition options for surplus HEU and resulted in alternatives that were not available for disposition of other weapons-usable fissile materials:

- HEU can be rendered non-weapons-usable by simple isotopic dilution (blend down) to LEU. This blending does not require further study or technical development for certain technologies (described later in Section 2.2.2) because the technologies and facilities needed to perform the required blending operations already exist. Furthermore, with the addition of some new processing equipment to these existing facilities, additional blending processes also can be performed.

- There is a substantial world market for LEU as commercial reactor fuel feed that provides opportunities for peaceful, beneficial reuse of the material and revenues to the United States Treasury through sale of the blended LEU product or HEU (with the transferee, such as USEC, to blend HEU to LEU).

The alternatives for disposition of surplus HEU considered in the screening evaluations include the following:

- No HEU disposition action (continued storage)

- Direct sale of HEU (buyer to blend HEU to LEU)

- Emplacement of HEU in deep boreholes

- Vitrification or immobilization of HEU with high-level waste (HLW)

- Blend to LEU (19-percent enrichment) and store indefinitely

- Blend to LEU (19-percent enrichment) and sell

- Blend to LEU (4-percent enrichment) and store indefinitely

- Blend to LEU (4-percent enrichment) and sell

- Blend to LEU (0.9-percent enrichment) and dispose as waste

As a result of the screening process, five alternatives were identified as reasonable alternatives for further evaluation:

- No HEU disposition action

- Direct sale of HEU to a commercial vendor for subsequent blending to LEU

- Blending HEU to 19-percent assay LEU and sell as commercial reactor fuel feed material

- Blending HEU to 4-percent assay LEU and sell as commercial reactor fuel feed material

- Blending HEU to 0.9-percent LEU for disposal as waste

2.1.1 Characterization of Surplus Highly Enriched Uranium Material

The surplus HEU material in inventory varies in levels of enrichment and purity (contamination with undesirable isotopes and chemicals). Therefore, not all of the surplus HEU material can be used commercially.

An important factor in determining the disposition of any specific batch of HEU would be whether it can be blended to meet the isotopic specifications of the American Society for Testing and Materials (ASTM)

for commercial reactor fuel. Of particular concern are the ASTM specifications for concentrations of the isotopes U-234 and U-236 relative to U-235 in the blended LEU product (the ASTM specifications are 1,000 micrograms [µg] U-234 per gram [g] U-235 and 5,000 µg U-236 per g U-235). U-234 is a major contributor to radiation exposure, which could be of concern during fuel fabrication, and U-236 inhibits the nuclear reaction in reactor cores, reducing core lifetime or requiring higher enrichments to achieve a normal core life. A substantial amount of the surplus HEU could meet those ASTM specifications when blended with NU or LEU. The surplus HEU material could be characterized as commercial, off-spec, or non-commercial depending upon its ability to be used as reactor fuel.

Commercial Material—If the HEU material has a low ratio of undesirable isotopes (U-234 and U-236), it is considered a commercial quality material (in-spec). The selection of uranium blendstock of adequate quality and form would allow production of LEU that will meet the ASTM specifications for use in fabrication of commercial reactor fuel.

Off-Spec Material—If the ratio of U-234 and U-236 is high in the HEU material relative to U-235 content (off-spec), then the ability to blend to the ASTM commercial fuel specifications may be limited. If customers are found (for example, private or public utilities) who are willing to use off-spec LEU, then this surplus HEU could be blended to commercial reactor fuel feed.

Non-Commercial Material—[Text deleted.] This is material that cannot be economically recovered from its existing form, such as HEU in spent fuel; HEU in low concentrations in waste or residues; and HEU in equipment that will not undergo decontamination and decommissioning in the foreseeable future. Some of this HEU material is also in dismantled weapons that cannot be recovered because the technology has not been developed.

Figure 2.1.1–1 provides a material flow diagram for the disposition of surplus HEU.

[Text deleted.]

2.1.2 Highly Enriched Uranium Disposition Alternatives

Following the screening process, the five alternatives identified as reasonable (Section 2.1) were further refined. The blend to 0.9 percent and discard as waste alternative, which was originally intended to address only material not suitable for use as commercial fuel, was expanded to include all surplus HEU. Although this would not recover the material's economic value, it would meet nonproliferation goals. [Text deleted.]

Another refinement was that the direct sale of HEU (buyer to blend HEU to LEU) alternative and the blend HEU to 4-percent LEU and sell as commercial reactor fuel feed alternative were combined. This was done because the potential environmental impacts of these two alternatives are the same. They differ only in whether the HEU is sold prior to or subsequent to blending.

Finally, the alternatives were further refined to account for the various combinations of blending technologies, candidate sites, and end products. The possible list of combinations is virtually infinite; therefore, DOE has selected reasonable alternatives that not only represent the spectrum of reasonable alternatives, but also include logical choices for consideration at the time the ROD is issued. These alternatives, shown in Table 2.1.2–1, are described in detail in the following section. Timeframes shown in Table 2.1.2–1 reflect assumptions concerning DOE's ability to make material available, market conditions, and legislative requirements to avoid adverse material impact on the domestic uranium industry. A graphical representation of the time required to complete alternatives, based on the use of 1, 2, or 4 blending sites, is shown in Figure 2.1.2–1.

As indicated in this figure, commercial blending periods for each alternative were determined using 8 metric tons per year (t/yr), which is approximately the amount of surplus HEU that DOE can make available for commercial blending due to material availability, market conditions, and legislative requirements.

[Figure deleted.]

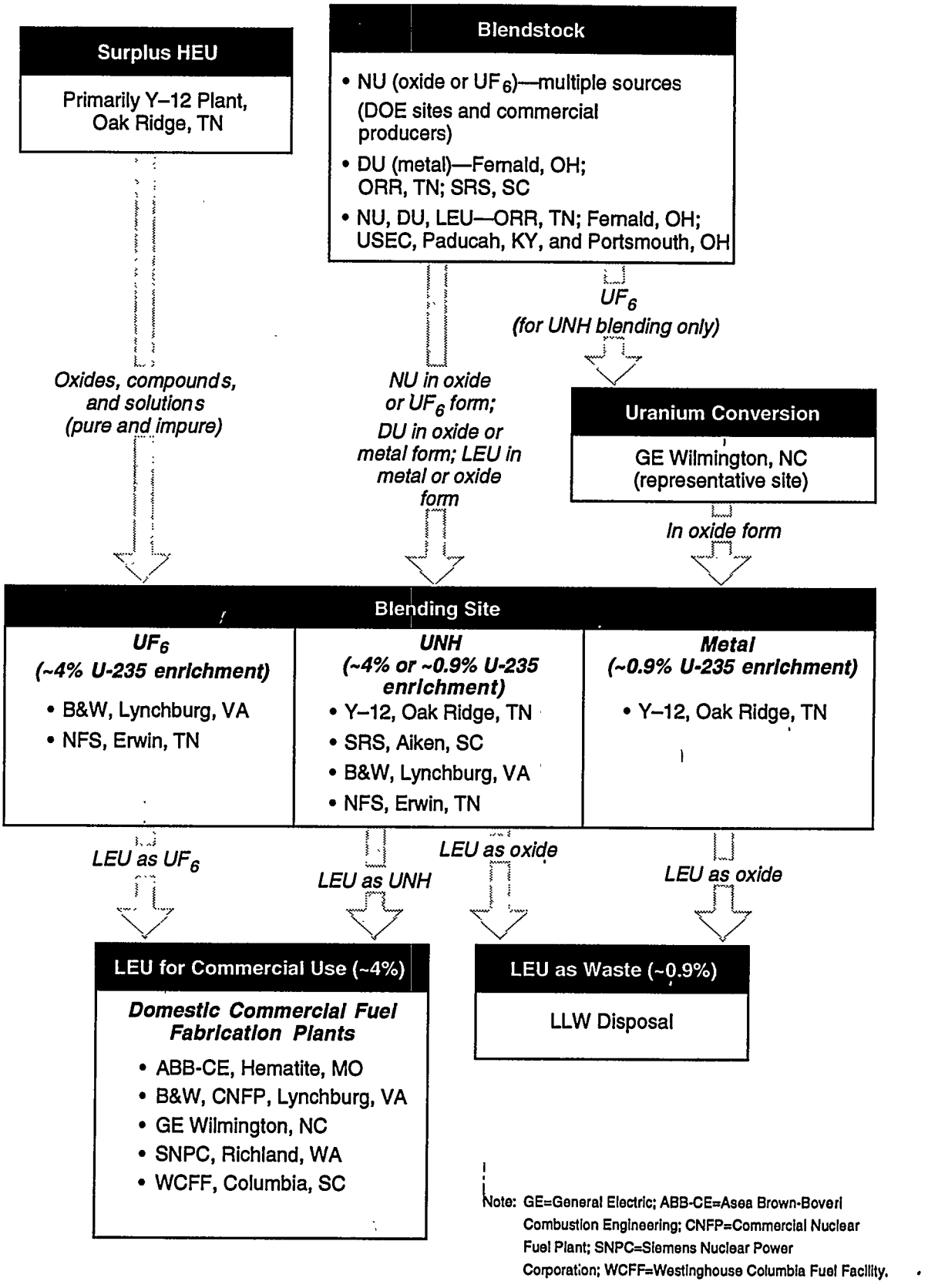

Figure 2.1.1–1. Material Flow Diagram for Surplus Highly Enriched Uranium Disposition.

Table 2.1.2–1. Alternatives for Disposition of Surplus Highly Enriched Uranium

Alternatives	Site Variations	Components	DOE Sites: Y–12 and SRS			Commercial Sites: B&W and NFS		
			Amount	Process	Duration[a]	Amount	Process	Duration[a]
1. No Action			200 t (Primarily Y–12)	Storage	10 yrs			
2. No Commercial Use 100-percent Waste	All four sites	200 t blended to waste	50 t/site	UNH metal[b]	24 yrs 16 yrs	50 t/site	UNH	24 yrs
3. Limited Commercial Use 25-percent fuel/ 75-percent waste	All four sites (commercial sites only for 50 t of USEC material)	50 t fuel[c]				25 t/site	UF_6 UNH	6 yrs 6 yrs
		150 t waste	37.5 t/site	UNH metal[b]	18 yrs 12 yrs	37.5 t/site	UNH	18 yrs
4. Substantial Commercial Use 65-percent fuel/ 35-percent waste	a) DOE sites only	130 t fuel[c]	65 t/site	UNH	16 yrs			
		70 t waste	35 t/site	UNH metal[b]	17 yrs 11 yrs			
	b) Commercial sites only	130 t fuel[c]				65 t/site	UF_6 UNH	16 yrs 16 yrs
		70 t waste				35 t/site	UNH	17 yrs
	c) All four sites	130 t fuel[c]	32.5 t/site	UNH	16 yrs	32.5 t/site	UF_6 UNH	16 yrs 16 yrs
		70 t waste	17.5 t/site	UNH metal[b]	8 yrs 6 yrs	17.5 t/site	UNH	8 yrs

Table 2.1.2–1. Alternatives for Disposition of Surplus Highly Enriched Uranium—Continued

Alternatives	Site Variations	Components	DOE Sites: Y–12 and SRS			Commercial Sites: B&W and NFS		
			Amount	Process	Duration[a]	Amount	Process	Duration[a]
	d) Single site	130 t fuel[c]	130 t/site	UNH	16 yrs	130 t/site	UF_6	16 yrs
							UNH	16 yrs
		70 t waste	70 t/site	UNH	33 yrs	70 t/site	UNH	33 yrs
				metal[b]	23 yrs			
5. **Maximum Commercial Use** 85-percent fuel/ 15-percent waste	a) DOE sites only	170 t fuel[c]	85 t/site	UNH	21 yrs			
		30 t waste	15 t/site	UNH	7 yrs			
				metal[b]	5 yrs			
	b) Commercial sites only	170 t fuel[c]				85 t/site	UF_6	21 yrs
							UNH	21 yrs
		30 t waste				15 t/site	UNH	7 yrs
	c) All four sites	170 t fuel[c]	42.5 t/site	UNH	21 yrs	42.5 t/site	UF_6	21 yrs
							UNH	21 yrs
		30 t waste	7.5 t/site	UNH	4 yrs	7.5 t/site	UNH	4 yrs
				metal[b]	2 yrs			
	d) Single site	170 t fuel[c]	170 t/site	UNH	21 yrs	170 t/site	UF_6	21 yrs
							UNH	21 yrs
		30 t waste	30 t/site	UNH	14 yrs	30 t/site	UNH	14 yrs
				metal[b]	10 yrs			

[a] Some indicated durations are revised substantially from those in the Draft EIS, in response to comments received. Whereas the Draft EIS based its projections of commercial blending durations on maximum possible blending capabilities of the facilities (up to 40 t/yr total in the four-sites variations), the durations indicated here (based on a total of 8 t/yr for commercial material) reflect more realistic assumptions concerning DOE's ability to make material available, market conditions, and legislative requirements to avoid adverse material impacts on the domestic uranium industry. Waste blending is based on processing rates of 3.1 t/yr for metal blending at Y–12 and 2.1 t/yr for UNH blending at other sites (about 9 t/yr for all four sites together).

[b] The Y–12 Plant only.

[c] The proposal to transfer 50 t of HEU to USEC is a component of each of the commercial use alternatives (3, 4, and 5). Included within this proposal, and as part of Alternatives 3, 4, and 5 is the proposed transfer to USEC of title to 7,000 t of NU.

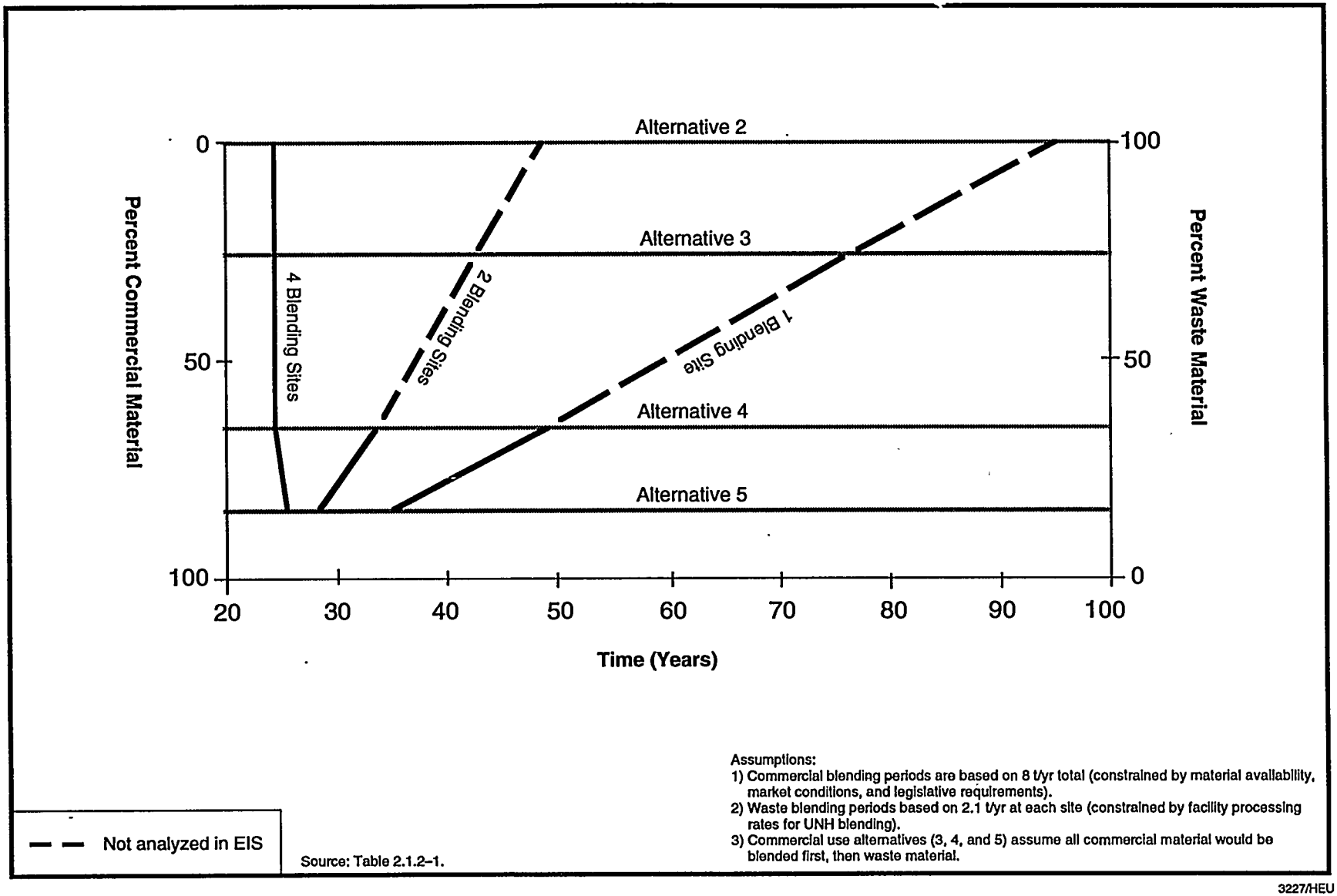

Figure 2.1.2–1. Time Required to Complete Various Alternatives Based on Number of Blending Sites Used.

The alternatives as described are not intended to represent exclusive choices among which DOE (or other decisionmakers) must choose, but rather are proffered to define a matrix of possible reasonable alternatives.[2]

Even though these alternatives explained below consider the entire surplus HEU inventory (200 t), for the reasons explained in Section 1.4.2, a portion of this inventory (the total quantity remains classified) may not be available for blend down since it is currently in the form of irradiated fuel. To provide a conservative analysis presenting maximum potential impacts, the following alternatives address the entire surplus inventory.

2.1.2.1 No Action

Under the No Action Alternative, DOE would continue to store surplus HEU (primarily at DOE's Y–12 Plant). As stated in Section 1.4.2, storage of surplus HEU is analyzed for a period of up to 10 years in the Y–12 EA. [Text deleted.] Should the surplus HEU disposition actions continue beyond 10 years, subsequent storage of surplus HEU pending disposition will be pursuant to and consistent with the ROD associated with the Storage and Disposition PEIS or tiered NEPA documents.[3] Current operations described in Section 2.2.3 at each of the potential HEU blending sites (Y–12, SRS, B&W, and NFS) would continue.

2.1.2.2 No Commercial Use (0/100 Fuel/Waste Ratio)

Under this alternative, DOE would blend the entire stockpile of surplus HEU (200 t) to LEU and dispose of it as waste. This would include surplus HEU with or without commercial value. The blending would be performed at all four sites. Although this alternative would not recover any of the economic value of HEU for the Government, it is evaluated for all surplus HEU to provide a comprehensive evaluation of a full range of alternatives in the HEU EIS.

Surplus HEU could be blended to waste as either UNH or as metal at a rate of up to 2.1 t/yr or 3.1 t/yr, respectively. All the blending sites have UNH blending capability. Only the Y–12 Plant at ORR has the capability to perform metal blending. [Text deleted.] The blending of surplus HEU for waste would not be initiated before an LLW disposal facility were identified to accept the LLW. Surplus HEU would remain in storage at the Y–12 Plant or at another storage facility pursuant to the Storage and Disposition PEIS pending identification of the LLW disposal facility.

2.1.2.3 Limited Commercial Use (25/75 Fuel/Waste Ratio)

Under this alternative, 50 t of surplus HEU would be blended to commercial fuel, while the remaining 150 t would be blended and then disposed of as waste. The title to 50 t of surplus HEU would be transferred to USEC. USEC (or a successor private corporation) then would select the commercial site or sites for blending 50 t of surplus HEU to LEU for use in commercial fuel. The remaining 150 t would be blended to waste.

This alternative would blend the 50 t of HEU at the two commercial sites. The 50 t would be distributed equally between the commercial sites, each blending 25 t of material.[4] The remaining 150 t of HEU material would be blended to waste using all four blending sites. Each DOE site and commercial site would receive 37.5 t of waste material for blending.

[Text deleted.]

[2] For example, while the alternatives assess blending 85, 65, or 25 percent of the material for use in commercial fuel, another percentage might more accurately represent ultimate disposition. Similarly, while two of the variations assume that material is divided evenly among the four possible facilities (25 percent to each), some other distribution among three or four facilities is possible. [Text deleted.] Such variations would be within the range of alternatives analyzed in this EIS. Section 4.5.6 explains how impacts would change if ultimate disposition distribution differed.

[3] Under the No Action Alternative for the Storage and Disposition Draft PEIS, if storage of surplus HEU pending disposition (or no action) continued beyond 10 years, storage facilities at Y–12 would be maintained to ensure safe facility operation, or surplus HEU material might be moved out of the Y–12 Plant at the end of the 10-year period with the completion of the relocation within the following 5 years. Subsequent NEPA review would be conducted as required.

[4] This distribution and the distributions for Alternatives 4 and 5 are assumed only for purposes of analysis. It is not intended to foreclose the selection of another distribution that might include DOE sites or only one site.

2.1.2.4 Substantial Commercial Use (65/35 Fuel/Waste Ratio)

[Text deleted.] This alternative assumes that 35 percent of the surplus HEU would be blended to LLW and disposed of as waste, leaving 65 percent of the material available for commercial use. The title to 50 t of surplus HEU would be transferred to USEC.[5] USEC then would select blending sites for blending 50 t of surplus HEU to LEU for use in commercial fuel. The remaining quantity of potentially commercially usable HEU (80 t) could be blended at any or all of the four sites. The LEU product would be sold for use in commercial reactor fuel. The remaining 70 t of surplus HEU would be blended to waste.

There are four variations of this alternative using different combinations of sites. These particular combinations of sites are representative only. The actual distribution among blending sites may differ depending on programmatic, commercial, or other considerations. The first variation would blend all of the HEU at the two DOE sites, with the HEU split equally between them. ORR and SRS would each blend 65 t of HEU to LEU for commercial fuel and 35 t of HEU to LEU for disposal as waste. The second variation would blend all of the HEU at the two commercial sites, with the HEU split equally between them. B&W and NFS would each blend 65 t of HEU to LEU for commercial fuel and 35 t of HEU to LEU for disposal as waste. The third variation would blend the HEU at all four sites, with the HEU split equally among them. Each site would blend 32.5 t of HEU to LEU for commercial fuel and 17.5 t of HEU to LEU for disposal as waste. The fourth variation would blend all of the HEU at a single site. The site would blend 130 t of HEU to LEU for commercial fuel and 70 t of HEU to LEU for disposal as waste.

[Text deleted.]

[5] The proposal to transfer 50 t of HEU to USEC is a component of each of the commercial use alternatives (3, 4, and 5). Included within the same proposed transaction, and as part of Alternatives 3, 4, and 5, is the proposed transfer of title to 7,000 t of NU at the Portsmouth Gaseous Diffusion Plant from DOE to USEC. Because it is part of the same proposed transaction as the disposition of 50 t of HEU, the environmental impacts of the proposed NU title transfer are assessed in Section 4.9 of this EIS.

2.1.2.5 Maximum Commercial Use (85/15 Fuel/Waste Ratio)

[Text deleted.] Under this alternative, it is assumed that only 15 percent of the HEU would be disposed of as waste. The title to 50 t of surplus HEU would be transferred to USEC. USEC then would select blending sites for blending 50 t of surplus HEU to LEU for use in commercial fuel. The remaining quantity of potentially commercially usable HEU (120 t) could be blended at any or all of the four sites. The LEU product would be sold for use in commercial reactor fuel. The remaining 30 t of surplus HEU would be blended to waste.

There are four variations of this alternative using different combinations of sites. They are the same as those assessed for the previous alternative. The first variation would blend all of the HEU at the two DOE sites, with the HEU split equally between them. ORR and SRS would each blend 85 t of HEU to LEU for commercial fuel and 15 t of HEU to LEU for disposal as waste. The second variation would blend all of the HEU at the two commercial sites, with the HEU split equally between them. B&W and NFS would each blend 85 t of HEU to LEU for commercial fuel, and 15 t of HEU to LEU for disposal as waste. The third variation would blend all of the HEU at all four sites, with the HEU split equally among them. Each site would blend 42.5 t of HEU to LEU for commercial fuel and 7.5 t of HEU to LEU for disposal as waste. The fourth variation would blend all of the HEU at a single site. The site would blend 170 t of HEU to LEU for commercial fuel and 30 t of HEU to LEU for disposal as waste.

[Text deleted.]

2.1.3 Alternatives Eliminated From Further Study

Four alternatives were eliminated from detailed analysis as unreasonable in the screening process and are not analyzed in detail in this EIS. The four alternatives were eliminated based on multiple low ratings and/or because the alternatives were clearly dominated by similar, more reasonable alternatives. None of these four alternatives fully meets the purpose and need for the proposed action. One additional alternative was considered but eliminated from detailed analysis as unreasonable after the screening process was completed—blend to LEU

(19-percent enrichment) and sell. The eliminated alternatives are the following.

Emplacement of Highly Enriched Uranium into Deep Boreholes. This alternative was less attractive than the blending alternatives because emplacement of HEU in deep boreholes has no nonproliferation advantage over isotopic blending to LEU. In addition, the borehole would not allow for beneficial reuse of surplus HEU and would not recover monetary value for the Government.

Immobilization of Highly Enriched Uranium with High-Level Waste. This alternative was less attractive than the blending alternatives because immobilization with HLW has no nonproliferation advantage over isotopic blending to LEU. A disposal site would need to be identified and legislation may be required. It would involve environment, safety, and health issues associated with handling and disposal of HLW that would need to be accommodated. In addition, it would not allow for beneficial reuse of surplus HEU and would not recover monetary value for the Government.

Blend to Low-Enriched Uranium (19-percent enrichment) and Store Indefinitely. [Text deleted.] This alternative was initially eliminated from further analysis after screening because it would delay recovery of the economic value of the material and add storage costs, thereby reducing net revenues. The following provides a more detailed discussion of the reasons why this alternative is not reasonable, in light of the level of interest shown by the public.

A discussion of the "blend to 19 percent and store" option must start with an assessment of the quality and quantity of HEU that might reasonably be considered for such an option. The rationale for this option is that it could quickly satisfy the nonproliferation objective of the program by making the material non-weapons-usable, and retain the capability to continue to downblend to 4-percent enrichment at a later date, while avoiding near-term impacts on the uranium market and the domestic uranium mining, conversion, and enrichment industries ("uranium industry"). Under this option, it would not appear reasonable to consider blending material that is non-commercial to only 19 percent (rather than 0.9 percent as waste), since that material cannot pose market impacts (such as impacts to supply or price of LEU commercial fuel, or demand for mined uranium for commercial fuel use), and such market based impacts on the uranium industry would not be sufficient reason to stop at 19 percent for waste material. Altogether, there are approximately 72 t of irradiated fuel and other materials unlikely to be "commercialized" in the next 10 to 15 years in the current 175 t inventory of surplus HEU, which leaves 103 t of currently declared surplus HEU inventory that would be potentially commercial material in the "near" term. Of that amount, 63 t has either already been transferred or is proposed to be transferred to USEC.[6] Thus, there is only 40 t of additional potentially commercial HEU left in the currently declared surplus inventory after waste materials and such previous or pending transactions have been subtracted.

The 40 t of potentially commercial HEU includes approximately 20 t of metal at (or destined for) the Y–12 Plant. The remaining 20 t is a combination of various material forms at SRS that are not currently suitable for the "blend-to-19-percent-and-store" option.[7] Thus, out of the current inventory of 175 t of surplus HEU, it appears reasonable under current conditions to consider the 19-percent option only for the 20 t of metal at Y–12.

Twenty metric tons of HEU metal at Y–12 could be blended to LEU as metal in the vacuum induction furnaces at Y–12 (for eventual blending to 4 percent using the UNH process), as analyzed in the HEU EIS.

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[6] The 63 t includes 50 t of surplus HEU that is proposed to be transferred to USEC pursuant to the *USEC Privatization Act* and 13 t of UF_6 at Portsmouth that is already being dispositioned (at Portsmouth) pursuant to the *Energy Policy Act* of 1992.

[7] At present, due to criticality configurations of processing equipment, SRS does not have the capability to solidify UNH solution at enrichment levels higher than about 1 percent. Although it is possible that a new solidification facility might be proposed for SRS in the future by DOE or another entity to process material at commercial enrichment levels (4 to 5 percent) (see Section 2.2.3.3), such a facility would not necessarily be designed to be critically safe for material at a 19-percent enrichment level. (For example, processing vessels would need to be considerably smaller for 19-percent material than for 4-percent material to ensure against criticality.) Transportation of such UNH solution at a 19-percent enrichment level to an offsite facility would involve transportation risks, criticality, safety, and health (worker and public) concerns that would need to be accommodated; such concerns would be greater than those for transportation of UNH solution at a 4-percent enrichment level.

The resulting approximately 54 t of 19-percent LEU metal could conceivably be stored in existing facilities at Y–12. This limited quantity of HEU could be blended to 19 percent at Y–12 in less than one year.

For a constant processing rate of HEU, potential environmental impacts from blending surplus HEU (with an average enrichment level of 50 percent) to 19-percent LEU would be approximately 5 to 6 times lower than those from blending to 4-percent LEU for the following resource areas: site infrastructure, water resources, public and occupational health under normal operations, waste, and intersite transportation. This is mainly because much less blendstock would be processed for 19-percent blending (each tonne of HEU would require 1.7 t of NU blendstock). Under accident conditions, which assume a release due to an evaluation basis earthquake and a simultaneous criticality, the source term and consequences (fatalities) for blending to 19 percent would be approximately half those estimated for blending to 4 percent. Impacts due to air quality, socioeconomics, and hazardous chemicals are expected to remain essentially the same. Although storage of 19-percent material would not require the elaborate safeguard measures required for HEU storage, it would still present criticality concerns that necessitate special packaging and spacing for storage. Storage of 19-percent material for a 5- to 10-year period could be accommodated in existing facilities at the Y–12 Plant, and the environmental impacts would be minimal for such accident-free storage (with the appropriate spacing, packaging, and environmental/safety measures).

Assuming that commercial use were chosen as the ultimate disposition of the material, it would eventually need to be further blended to approximately the 4-percent enrichment level. Such subsequent blending would be accomplished using UNH blending, since metal product is not conducive to commercial use. The impacts of blending from 19 percent to 4 percent using UNH blending would be lower than the analyzed impacts of blending from 50 percent to 4 percent using UNH blending, since less blendstock and blending would be required.

The environmental impacts—particularly to workers—would be higher in the aggregate for the option of blending to 19 percent and then subsequently to 4 percent than for the analyzed options of blending directly from 50 percent to 4 percent. This is primarily because about twice as much handling would be required.

Impacts on the uranium market would be more readily moderated under the blend-to-4-percent-enrichment alternative considered in the HEU EIS due to the rate that LEU fuel (derived from surplus HEU) would be introduced into the market. This rate would be dictated by market prices, DOE's ability to make surplus HEU available, and legislative requirements to avoid adverse material impacts on the domestic uranium industry. It would be much easier and less costly to simply continue to store the material as HEU rather than as 19-percent LEU. Such an approach would avoid the added impacts and costs from handling and blending the material in two steps instead of one. Although it would delay fully satisfying the nonproliferation and economic recovery objectives of the HEU disposition program, it would preserve the economic viability of the U.S.-Russian HEU Agreement and the domestic uranium industry, moderate impacts on the uranium market, and meet legislative requirements.

Blend to Low-Enriched Uranium (4-percent enrichment) and Store Indefinitely. This alternative is similar to the blend to LEU (4-percent enrichment) and sell alternative, except that the material would be stored indefinitely instead of sold. The same disadvantages and concerns cited for the blend to LEU (19-percent enrichment) and store alternative apply. This alternative would provide no nonproliferation advantage over blending and selling, which would allow for beneficial reuse of the material, recover monetary value for the Government, and provide for peaceful, beneficial use of the material.

Blend to Low-Enriched Uranium (19-percent enrichment) and Sell. This alternative was eliminated from analysis because LEU with an enrichment level of 19 percent cannot be used commercially as reactor fuel without further blending; it presents criticality concerns; and, as an interim blending level, it is not as economical as blending directly to 4 percent in a one-step process.

2.2 ENVIRONMENTAL IMPACT ANALYSIS

The HEU EIS assesses the direct, indirect, and cumulative environmental consequences of reasonable alternatives under consideration for each of the potentially affected DOE and commercial blending candidate sites. Where appropriate, the unknowns and uncertainties associated with the environmental issues are identified and presented. The EIS also provides a description of all potentially affected environments as they exist. Existing environmental documents and models developed and/or data generated for regions or sites considered in the EIS were evaluated and either used or incorporated by reference to the maximum extent possible. In cases where information was obtained from documents that were several years old, further research was conducted to determine whether there were any changes in the affected environment from the time when those reports were prepared. All candidate sites have reviewed and updated the affected environment descriptions, as appropriate, to accurately represent the site and its environment.

Because the analyses in this EIS considered current and future stockpiles of surplus HEU and the decisions on disposition of current surplus HEU could begin to be implemented immediately, the baseline conditions were assumed to be the current conditions (1995 or the most recent data available) at each site. Therefore, the No Action (baseline conditions) Alternative is the existing environment for each candidate site.

The data used to evaluate the environmental impacts of conversion and blending processes at each candidate site were based on data reports prepared specifically for those processes by the Nuclear Materials Disposition Program Office at Y–12 (OR LMES 1995a, OR LMES 1995b, OR LMES 1995c, and OR LMES 1995d). These reports provide information regarding the UNH, metal and UF_6 blending processes, but do not focus on site-specific processes at the candidate sites.

[Text deleted.]

Blending operations at the various sites may differ because of site-specific process design variations and different levels of activity. One set of representative data is used in the EIS for each blending process with nominal throughput rates that assume a full-scale operation with bounding values for operational requirements, emissions, waste streams, and other parameters. This provides a conservative evaluation of each of the blending processes.

This EIS evaluates alternatives and their environmental impacts in sufficient detail to allow implementation of the decisions following the ROD. As appropriate, this EIS may be followed by additional site-specific NEPA analysis.

2.2.1 BASIS FOR ANALYSIS

A number of key assumptions form the basis for the analyses of impacts presented in this EIS. If these assumptions change substantially, DOE will conduct additional NEPA review as appropriate.

- The EIS analyses are based on the disposition of a nominal 200 t of HEU. This amount includes HEU that is currently surplus, as well as additional HEU (not yet identified) that may be declared surplus in the future. The analyses also addresses the expected impacts that would result from the proposed transfer of 7,000 t of NU to USEC.

- This EIS addresses all surplus HEU, in various forms including metals and alloys, oxides and compounds, and solutions, with enrichment levels of 20 percent or greater by weight of the isotope U-235. [Text deleted.] To assess potential environmental impacts, the blending analyses in the HEU EIS are based on the assumption that surplus HEU is enriched to 50 percent U-235. That assumption is based on an assessment of the relevant portion of the materials in the surplus inventory. While HEU is defined as all uranium with 20 percent or higher enrichment, and ranges to above 92 percent, most (80 percent) of the HEU that is surplus is in the range between 35-percent and 70-percent enrichment. The enrichment levels of the discrete components of the surplus HEU

inventory at specific locations remain classified. However, an analysis was performed on the inventory of surplus HEU that excluded certain categories of materials not directly subject to disposition pursuant to the HEU EIS, such as material under IAEA safeguards at the Y–12 Plant, UF_6 at Portsmouth, and irradiated fuel.[8] That analysis yielded the result that the weighted average enrichment of the pertinent material is 50 percent. The relative impacts of blending HEU of different enrichment levels are expected to be either unchanged or essentially proportional, depending on the resource.[9] Therefore, it is reasonable to use 50 percent as the enrichment level for purposes of analysis in the HEU EIS.

- Surplus HEU can be blended down to approximately 4-percent (more or less depending on market demand) assay LEU for fabrication as fuel in commercial reactors. The representative enrichment level of 4 percent was selected for commercial fuel based on current fuel vendor experience, which ranges between 3 and 5 percent. [Text deleted.]

- If the enrichment level is reduced to approximately 0.9 percent (depending upon waste acceptance criteria), LEU approaches an NU enrichment state and becomes suitable for disposal as LLW. This enrichment level was selected for waste disposal based on current LLW disposal experience both in the United States and Europe where similar types of waste have been disposed of with an enrichment level slightly greater than 1-percent U-235. This low enrichment level ensures that an inadvertent criticality would not occur. The actual enrichment level of the waste material would be dictated ultimately by the waste acceptance criteria for the selected LLW disposal site.

- The data for UNH and UF_6 blending (for commercial fuel) were based on an HEU throughput of 10 t/yr with an average starting U-235 enrichment of 50-percent HEU blended to a final enrichment of 4-percent U-235 LEU. The data for blending HEU as UNH to 0.9-percent enrichment LEU were based on an HEU throughput of 2.1 t/yr with an average U-235 enrichment of 50 percent. The data for metal blending were based on an HEU throughput of 3.1 t/yr with an average of 50-percent U-235 enrichment blended to 0.9-percent U-235 enrichment. Since HEU exists in a variety of forms (metal, oxides, alloys, compounds, and solutions), conservative scenarios (those that exhibit the highest potential for environmental impact) were assumed for preprocessing of HEU prior to blending. The assumed blending rates are based on dilution ratios for blend down and reasonable judgement about anticipated blending capability and capacity. Actual blending rates will be based on market conditions, blending facility capabilities and capacities, DOE's ability to make the material available, blending contract limitations, and legislative requirements

[8] These materials are not directly subject to disposition pursuant to the HEU EIS because: 1) the material under IAEA safeguards at Y–12 is expected to remain in its current status for the foreseeable future and is not proposed to be blended down under this program; 2) the UF_6 at Portsmouth is already being blended (at Portsmouth) pursuant to the *Energy Policy Act* of 1992; and 3) the irradiated fuel would not require disposition actions pursuant to this program unless it were first processed to separate the HEU pursuant to other programs, as explained in Section 1.4.2.

[9] For a constant processing rate of HEU, when the enrichment level of the HEU feed increases, potential impacts on site infrastructure, water, public and occupational health (under normal operations and accident conditions), and waste would increase. An increase in enrichment level (of HEU for down blending) would increase the amount of blendstock which in turn requires additional resources and generates more waste due to the amount of material processed. Under accident conditions due to processing more material, and an increase in the source term, impacts to workers and the public would be greater. Potential impacts on air quality, socioeconomics, and intersite transportation are not expected to change, because pollutant releases from boilers used for heating are independent of blending operations, the number of jobs is determined by the type of process, not the enrichment level or the amount of material, and transportation risk analyses have been done using a conservative 93-percent enrichment level (most of the transportation risk is not due to exposure to uranium).

to avoid adverse material impacts on the domestic uranium industry. The blending rates analyzed are not the actual capacities of the four sites but are rates that have been selected for analysis so a comparison can be done for the impacts among the sites. All the sites could process material at the analyzed rates.

- Surplus HEU is currently located at 10 DOE sites around the country (ORR, SRS, Rocky Flats, Portsmouth, Pantex, Los Alamos National Laboratory [LANL], Idaho National Engineering Laboratory [INEL], Hanford, Brookhaven National Laboratory, and Sandia National Laboratories [SNL]) (see Figure 1.3–1). Most of the unirradiated surplus HEU will be moved to the Y–12 Plant for pre-storage processing and interim storage. The Y–12 Plant provides a broad spectrum of enriched uranium handling, processing, and storage capabilities not available at any other single DOE site. Therefore, for the purposes of this EIS, it is assumed that most of the surplus HEU will originate from the Y–12 Plant. Two locations where surplus HEU exist (Portsmouth and SRS) may not relocate their HEU to Y–12. Surplus material could either be blended at these sites (in the case of SRS) or sent directly to commercial blending sites. The environmental impacts of the proposed transfer of HEU to the Y–12 Plant and its storage there are analyzed in the Y–12 EA.

- Several types of blendstock material could be used during blending of HEU, such as DU, NU, or LEU. LEU in UF_6 form could be shipped from ORR; Paducah, Kentucky; or Portsmouth (or Piketon), Ohio. The DOE site in Fernald, Ohio has LEU in metal or oxide form. DU blendstock is available in metal, oxide, and UF_6 forms and may be obtained from Portsmouth; Paducah; Y–12; SRS; Hanford; or Fernald, Ohio. The NU blendstock could be purchased from domestic uranium producers or obtained from one of the same DOE sites where LEU is available. For the purposes of the EIS transportation analyses, one route (Hanford to all potential blending sites) is used as representative for all the potential shipping routes associated with both the domestic and DOE NU blendstock suppliers, because it is the longest distance from the blending sites.

- The Department of Energy's NTS is used as a representative site to evaluate transportation impacts from the blending sites to a waste disposal site (for the reasons explained in Section 1.4.2). If another LLW disposal facility is identified, the route-specific transportation impacts may be provided in tiered NEPA documentation, as appropriate.

[Text deleted.]

- Design basis accident data were obtained from safety evaluation reports for accident analysis at commercial sites because EAs recently prepared for these sites did not include accident information. For severe accidents, generic scenarios and source terms prepared by Y–12 were applied to each candidate site to determine site-specific impacts. For accident analysis at DOE sites, Safety Analysis Reports (SARs) and recent NEPA documents prepared for those sites were reviewed and used for both design basis and severe accidents.

- No construction of new facilities is proposed or, with the possible exception of SRS, would be required; any expanded capabilities can be accommodated through modification or addition of process equipment in existing facilities. SRS currently does not have a solidification or crystallization facility to convert UNH solutions (for 4-percent enrichment) to UNH crystals (as described in Section 2.2.3.3). However, impacts were assessed in this EIS as if solidification could be performed at SRS.

Should new facilities be proposed to add solidification capability at SRS, there would be land disturbance and minor air emissions associated with construction (among other things), and appropriate NEPA review would be conducted at that time if necessary. If B&W or NFS should decide to construct new facilities for UF_6 conversion and blending, construction impacts would likely include land disturbance and minor air emissions from construction equipment, and the applicable Nuclear Regulatory Commission (NRC) license may need to be amended. Any such construction would be based on the business judgement of these commercial facilities and would not be necessitated by DOE's proposed action. Environmental impacts would be analyzed by those facilities as part of the NEPA review associated with the NRC licensing process.[10]

- The B&W and NFS facilities are analyzed for siting new UF_6 capability because these are the only commercial sites that have NRC licenses to process HEU. The addition of new equipment in existing facilities would be required to provide UF_6 capability at those sites. UF_6 blending would not be used to blend surplus HEU to waste, since the process is similar to UNH but requires additional steps. It would only be used to make fuel for the commercial reactor industry (because fuel fabricators usually do, and prefer to, receive uranium in UF_6 form). It would not be reasonable to add UF_6 blending capability at DOE sites for blending to commercial fuel feed, and this alternative is not discussed in the EIS, due to the capital investment required, the limited use, if any, of such capability for other DOE missions, and environmental concerns that would need to be accommodated.

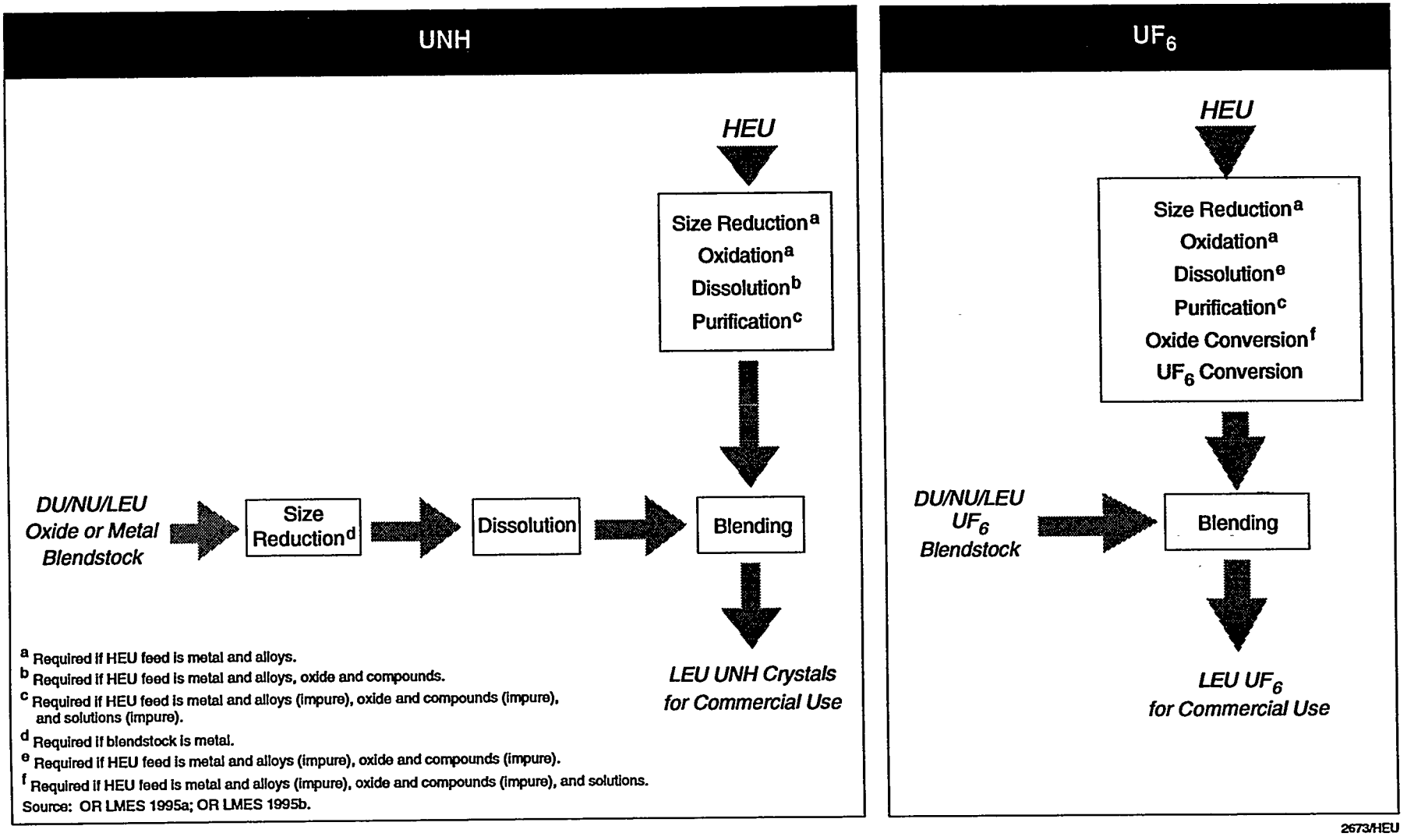
[10]Use of DOE facilities for UF_6 blending is not contemplated or proposed at this time. However, if DOE proposes its facilities for such UF_6 conversion and blending, DOE will conduct further NEPA review as appropriate.

2.2.2 BLENDING PROCESSES

There are three technically viable processes that can be used to blend HEU to LEU, and three forms of blendstock that can be used to achieve the desired LEU assay. The processes are the following: 1) blend as UNH, 2) blend as metal, and 3) blend as UF_6. All the processes can be used to blend HEU to LEU, but the most reasonable process for blending varies depending upon the desired end product and the feed material used. Because HEU will be available in a variety of forms, with different uranium isotopes, impurity contents, and U-235 assays, a variety of blending processes would be necessary for the disposition of the entire inventory of surplus HEU. Figures 2.2.2–1 and 2.2.2–2 exhibit flow diagrams showing basic processes associated with various blending technologies for commercial and non-commercial HEU material, respectively. Because off-spec material could either be sold as commercial fuel or discarded as waste, all processes shown could apply to off-spec material. Figures 2.2.2–3 and 2.2.2–4 present logic diagrams illustrating steps that would be used to identify a blending process for specific forms of surplus HEU destined for either commercial use or waste disposal.

Product Forms for Highly Enriched Uranium Destined as Commercial Reactor Fuel. Two of the three product forms are reasonable for commercial reactor fuel feed: UF_6 and UNH. The commercial reactor fuel industry receives LEU feed as UF_6 and converts it to uranium dioxide (UO_2) pellets for loading into fuel rods. The fuel fabricators have a recovery capability that can process UNH crystals to make UO_2 for commercial reactor fuel feed. Blended LEU product as metal is not an acceptable form for commercial reactor fuel. Because of the additional costs involved in handling, metal blending is not reasonable for producing LEU destined for commercial use.

Product Forms for Highly Enriched Uranium Destined as Waste. The blended LEU product that is considered a reasonable waste form for disposal is uranium oxide as triuranic octaoxide (U_3O_8). This oxide is more stable in the environment than metal and other forms. UNH, metal, and UF_6 are reactive and are not suitable waste forms for land disposal. The LEU product blended as UNH or metal would therefore be converted to an oxide prior to disposal.



[a] Required if HEU feed is metal and alloys.
[b] Required if HEU feed is metal and alloys, oxide and compounds.
[c] Required if HEU feed is metal and alloys (impure), oxide and compounds (impure), and solutions (impure).
[d] Required if blendstock is metal.
[e] Required if HEU feed is metal and alloys (impure), oxide and compounds (impure).
[f] Required if HEU feed is metal and alloys (impure), oxide and compounds (impure), and solutions.
Source: OR LMES 1995a; OR LMES 1995b.

Figure 2.2.2–1. Process Flow Diagram for Commercial Material (applies to off-spec material that would be blended for commercial use).

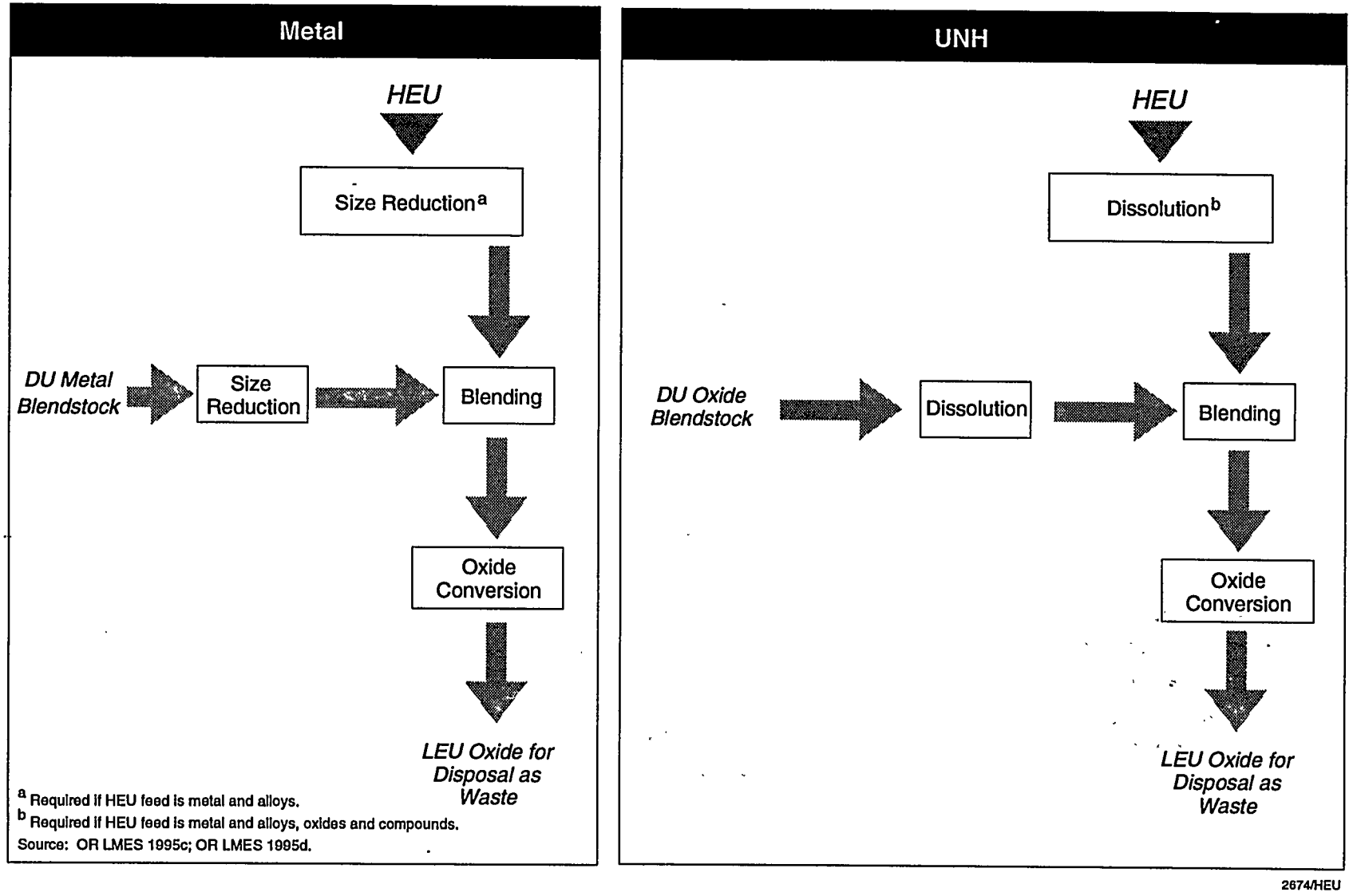


Figure 2.2.2–2. Process Flow Diagram for Non-Commercial Material (applies to off-spec material that would be blended to waste).

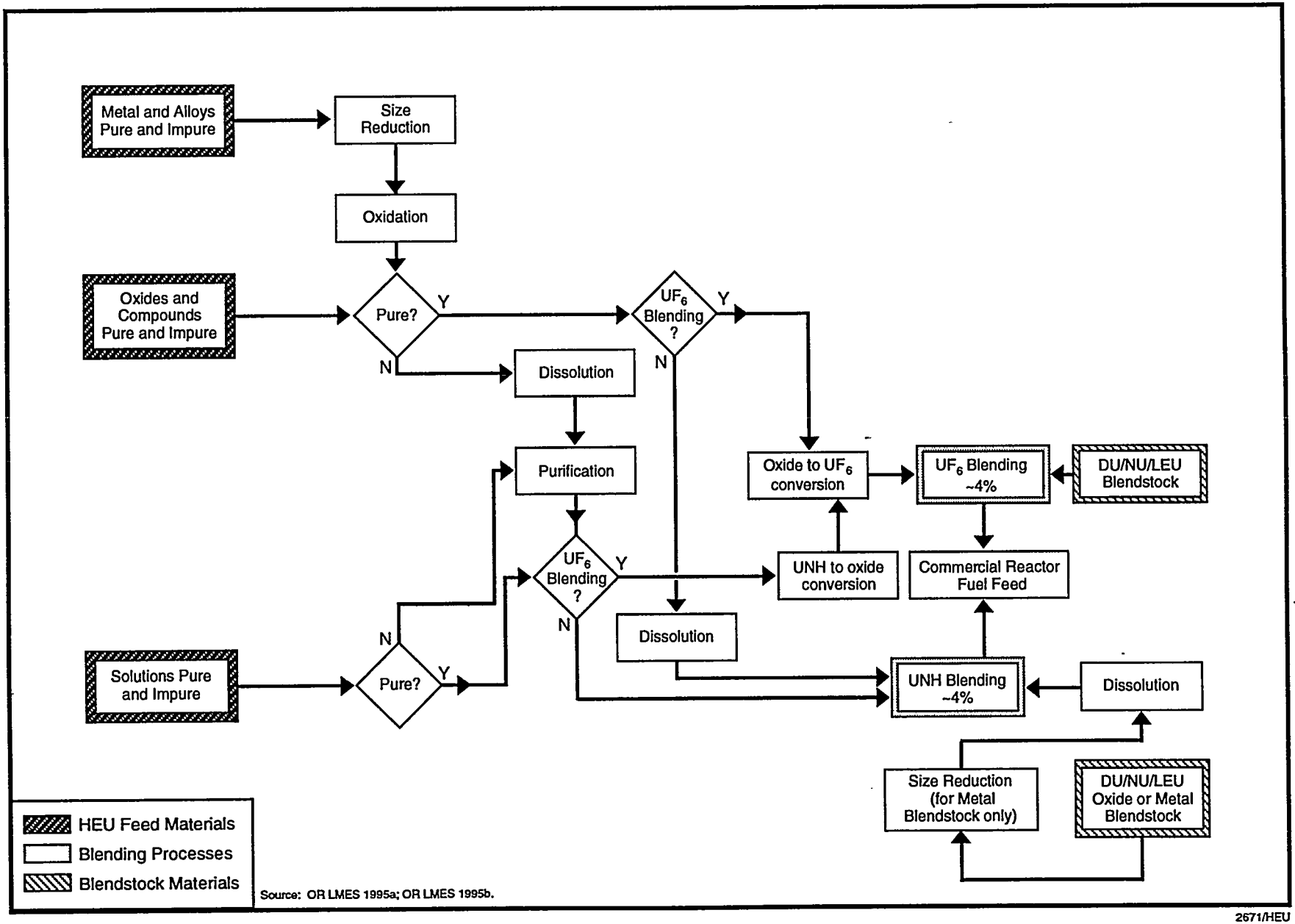


Figure 2.2.2–3. Blending Logic: Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Commercial Fuel (applies to off-spec material that would be blended for commercial use).

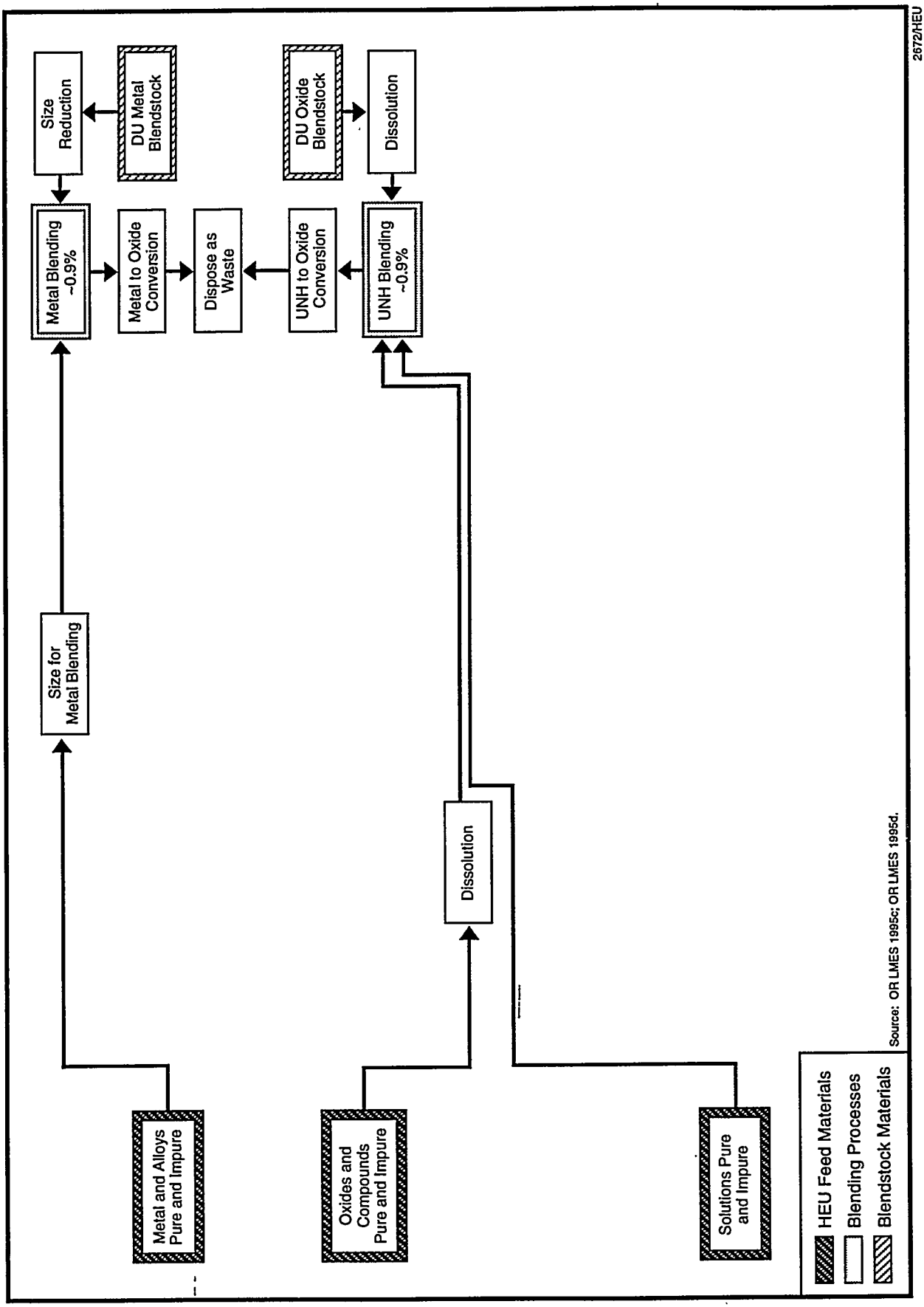


Figure 2.2.2–4. Blending Logic: Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Waste (applies to off-spec material that would be blended to waste).

The descriptions of processes and associated data presented in the following sections include this oxide conversion step which is necessary prior to disposal.

Assumptions. The following assumptions form the basis for the blending technology descriptions in the following sections:

- Chemical and isotopic analysis of individual batches of surplus HEU enables advance determination of whether the material can be blended to produce standard commercial reactor fuel, off-spec reactor fuel, or waste.
- Surplus HEU determined suitable for commercial reactor fuel use would be blended to a final product assay of approximately 4-percent U-235.
- The LEU product for commercial reactor fuel use would be provided in the form of UF_6 or UNH crystals.
- Surplus HEU blended to waste would be blended to a final oxide waste product at approximately 0.9-percent U-235 assay.
- Purification of the incoming HEU stream using solvent extraction of UNH solution would be provided for impure material before blending to commercial or off-spec LEU.
- Adequate supplies of low-assay DU, NU, and LEU blendstock can be provided in all of the chemical forms, UNH, metal, UF_6, and oxide.
- No purification would be required for the uranium blendstock material or for material to be blended to waste because material to be disposed of does not need to be pure.

2.2.2.1 Uranyl Nitrate Hexahydrate Blending

Surplus HEU, at various assay and impurity levels, could be converted to UNH. The UNH would be purified and blended with blendstock from oxide or metal form that has been converted to UNH to produce LEU as UNH crystals. The LEU product, at a 4-percent U-235 assay, could be used as feed for commercial reactor fuel; or at a 0.9-percent assay, the material could be converted to oxide and disposed of as waste. UNH crystals are a chemically reactive, solid form of uranium that can be used by commercial fuel fabricators if oxidized. The processes that would be used to blend HEU as UNH are outlined in Figure 2.2.2.1–1.

Of the three HEU forms (feed streams) shown in Figure 2.2.2.1–1, converting and blending impure HEU metal to UNH crystals involves greater volumes, more chemical processing, greater energy consumption, and a larger amount of process waste generation than other forms of HEU. This scenario applies to all material, whether it is blended to 4-percent assay LEU or to 0.9-percent assay LEU. The difference between the two product assay levels with respect to impacts is the amount of HEU that would be processed annually and the fact that 0.9-percent assay LEU does not require purification. For example, a dilution ratio of 14 to 1 would be required to convert and blend 50-percent assay HEU with NU into 4-percent assay LEU. Therefore, blendstock containing 140 t of NU would be required to blend with 10 t of HEU for a total annual throughput of 150 t of LEU. This same facility would have a similar LEU throughput capacity when producing the 0.9-percent assay material for waste disposal. However, because of the greater dilution ratio (70 to 1) required to produce 0.9-percent assay material, the facility would only be capable of blending approximately 2.1 t of HEU annually. More HEU would be blended under the 4-percent assay scenario; however, under the 0.9-percent assay scenario, more blendstock would be required. In each case, the LEU output quantity would be about the same. Radiological and nonradiological emissions would remain the same, however there would be a slight increase in electrical energy and natural gas requirements when blending to 0.9-percent assay LEU.

During the UNH blending process, HEU metal is reduced in size (may be oxidized), dissolved in nitric acid, purified through solvent extraction (4-percent blending only), and then blended with DU, NU, or LEU. The blended product is then dried to form UNH crystals for reactor fuel feed or converted to oxide for

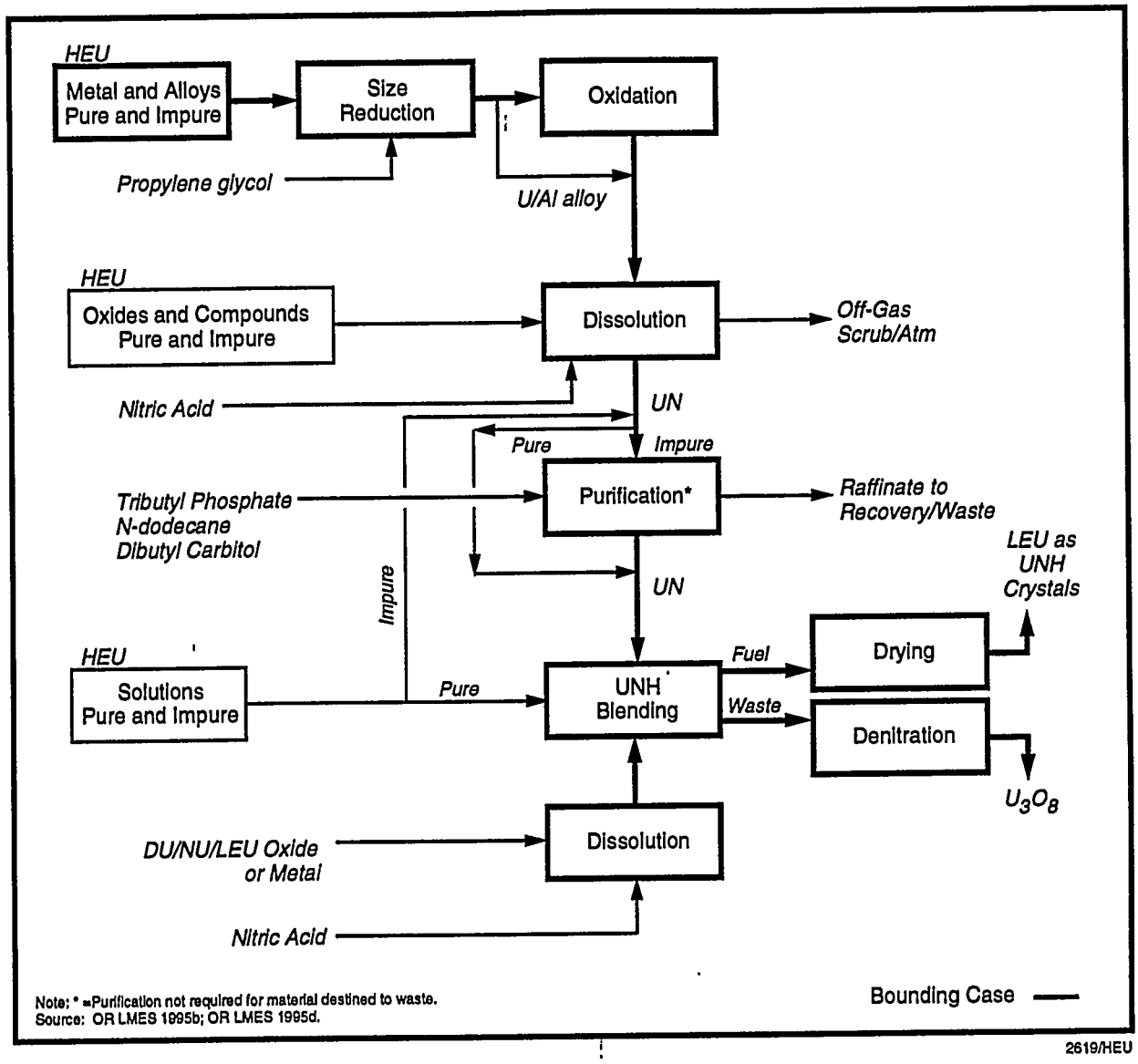


Figure 2.2.2.1–1. Blending Highly Enriched Uranium as Uranyl Nitrate Hexahydrate.

disposal as waste (for 0.9 percent blending only). The purification step in the blending process would not be performed for material to be disposed of as waste, since purity of the final product is not important. The UNH blending process is described for each step including the feed and product streams.

Feed Streams. The UNH blending process has two feed streams:

- Pure and impure HEU metal alloys, solutions, or oxides with an average U-235 assay of 50 percent (bounding case is impure HEU metal)
- Pure DU, NU, or LEU (impure for the 0.9-percent blending) blendstock

Size Reduction. Surplus HEU feed materials vary in form, size, and shape. Size reduction may be necessary with metallic feed material to facilitate process handling, oxidation, and dissolution. Size reduction can be accomplished by crushing, machining, or rolling and shearing.

Oxidation. Size-reduced metal is oxidized in air in a criticality-safe furnace to produce a powder. For ease of dissolving, this powder is preferred over metal for nitric acid dissolution. However, size-reduced metal also can be directly dissolved in nitric acid.

Nitric Acid Dissolution. Highly enriched uranium and blendstock oxide powder or size-reduced metal are dissolved in nitric acid to create an aqueous uranyl nitrate solution for purification or blending.

Purification (4-percent blending only). Any impurities contained in the uranyl nitrate solution must be removed prior to blending. (Only material being blended for commercial fuel requires purification; surplus HEU destined for disposal would not go through this step.) Impure HEU as UNH is purified in a two-step solvent extraction process. Uranyl nitrate transfers selectively from the aqueous solution into immiscible organic extraction media, leaving impurities in the aqueous solution. Pure uranyl nitrate is stripped from the media and is concentrated by evaporation.

Assay Blending. The assay blending operation blends HEU in UNH form with blendstock UNH to produce a commercial reactor fuel grade LEU with a reference U-235 assay of 4 percent or a waste material with an assay of 0.9 percent. This product is concentrated by evaporation, dried to a crystalline state, collected, and packaged for shipment. The product intended for disposal would be thermally decomposed to U_3O_8 and could be processed to meet the acceptance criteria of the disposal facility.

Packaging. Uranyl nitrate hexahydrate crystals, UO_2, uranium trioxide (UO_3), or U_3O_8 intended for commercial fuel fabrication are packaged in Department of Transportation (DOT)-certified containers for storage and eventual shipment to a fuel fabricator. U_3O_8 destined for disposal would be certified to meet waste acceptance criteria of the designated disposal facility and packaged for shipment and disposal.

Product Streams. The UNH blending scenario has three potential product streams:

- LEU oxide with approximately 0.9-percent U-235 assay for disposal
- LEU UNH crystals with approximately 4-percent U-235 assay that meets ASTM specifications for reactor feed material
- Off-spec LEU with the same (or slightly higher) assay should one or more customers request that material

Operational requirements for blending HEU to LEU as UNH are given in Table 2.2.2.1–1 for 4-percent and 0.9-percent LEU. Estimates of waste generation and emissions generated during the conversion and blending processes are presented in Tables 2.2.2.1–2 and 2.2.2.1–3, respectively.

2.2.2.2 Metal Blending

In the metal blending process, the HEU and blendstock metal pieces are melted and cast to form a desired assay metal product. All forms of HEU at various assay and impurity levels can be blended as metal by casting. Since commercial fuel fabricators do not handle uranium metal, casting would not be used to produce reactor fuel feed material. Therefore, metal blending is a reasonable option only for blending to waste at a 0.9-percent assay.[11] Blending to assays of less than 1 percent requires DU as

Table 2.2.2.1–1. Blending Highly Enriched Uranium to Low-Enriched Uranium as Uranyl Nitrate Hexahydrate—Operational Requirements (For Processing 10 t/yr and 2.1 t/yr Highly Enriched Uranium to Approximately 150 t/yr of 4-Percent and 0.9-Percent Low-Enriched Uranium, Respectively)

Requirement	Consumption	
	4-Percent LEU	0.9-Percent LEU
Electrical Energy (MWh/yr)	4,000	5,000
Peak Load (MWe)	2	2
Fuel		
Diesel (l/yr)	56,800	56,800
Natural gas (m^3/yr)	17,000	19,800
Coal (t/yr)	363	363
Steam (kg/yr)	8,700	8,700
Water (million l/yr)	19	19
Solid Chemicals		
Sodium hydroxide (t/yr)	1.0	NA
Liquid Chemicals		
Propylene glycol (kg/yr)	400	400
Potassium hydroxide, 20 percent by wt. (t/yr)	15	NA
Nitric acid, new, 30 percent by wt. (t/yr)	400	1,080
Nitric acid, recovered, 30 percent by wt. (t/yr)	40	133
Dibutyl carbitol (kg/yr)	400	NA
Tributyl phosphate (kg/yr)	50	NA
Sodium hydroxide (t/yr)	NA	352
N-dodecane (or high-grade kerosene) (t/yr)	1.5	NA
Gaseous Chemicals		
Argon (m^3/yr)	14,160	14,160
Nitrogen (m^3/yr)	14,160	14,160
Employment		
Total workers	125	125

Note: NA=not applicable; MWh=megawatt hour; MWe=megawatt electric; l=liters; m^3=cubic meters; kg=kilograms.
Source: OR LMES 1995b; OR LMES 1995d.

[11]Metal blending may also be proposed to be used, pursuant to appropriate NEPA documentation, to produce feedstock for USEC's Advanced Vapor Laser Isotope Separation program. However, this program is outside the scope of the proposed action of this EIS.

blendstock. HEU metal and DU blendstock are reduced in size, weighed, placed in appropriate batches, loaded into graphite crucibles, melted in vacuum induction furnaces, and cast. All casting wastes can be discarded as waste after being converted to U_3O_8. The metal blending option by casting is described in the following sections for each process step. The processes that would be used to produce LEU as metal are outlined in Figure 2.2.2.2–1. The metal blending processes are described for each process step including the feed and product streams.

Feed Streams. The metal blending scenario has two feed streams:

- HEU metal and alloy with an average U-235 assay of 50 percent (bounding case is alloy with 75-percent aluminum and 25-percent uranium)
- DU metal with a U-235 assay of approximately 0.2 percent

Size Reduction. Surplus HEU feed materials vary in size and shape. Size reduction by breaking in a hydraulic press, shearing, or sawing is required for two principle purposes: 1) to produce roughly uniform size pieces to facilitate process handling and to protect process equipment, and 2) to permit accurate preparation of individual furnace batches containing the required mix of HEU and DU blend metal.

Batch Preparation. Individual quantities of HEU and DU blendstock are weighed and combined in proportions necessary to produce the required 0.9-percent U-235 assay in the mix. These metals will be placed in a graphite crucible for melting.

Assay Blending. The HEU and DU batches will be melted in criticality-safe vacuum induction furnaces. These materials will be allowed to blend together in the vacuum atmosphere until a homogenous mixture is achieved. During the blending process, argon gas will be injected into the furnace to form a blanket inside the furnace surface to prevent oxide buildup.

Table 2.2.2.1–2. Blending Highly Enriched Uranium to Low-Enriched Uranium as Uranyl Nitrate Hexahydrate—Estimated Annual Average Operational Waste Volumes (For Processing 10 t/yr and 2.1 t/yr Highly Enriched Uranium to Approximately 150 t/yr of 4-Percent and 0.9-Percent Low-Enriched Uranium, Respectively.)

Waste Category	4-Percent LEU		0.9-Percent LEU	
	Generated Volume (m^3)	Post Treatment Volume[a] (m^3)	Generated Volume (m^3)	Post Treatment Volume[a] (m^3)
Low-Level				
Liquid	22	0	19	0
Solid	76	46	69	36
Mixed Low-Level				
Liquid	46	0	7	0
Solid	0	0	0	<1
Hazardous				
Liquid	88	0	11	0
Solid	0	0	0	0
Nonhazardous (Sanitary)				
Liquid	18,000	17,820	18,000	17,820
Solid	820[b]	591	820[b]	590
Nonhazardous (Other)				
Liquid	773	923[b]	763	795
Solid	0	0	0	<1

[a] Post treatment is described in Sections 4.3.1.7 and 4.3.3.7.

[b] Includes 410 m^3 of recyclable waste.

Note: Waste volumes are rounded to the nearest cubic meter (m^3). Waste volumes do not include "end product" LLW that would result from blending to 0.9-percent LEU and do not include any HLW if the irradiated and spent fuel were not down blended after processing.

Source: OR LMES 1995b; OR LMES 1995d.

Table 2.2.2.1–3. Blending Highly Enriched Uranium to Low-Enriched Uranium as Uranyl Nitrate Hexahydrate—Airborne Emissions During Operations (For Processing 10 t/yr and 2.1 t/yr Highly Enriched Uranium to Approximately 150 t/yr of 4-Percent and 0.9-Percent Low-Enriched Uranium, Respectively)

Pollutants	Emissions (t/yr)[a]			
	Y–12	SRS	B&W	NFS
Nonradiological				
Carbon monoxide (CO)	2.16	2.16	2.17	2.17
Lead (Pb)	0	0	0	0
Nitrogen dioxide (NO_2)	7.3	7.3	1.1	1.1
Ozone (O_3)[b]	0.22	0.22	0.2	0.2
Particulate matter (PM_{10})	0.17	0.17	0.17	0.17
Sulfur dioxide (SO_2)	13.5	13.5	1.96	1.96
Total suspended particulates (TSP)	37	37	0.17	0.17
Radiological				
U-235 (Ci/yr)	$6.9x10^{-5}$	$6.9x10^{-5}$	$6.9x10^{-5}$	$6.9x10^{-5}$
U-238 (Ci/yr)	$3.2x10^{-4}$	$3.2x10^{-4}$	$3.2x10^{-4}$	$3.2x10^{-4}$

[a] Air emissions differ between sites for this process because of the difference in their fuel source (for example, the commercial facilities do not burn coal).

[b] Based on estimated generation of volatile organic compounds.

Note: Ci=curies

Source: OR LMES 1995b; OR LMES 1995d.

Low-Enriched Uranium Metal Casting. The blended melt will be cast (using a graphite mold) into an ingot in a vacuum atmosphere. After the cast ingot has solidified and cooled, it is removed from its casting mold as LEU metal.

Low-Enriched Uranium Size Reduction. LEU metal is reduced in size by breaking in a hydraulic press, shearing, or sawing in order to facilitate the next step in the blending process which is oxidation.

Low-Enriched Uranium Chip Oxidation. The size-reduced LEU is oxidized in air in a criticality safe furnace to produce powder. Oxidized LEU is more stable than metal and is the preferred form for material destined for disposal.

Packaging. The LEU oxide powder will be sampled and packaged in a storage container.

Product Streams. The metal blending scenario has two potential product streams:

- Pure and impure LEU oxide with approximately 0.9-percent U-235 assay
- Pure and impure LEU oxide with approximately 0.9-percent U-235 assay and an aluminum content of approximately 4 percent (bounding case)

Operational requirements for blending HEU to LEU as metal are given in Table 2.2.2.2–1. Estimated waste generation and emissions generated during the conversion and blending processes are presented in Tables 2.2.2.2–2 and 2.2.2.2–3, respectively.

2.2.2.3 Uranium Hexafluoride Blending

It is possible to convert all forms of surplus HEU at various assay and impurity levels to UF_6. The feed material (HEU) and the blendstock can be blended directly as UF_6 or converted to UNH, purified, converted to oxide, then to UF_6 by dissolution in hydrofluoric acid before blending. A dilution ratio of 18.4 to 1 would be needed to convert and blend 50-percent assay HEU with 1.5 percent assay LEU blendstock into 4-percent assay LEU. UF_6 is generally the form of LEU received by fuel fabricators. Therefore, it is the preferred choice for material to be sold commercially. UF_6 is not an appropriate form for disposal as waste. The processes

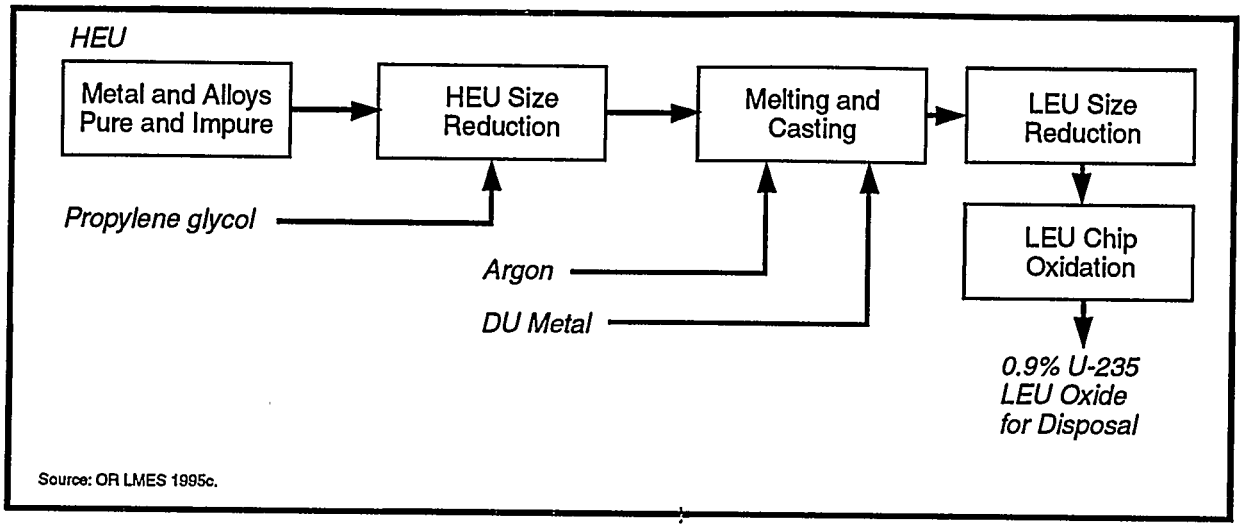


Figure 2.2.2.2–1. Blending Highly Enriched Uranium as Metal.

Table 2.2.2.2–1. Blending Highly Enriched Uranium to Low-Enriched Uranium as Metal—Operational Requirements (For Processing 3.1 t/yr Highly Enriched Uranium to Approximately 247 t/yr of 0.9-Percent Low-Enriched Uranium)

Requirement	Consumption
Electrical Energy (MWh/yr)	3,800
Peak Load (MWe)	1
Fuel	
Diesel (l/yr)	37,850
Natural gas (m^3/yr)	708
Coal (t/yr)	127
Water (million l/yr)	12
Solid Chemicals	
Graphite (t/yr)	1
[Text deleted.]	
Liquid Chemicals	
Pump oil (kg/yr)	400
Propylene glycol (kg/yr)	16,000
Gaseous Chemicals	
Argon (m^3/yr)	7,000
Nitrogen (m^3/yr)	7,000
Employment	
Total workers	72

Note: MWh=megawatt hour; MWe=megawatt electric; l=liters; m^3=cubic meters; kg=kilogram

Source: OR LMES 1995c.

Table 2.2.2.2–2. Blending Highly Enriched Uranium to Low-Enriched Uranium as Metal—Estimated Annual Average Operational Waste Volumes (For Processing 3.1 t/yr Highly Enriched Uranium to Approximately 247 t/yr of 0.9-Percent Low-Enriched Uranium)

Waste Category	Generated Volume (m^3)	Post Treatment Volume[a] (m^3)
Low-Level		
Liquid	280	0
Solid	545	364
Mixed Low-Level		
Liquid	9	0
Solid	0	0
Hazardous		
Liquid	<1	0
Solid	0	0
Nonhazardous (Sanitary)		
Liquid	11,000	10,890
Solid	470[b]	345
Nonhazardous (Other)		
Liquid	664	793
Solid	0	0

[a] Post treatment is described in Section 4.3.4.7.

[b] Includes 235 m^3 of recyclable waste.

Note: Waste volumes are rounded to the nearest cubic meter (m^3). Waste volumes do not include "end product" LLW that would result from blending to 0.9-percent LEU.

Source: OR LMES 1995c.

Table 2.2.2.2–3. Blending Highly Enriched Uranium to Low-Enriched Uranium as Metal—Airborne Emissions During Operations (For Processing 3.1 t/yr Highly Enriched Uranium to Approximately 247 t/yr of 0.9-Percent Low-Enriched Uranium)

Pollutants	Emissions (t/yr)
Nonradiological	
Carbon monoxide (CO)	1.3
Lead (Pb)	0
Nitrogen dioxide (NO_2)	2.6
Ozone[a] (O_3)	0.11
Particulate matter (PM_{10})	0.13
Sulfur dioxide (SO_2)	4.7
Total suspended particulates (TSP)	13
Radiological	
U-235 (Ci/yr)	1.1×10^{-5}
U-238 (Ci/yr)	2.5×10^{-4}

[Text deleted.]

[a] Based on estimated generation of volatile organic compounds.

Source: OR LMES 1995c.

that would be used to produce UF_6 are outlined in Figure 2.2.2.3–1.

During the UF_6 blending process, HEU metal is reduced in size, dissolved in nitric acid, purified through solvent extraction, converted to UO_3, reduced to UO_2, hydrofluorinated to uranium tetrafluoride (UF_4), fluorinated to UF_6, then blended with UF_6 blendstock to the desired commercial LEU assay. The process steps are described in more detail in the following paragraphs:

Feed Streams. The UF_6 blending scenario has two feed streams:

- Pure and impure HEU metal alloys, solutions, or oxides with an average U-235 assay of 50 percent (bounding case is alloy with 75-percent aluminum and 25-percent uranium which uses more resources and produces more waste)
- Pure DU, NU, or LEU UF_6 blendstock

Size Reduction. The HEU feed materials (metal) vary in size and shape. Size reduction is necessary to facilitate process handling, oxidation, and dissolution. Size reduction can be accomplished by crushing, machining, or by rolling and shearing.

Oxidation. Size-reduced metal is oxidized in air in a criticality-safe furnace to produce uranium oxide powder. For process purposes, this powder is preferred over metal for nitric acid dissolution. However, size-reduced metal also can be directly dissolved in nitric acid. With the uranium converted to oxide, alternative paths are available for conversion to UF_6. If purification is not required, the oxide may be fluorinated directly to UF_6 as described below.

Nitric Acid Dissolution. Either the oxides or size-reduced metal is dissolved in nitric acid to create an aqueous UNH solution for purification.

Purification. If UNH solution contains impurities, the solutions must be purified prior to blending. The bounding case assumes purification for the HEU stream only, since additional steps are needed. Impure HEU as uranyl nitrate is purified in a two-step solvent extraction process. Uranyl nitrate transfers selectively from the aqueous solution into immiscible organic extraction media, leaving impurities in the aqueous solution. The pure uranyl nitrate is transferred to an aqueous stripping solution and is concentrated by evaporation before denitration.

Denitration. Denitration is a thermal decomposition process in which the concentrated uranyl nitrate is decomposed in a heated rotary kiln to form UO_3.

Reduction. Uranium trioxide is reduced with hydrogen at 600 degrees Celsius (°C) (1,112° Fahrenheit [°F]) converting it to UO_2.

Hydrofluorination. Hydrofluorination of UO_2 to UF_4 uses hydrogen fluoride (HF) gas as the fluorinating agent.

Fluorination. Following hydrofluorination, UF_4 is fluorinated to UF_6 using elemental fluorine gas (F_2). Direct fluorination of UO_3 or U_3O_8 to UF_6 requires elemental fluorine, which is produced in electrolytic fluorine cells from HF or is purchased in fluorine cylinders. Fluorination of UF_4 to UF_6 requires only

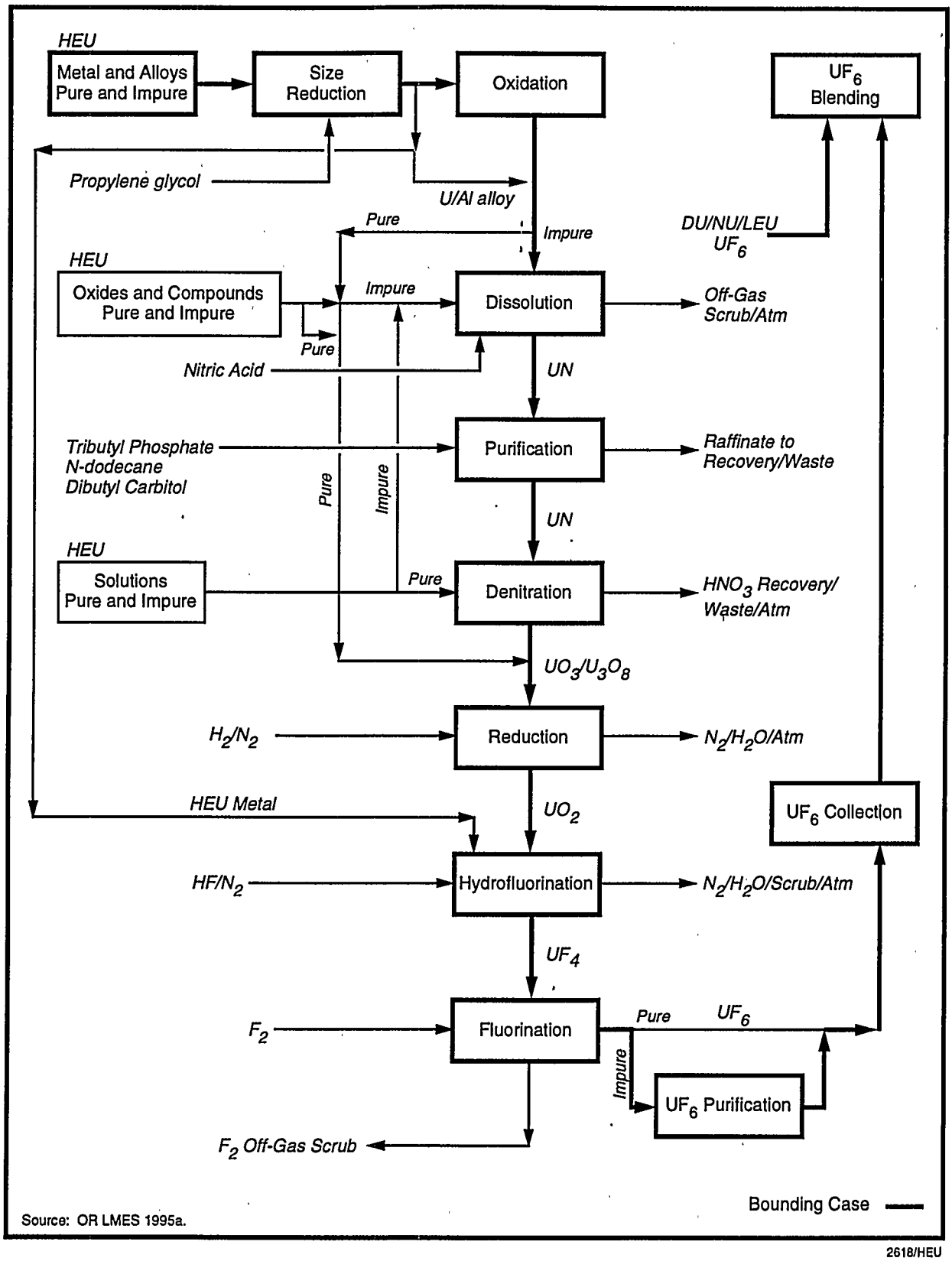


Figure 2.2.2.3–1. Blending Highly Enriched Uranium as Uranium Hexafluoride.

one third as much elemental fluorine and is significantly less expensive.

Assay Blending. Prior to blending, HEU and the blendstock are separately liquefied, each in its own container, and sampled to verify the purity and assay of the feed. HEU and blendstock are vaporized, blended together in precise ratios to achieve the desired U-235 assay in the blended product, liquefied, and collected. The product cylinders are heated for homogenization and sampled for purity and assay verification.

Packaging. The LEU UF_6 is collected in cold traps and transferred (as liquid) into DOT-approved shipping cylinders.

Product Streams. The UF_6 blending scenario has one product stream: pure LEU UF_6 with a U-235 assay of 4 percent (bounding case).

Operational requirements for blending HEU to LEU as UF_6 are given in Table 2.2.2.3–1. Estimated waste generation and emissions generated during the conversion and blending processes are presented in Tables 2.2.2.3–2 and 2.2.2.3–3, respectively.

2.2.3 CANDIDATE SITES

Four candidate sites are analyzed in this EIS for disposition (using one or more of the blending processes) of surplus HEU. They are DOE's Y–12 Plant at ORR; SRS; and two privately owned and operated facilities, B&W and NFS. The Y–12 Plant is the interim storage site for most of the surplus HEU. B&W and NFS have NRC licenses to process HEU. All of these sites are currently performing, or until recently have performed, national security activities involving HEU. The selection of sites and the descriptions of current blending activities at these sites are presented in the following sections.

2.2.3.1 Site Selection

All candidate sites currently have technically viable HEU conversion and blending capabilities and could begin, in the relatively near future, to convert surplus HEU to proliferation-resistant forms consistent with the President's nonproliferation policy. New sites and facilities are not considered reasonable for blending, given the availability of existing sites and facilities,

Table 2.2.2.3–1. Blending Highly Enriched Uranium to Low-Enriched Uranium as Uranium Hexafluoride—Operational Requirements (For Processing 10 t/yr Highly Enriched Uranium to Approximately 194 t/yr of 4-Percent Low-Enriched Uranium)

Requirement	Consumption
Electrical Energy (MWh/yr)	25,000
Peak Load (MWe)	2
Fuel	
Diesel (l/yr)	56,800
Natural gas (m^3/yr)	21,200
Coal (t/yr)	545
Steam (kg/yr)	8,700
Water (million l/yr)	20
Solid Chemicals	
Potassium hydroxide (t/yr)	6
Barium nitrate (t/yr)	3.5
Sodium hydroxide (t/yr)	1
Sodium fluoride (t/yr)	0.1
Liquid Chemicals	
Propylene glycol (kg/yr)	1,600
Sodium hydroxide, 50 percent by wt. (t/yr)	60
Sodium nitrate, 40 percent by wt. (t/yr)	40
Nitric acid, new, 30 percent by wt. (t/yr)	20
Nitric acid, recovered, 30 percent by wt. (t/yr)	20
Dibutyl carbitol (kg/yr)	400
Tributyl Phosphate (kg/yr)	50
N-dodecane (or high-grade kerosene) (t/yr)	1.5
Gaseous Chemicals	
Hydrogen (m^3/yr)	1,130
Anhydrous hydrogen fluoride (t/yr)	4
Fluorine (t/yr)	2
Argon (m^3/yr)	2,830
Nitrogen (m^3/yr)	2,830
Employment	
Total workers	126

Note: MWh=megawatt hour; MWe=megawatt electric; l=liter; m^3=cubic meter; kg=kilogram

Source: OR LMES 1995a.

Table 2.2.2.3–2. Blending Highly Enriched Uranium to Low-Enriched Uranium as Uranium Hexafluoride—Estimated Annual Average Operational Waste Volumes (For Processing 10 t/yr Highly Enriched Uranium to Approximately 194 t/yr of 4-Percent Low-Enriched Uranium)

Waste Category	Generated Volume (m^3)	Post Treatment Volume (m^3)[a]
Low-Level		
Liquid	49	0
Solid	145	89
Mixed Low-Level		
Liquid	159	0
Solid	0	0
Hazardous		
Liquid	6	0
Solid	0	0
Nonhazardous (Sanitary)		
Liquid	18,000	17,820
Solid	820[b]	590
Nonhazardous (Other)		
Liquid	1,155	1,350
Solid	<1	<1

[a] Post treatment is described in Section 4.3.2.7.

[b] Includes 410 m^3 of recyclable waste.

Note: Waste volumes are rounded to the nearest cubic meter (m^3).

Source: OR LMES 1995a.

Table 2.2.2.3–3. Blending Highly Enriched Uranium to Low-Enriched Uranium as Uranium Hexafluoride—Airborne Emissions During Operations (For Processing 10 t/yr Highly Enriched Uranium to Approximately 194 t/yr of 4-Percent Low-Enriched Uranium)

Pollutants	Emissions (t/yr)
Nonradiological	
Carbon monoxide (CO)	2.3
Lead (Pb)	[a]
Nitrogen dioxide (NO_2)	1.4
Ozone (O_3)[b]	0.2
Particulate matter (PM_{10})[c]	0.2
Sulfur dioxide (SO_2)	2.9
Total suspended particulates (TSP)[c]	0.2
Gaseous fluorides (as HF)	[d]
Radiological	
U-235 (Ci/yr)	1.1×10^{-4}
U-238 (Ci/yr)	6.2×10^{-4}

[a] No emissions from this process.

[b] Based on estimated generation of volatile organic compounds.

[c] It is conservatively assumed that all PM_{10} emissions are TSP emissions.

[d] Emission of gaseous fluorides is estimated to be a trace amount.

Source: OR LMES 1995a.

because new facilities would require capital investment and may not be cost effective. Moreover, new construction would pose additional impacts to the environment, although impacts from normal operations would be similar.

The Y–12 Facility has both molten metal and UNH blending capabilities. The commercial vendor sites, B&W and NFS, have only UNH blending capability at this time. UNH facilities at Y–12 and SRS are currently not in operation and may require upgrading before conversion and blending operations can resume. B&W and NFS hold NRC licenses for their HEU operations, including blending. [Text deleted]

2.2.3.2 Y–12 Plant, Oak Ridge, Tennessee

The ORR facility is located within the city boundaries of Oak Ridge, approximately 19 kilometers (km) or 12 miles (mi) west of Knoxville, Tennessee. ORR's Y–12 Plant is the primary location of several defense program missions including: maintaining the capabilities to fabricate components (primarily uranium and lithium) for nuclear weapons, storing uranium and lithium parts, dismantling nuclear weapon components returned from the national stockpile, processing special nuclear materials, and providing special production support to DOE design agencies and other Departmental programs. A description of existing uranium conversion and blending facilities at the Y–12 Plant is presented below. Descriptions of the affected environment for various resources at ORR, including Y–12, are provided in Section 3.3.

The existing enriched uranium operations facilities at the Y–12 Plant perform a variety of HEU processing and manufacturing operations. A few of the operations performed could be utilized to blend HEU down to LEU utilizing DU, NU, or LEU blendstock.

[Text deleted.]

Uranyl Nitrate Hexahydrate Blending. UNH blending is performed in the Building 9212-Chemical Recovery Facility. The facility has the capability to recover and purify uranium in very dilute amounts from a wide variety of material streams. The facility has the capability to convert HEU materials to pure UNH and blend the pure UNH to LEU in the form of UNH crystals. Processes include incineration, nitric acid dissolution, primary and secondary solvent extraction (purification), evaporation, thermal denitration (oxide preparation), hydrogen reduction of UO_3, hydrofluorination of UO_2, and reduction of UF_4.

If feed materials are pure, the blending process is simplified. In that case, only dissolution and oxide preparation are required to blend HEU with DU, NU, or LEU. The UNH blending process consists of feed size reduction, oxidation, nitric acid dissolution, purification, UNH blending, and drying and crystallizing to produce UNH crystals. Blending can occur at a rate of 5.6 t/yr for UNH blending of 50-percent assay HEU to 4-percent assay LEU, operating 21 shifts per week or 1.5 t/yr to 0.9-percent assay LEU for waste disposal. This capacity could be doubled if a second denitrator, which has been purchased by Y–12 but not yet installed, is added to the system.

Metal Blending. Molten metal blending is performed in the Building 9212 E-Wing Casting Facility. The casting facility has 12 vacuum induction furnaces, but due to use of the facility for other missions and routine maintenance requirements, it is assumed that 6 of the 12 furnaces, with 75-percent availability, would be available to perform HEU blending. The metal blending processes consist of feed size reduction, batch preparation, melting, assay blending, LEU metal casting, oxidation, and packaging.

The HEU and blendstock metal pieces are melted and cast to form the desired assay LEU metal product. The blendstock pieces are batch-weighed and mixed with HEU, applying the appropriate blend ratio. The blend would be cast into 18.5-kilogram (kg) (40.7-pound [lb]) LEU logs. Blending can occur at a maximum rate of 3.1 t/yr for molten metal blending of 50-percent assay HEU to 0.9-percent assay LEU with DU operating 21 shifts per week. Use of all 12 vacuum induction furnaces with 75-percent availability would double the capacity.

Since capabilities exist at Y–12 to perform HEU blending operations, no additional facilities need to be constructed. Y–12 facilities are currently not operational and to improve conduct of operations,

DOE must successfully complete an Operational Readiness Review prior to restart based on DOE O 425.1, *Startup and Restart of Nuclear Facilities.* Blending operations are expected to resume in 1997.

2.2.3.3 Savannah River Site, Aiken, South Carolina

The Savannah River Site is approximately 32 km (20 mi) south of Aiken, South Carolina, and occupies approximately 80,130 hectares (ha) (198,000 acres). Its primary mission was to produce strategic isotopes (Pu-239 and tritium) used in the development and production of nuclear weapons for national defense. The historical production cycle at SRS involved the fabrication of metal fuel and target assemblies for irradiation in the site reactors, followed by chemical dissolution, separation, and conversion into solid forms. The current mission is to store, treat, stabilize, and dispose of waste materials; manage and dispose of nuclear materials and facilities; restore the environment and manage natural resources; develop mission-supportive technology partnerships; and support current and future national security and nuclear materials requirements. Descriptions of the affected environment for various resources at SRS are provided in Section 3.4.

Except as noted below, SRS has the capability to blend HEU to either 4-percent or 0.9-percent LEU. The facilities for the UNH processes are located in the F- and H-Canyons. The F-Canyon facility was completed in 1954 with the primary mission being the separation and recovery of Pu-239 and U-235 from irradiated fuel. The H-Canyon facility was completed in 1955 and was originally designed for the same missions as F-Canyon and utilizes the same processes. H-Canyon's mission was changed in 1959 to the processing of irradiated enriched uranium to recover uranium with U-235 content of 1.1 percent to 93.5 percent.

Uranyl Nitrate Hexahydrate Blending. Blending HEU to LEU as UNH could be accomplished in the F- and/or H-Canyons at SRS. The canyons are large facilities for chemical separation, with large portions of the facilities shielded for remotely controlled operations. Overhead cranes allow remote equipment repairs, the installation of control systems, and other activities associated with operations. The canyons are equipped with dissolvers, centrifugal clarifiers, and solvent extraction systems. HEU would be prepared and staged in either F- or H-Canyon and the blendstock material (DU, NU, or LEU) would be prepared and staged in either canyon but not necessarily the same canyon as the HEU.

Blending HEU and LEU could be done in the H-Area, using a new blending tank recently installed. LEU solutions then could be transferred to F-Area for solidification. [Text deleted.] Blending could theoretically occur at a rate of 37 t/yr of HEU for UNH blending of 50-percent assay HEU to 4-percent assay LEU or 7.5 t/yr to 0.9-percent assay LEU (both canyons, all dissolvers). Actual throughput would likely be significantly lower since the HEU blending would have to share the resources (facilities and personnel) with other nuclear materials stabilization activities. The proportion of resources available to the HEU blending, and the associated throughput, would be determined by programmatic and budget decisions made to coordinate all nuclear materials stabilization activities.

The existing facility that could be used to solidify blended down UNH solutions at SRS (the FA-Line) is not designed to be critically safe for processing solutions with enrichment levels higher than about 1 percent. Thus, SRS could perform UNH blending of HEU to 0.9-percent LEU and subsequent solidification, but it could not, at present, solidify (crystallize and/or oxidize) HEU that is blended to commercial enrichment levels (4 to 5 percent). There are about 20 t of surplus HEU at SRS. (The quantities of the various forms of surplus HEU at SRS remain classified.) While it is virtually all off-spec material, including solutions and some irradiated fuel, most of it is considered to be potentially suitable for commercial use. (In connection with the *Final Environmental Impact Statement Interim Management of Nuclear Materials* [DOE/EIS-0220, October 1995] and the associated ROD(s), the DOE will dissolve and stabilize some of the irradiated fuel in the F-Canyon and/or H-Canyon at SRS to make it suitable for safe storage. If carried out, that process would result in the separation of the HEU, thus making it available to the HEU disposition program.)

One or more of several options for providing for solidification of UNH solutions at commercial enrichment levels at SRS may be proposed in the future, although none is being proposed by

DOE at this time.[12] DOE could complete a partially built Uranium Solidification Facility in the H-Area at SRS, or build a new facility. Another possibility is that a private, commercial entity, or another Federal agency, would build such a facility either within SRS (on land leased from DOE) or nearby. Such a private facility would need to be licensed by NRC. To conservatively estimate impacts, the HEU EIS includes the impacts of the solidification process as if it could occur at SRS. If a solidification facility were proposed and constructed, impacts would likely include land disturbance and minor air emissions from construction equipment. If construction of such a facility were proposed, additional NEPA review, as appropriate, would be conducted by DOE (or in connection with NRC licensing proceedings for a private facility). Using existing facilities, blended down LEU UNH solution (at 4-5 percent enrichment) could be transported to another facility (such as Y-12, B&W, NFS, or a fuel fabricator) for solidification.[13] Alternatively, all of the SRS material could be blended to about 0.9-percent enrichment and solidified at SRS. (This was the alternative considered in the Interim Management of Nuclear Materials EIS.)

[Text deleted.]

Other minor facility upgrades, such as loading dock modifications for F- and/or H-Canyons to facilitate the transfer of UNH solutions, would also be required to provide blending of HEU to LEU as UNH.[14]

2.2.3.4 Babcock & Wilcox Site, Lynchburg, Virginia

The B&W facility is located 8 km (5 mi) east of Lynchburg, Virginia. The facility is situated on approximately 212 ha (524 acres). B&W is an operating company of McDermott Inc., a subsidiary of McDermott International, Inc. Three facilities are located at the B&W Lynchburg site: Naval Nuclear Fuel Division (NNFD); Lynchburg Technology Center, which includes the Research and Development Division; and the Commercial Nuclear Fuel Plant.[15] A description of existing uranium conversion and blending operations at B&W is presented below. Descriptions of the affected environment for various resources at B&W are provided in Section 3.5.

The current primary mission of B&W NNFD is the fuel fabrication and purification of HEU and scrap uranium and the removal and recovery of materials generated in manufacturing waste streams to prevent environmental degradation. The capacity of B&W for recovery and purification is about 24 t/yr of HEU. These operations occur in the NNFD complex buildings Bays 12A, 13A, and 14A. Other operations in the NNFD complex include the conversion of HEU into a classified product used in the fabrication of naval nuclear fuel. B&W also is involved in research and development of improved manufacturing techniques and operates several

[12]The list of possible alternatives is not intended to be, and should not be construed to be, an exhaustive list of all reasonable alternatives for solidification of UNH at commercial enrichment levels at SRS, should such solidification be proposed.

[13]The approximately 20 t of HEU solutions at SRS could be blended to approximately 617 t of 4-percent UNH solution. The UNH solution could be transported from SRS using NRC-certified liquid cargo tank trailers (for example, DOE-specification MC-312, NRC Certificate of Compliance Number 5059), or other DOT-approved Type A fissile packaging to one of several offsite facilities that could perform the solidification of the material. The SRS site is in close proximity to existing commercial fuel fabrication facilities in both South Carolina and North Carolina that could perform the solidification. The South Carolina facility (97 km [61 mi]) from SRS) is assumed as a representative solidification site for the purpose of analysis only (it is not proposed at this time). This project (transportation for solidification of 617 t of LEU solution) would require about 350 truckloads of 16,800 kg (37,000 lb each) of UNH solution (includes 1.8 t uranium per truckload). The impact from nonradiological accidents would be about 3.7×10^{-3} fatalities for the entire project. The risk from radiological accidents is estimated to be 3.9×10^{-5} fatalities for the entire project. The impacts from normal (accident-free) transportation, inclu- ding handling and air pollution would be about 1.9×10^{-2} fatalities. The combined impact for the total campaign would be about 2.3×10^{-2} fatalities. The location of such offsite solidification and the extent of any transportation may depend in part on future proposals concerning the off-spec material at SRS and/or construction of a UNH solidification facility. Additional NEPA review would be conducted, as appropriate.

[14]As part of ongoing activities to upgrade the Safety Authorization Basis for the nuclear facilities at SRS, DOE is further evaluating the structural integrity and seismic response of the canyon facilities. These analyses are expected to be completed in July 1996.

[15]The Commercial Nuclear Fuel Plant was previously a B&W facility but is now owned and operated by the B&W Fuel Company, a conglomerate of French companies that includes Framatome.

laboratories. These operations occur primarily in the Lynchburg Technology Center facility. This facility is northwest of NNFD and would not be used for operations involved in the HEU EIS.

The NNFD Facility is one of only two commercial facilities in the United States capable of providing HEU processing services. The facility is operated under License SNM-42, Docket Number 70-27, granted by NRC. The license includes both the recovery and the blending of HEU. Current processes are for uranium in a UNH form. Recovery and blending operations have been performed for several years at B&W. The most recent NEPA document addressing its operations is the *Supplemental Environmental Assessment for Renewal of Special Nuclear Material License SNM-42,* U.S. NRC, dated June 1995. The resultant FONSI indicated that these operations were within the scope of the license.

The B&W NNFD Facility is licensed to possess up to 60,000 kg (132,000 lb) of U-235 in any required chemical or physical form (except UF_6) and at any enrichment. The total quantities of the HEU and uranium oxide blendstock required for the proposed action may exceed these limits for the alternatives in this EIS. Therefore, it might be necessary to increase the licensed possession limits or to schedule and stage the receipt and processing of these materials so that the quantity of uranium on site would not exceed any NRC license conditions.

Because the capabilities already exist at B&W for recovery and blending of HEU, no construction of additional buildings is required. Modifications to the buildings may be needed, which could include the purchase of additional equipment. The B&W facility could effectively begin processing HEU immediately. B&W already meets security requirements, since the processing of similar material has occurred in the past. No new equipment would be needed to meet current security requirements.

The facility has a complete environment, safety, and health program that includes all relevant areas (for example, radiation safety, industrial safety, industrial hygiene, and environmental engineering) as required by NRC. A criticality analysis has been performed for all areas where uranium would be located to establish mass criticality safety limits. Uranium metal dissolution in acid would be conducted in fume hoods, since there would be no particulate matter initially. Uranium oxide dissolution in acid would be conducted in gloveboxes since particulate matter could exist. Machining and grinding operations would be conducted in a separate glovebox, if grinding or crushing of the material is necessary. The gloveboxes would be under negative pressure at all times to ensure that material is not released into the worker area. The separation of metals and oxides is already conducted for all uranium operations. The processing of the HEU would be based on dissolution with a centrifuge operation to remove wet, undissolved material. The uranium solution then would go through a tertiary solvent extraction to remove over 99 percent of the uranium. B&W has air pollution control systems and liquid effluent treatment systems in place that would ensure that the facility is in compliance with applicable NRC (10 CFR 20) and Virginia Department of Environmental Quality regulations. The facility can address any permit modifications with the existing air pollution control system and liquid effluent treatment systems.

2.2.3.5 Nuclear Fuel Services, Inc., Erwin, Tennessee

The NFS facility is located in the city of Erwin, Tennessee. The facility is situated on approximately 25.5 ha (63 acres). A description of existing uranium conversion and blending operations at NFS is presented below. Descriptions of the affected environment for various resources at NFS are provided in Section 3.6.

The primary mission of NFS has been to convert HEU into a classified product used in the naval nuclear fuel program. This operation occurred in the 300-complex area. NFS was also involved in research on and development of improved manufacturing techniques, recovery and purification of scrap uranium, and removal and recovery of materials generated in manufacturing waste streams to prevent environmental degradation. The capacity of NFS for recovery and purification is about 10 t of HEU at 93-percent assay of U-235 per year. The recovery and purification operations occur in the 300-complex area.

The NFS Facility is one of only two commercial facilities in the United States capable of providing HEU processing services. The facility is operated

under License SNM-124, Docket Number 70-143, granted by NRC. The license includes both the recovery and the blending of HEU. Blending operations currently are for uranium in a UNH form. Recovery and blending operations have been performed for several years at NFS. The most recent NEPA document addressing its operations is the *Environmental Assessment for Renewal of Special Nuclear Material License SNM-124,* U.S. NRC, dated August 1991. The resultant FONSI indicated that these operations were within the license basis. On May 7, 1993, NRC issued Amendment No. 3 to SNM-124, which authorizes NFS to perform downblending of HEU. This amendment was based on the analysis in the Safety Evaluation Report, Docket Number 70-143. Upon reviewing the report, NRC determined that there would not be a significant impact to health, safety, or the environment and that because the provisions of 10 CFR 51.22(c)(11) had been met, neither an EA nor an EIS was necessary for the amendment.

The NFS facility is licensed to possess up to 7,000 kg (15,400 lb) of U-235 in any required chemical or physical form and at any enrichment. The total quantities of the HEU and uranium oxide blendstock under the proposed action might exceed these limits; therefore, it might be necessary to increase the licensed possession limits or to schedule and stage the receipt and processing of these materials so that the quantity of uranium onsite would not exceed any NRC requirements.

Because the capabilities exist already at NFS for performing the recovery and blending of HEU, no additional buildings need to be constructed. Modifications to the buildings may be needed, which may include the purchase of additional equipment. The NFS facility could cost effectively begin processing the material within one year. In addition, NFS already meets security requirements, since the processing of similar material has occurred in the past. No new equipment would be needed to meet current security requirements.

The facility has a complete environment, safety, and health program that includes all relevant areas (for example, radiation safety, industrial safety, industrial hygiene, environmental monitoring) as required by NRC. A criticality analysis has been performed for all areas where uranium would be located to establish mass criticality safety limits. Uranium metal and uranium oxide dissolution in nitric acid would be conducted in fume hoods. The fume hoods have a dual layer of air flow to reduce exposure to the workers. Hydrofluoric acid would be used to enhance dissolution. Uranium oxide production would be conducted in gloveboxes since particulate matter could exist. The gloveboxes would be under negative pressure at all times to ensure that material is not released into the worker area. NFS has air pollution control systems and liquid effluent treatment systems in place that allow the facility to comply with permit requirements, and potential permit modifications, for uranium and other hazardous pollutants in accordance with 10 CFR 20 and State of Tennessee Rule 1200-3-11.03.

2.3 POLLUTION PREVENTION

The *Pollution Prevention Act* of 1990 established a national policy that, whenever feasible, pollution should be prevented or reduced at the source. Under this Act, pollution that cannot be prevented should be recycled and disposal or other releases into the environment should be employed only as a last resort. It also requires that these pollution prevention activities should be conducted in an environmentally safe manner. Executive Order 12856, dated August 3, 1993, and DOE Order 5400.1 implement the provisions of the *Pollution Prevention Act* of 1990.

Pollution prevention is designed to keep pollutants from being released to the environment. These preventive measures include source reduction, recycling, treatment, and disposal. The emphasis is on source reduction and recycling to prevent the creation of wastes (that is, waste minimization). Source reduction and waste minimization techniques include good operating practices, technology modifications, input material changes, and product changes. Use and reuse plus reclamation are onsite and offsite recycling techniques.

Highly enriched uranium blending would incorporate waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for

cost-effective disposal or recycling. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous or mixed waste. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible.

2.4 COMPARISON OF ALTERNATIVES

A comparison of the site-specific environmental impacts of the surplus HEU disposition alternatives is presented in this section. The combined impacts of each alternative for the disposition of the 200 t of surplus HEU inventory, which may involve multiple technologies, sites, and end products, are summarized. The annual operational impacts of each of the blending technologies for various resources at the candidate sites are fully described in Sections 4.3 and 4.4.

For each alternative analyzed other than the No Action Alternative, there are two potential processes for blending to commercial fuel (UNH and UF_6) and two potential processes for blending to waste (UNH and metal). The impacts and, in the case of blending to waste, the processing rate of the respective processes differ. In other words, the magnitude of expected impacts and the time required to complete disposition actions depend on the process selected.

Material could be blended to waste at the two DOE sites using UNH blending, however, at ORR both UNH and metal blending could be used for blending to waste. Similarly, material could be blended to commercial fuel feed at the two commercial sites using either UNH or UF_6 blending. To provide conservatism in the site-specific analyses below, where there is such a choice of applicable processes at a site (that is, blending to waste at DOE's ORR [Y–12 Plant]) site and blending to commercial fuel feed at the commercial sites), the value given for each resource area is based on whichever process produces the greatest impact.

For blending to waste at Y–12, the UNH process would produce the greatest impact in all resource areas except three. The metal process would produce the greatest impacts for liquid LLW generated, solid LLW generated, and solid LLW after treatment. Therefore, the analyses below conservatively use the metal impacts for these three resource areas and the UNH impacts for all other resource areas at Y–12.

For blending to commercial fuel feed at the commercial sites, the UF_6 process would produce the greatest impacts in all resource areas except three. The UNH process would produce the greatest impacts for liquid hazardous waste generated, solid nonhazardous waste after treatment, and transportation. The analyses below conservatively use the UNH impacts for these three resource areas, and the UF_6 impacts for all other resource areas at Y–12.

The results indicate that all four sites have the capacity to process material with minimal impacts to workers, the public, or the environment. For the two DOE sites, the generation of waste based on an increased usage of utilities represents small increases—less than 5 percent over current operations. For the two commercial sites, the generation of waste based on an increased usage of utilities represents increases of over 20 percent, but both facilities have adequate capacity to accommodate the increases since neither site is currently operating at full capacity. The NFS site would require a large increase in water usage (166 percent) and fuel requirements (933 percent). [Text deleted.] Because the quantity of water and fuel used in the past for similar operations was also used for the proposed action and in the analyses in this EIS, it is anticipated that the increase in these requirements can easily be accommodated at NFS. The alternatives as described are not intended to represent exclusive choices among which DOE (or other decisionmakers) must choose, but rather to provide a range of reasonable alternatives.

A comparison of the incremental environmental impacts of the HEU disposition alternatives is summarized in Tables 2.4–1 and 2.4–2. Table 2.4–1 compares the total campaign and maximum incremental impacts for each resource and alternative at each of the four alternative blending sites. Table 2.4–2 presents the summary comparison of total campaign maximum incremental impacts for each alternative. In addition, impacts assbciated with no action are included for a baseline comparison.

Incremental impacts shown in Tables 2.4–1 and 2.4–2 are based on the maximum impact for each resource at each site (that is, the maximum electricity needed for either UNH or UF_6 blending to fuel or UNH or metal blending to waste) using 10 t/yr processing rate for commercial blending and 2.1 or 3.1 t/yr processing rate for blending to waste. These processing rates were also used to determine the duration of commercial blending for each alternative. If two sites were used for commercial blending a total of 20 t would be blended annually (10 t/yr at each site) and would take 4 years to blend 80 t of HEU, whereas, in the case of 4 sites, a total of 40 t/yr would be blended continuing over a period of 2 years to blend 80 t. However, as shown in Table 2.1.2–1, DOE expects to make only 8 t of surplus HEU available for commercial use annually due to material availability, market conditions, and legislative requirements which would reduce the annual processing rate for each site when multiple sites are used. Therefore, because total campaign impacts presented in Table 2.4–1 use incremental impacts estimated for each resource using the processing rates analyzed in this EIS, they represent upper bound total campaign impacts. If surplus HEU is made available at less than the combined capacity of blending sites, it would take more time to blend the surplus inventory to commercial fuel. In such a case, total campaign impacts are anticipated to be roughly the same, but would be realized at lower rates over a longer period of time.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site

Alternative 1: No Action

Site Infrastructure Baseline Characteristics (No Action)

Site	Y–12	SRS	B&W	NFS
Electricity (MWh/yr)	420,500	659,000	64,700	21,800
Electric peak load (MWe)	62	130	14.3	3.5
Diesel/oil (l/yr)	0	28,400,000	470,000	36,000
Natural gas (m^3/yr)	66,000,000	0	2,850,000	12,900
Coal (t/yr)	2,940	210,000	0	0
Steam generation (kg/hr)	99,000	85,400	1,460	6,260
Water usage (l/yr)	7,530,000,000	153,687,000,000	195,000,000	57,000,000

Note: MWh=megawatt hour; MWe=megawatt electric; l=liter; m^3=cubic meter.

Source: Derived from tables in Section 4.2.

Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at Each Candidate Site Boundary (No Action)

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	5	22	4	1.97
	1 hour	40,000[a]	11	171	13.1	2.52
Lead (Pb)	Calendar Quarter	1.5[a]	0.05	0.0004	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	3	5.7	3.5	0.62
Particulate matter (PM_{10})	Annual	50[a]	1	3	0.02	0.03
	24 hours	150[a]	2	50.6	0.16	0.21
Sulfur dioxide (SO_2)	Annual	80[a]	2	14.5	0.34	0.02
	24 hours	365[a]	32	196	2.28	0.15
	3 hours	1,300[a]	80	823	11.8	0.35
Mandated by South Carolina, Tennessee, and Virginia						
Total suspended particulates (TSP)	Annual	60[c]	1[d]	12.6	0.03	0.03[d]
	24 hours	150[c]	2	47[d,e]	0.22	0.21
Gaseous fluorides (as HF)	1 month	0.8[c]	0.2	0.09	[b, d]	0.02
	1 week	1.6[c]	0.3	0.39	[b, d]	<0.06
	24 hours	2.9[c]	<0.6	1.04	[b, d]	0.06
	12 hours	3.7[c]	<0.6	1.99	[b, d]	0.1
	8 hours	250[c]	0.6	<2.99[d]	[b, d]	0.11

[a] Federal standard.

[b] No emissions from processes used at the site.

[c] State standard or guideline.

[d] No State standard.

[e] Based on maximum measured SRS ambient monitoring data for 1985.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations; m^3=cubic meter.

Source: Derived from tables in Section 4.2.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Socioeconomic Parameters Baseline Characteristics (No Action)

Site	ORR	SRS	B&W	NFS
Employment	15,273	19,208	1,846	325
Payroll (million $)	523	1,149[a]	80	13.2
Regional Economic Area				
Employment				
1995	462,900	243,800	321,400	253,800
2000	488,700	259,400	334,700	265,500
Unemployment (%)				
1994	4.9	6.7	4.9	5.9
Per capita income				
1995 ($)	18,200	17,800	18,000	16,800
2000 ($)	19,214	18,930	18,788	17,594
Region of Influence				
Population				
1995	519,300	477,600	219,900	322,600
2000	548,200	508,300	229,000	337,600
Housing units				
1995	222,000	189,400	90,500	135,700
2000	234,400	201,600	94,300	141,900
[Text deleted.]				

[a] Total payroll for 1992 is based on 1990 employee wage and 1992 total number of employees (SRS 1995a:4).

Source: Derived from tables in Section 4.2.

Potential Radiological Impacts to Workers and the Public Resulting From Normal Operations Baseline Characteristics (No Action)

Receptor	ORR	SRS	B&W	NFS
Natural background radiation dose (mrem/yr)	295	298	329	340
Average worker (mrem/yr)	4	17.9	10	50
Fatal cancer risk for 20 years	3.2×10^{-5}	1.4×10^{-4}	8.0×10^{-5}	4.0×10^{-4}
Maximum worker exposure (mrem/yr)	2,000	3,000	3,300	470[a]
Maximally exposed member of public (mrem/yr)	2[b]	0.32	5.0×10^{-2}	3.3×10^{-2}
Fatal cancer risk for 20 years	2.0×10^{-5}	3.2×10^{-6}	5.0×10^{-7}	3.3×10^{-7}
Total worker dose (person-rem/yr)	68	216	18	16.3
Number of fatal cancers for 20 years	0.54	1.7	0.14	0.13
Total population dose (person-rem/yr)	28	21.5	0.35	0.2
Number of fatal cancers for 20 years	0.28	0.22	3.5×10^{-3}	2.0×10^{-3}

[a] Representative of one-half year.

[b] Representative of air and liquid media only; an additional 1 mrem/yr may be incurred due to direct exposure.

Note: mrem=millirem; rem=roentgen equivalent man.

Source: Derived from tables in Section 4.2.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Potential Hazardous Chemical Impacts[a] to Workers and the Public Resulting From Normal Operations Baseline Characteristics (No Action)

Receptor	ORR	SRS	B&W	NFS
Maximally Exposed Individual				
Hazard index[b]	3.95×10^{-2}	5.16×10^{-3}	1.15×10^{-5}	9.55×10^{-2}
Cancer risk[c]	0	1.31×10^{-7}	1.68×10^{-8}	0
Onsite Worker				
Hazard index[d]	0.154	1.16	4.07×10^{-3}	7.57×10^{-3}
Cancer risk[e]	0	1.94×10^{-4}	3.94×10^{-5}	0

[a] Includes any background emissions that would be present at the site in the absence of site operations plus site emissions that exist at the present time.

[b] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[c] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[d] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[e] Lifetime cancer risk=(emissions for 8-hr.) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.2.

Baseline Characteristics for Annual Waste Generated (No Action)

Waste Category	ORR	SRS	B&W	NFS
Low-Level				
Liquid (m^3)	2,576	0	50,005	18,900
Solid (m^3)	8,030	14,100	620	3,000
Mixed Low-Level				
Liquid (m^3)	84,210	115	0	<1
Solid (m^3)	960	18	14	<1
Hazardous				
Liquid (m^3)	32,640	Included in solid	55,115	<1
Solid (m^3)	1,434	74	0	<1
Nonhazardous				
Liquid (m^3)	1,743,000	700,000	576,160	56,700
Solid (m^3)	52,730	6,670	1,700	2,300

Note: m^3=cubic meter

Source: Derived from tables in Section 4.2.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Alternative 2: No Commercial Use (0/100 Fuel/Waste Ratio)

Total Campaign[a] Site Infrastructure Incremental Impacts Using All Four Sites (200 t to waste)

Characteristic	Y–12	SRS	B&W	NFS	Total
Electricity (MWh)	119,000	119,000	119,000	119,000	476,000
Diesel/oil (l)	1,352,000	2,024,000	8,004,000	8,004,000	19,384,000
Natural gas (m^3)	471,000	0[b]	471,000	471,000	1,413,000
Coal (t)	8,640	8,640	0[c]	0[c]	17,280
Steam (kg)	207,000	207,000	207,000	207,000	828,000

[a] Total campaign refers to the time required to complete blending disposition actions evaluated for Alternatives 2 through 5. Annual values are presented in Section 2.2.2.

[b] Natural gas is not available at SRS; therefore, liquid petroleum gas (approximately 671,000 l) would be substituted for a natural gas requirement of 471,000 m^3.

[c] Fuel oil is considered the primary fuel at B&W and NFS; therefore, blending facility coal requirements have been converted to a fuel oil energy equivalent. Fuel oil energy content is assumed to be 40,128 BTUs/l, and the coal energy content is assumed to be 30.9 million BTUs/t.

Note: BTU=British thermal unit.

Source: Derived from tables in Section 4.3.

Maximum Air Quality Incremental Impacts Using All Four Sites (200 t to waste)

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	11.5	0.07	5.22	0.6
	1 hour	40,000[a]	53	0.14	16.96	0.77
Lead (Pb)	Calendar Quarter	1.5[a]	b	b	b	b
Nitrogen dioxide (NO_2)	Annual	100[a]	1.33	0.01	0.1	0.02
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01	0.02	<0.01
	24 hours	150[a]	0.37	<0.01	0.16	0.02
Sulfur dioxide (SO_2)	Annual	80[a]	2.46	0.02	0.27	0.04
	24 hours	365[a]	29.3	0.32	1.82	0.27
	3 hours	1,300[a]	161	0.71	9.41	0.64
Mandated by South Carolina, Tennessee, and Virginia						
Total suspended particulates (TSP)	Annual	60[c]	6.74[d]	0.05	0.02	<0.01[d]
	24 hours	150[c]	80.16	0.88[d]	0.16	0.02
Gaseous fluorides (as HF)	1 month	0.8[c]	b	b	b, d	b
	1 week	1.6[c]	b	b	b, d	b
	24 hours	2.9[c]	b	b	b, d	b
	12 hours	3.7[c]	b	b	b, d	b
	8 hours	250[c]	b	b, d	b, d	b

[a] Federal standard.

[b] No emissions from UNH and metal blending process.

[c] State standard or guideline.

[d] No State standard.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Water Resources Incremental Impacts Using All Four Sites (200 t to waste)

Resource	Y–12	SRS	B&W	NFS	Total
Water (million l)	452	452	452	452	1,808
Wastewater (million l)[a]	446	446	446	446	1,784

[a] Includes sanitary and nonhazardous, nonradioactive (other) liquid discharges after treatment.

Source: Derived from tables in Section 4.3.

Maximum Socioeconomic Incremental Impacts Using All Four Sites (200 t to waste)

Characteristic	Y–12	SRS	B&W	NFS
Direct employment	125	125	125	125
Indirect employment	319	245	283	251
Total jobs	444	370	408	376
Unemployment rate change (percent)	-0.09	-0.14	-0.12	-0.14

Source: Derived from tables in Section 4.3.

Total Campaign Normal Operations Radiological Exposure Incremental Impacts Using All Four Sites (200 t to waste)

Receptor	Y–12	SRS	B&W	NFS	Total
Involved Workers					
Total dose to involved workforce[a] (person-rem)	269	269	269	269	1,076
Risk (cancer fatalities per campaign)	0.108	0.108	0.108	0.108	0.43
Maximally Exposed Individual (Public)					
Dose to maximally exposed individual member of the public (mrem)	0.928	5.95×10^{-2}	4.52×10^{-2}	3.33	NA[b]
Risk (cancer fatality per campaign)	4.64×10^{-7}	2.98×10^{-8}	2.26×10^{-8}	1.67×10^{-6}	NA[b]
Population Within 80 km					
Dose to population within 80 km[c] (person-rem)	3.81	3.81	0.405	28.6	36.6
Risk (cancer fatalities per campaign)	1.91×10^{-3}	1.91×10^{-3}	2.03×10^{-4}	1.43×10^{-2}	1.83×10^{-2}

[a] The involved workforce is 125 for UNH blending and 72 for metal blending.

[b] The dose and the latent cancer fatality for the maximally exposed individual cannot be totaled because they are based on maximum exposure to an individual at each site using site-specific information.

[c] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12; 710,000 for SRS; 730,000 for B&W, and 1,260,000 for NFS.

Note: NA=not applicable.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Facility Accidents Incremental Impacts Using All Four Sites (200 t to waste)[a]

Receptor	Y–12	SRS	B&W	NFS
Campaign accident frequency[b]	2.4×10^{-3}	2.4×10^{-3}	2.4×10^{-3}	2.4×10^{-3}
Noninvolved Workers[c]				
Latent cancer fatalities per accident	0.4	8.7×10^{-2}	0.94	8.4×10^{-2}
Risk (cancer fatalities per campaign)	9.4×10^{-4}	2.1×10^{-4}	2.2×10^{-3}	2.0×10^{-4}
Maximally Exposed Individual (Public)				
Latent cancer fatality per accident	5.0×10^{-4}	3.1×10^{-6}	5.7×10^{-4}	1.3×10^{-4}
Risk (cancer fatality per campaign)	1.2×10^{-6}	7.3×10^{-9}	1.4×10^{-6}	3.0×10^{-7}
Population Within 80 km[d]				
Latent cancer fatalities per accident	6.9×10^{-2}	1.6×10^{-2}	4.0×10^{-2}	5.8×10^{-2}
Risk (cancer fatalities per campaign)	1.6×10^{-4}	3.8×10^{-5}	9.5×10^{-5}	1.4×10^{-4}

[a] The risk values for this alternative are based on the most conservative combination of the options within the alternative (that is, blending 50 t HEU to 0.9-percent LEU as UNH waste at each site).

[b] Values shown represent probability for the life of campaign and are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.

[c] The noninvolved workers are workers on site but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.

[d] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12; 710,000 for SRS; 730,000 for B&W; and 1,260,000 for NFS.

Source: Derived from tables in Section 4.3.

Maximum Chemical Exposure Incremental Impacts Using All Four Sites (200 t to waste)

Receptor	Y–12	SRS	B&W	NFS
Maximally Exposed Individual (Public)				
Hazard index[a]	1.92×10^{-3}	2.13×10^{-4}	6.90×10^{-6}	1.01×10^{-2}
Cancer risk[b]	2.66×10^{-15}	2.30×10^{-16}	7.43×10^{-18}	1.08×10^{-14}
Onsite Worker				
Hazard index[c]	6.30×10^{-3}	5.65×10^{-3}	2.34×10^{-3}	3.21×10^{-3}
Cancer risk[d]	8.18×10^{-14}	7.35×10^{-14}	3.06×10^{-14}	4.19×10^{-14}

[Text deleted.]

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[b] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Waste Generation Incremental Impacts Using All Four Sites (200 t to waste)

Waste Category[a]	Y–12	SRS	B&W	NFS	Total
Low-Level					
Liquid (m^3)	4,510	452	452	452	5,866
Solid (m^3)	8,780	1,640	1,640	1,640	13,700
Mixed Low-Level					
Liquid (m^3)	167	167	167	167	668
Solid (m^3)	0	0	0	0	0
Hazardous					
Liquid (m^3)	262	262	262	262	1,048
Solid (m^3)	0	0	0	0	0
Nonhazardous (Sanitary)					
Liquid (m^3)	428,000	428,000	428,000	428,000	1,712,000
Solid (m^3)	19,500	19,500	19,500	19,500	78,000
Nonhazardous (Other)					
Liquid (m^3)	18,200	18,200	18,200	18,200	72,800
Solid (m^3)	0	0	0	0	0
Solid Low-Level (m^3)[b]	5,810	881	881	881	8,453
Solid Nonhazardous (m^3)[b]	14,100	14,100	14,100	14,100	56,400
LEU Low-Level (m^3)[c]	9,820	9,730	9,730	9,730	39,010

[a] Waste volumes are based on the blending process which produces the highest volume for each category.

[b] Process waste after treatment.

[c] End product waste as a result of blending. Includes irradiated fuel that is currently in the surplus HEU inventory (quantity is classified), which potentially could be disposed of as high-level waste.

Source: Derived from tables in Section 4.3.

Total Campaign Transportation Risk Incremental Impacts Using All Four Sites (200 t to waste)

Receptor	Y–12	SRS	B&W	NFS	Total
Accident-Free Operations					
Fatalities to the public from radiological effects	0.13	0.15	0 15	0.14	0.58
Fatalities to the crew from radiological effects	0.11	0.11	0.11	0.11	0.44
Fatalities to the public from nonradiological effects	$1.1x10^{-2}$	$1.5x10^{-2}$	$1.7x10^{-2}$	$1.2x10^{-2}$	$5.5x10^{-2}$
Accidents					
Fatalities to the public from radiological effects[a]	$4.3x10^{-3}$	$4.8x10^{-3}$	$5.0x10^{-3}$	$4.8x10^{-3}$	$1.88x10^{-2}$
Fatalities to the public from nonradiological effects	0.4	0.48	0.5	0.45	1.83
Fatalities to the crew from nonradiological effects	0.11	0.14	0.14	0.12	0.51
Total Fatalities	0.77	0.9	0.93	0.84	3.43

[a] The transportation crew and the public are considered as one population for the purposes of radiological accidents.

Source: Derived from tables in Appendix G.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Alternative 3: Limited Commercial Use (25/75 Fuel/Waste Ratio)

Total Campaign[a] Site Infrastructure Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)

Characteristic	Y–12	SRS	B&W	NFS	Total
Electricity (MWh)	89,000	89,000	152,000	152,000	482,000
Diesel/oil (l)	1,017,000	1,522,000	7,211,000	7,211,000	16,961,000
Natural gas (m^3)	354,000	0[b]	406,000	406,000	1,166,000
Coal (t)	6,480	6,480	0[c]	0[c]	12,960
Steam (kg)	155,400	155,400	177,100	177,100	665,000

[a] Total campaign refers to the time required to complete blending disposition actions evaluated for Alternatives 2 through 5. Annual values are presented in Section 2.2.2.

[b] Natural gas is not available at SRS; therefore, liquid petroleum gas (approximately 504,000 l) would be substituted for a natural gas requirement of 354,000 m^3.

[c] Fuel oil is considered the primary fuel at B&W and NFS; therefore, blending facility coal requirements have been converted to a fuel oil energy equivalent. Fuel oil energy content is assumed to be 40,128 BTUs/l, and the coal energy content is assumed to be 30.9 million BTUs/t. A coal requirement of 7,845 t equals 6,040,000 l of fuel oil.

Source: Derived from tables in Section 4.3.

Maximum Air Quality Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	11.5	0.07	5.43	0.62
	1 hour	40,000[a]	53	0.14	17.63	0.8
Lead (Pb)	Calendar Quarter	1.5[a]	b	b	b	b
Nitrogen dioxide (NO_2)	Annual	100[a]	1.33	0.01	0.14	0.03
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01	0.03	<0.01
	24 hours	150[a]	0.37	<0.01	0.19	0.03
Sulfur dioxide (SO_2)	Annual	80[a]	2.46	0.02	0.4	0.05
	24 hours	365[a]	29.3	0.32	2.74	0.4
	3 hours	1,300[a]	161	0.71	14.11	0.96
Mandated by South Carolina, Tennessee, and Virginia						
Total suspended particulates (TSP)	Annual	60[c]	6.74[d]	0.05	0.03	<0.01[d]
	24 hours	150[c]	80.16	0.88[d]	0.19	0.03

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Air Quality Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Gaseous fluorides (as HF)	1 month	0.8[c]	[b]	[b]	trace[d, e]	trace[e]
	1 week	1.6[c]	[b]	[b]	trace[d, e]	trace[e]
	24 hours	2.9[c]	[b]	[b]	trace[d, e]	trace[e]
	12 hours	3.7[c]	[b]	[b]	trace[d, e]	trace[e]
	8 hours	250[c]	[b]	[b, d]	trace[d, e]	trace[e]

[a] Federal standard.

[b] No lead emissions from any of the blending processes and no gaseous fluoride emissions from UNH and metal blending processes.

[c] State standard or guideline.

[d] No State standard.

[e] Hydrofluorination is anticipated to be a closed system with a scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate site. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: Derived from tables in Section 4.3.

Total Campaign Water Resources Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)

Resource	Y–12	SRS	B&W	NFS	Total
Water (million l)	340	340	390	390	1,460
Wastewater (million l)[a]	336	336	384	384	1,440

[a] Includes sanitary and nonhazardous, nonradioactive (other) liquid discharges after treatment.

Source: Derived from tables in Section 4.3.

Maximum Socioeconomic Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)

Characteristic	Y–12	SRS	B&W	NFS
Direct employment	125	125	126	126
Indirect employment	319	245	285	253
Total jobs	444	370	411	379
Unemployment rate change (percent)	-0.09	-0.14	-0.12	-0.14

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Normal Operations Radiological Exposure Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)

Receptor	Y–12	SRS	B&W	NFS	Total
Involved Workers					
Total dose to involved workforce[a] (person-rem)	202	202	238	238	880
Risk (cancer fatalities per campaign)	8.08×10^{-2}	8.08×10^{-2}	9.52×10^{-2}	9.52×10^{-2}	0.352
Maximally Exposed Individual (Public)					
Dose to maximally exposed individual member of the public (mrem)	0.698	4.48×10^{-2}	4.27×10^{-2}	3.13	NA[b]
Risk (cancer fatality per campaign)	3.49×10^{-7}	2.24×10^{-8}	2.14×10^{-8}	1.57×10^{-6}	NA[b]
Population Within 80 km					
Dose to population within 80 km[c] (person-rem)	2.86	2.86	0.384	27.2	33.3
Risk (cancer fatalities per campaign)	1.43×10^{-3}	1.43×10^{-3}	1.92×10^{-4}	1.36×10^{-2}	1.67×10^{-2}

[a] The involved workforce is 125 for UNH blending, 126 for UF_6 blending, and 72 for metal blending.

[b] The dose and the latent cancer fatality for the maximally exposed individual cannot be totaled since they are based on maximum exposure to an individual at each site using site-specific information.

[c] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12; 710,000 for SRS; 730,000 for B&W; and 1,260,000 for NFS.

Note: NA=not applicable.

Source: Derived from tables in Section 4.3.

Maximum Facility Accidents Incremental Impacts Using All Four Sites (50 t to fuel and 150 to waste)[a]

Receptor	Y–12	SRS	B&W	NFS
Campaign accident frequency[b]	1.8×10^{-3}	1.8×10^{-3}	1.8×10^{-3}	1.8×10^{-3}
Noninvolved Workers[c]				
Latent cancer fatalities per accident	0.4	8.7×10^{-2}	30	2.5
Risk (cancer fatalities per campaign)	7.1×10^{-4}	1.6×10^{-4}	9.2×10^{-3}	7.8×10^{-4}
Maximally Exposed Individual (Public)				
Latent cancer fatality per accident	5.0×10^{-4}	3.1×10^{-6}	1.9×10^{-2}	3.0×10^{-3}
Risk (cancer fatality per campaign)	8.9×10^{-7}	5.5×10^{-9}	5.8×10^{-6}	9.9×10^{-7}
Population Within 80 km[d]				
Latent cancer fatalities per accident	6.9×10^{-2}	1.6×10^{-2}	1	1.4
Risk (cancer fatalities per campaign)	1.2×10^{-4}	2.9×10^{-5}	3.2×10^{-4}	4.6×10^{-4}

[a] The risk values for this alternative are based on the most conservative combination of the options within the alternative (that is, blending 25 t HEU to 4-percent LEU as UF_6 fuel and 37.5 t HEU to 0.9-percent LEU as UNH waste at B&W and NFS, and 37.5 t HEU to 0.9-percent LEU as UNH waste at Y–12 and SRS).

[b] Values shown represent probability for the life of campaign and are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.

[c] The noninvolved workers are workers on site but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.

[d] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12; 710,000 for SRS; 730,000 for B&W; and 1,260,000 for NFS.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Chemical Exposure Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)

Receptor	Y–12	SRS	B&W	NFS
Maximally Exposed Individual (Public)				
Hazard index[a]	1.92×10^{-3}	2.13×10^{-4}	6.90×10^{-6}	1.01×10^{-2}
Cancer risk[b]	1.22×10^{-15}	1.36×10^{-16}	4.39×10^{-18}	6.40×10^{-15}
Onsite Worker				
Hazard index[c]	6.30×10^{-3}	5.65×10^{-3}	2.34×10^{-3}	3.21×10^{-3}
Cancer risk[d]	4.83×10^{-14}	4.34×10^{-14}	1.81×10^{-14}	2.48×10^{-14}

[Text deleted.]

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[b] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.3.

Total Campaign Waste Generation Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)

Waste Category[a]	Y–12	SRS	B&W	NFS	Total
Low-Level					
Liquid (m^3)	3,390	369	463	463	4,685
Solid (m^3)	6,600	1,330	1,600	1,600	11,130
Mixed Low-Level					
Liquid (m^3)	125	125	523	523	1,296
Solid (m^3)	0	0	0	0	0
Hazardous					
Liquid (m^3)	197	197	417	417	1,228
Solid (m^3)	0	0	0	0	0
Nonhazardous (Sanitary)					
Liquid (m^3)	322,000	322,000	367,000	367,000	1,378,000
Solid (m^3)	14,700	14,700	16,700	16,700	62,800
Nonhazardous (Other)					
Liquid (m^3)	13,700	13,700	16,500	16,500	60,400
Solid (m^3)	0	0	3	3	6
Solid Low-Level (m^3)[b]	4,370	662	885	885	6,802
Solid Nonhazardous (m^3)[b]	10,600	10,600	12,100	12,100	45,400
LEU Low-Level (m^3)[c]	7,380	7,320	7,320	7,320	29,340

[a] Waste volumes are based on the blending process that produces the highest volume for each category.

[b] Process waste after treatment.

[c] End product waste as a result of blending. Includes irradiated fuel that is currently in the surplus inventory (quantity is classified), which potentially could be disposed of as high-level waste.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Transportation Risk Incremental Impacts Using All Four Sites (50 t to fuel and 150 t to waste)

Receptor	Y–12	SRS	B&W	NFS	Total
Accident-Free Operations					
Fatalities to the public from radiological effects	0.1	0.11	0.14	0.13	0.48
Fatalities to the crew from radiological effects	0.08	0.08	0.1	0.1	0.36
Fatalities to the public from nonradiological effects	8.2×10^{-3}	1.1×10^{-2}	1.6×10^{-2}	1.1×10^{-2}	4.6×10^{-2}
Accidents					
Fatalities to the public from radiological effects[a]	3.2×10^{-3}	3.6×10^{-3}	4.7×10^{-3}	4.5×10^{-3}	1.6×10^{-2}
Fatalities to the public from nonradiological effects	0.3	0.36	0.46	0.42	1.54
Fatalities to the crew from nonradiological effects	0.09	0.1	0.13	0.12	0.43
Total Fatalities	0.58	0.67	0.85	0.78	2.89

[a] The transportation crew and the public are considered as one population for the purposes of radiological accidents.

Source: Derived from tables in Appendix G.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Alternative 4: Substantial Commercial Use (65/35 Fuel/Waste Ratio)

Variation a) Two Department of Energy Sites

Total Campaign[a] Site Infrastructure Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)

Characteristic	Y–12	SRS	Total
Electricity (MWh)	109,000	109,000	218,000
Diesel/oil (l)	1,318,000	1,947,000	3,265,000
Natural gas (m^3)	441,000	0[b]	441,000
Coal (t)	8,410	8,410	16,820
Steam (kg)	201,600	201,600	403,200

[a] Total campaign refers to the time required to complete blending disposition actions evaluated for Alternatives 2 through 5. Annual values are presented in Section 2.2.2.

[b] Natural gas is not available at SRS; therefore, liquid petroleum gas (approximately 628,000 l) would be substituted for a natural gas requirement of 441,000 m^3.

Source: Derived from tables in Section 4.3.

Maximum Air Quality Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	11.5	0.07
	1 hour	40,000[a]	53	0.14
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	1.33	0.01
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01
	24 hours	150[a]	0.37	<0.01
Sulfur dioxide (SO_2)	Annual	80[a]	2.46	0.02
	24 hours	365[a]	29.3	0.32
	3 hours	1,300[a]	161	0.71
Mandated by South Carolina and Tennessee				
Total suspended particulates (TSP)	Annual	60[c]	6.74[d]	0.05
	24 hours	150[c]	80.16	0.88[d]

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Air Quality Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)
Gaseous fluorides (as HF)	1 month	0.8[c]	b	b
	1 week	1.6[c]	b	b
	24 hours[f]	2.9[c]	b	b
	12 hours	3.7[c]	b	b
	8 hours	250[e]	b	b, d

[a] Federal standard.

[b] No emissions from UNH and metal blending processes.

[c] State standard or guideline.

[d] No State standard.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: Derived from tables in Section 4.3.

Total Water Resources Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)

Resource	Y–12	SRS	Total
Water (million l)	441	441	882
Wastewater (million l)[a]	433	433	866

[a] Includes sanitary and nonhazardous, nonradioactive (other) liquid discharges after treatment.

Source:Derived from tables in Section 4.3.

Maximum Socioeconomic Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)

Characteristic	Y–12	SRS
Direct employment	125	125
Indirect employment	319	245
Total jobs	444	370
Unemployment rate change (percent)	- 0.09	- 0.14

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Normal Operations Radiological Exposure Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)

Receptor	Y–12	SRS	Total
Involved Workers			
Total dose to involved workforce[a] (person-rem)	262	262	524
Risk (cancer fatalities per campaign)	0.105	0.105	0.21
Maximally Exposed Individual (Public)			
Dose to maximally exposed individual member of the public (mrem)	0.905	5.80×10^{-2}	NA[b]
Risk (cancer fatality per campaign)	4.53×10^{-7}	2.90×10^{-8}	NA[b]
Population Within 80 km			
Dose to population within 80 km[c] (person-rem)	3.71	3.71	7.42
Risk (cancer fatalities per campaign)	1.86×10^{-3}	1.86×10^{-3}	3.71×10^{-3}

[a] The involved workforce is 125 for UNH blending and 72 for metal blending.

[b] The dose and the latent cancer fatality for the maximally exposed individual cannot be totaled because they are based on maximum exposure to an individual at each site using site-specific information.

[c] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12 and 710,000 for SRS.

Note: NA=not applicable.

Source: Derived from tables in Section 4.3.

Maximum Facility Accidents Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 to waste)[a]

Receptor	Y–12	SRS
Campaign accident frequency[b]	1.7×10^{-3}	1.7×10^{-3}
Noninvolved Workers[c]		
Latent cancer fatalities per accident	0.4	8.7×10^{-2}
Risk (cancer fatalities per campaign)	7.5×10^{-4}	1.7×10^{-4}
Maximally Exposed Individual (Public)		
Latent cancer fatality per accident	5.0×10^{-4}	3.1×10^{-6}
Risk (cancer fatality per campaign)	9.5×10^{-7}	5.8×10^{-9}
Population Within 80 km[d]		
Latent cancer fatalities per accident	6.9×10^{-2}	1.6×10^{-2}
Risk (cancer fatalities per campaign)	1.3×10^{-4}	3.1×10^{-5}

[a] The risk values for this alternative are based on the most conservative combination of the options within the alternative (that is, blending 65 t HEU to 4-percent as LEU as UNH fuel and 35 t HEU to 0.9-percent LEU as UNH waste at each site).

[b] Values shown represent probability for the life of campaign and are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.

[c] The noninvolved workers are workers on site but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.

[d] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12 and 710,000 for SRS.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Chemical Exposure Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)

Receptor	Y–12	SRS
Maximally Exposed Individual (Public)		
Hazard index[a]	3.84×10^{-3}	4.26×10^{-4}
Cancer risk[b]	4.01×10^{-15}	4.47×10^{-16}
Onsite Worker		
Hazard index[c]	1.26×10^{-2}	1.13×10^{-2}
Cancer risk[d]	1.60×10^{-13}	1.43×10^{-13}

[Text deleted.]

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[b] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.3.

Maximum Waste Generation Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)

Waste Category[a]	Y–12	SRS	Total
Low-Level			
Liquid (m^3)	3,310	460	3,770
Solid (m^3)	6,650	1,650	8,300
Mixed Low-Level			
Liquid (m^3)	416	416	832
Solid (m^3)	0	0	0
Hazardous			
Liquid (m^3)	756	756	1,512
Solid (m^3)	0	0	0
Nonhazardous (Sanitary)			
Liquid (m^3)	418,000	418,000	836,000
Solid (m^3)	19,000	19,000	38,000
Nonhazardous (Other)			
Liquid (m^3)	17,700	17,700	35,400
Solid (m^3)	0	0	0
Solid Low-Level (m^3)[b]	4,380	917	5,297
Solid Nonhazardous (m^3)[b]	13,700	13,700	27,400
LEU Low-Level (m^3)[c]	6,890	6,830	13,720

[a] Waste volumes are based on the blending process that produces the highest volume for each category.

[b] Process waste after treatment.

[c] End product waste as a result of blending. Includes HEU irradiated fuel that is currently in the surplus inventory (quantity is identified), which potentially could be disposed of as high-level waste.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Transportation Risk Incremental Impacts Using Two Department of Energy Sites (130 t to fuel and 70 t to waste)

Receptor	Y–12	SRS	Total
Accident-Free Operations			
Fatalities to the public from radiological effects	0.15	0.18	0.33
Fatalities to the crew from radiological effects	0.11	0.12	0.23
Fatalities to the public from nonradiological effects	1.4×10^{-2}	1.7×10^{-2}	3.1×10^{-2}
Accidents			
Fatalities to the public from radiological effects[a]	5.2×10^{-3}	5.8×10^{-3}	1.1×10^{-2}
Fatalities to the public from nonradiological effects	0.48	0.56	1.04
Fatalities to the crew from nonradiological effects	0.14	0.16	0.3
Total Fatalities	0.9	1.04	1.94

[a] The transportation crew and the public are considered as one population for the purposes of radiological accidents.
Source: Derived from tables in Appendix G.

Variation b) Two Commercial Sites

Total Campaign Site Infrastructure Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)

Characteristic	B&W	NFS	Total
Electricity (MWh)	246,000	246,000	492,000
Diesel/oil (l)	8,713,000	8,713,000	17,426,000
Natural gas (m^3)	468,000	468,000	936,000
Coal (t)	0[a]	0[a]	0
Steam (kg)	201,600	201,600	403,200

[a] Fuel oil is considered the primary fuel at B&W and NFS; therefore, blending facility coal requirements have been converted to a fuel oil energy equivalent. Fuel oil energy content is assumed to be 40,128 BTUs/l, and the coal energy content is assumed to be 30.9 million BTUs/t. A coal requirement of 9,590 t equals 7,400,000 l of fuel oil.
Source: Derived from tables in Section 4.3.

Maximum Air Quality Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	5.43	0.62
	1 hour	40,000[a]	17.63	0.8
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	0.14	0.03
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01
	24 hours	150[a]	0.19	0.03
Sulfur dioxide (SO_2)	Annual	80[a]	0.4	0.05
	24 hours	365[a]	2.74	0.4
	3 hours	1,300[a]	14.11	0.96

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Air Quality Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Mandated by Tennessee and Virginia				
Total suspended particulates (TSP)	Annual	60[c]	0.03	<0.01[d]
	24 hours	150[c]	0.19	0.03
Gaseous fluorides (as HF)	1 month	1.2[c]	trace[d, e]	trace[e]
	1 week	1.6[c]	trace[d, e]	trace[e]
	24 hours	2.9[c]	trace[d, e]	trace[e]
	12 hours	3.7[c]	trace[d, e]	trace[e]
	8 hours	250[c]	trace[d, e]	trace[e]

[a] Federal standard

[b] No emissions from UF_6 and UNH blending processes.

[c] State standard or guideline.

[d] No State standard.

[e] Hydrofluorination is anticipated to be closed with scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: Derived from tables in Section 4.3.

Total Campaign Water Resources Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)

Resource	B&W	NFS	Total
Water (million l)	447	447	894
Wastewater (million l)[a]	435	435	870

[a] Includes sanitary and nonhazardous, nonradioactive (other) liquid discharges after treatment.

Source: Derived from tables in Section 4.3.

Maximum Socioeconomic Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)

Characteristic	B&W	NFS
Direct employment	126	126
Indirect employment	285	253
Total jobs	411	379
Unemployment rate change (percent)	-0.12	-0.14

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Normal Operations Radiological Exposure Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)

Receptor	B&W	NFS	Total
Involved Workers			
Total dose to involved workforce[a] (person-rem)	283	283	566
Risk (cancer fatalities per campaign)	0.113	0.113	0.226
Maximally Exposed Individual (Public)			
Dose to maximally exposed individual member of the public (mrem)	5.45×10^{-2}	3.96	NA[b]
Risk (cancer fatality per campaign)	2.73×10^{-8}	1.98×10^{-6}	NA[b]
Population Within 80 km			
Dose to population within 80 km[c] (person-rem)	0.492	35	35.5
Risk (cancer fatalities per campaign)	2.46×10^{-4}	1.75×10^{-2}	1.78×10^{-2}

[a] The involved workforce is 125 for UNH blending and 126 for UF_6 blending.

[b] The dose and the latent cancer fatality for the maximally exposed individual cannot be totaled because they are based on maximum exposure to an individual at each site using site-specific information.

[c] The population within 80 km (50 mi) in the year 2010 is 730,000 for B&W and 1,260,000 for NFS.

Source: Derived from tables in Section 4.3.

Maximum Facility Accidents Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 to waste)[a]

Receptor	B&W	NFS
Campaign accident frequency[b]	1.7×10^{-3}	1.7×10^{-3}
Noninvolved Workers[c]		
Latent cancer fatalities per accident	30	2.5
Risk (cancer fatalities per campaign)	2.1×10^{-2}	1.8×10^{-3}
Maximally Exposed Individual (Public)		
Latent cancer fatality per accident	1.9×10^{-2}	3.0×10^{-3}
Risk (cancer fatality per campaign)	1.3×10^{-5}	2.2×10^{-6}
Population Within 80 km[d]		
Latent cancer fatalities per accident	1	1.4
Risk (cancer fatalities per campaign)	7.2×10^{-4}	1.0×10^{-3}

[a] The risk values for this alternative are based on the most conservative combination of the options within the alternative (that is, blending 65 t HEU to 4-percent LEU as UF_6 fuel and 35 t HEU to 0.9-percent LEU as UNH waste at each site).

[b] Values shown represent probability for the life of campaign and are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.

[c] The noninvolved workers are workers onsite but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.

[d] The population within 80 km (50 mi) in the year 2010 is 730,000 for B&W and 1,260,000 for NFS.

Source: Derived from tables in Section 4.3.

Table 2.4–1. · Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Chemical Exposure Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)

Receptor	B&W	NFS
Maximally Exposed Individual (Public)		
Hazard index[a]	1.38×10^{-5}	2.02×10^{-2}
Cancer risk[b]	1.45×10^{-17}	2.11×10^{-14}
Onsite Worker		
Hazard index[c]	4.68×10^{-3}	6.42×10^{-3}
Cancer risk[d]	5.97×10^{-14}	8.18×10^{-14}

[Text deleted.]

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[b] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.3.

Total Campaign Waste Generation Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)

Waste Category[a]	B&W	NFS	Total
Low-Level			
Liquid (m^3)	636	636	1,272
Solid (m^3)	2,100	2,100	4,200
Mixed Low-Level			
Liquid (m^3)	1,150	1,150	2,300
Solid (m^3)	0	0	0
Hazardous			
Liquid (m^3)	756	756	1,512
Solid (m^3)	0	0	0
Nonhazardous (Sanitary)			
Liquid (m^3)	418,000	418,000	836,000
Solid (m^3)	19,000	19,000	38,000
Nonhazardous (Other)			
Liquid (m^3)	20,300	20,300	40,600
Solid (m^3)	7	7	14
Solid Low-Level (m^3)[b]	1,200	1,200	2,400
Solid Nonhazardous (m^3)[b]	13,700	13,700	27,400
LEU Low-Level (m^3)[c]	6,830	6,830	13,660

[a] Waste volumes are based on the blending process that produces the highest volume for each category.

[b] Process waste after treatment.

[c] End product waste as a result of blending. Includes irradiated fuel that is currently in the surplus HEU inventory (quantity is classified), which potentially could be disposed of as high-level waste.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Transportation Risk Incremental Impacts Using Two Commercial Sites (130 t to fuel and 70 t to waste)

Receptor	B&W	NFS	Total
Accident-Free Operations			
Fatalities to the public from radiological effects	0.18	0.16	0.34
Fatalities to the crew from radiological effects	0.12	0.12	0.24
Fatalities to the public from nonradiological effects	1.9×10^{-2}	1.5×10^{-2}	3.4×10^{-2}
Accidents			
Fatalities to the public from radiological effects[a]	6.0×10^{-3}	5.6×10^{-3}	1.16×10^{-2}
Fatalities to the public from nonradiological effects	0.57	0.53	1.1
Fatalities to the crew from nonradiological effects	0.16	0.15	0.31
Total Fatalities	1.06	0.98	2.04

[a] The transportation crew and the public are considered as one population for the purposes of radiological accidents.

Source: Derived from tables in Appendix G.

Variation c) All Four Sites

Total Campaign[a] Site Infrastructure Incremental Impacts Using All Four Sites (130 t to fuel and 70 t to waste)

Characteristic	Y–12	SRS	B&W	NFS	Total
Electricity (MWh)	54,700	54,700	124,000	124,000	357,400
Diesel/oil (l)	659,000	973,000	4,364,000	4,364,000	10,360,000
Natural gas (m^3)	220,000	0[b]	234,000	234,000	688,000
Coal (t)	4,210	4,210	0[c]	0[c]	8,420
Steam (kg)	100,800	100,800	100,800	100,800	403,200

[a] Total campaign refers to the time required to complete blending disposition actions evaluated for Alternatives 2 through 5. Annual values are presented in Section 2.2.2.

[b] Natural gas is not available at SRS; therefore liquid petroleum gas (approximately 313,000 l) would be substituted for a natural gas requirement of 220,000 m^3.

[c] Fuel oil is considered the primary fuel at B&W and NFS; therefore, blending facility coal requirements have been converted to a fuel oil energy equivalent. Fuel oil energy content is assumed to be 40,128 BTUs/l, and the coal energy content is assumed to be 30.9 million BTUs/t. A coal requirement of 4,800 t equals 3,700,000 l of fuel oil.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Air Quality Incremental Impacts Using All Four Sites (130 t to fuel and 70 t to waste)

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	11.5	0.07	5.43	0.62
	1 hour	40,000[a]	53	0.14	17.63	0.8
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	1.33	0.01	0.14	0.03
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01	0.03	<0.01
	24 hours	150[a]	0.37	<0.01	0.19	0.03
Sulfur dioxide (SO_2)	Annual	80[a]	2.46	0.02	0.4	0.05
	24 hours	365[a]	29.3	0.32	2.74	0.4
	3 hours	1,300[a]	161	0.71	14.11	0.96
Mandated by South Carolina, Tennessee, and Virginia						
Total suspended particulates (TSP)	Annual	60[c]	6.74[d]	0.05	0.03	<0.01[d]
	24 hours	150[c]	80.16	0.88[d]	0.19	0.03
Gaseous fluorides (as HF)	1 month	0.8[c]	[b]	[b]	trace[d, e]	trace[e]
	1 week	1.6[c]	[b]	[b]	trace[d, e]	trace[e]
	24 hours	2.9[c]	[b]	[b]	trace[d, e]	trace[e]
	12 hours	3.7[c]	[b]	[b]	trace[d, e]	trace[e]
	8 hours	250[c]	[b]	[b, d]	trace[d, e]	trace[e]

[a] Federal standard.

[b] No lead emissions from any of the blending processes and no gaseous fluorides from UNH and metal blending processes.

[c] State standard or guideline.

[d] No State standard.

[e] Hydrofluorination is anticipated to be a closed system with scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: Derived from tables in Section 4.3.

Total Campaign Water Resources Incremental Impacts Using All Four Sites (130 t to fuel and 70 t to waste)

Resource	Y–12	SRS	B&W	NFS	Total
Water (million l)	220	220	224	224	888
Wastewater (million l)[a]	216	216	218	218	868

[a] Includes sanitary and nonhazardous, nonradioactive (other) liquid discharges after treatment.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Socioeconomic Incremental Impacts Using All Four Sites (130 t to fuel and 70 t to waste)

Characteristic	Y–12	SRS	B&W	NFS
Direct employment	125	125	126	126
Indirect employment	319	245	285	253
Total jobs	444	370	411	379
Unemployment rate change (percent)	-0.09	-0.14	-0.12	-0.14

Source: Derived from tables in Section 4.3.

Total Campaign Normal Operations Radiological Exposure Incremental Impacts for All Four Sites (130 t to fuel and 70 t to waste)

Receptor	Y–12	SRS	B&W	NFS	Total
Involved Workers					
Total dose to involved workforce[a] (person-rem)	131	131	141	141	544
Risk (cancer fatalities per campaign)	5.24×10^{-2}	5.24×10^{-2}	5.65×10^{-2}	5.65×10^{-2}	0.218
Maximally Exposed Individual (Public)					
Dose to maximally exposed individual member of the public (mrem)	0.452	2.90×10^{-2}	2.73×10^{-2}	1.98	NA[b]
Risk (cancer fatality per campaign)	2.26×10^{-7}	1.45×10^{-8}	1.37×10^{-8}	9.94×10^{-7}	NA[b]
Population Within 80 km					
Dose to population within 80 km[c] (person-rem)	1.86	1.86	0.246	17.5	21.5
Risk (cancer fatalities per campaign)	9.30×10^{-4}	9.30×10^{-4}	1.24×10^{-4}	8.80×10^{-3}	1.08×10^{-2}

[a] The involved workforce is 125 for UNH blending, 126 for UF_6 blending, and 72 for metal blending.

[b] The dose and the latent cancer fatality for the maximally exposed individual can not be totaled because they are based on maximum exposure to an individual at each site using site specific information.

[c] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12; 710,000 for SRS; 730,000 for B&W; and 1,260,000 for NFS.

Note: NA=not applicable.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Facility Accidents Incremental Impacts Using All Four Sites (130 t to fuel and 70 t to waste)[a]

Receptor	Y–12	SRS	B&W	NFS
Campaign accident frequency[b]	8.3×10^{-3}	8.3×10^{-3}	8.3×10^{-3}	8.3×10^{-3}
Noninvolved Workers[c]				
Latent cancer fatalities per accident	0.4	8.7×10^{-2}	30	2.5
Risk (cancer fatalities per campaign)	3.8×10^{-4}	8.3×10^{-5}	1.1×10^{-2}	9.0×10^{-4}
Maximally Exposed Individual (Public)				
Latent cancer fatality per accident	5.0×10^{-4}	3.1×10^{-6}	1.9×10^{-2}	3.0×10^{-3}
Risk (cancer fatality per campaign)	4.7×10^{-7}	2.9×10^{-9}	6.8×10^{-6}	1.1×10^{-6}
Population Within 80 km[d]				
Latent cancer fatalities per accident	6.9×10^{-2}	1.6×10^{-2}	1	1.4
Risk (cancer fatalities per campaign)	6.5×10^{-5}	1.5×10^{-5}	3.7×10^{-4}	5.1×10^{-4}

[a] The risk values for this alternative are based on the most conservative combination of the options within the alternative (that is, blending 32.5 t HEU to 4-percent LEU as UNH fuel and 17.5 t HEU to 0.9-percent LEU as UNH waste at Y–12 and SRS, and 32.5 t HEU to 4-percent LEU as UF_6 fuel and 17.5 t HEU to 0.9-percent LEU and UNH waste at B&W and NFS).

[b] Values shown represent probability for the life of campaign and are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.

[c] The noninvolved workers are workers on site but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.

[d] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12; 710,000 for SRS; 730,000 for B&W; and 1,260,000 for NFS.

Source: Derived from tables in Section 4.3.

Maximum Chemical Exposure Incremental Impacts Using All Four Sites (130 t to fuel and 70 t to waste)

Receptor	Y–12	SRS	B&W	NFS
Maximally Exposed Individual (Public)				
Hazard index[a]	1.92×10^{-3}	2.13×10^{-4}	6.90×10^{-6}	1.01×10^{-2}
Cancer risk[b]	1.00×10^{-15}	1.12×10^{-16}	3.62×10^{-18}	5.28×10^{-15}
Onsite Worker				
Hazard index[c]	6.30×10^{-3}	5.65×10^{-3}	2.34×10^{-3}	3.21×10^{-3}
Cancer risk[d]	3.98×10^{-14}	3.58×10^{-14}	1.49×10^{-14}	2.05×10^{-14}

[Text deleted.]

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[b] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Waste Generation Incremental Impacts Using All Four Sites (130 t to fuel and 70 t to waste)

Waste Category[a]	Y–12	SRS	B&W	NFS	Total
Low-Level					
Liquid (m^3)	1,640	230	319	319	2,508
Solid (m^3)	3,300	824	1,050	1,050	6,224
Mixed Low-Level					
Liquid (m^3)	210	210	583	583	1,586
Solid (m^3)	0	0	0	0	0
Hazardous					
Liquid (m^3)	382	382	382	382	1,528
Solid (m^3)	0	0	0	0	0
Nonhazardous (Sanitary)					
Liquid (m^3)	209,000	209,000	209,000	209,000	836,000
Solid (m^3)	9,510	9,510	9,510	9,510	38,040
Nonhazardous (Other)					
Liquid (m^3)	8,870	8,870	10,100	10,100	37,940
Solid (m^3)	0	0	3	3	6
Solid Low-Level (m^3)[b]	2,170	459	601	601	3,831
Solid Nonhazardous (m^3)[b]	6,860	6,860	6,860	6,860	27,440
LEU Low-Level (m^3)[c]	3,420	3,400	3,400	3,400	13,620

[a] Waste volumes are based on the blending process which produces the highest volume for each category.

[b] Process waste after treatment.

[c] End product waste as a result of blending. Includes irradiated fuel that is currently in the surplus HEU inventory (quantity is classified), which potentially could be disposed of as high-level waste.

Source: Derived from tables in Section 4.3.

Total Campaign Transportation Risk Impacts Using All Four Sites (130 t to fuel and 70 t to waste)

Receptor	Y–12	SRS	B&W	NFS	Total
Accident-Free Operations					
Fatalities to the public from radiological effects	0.08	0.09	0.09	0.08	0.34
Fatalities to the crew from radiological effects	0.06	0.06	0.06	0.06	0.24
Fatalities to the public from nonradiological effects	7.0×10^{-3}	9.0×10^{-3}	9.7×10^{-3}	7.4×10^{-3}	3.3×10^{-2}
Accidents					
Fatalities to the public from radiological effects[a]	2.6×10^{-3}	2.9×10^{-3}	3.0×10^{-3}	2.8×10^{-3}	1.13×10^{-2}
Fatalities to the public from nonradiological effects	0.24	0.28	0.28	0.26	1.06
Fatalities to the crew from nonradiological effects	0.07	0.08	0.08	0.07	0.3
Total Fatalities	0.46	0.52	0.52	0.48	1.98

[a] The transportation crew and the public are considered as one population for the purposes of radiological accidents.

Source: Derived from tables in Appendix G.

Variation d) Single Site

The incremental impacts of blending all surplus HEU to LEU at a single DOE site are the same as either the total or maximum impacts presented in Variation a. Blending all at a single commercial site can be obtained from Variation b. The only exception is the normal operations dose and risk to the maximally exposed individual of the public and the population within 80 km (50 mi). The dose to the maximally exposed individual for Y–12, SRS, B&W, and NFS is 1.81, 0.116, 0.109, and 7.92 mrem, respectively. The risk of cancer fatalities per campaign is 9.06×10^{-7}, 5.80×10^{-8}, 5.46×10^{-8}, and 3.96×10^{-6}, respectively. The dose to the population within 80 km (50 mi) for Y–12, SRS, B&W, and NFS is 7.41, 7.41, 0.982, and 69.9 person-rem, respectively. The risk of cancer fatalities per campaign is 3.7×10^{-3}, 3.7×10^{-3}, 4.9×10^{-4}, and 3.5×10^{-2}, respectively.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Alternative 5: Maximum Commercial Use (85/15 Fuel/Waste Ratio)

Variation a) Two Department Of Energy Sites

Total Campaign[a] Site Infrastructure Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)

Characteristic	Y–12	SRS	Total
Electricity (MWh)	69,700	69,700	139,400
Diesel/oil (l)	886,000	1,293,000	2,179,000
Natural gas (m^3)	286,000	0[b]	286,000
Coal (t)	5,680	5,680	11,360
Steam (kg)	136,000	136,000	272,000

[a] Total campaign refers to the time required to complete blending disposition actions evaluated for Alternatives 2 through 5. Annual values are presented in Section 2.2.2.

[b] Natural gas is not available at SRS; therefore, liquid petroleum gas (approximately 407,000 l) would be substituted for a natural gas requirement of 286,000 m^3.

Source: Derived from tables in Section 4.3.

Maximum Air Quality Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	11.5	0.07
	1 hour	40,000[a]	53	0.14
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	1.33	0.01
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01
	24 hours	150[a]	0.037	<0.01
Sulfur dioxide (SO_2)	Annual	80[a]	2.46	0.02
	24 hours	365[a]	29.3	0.32
	3 hours	1,300[a]	161	0.71

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Air Quality Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)
Mandated by South Carolina and Tennessee				
Total suspended particulates (TSP)	Annual	60[c]	6.74[d]	0.05
	24 hours	150[c]	80.16	0.88[d]
Gaseous fluorides (as HF)	1 month	0.8[c]	[b]	[b]
	1 week	1.6[c]	[b]	[b]
	24 hours	2.9[c]	[b]	[b]
	12 hours	3.7[c]	[b]	[b]
	8 hours	250[c]	[b]	[b, d]

[a] Federal standard.

[b] No lead emissions from any of the blending processes and no gaseous fluoride emissions from UNH and metal blending processes.

[c] State standard or guideline.

[d] No State standard.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: Derived from tables in Section 4.3.

Total Campaign Water Resources Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)

Resource	Y–12	SRS	Total
Water (million l)	296	296	592
Wastewater (million l)[a]	291	291	582

[a] Includes sanitary and nonhazardous, nonradioactive (other) liquid discharges after treatment.

Source: Derived from tables in Section 4.3.

Maximum Socioeconomic Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)

Characteristic	Y–12	SRS
Direct employment	125	125
Indirect employment	319	245
Total jobs	444	370
Unemployment rate change (percent)	-0.09	-0.14

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Normal Operations Radiological Exposure Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)

Receptor	Y–12	SRS	Total
Involved Workers			
Total dose to involved workforce[a] (person-rem)	176	176	352
Risk (cancer fatalities per campaign)	7.05×10^{-2}	7.05×10^{-2}	0.141
Maximally Exposed Individual (Public)			
Dose to maximally exposed individual member of the public (mrem)	0.608	3.90×10^{-2}	NA[b]
Risk (cancer fatality per campaign)	3.04×10^{-7}	1.95×10^{-8}	NA[b]
Population Within 80 km			
Dose to population within 80 km[c] (person-rem)	2.5	2.5	5
Risk (cancer fatalities per campaign)	1.25×10^{-3}	1.25×10^{-3}	2.50×10^{-3}

[a] The involved workforce is 125 for UNH blending and 72 for metal blending.

[b] The dose and the latent cancer fatality for the maximally exposed individual cannot be totaled because they are based on maximum exposure to an individual at each site using site-specific information.

[c] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12 and 710,000 for SRS.

Note: NA=not applicable.

Source: Derived from tables in Section 4.3.

Maximum Facility Accidents Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)[a]

Receptor	Y–12	SRS
Campaign accident frequency[b]	8.5×10^{-4}	8.5×10^{-4}
Noninvolved Workers[c]		
Latent cancer fatalities per accident	0.4	8.7×10^{-2}
Risk (cancer fatalities per campaign)	4.0×10^{-4}	8.9×10^{-5}
Maximally Exposed Individual (Public)		
Latent cancer fatality per accident	5.0×10^{-4}	3.1×10^{-6}
Risk (cancer fatality per campaign)	5.1×10^{-7}	3.1×10^{-9}
Population Within 80 km[d]		
Latent cancer fatalities per accident	6.9×10^{-2}	1.6×10^{-2}
Risk (cancer fatalities per campaign)	6.9×10^{-5}	1.6×10^{-5}

[a] The risk values for this alternative are based on the most conservative combination of the options within the alternative (that is, blending 85 t HEU to 4 percent as UNH fuel and 15 t HEU to 0.9-percent LEU as UNH waste at each site).

[b] Values shown represent probability for the life of campaign and are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.

[c] The noninvolved workers are workers on site but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.

[d] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12 and 710,000 for SRS.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Chemical Exposure Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)

Receptor	Y–12	SRS
Maximally Exposed Individual (Public)		
Hazard index[a]	3.84×10^{-3}	4.26×10^{-4}
Cancer risk[b]	2.69×10^{-15}	2.99×10^{-16}
Onsite Worker		
Hazard index[c]	1.26×10^{-2}	1.13×10^{-2}
Cancer risk[d]	1.08×10^{-13}	9.66×10^{-14}

[Text deleted.]

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[b] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.3.

Total Campaign Waste Generation Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)

Waste Category[a]	Y–12	SRS	Total
Low-Level			
Liquid (m^3)	1,530	322	1,852
Solid (m^3)	3,260	1,140	4,400
Mixed Low-Level			
Liquid (m^3)	441	441	882
Solid (m^3)	0	0	0
Hazardous			
Liquid (m^3)	826	826	1,652
Solid (m^3)	0	0	0
Nonhazardous (Sanitary)			
Liquid (m^3)	281,000	281,000	561,000
Solid (m^3)	12,800	12,800	25,600
Nonhazardous (Other)			
Liquid (m^3)	12,000	12,000	24,000
Solid (m^3)	0	0	0
Solid Low-Level (m^3)[b]	2,120	654	2,774
Solid Nonhazardous (m^3)[b]	9,220	9,220	18,440
LEU Low-Level (m^3)[c]	2,930	2,900	5,830

[a] Waste volumes are based on the blending process that produces the highest volume for each category.

[b] Process waste after treatment.

[c] End product waste as a result of blending. Includes irradiated fuel that is currently in the surplus HEU inventory (quantity is classified), which potentially could be disposed of as high-level waste.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Transportation Risk Incremental Impacts Using Two Department of Energy Sites (170 t to fuel and 30 t to waste)

Receptor	Y–12	SRS	Total
Accident-Free Operations			
Fatalities to the public from radiological effects	0.12	0.14	0.26
Fatalities to the crew from radiological effects	0.08	0.08	0.16
Fatalities to the public from nonradiological effects	1.1×10^{-2}	1.4×10^{-2}	2.5×10^{-2}
Accidents			
Fatalities to the public from radiological effects[a]	4.1×10^{-3}	4.7×10^{-3}	8.8×10^{-3}
Fatalities to the public from nonradiological effects	0.38	0.43	0.81
Fatalities to the crew from nonradiological effects	0.11	0.12	0.23
Total Fatalities	0.7	0.79	1.49

[a] The transportation crew and the public are considered as one population for the purposes of radiological accidents.

Source: Derived from tables in Appendix G.

Variation b) Two Commercial Sites

Total Campaign Site Infrastructure Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)

Characteristic	B&W	NFS	Total
Electricity (MWh)	248,000	248,000	496,000
Diesel/oil (l)	6,438,000	6,438,000	12,876,000
Natural gas (m^3)	322,000	322,000	644,000
Coal (t)	0[a]	0[a]	0
Steam (kg)	136,000	136,000	272,000

[a] Fuel oil is considered the primary fuel at B&W and NFS; therefore, blending facility coal requirements have been converted to a fuel oil energy equivalent. Fuel oil content is assumed to be 40,128 BTUs/l, and the coal energy content is assumed to be 30.9 million BTUs/t. A coal requirement of 7,230 t equals 5,600,000 l of fuel oil.

Source: Derived from tables in Section 4.3.

Maximum Air Quality Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	5.43	0.62
	1 hour	40,000[a]	17.63	0.8
Lead (Pb)	Calendar Quarter	1.5[a]	b	b
Nitrogen dioxide (NO_2)	Annual	100[a]	0.14	0.03
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01
	24 hours	150[a]	0.19	0.03
Sulfur dioxide (SO_2)	Annual	80[a]	0.4	0.05
	24 hours	365[a]	2.74	0.4
	3 hours	1,300[a]	14.11	0.96

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Air Quality Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Mandated by Tennessee and Virginia				
Total suspended particulates (TSP)	Annual	60[c]	0.03	<0.01[d]
	24 hours	150[c]	0.19	0.03
Gaseous fluorides (as HF)	1 month	1.2[c]	trace[d, e]	trace[e]
	1 week	1.6[c]	trace[d, e]	trace[e]
	24 hours	2.9[c]	trace[d, e]	trace[e]
	12 hours	3.7[c]	trace[d, e]	trace[e]
	8 hours	250[c]	trace[d, e]	trace[e]

[a] Federal standard.

[b] No emissions from UF_6 and UNH blending processes.

[c] State standard or guideline.

[d] No State standard.

[e] Hydrofluorination is anticipated to be a closed system with scrubber filter exhaust system. Therefore, emission of gaseous fluoride is estimated to be a trace amount.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: Derived from tables in Section 4.3.

Total Campaign Water Resources Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)

Resources	B&W	NFS	Total
Water (million l)	305	305	610
Wastewater (million l)[a]	295	295	590

[a] Includes sanitary and nonhazardous, nonradioactive (other) liquid discharges after treatment.

Source: Derived from tables in Section 4.3.

Maximum Socioeconomic Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)

Characteristic	B&W	NFS
Direct employment	126	126
Indirect employment	285	253
Total jobs	411	379
Unemployment rate change (percent)	-0.12	-0.14

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Normal Operations Radiological Exposure Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)

Receptor	B&W	NFS	Total
Involved Worker			
Total dose to involved workforce[a] (person-rem)	203	203	406
Risk (cancer fatalities per campaign)	8.12×10^{-2}	8.12×10^{-2}	0.162
Maximally Exposed Individual (Public)			
Dose to maximally exposed individual member of the public (mrem)	4.32×10^{-2}	3.12	NA[b]
Risk (cancer fatality per campaign)	2.16×10^{-8}	1.56×10^{-6}	NA[b]
Population Within 80 km			
Dose to population within 80 km[c] (person-rem)	0.393	28.1	28.5
Risk (cancer fatalities per campaign)	1.97×10^{-4}	1.41×10^{-2}	1.43×10^{-2}

[a] The involved workforce is 125 for UNH blending and 126 for UF_6 blending.
[b] The dose and the latent cancer fatality for the maximally exposed individual cannot be totaled because they are based on maximum exposure to an individual at each site using site-specific information.
[c] The population within 80 km (50 mi) in the year 2010 is 730,000 for B&W and 1,260,000 for NFS.
Note: NA=not applicable.
Source: Derived from tables in Section 4.3.

Maximum Facility Accidents Incremental Impacts for Two Commercial Sites (170 t to fuel and 30 t to waste)[a]

Receptor	B&W	NFS
Campaign accident frequency[b]	8.5×10^{-4}	8.5×10^{-4}
Noninvolved Workers[c]		
Latent cancer fatalities per accident	30	2.5
Risk (cancer fatalities per campaign)	2.6×10^{-2}	2.2×10^{-3}
Maximally Exposed Individual (Public)		
Latent cancer fatality per accident	1.9×10^{-2}	3.0×10^{-3}
Risk (cancer fatality per campaign)	1.7×10^{-5}	2.7×10^{-6}
Population Within 80 km[d]		
Latent cancer fatalities per accident	1	1.4
Risk (cancer fatalities per campaign)	8.9×10^{-4}	1.2×10^{-3}

[a] The risk values for this alternative are based on the most conservative combination of the options within the alternative (that is, blending 85 t HEU to 4 percent as UF_6 fuel and 15 t HEU to 0.9-percent LEU as UNH waste at each site).
[b] Values shown represent probability for the life of campaign and are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.
[c] The noninvolved workers are workers on site but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.
[d] The population within 80 km (50 mi) in the year 2010 is 730,000 for B&W and 1,260,000 for NFS.
Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Chemical Exposure Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)

Receptor	B&W	NFS
Maximally Exposed Individual (Public)		
Hazard index[a]	1.38×10^{-5}	2.02×10^{-2}
Cancer risk[b]	9.70×10^{-18}	1.41×10^{-14}
Onsite Worker		
Hazard index[c]	4.68×10^{-3}	6.42×10^{-3}
Cancer risk[d]	4.03×10^{-14}	5.51×10^{-14}

[Text deleted.]

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[b] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.3.

Total Campaign Waste Generation Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)

Waste Category[a]	B&W	NFS	Total
Low-Level			
Liquid (m^3)	551	551	1,102
Solid (m^3)	1,720	1,720	3,440
Mixed Low-Level			
Liquid (m^3)	1,400	1,400	2,800
Solid (m^3)	0	0	0
Hazardous			
Liquid (m^3)	826	826	1,652
Solid (m^3)	0	0	0
Nonhazardous (Sanitary)			
Liquid (m^3)	281,000	281,000	562,000
Solid (m^3)	12,800	12,800	25,600
Nonhazardous (Other)			
Liquid (m^3)	15,200	15,200	30,400
Solid (m^3)	9	9	18
Solid Low-Level (m^3)[b]	1,020	1,020	2,040
Solid Nonhazardous (m^3)[b]	9,220	9,220	18,440
LEU Low-Level (m^3)[c]	2,900	2,900	5,800

[a] Waste volumes are based on the blending process that produces the highest volume for each category.

[b] Process waste after treatment.

[c] End product waste as a result of blending. Includes irradiated fuel that is currently in the surplus HEU inventory (quantity is classified), which potentially could be disposed of as high-level waste.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Transportation Risk Incremental Impacts Using Two Commercial Sites (170 t to fuel and 30 t to waste)

Receptor	B&W	NFS	Total
Accident-Free Operations			
Fatalities to the public from radiological effects	0.14	0.13	0.27
Fatalities to the crew from radiological effects	0.08	0.08	0.16
Fatalities to the public from nonradiological effects	1.5×10^{-2}	1.2×10^{-2}	2.7×10^{-2}
Accidents			
Fatalities to the public from radiological effects[a]	4.8×10^{-3}	4.4×10^{-3}	9.2×10^{-3}
Fatalities to the public from nonradiological effects	0.43	0.41	0.84
Fatalities to the crew from nonradiological effects	0.12	0.11	0.23
Total Fatalities	0.79	0.75	1.54

[a] The transportation crew and the public are considered as one population for the purposes of radiological accidents.

Source: Derived from tables in Appendix G.

Variation c) All Four Sites

Total Campaign[a] Site Infrastructure Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)

Characteristic	Y–12	SRS	B&W	NFS	Total
Electricity (MWh)	35,200	35,200	125,500	125,500	321,400
Diesel/oil (l)	449,000	655,000	3,259,000	3,259,000	7,622,000
Natural gas (m^3)	143,000	0[b]	161,000	161,000	465,000
Coal (t)	2,840	2,840	0[c]	0[c]	5,680
Steam (kg)	68,000	68,000	68,000	68,000	272,000

[a] Total campaign refers to the time required to complete blending disposition actions evaluated for Alternatives 2 through 5. Annual values are presented in Section 2.2.2.

[b] Natural gas is not available at SRS; therefore, liquid petroleum gas (approximately 204,000 l) would be substituted for a natural gas requirement of 143,000 m^3.

[c] Fuel oil is considered the primary fuel at B&W and NFS; therefore, blending facility coal requirements have been converted to fuel oil energy equivalent. Fuel oil energy content is assumed to be 40,128 BTUs/l, and the coal energy content is assumed to be 30.9 million BTUs/t. A coal requirement of 3,610 t equals 2,800,000 l of fuel oil.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Air Quality Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)

Pollutant	Averaging Time	Most Stringent Regulation or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	11.5	0.07	5.43	0.62
	1 hour	40,000[a]	53	0.14	17.63	0.8
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	1.33	0.01	0.14	0.03
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01	0.03	<0.01
	24 hours	150[a]	0.37	<0.01	0.19	0.03
Sulfur dioxide (SO_2)	Annual	80[a]	2.46	0.02	0.4	0.05
	24 hours	365[a]	29.3	0.32	2.74	0.4
	3 hours	1,300[a]	161	0.71	14.11	0.96
Mandated by South Carolina, Tennessee, and Virginia						
Total suspended particulates (TSP)	Annual	60[c]	6.74[d]	0.05	0.03	<0.01[d]
	24 hours	150[c]	80.16	0.88[d]	0.19	0.03
Gaseous fluorides (as HF)	1 month	0.8[c]	[b]	[b]	trace[d, e]	trace[e]
	1 week	1.6[c]	[b]	[b]	trace[d, e]	trace[e]
	24 hours	2.9[c]	[b]	[b]	trace[d, e]	trace[e]
	12 hours	3.7[c]	[b]	[b]	trace[d, e]	trace[e]
	8 hours	250[c]	[b]	[b, d]	trace[d, e]	trace[e]

[a] Federal standard.

[b] No lead emissions from any of the blending processes and no gaseous fluoride emissions from UNH and metal blending processes.

[c] State standard or guideline.

[d] No State standard.

[e] Hydrofluorination is anticipated to be a closed system with scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: Derived from tables in Section 4.3.

Total Campaign Water Resources Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)

Resource	Y–12	SRS	B&W	NFS	Total
Water (million l)	150	150	154	154	608
Wastewater (million l)[a]	148	148	149	149	594

[a] Includes sanitary and nonhazardous, nonradioactive (other) liquid discharges after treatment.

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Socioeconomic Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)

Characteristic	Y–12	SRS	B&W	NFS
Direct employment	125	125	126	126
Indirect employment	319	245	285	253
Total jobs	444	370	411	379
Unemployment rate change (percent)	-0.09	-0.14	-0.12	-0.14

Source: Derived from tables in Section 4.3.

Maximum Normal Operations Radiological Exposure Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)

Receptor	Y–12	SRS	B&W	NFS	Total
Involved Worker					
Total dose to involved workforce[a] (person-rem)	89	89	103	103	384
Risk (cancer fatalities per campaign)	3.56×10^{-2}	3.56×10^{-2}	4.12×10^{-2}	4.12×10^{-2}	0.154
Maximally Exposed Individual Public					
Dose to maximally exposed individual member of the public (mrem)	0.308	1.98×10^{-2}	2.19×10^{-2}	1.58	NA[b]
Risk (cancer fatality per campaign)	1.54×10^{-7}	9.90×10^{-9}	1.10×10^{-8}	7.90×10^{-7}	NA[b]
Population Within 80 km					
Dose to population within 80 km[c] (person-rem)	1.26	1.26	0.199	14.2	16.9
Risk (cancer fatalities per campaign)	6.30×10^{-4}	6.30×10^{-4}	9.95×10^{-5}	7.10×10^{-3}	8.45×10^{-3}

[a] The involved workforce is 125 for UNH blending, 126 for UF_6 blending, and 72 for metal blending.

[b] The dose and the latent cancer fatality for the maximally exposed individual cannot be totaled because they are based on maximum exposure to an individual at each site using site-specific information.

[c] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12; 710,000 for SRS; 730,000 for B&W; and 1,260,000 for NFS.

Note: NA=not applicable.

Source: Derived from tables in Section 4.3.

Maximum Facility Accidents Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)[a]

Receptor	Y–12	SRS	B&W	NFS
Campaign accident frequency[b]	4.3×10^{-4}	4.3×10^{-4}	4.3×10^{-4}	4.3×10^{-4}
Noninvolved Workers[c]				
Latent cancer fatalities per accident	0.4	8.7×10^{-2}	30	2.5
Risk (cancer fatalities per campaign)	2.0×10^{-4}	4.4×10^{-5}	1.3×10^{-2}	1.1×10^{-3}
Maximally Exposed Individual Public				
Latent cancer fatality per accident	5.0×10^{-4}	3.1×10^{-6}	1.9×10^{-2}	3.0×10^{-3}
Risk (cancer fatality per campaign)	2.6×10^{-7}	1.6×10^{-9}	8.4×10^{-6}	1.4×10^{-6}

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Maximum Facility Accidents Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)[a]—Continued

Receptor	Y–12	SRS	B&W	NFS
Population Within 80 km[d]				
Latent cancer fatalities per accident	6.9×10^{-2}	1.6×10^{-2}	1	1.4
Risk (cancer fatalities per campaign)	3.5×10^{-5}	8.2×10^{-6}	4.5×10^{-4}	6.3×10^{-4}

[a] The risk values for this alternative are based on the most conservative combination of the options within the alternative (that is, blending 42.5 t HEU to 4-percent LEU as UNH fuel and 7.5 t HEU to 0.9-percent LEU as UNH waste at Y–12 and SRS, and 42.5 t HEU to 4-percent LEU as UF_6 fuel and 7.5 t HEU to 0.9-percent LEU as UNH waste at B&W and NFS).

[b] Values shown represent probability for the life of campaign which are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.

[c] The noninvolved workers are workers on site but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.

[d] The population within 80 km (50 mi) in the year 2010 is 1,040,000 for Y–12; 710,000 for SRS; 730,000 for B&W; and 1,260,000 for NFS.

Source: Derived from tables in Section 4.3.

Maximum Chemical Exposure Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)

Receptor	Y–12	SRS	B&W	NFS
Maximally Exposed Individual (Public)				
Hazard index[a]	1.92×10^{-3}	2.13×10^{-4}	6.90×10^{-6}	1.01×10^{-2}
Cancer risk[b]	6.84×10^{-16}	7.63×10^{-17}	2.47×10^{-18}	3.60×10^{-15}
Onsite Worker				
Hazard index[c]	6.30×10^{-3}	5.65×10^{-3}	2.34×10^{-3}	3.21×10^{-3}
Cancer risk[d]	2.71×10^{-14}	2.44×10^{-14}	1.02×10^{-14}	1.39×10^{-14}

[Text deleted.]

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for maximally exposed individual.

[b] Lifetime cancer risk=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[Text deleted.]

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: Derived from tables in Section 4.3.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Total Campaign Waste Generation Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)

Waste Category[a]	Y–12	SRS	B&W	NFS	Total
Low-Level					
Liquid (m^3)	767	163	279	279	1,488
Solid (m^3)	1,640	575	872	872	3,959
Mixed Low-Level					
Liquid (m^3)	223	223	709	709	1,864
Solid (m^3)	0	0	0	0	0
Hazardous					
Liquid (m^3)	418	418	418	418	1,672
Solid (m^3)	0	0	0	0	0
Nonhazardous (Sanitary)					
Liquid (m^3)	142,000	142,000	142,000	142,000	568,000
Solid (m^3)	6,480	6,480	6,480	6,480	25,920
Nonhazardous (Other)					
Liquid (m^3)	6,060	6,060	7,710	7,710	27,540
Solid (m^3)	0	0	4	4	8
Solid Low-Level (m^3)[b]	1,060	331	516	516	2,423
Solid Nonhazardous (m^3)[b]	4,670	4,670	4,670	4,670	18,680
LEU Low-Level (m^3)[c]	1,470	1,470	1,470	1,470	5,880

[a] Waste volumes are based on the blending process that produces the highest volume for each category.

[b] Process waste after treatment.

[c] End product waste as a result of blending. Includes irradiated fuel that is currently in the surplus HEU inventory (quantity is classified), which potentially could be disposed of as high-level waste.

Source: Derived from tables in Section 4.3.

Total Campaign Transportation Risk Incremental Impacts Using All Four Sites (170 t to fuel and 30 t to waste)

Receptor	Y–12	SRS	B&W	NFS	Total
Accident-Free Operations					
Fatalities to the public from radiological effects	0.06	0.07	0.07	0.06	0.26
Fatalities to the crew from radiological effects	0.04	0.04	0.05	0.05	0.16
Fatalities to the public from nonradiological effects	5.7×10^{-3}	6.9×10^{-3}	7.4×10^{-3}	6.1×10^{-3}	2.6×10^{-2}
Accidents					
Fatalities to the public from radiological effects[a]	2.1×10^{-3}	2.4×10^{-3}	2.4×10^{-3}	2.2×10^{-3}	9.1×10^{-3}
Fatalities to the public from nonradiological effects	0.19	0.22	0.22	0.21	0.83
Fatalities to the crew from nonradiological effects	0.05	0.06	0.06	0.06	0.23
Total Fatalities	0.35	0.40	0.41	0.39	1.55

[a] The transportation crew and the public are considered as one population for the purposes of radiological accidents.

Source: Derived from tables in Appendix G.

Table 2.4–1. Summary Comparison of Maximum Incremental Impacts for Each Alternative and Candidate Site—Continued

Variation d) Single Site

The incremental impacts of blending all surplus HEU to LEU at a single DOE site are the same as either the total or maximum impacts presented in Variation a. Blending all at a single commercial site can be obtained from Variation b. The only exception is the normal operations dose and risk to the maximally exposed individual of the public and the population within 80 km (50 mi). The dose to the maximally exposed individual for Y–12, SRS, B&W, and NFS is 1.22, 0.078, 0.0864, and 6.24 mrem, respectively. The risk of cancer fatalities per campaign is 6.08×10^{-7}, 3.9×10^{-8}, 4.32×10^{-8}, and 3.12×10^{-6}, respectively. The dose to the population within 80 km (50 mi) for Y–12, SRS, B&W, and NFS is 5.01, 5.01, 0.787, and 56.3 person-rem, respectively. The risk of cancer fatalities per campaign are 2.5×10^{-3}, 2.5×10^{-3}, 3.9×10^{-4}, and 2.8×10^{-2}, respectively.

Table 2.4–2. Summary Comparison of Total Campaign[a] Incremental Environmental Impacts for the Disposition of Surplus Highly Enriched Uranium for Each Alternative

	Alternative 2 No Commercial Use 0/100 Fuel/Waste	Alternative 3 Limited Commercial Use 25/75 Fuel/Waste	Alternative 4 Substantial Commercial Use 65/35 Fuel/Waste	Alternative 5 Maximum Commercial Use 85/15 Fuel/Waste
Site Infrastructure				
Electricity (MWh)	476,000	482,000	492,000	496,000
Diesel/oil (l)	19,384,000	16,961,000	17,426,000	12,876,000
Natural gas (m^3)	1,413,000	1,166,000	936,000	644,000
Coal (t)	17,280	12,960	16,820	11,360
Steam (kg)	828,000	665,000	403,200	272,000
Air Quality and Noise				
The impacts for all four alternatives would be negligible. UNH and metal blending would be used for Alternative 2 and UNH, UF_6 and metal blending would be used for Alternatives 3, 4, and 5 and give similar incremental annual emissions. The maximum incremental annual emissions for all four alternatives would be less than 1 percent of the NAAQS standard for all criteria pollutants.				
Water				
Water (million l)	1,808	1,460	894	610
Wastewater (million l)	1,784	1,440	870	590
Socioeconomics				
The impacts for all four alternatives would be negligible. For Alternative 2, the UNH blending process to 0.9-percent LEU waste gives the maximum impacts. For Alternative 2, the maximum direct employment for any of the four sites would be 125 employees and the indirect employment would range from 245 at SRS to 319 at Y–12. The unemployment changes for all four sites range from 0.09 percent to 0.14 percent. The only difference between Alternatives 3, 4, and 5 from Alternative 2 is that the maximum direct employment at B&W and NFS would be 126 since the UF_6 blending process could be used.				
Radiological Exposure				
Involved Workers				
Total dose to involved workforce (person-rem)	1,076	880	566	406
Risk (cancer fatalities per campaign)	0.43	0.352	0.226	0.162
Maximally Exposed Individual (Public)				
Dose to maximum exposed individual member of the public (mrem)	3.33	3.13	3.96	3.12
Risk (cancer fatality per campaign)	1.67×10^{-6}	1.57×10^{-6}	1.98×10^{-6}	1.56×10^{-6}

Table 2.4–2. Summary Comparison of Total Campaign[a] Incremental Environmental Impacts for the Disposition of Surplus Highly Enriched Uranium for Each Alternative—Continued

	Alternative 2 No Commercial Use 0/100 Fuel/Waste	Alternative 3 Limited Commercial Use 25/75 Fuel/Waste	Alternative 4 Substantial Commercial Use 65/35 Fuel/Waste	Alternative 5 Maximum Commercial Use 85/15 Fuel/Waste
Population Within 80 km				
Dose to population within 80 km (person-rem)	36.6	33.3	35.5	28.5
Risk (cancer fatalities per campaign)	1.83×10^{-2}	1.67×10^{-2}	1.78×10^{-2}	1.43×10^{-2}
Facility Accidents[b]				
Campaign accident frequency[c]	2.4×10^{-3}	1.8×10^{-3}	1.7×10^{-3}	8.5×10^{-4}
Noninvolved Workers[d]				
Latent cancer fatalities per accident	0.94	30	30	30
Risk (cancer fatalities per campaign)	2.2×10^{-3}	9.2×10^{-3}	2.1×10^{-2}	2.6×10^{-2}
Maximally Exposed Individual (Public)				
Latent cancer fatality per accident	5.7×10^{-4}	1.9×10^{-2}	1.9×10^{-2}	1.9×10^{-2}
Risk (cancer fatality per campaign)	1.4×10^{-6}	5.8×10^{-6}	1.3×10^{-5}	1.7×10^{-5}
Population Within 80 km				
Latent cancer fatalities per accident	6.9×10^{-2}	1.4	1.4	1.4
Risk (cancer fatalities per campaign)	1.6×10^{-4}	4.6×10^{-4}	1.0×10^{-3}	1.2×10^{-3}
Chemical Exposure				
The impacts for all four alternatives would be negligible. For all four alternatives, the maximum incremental hazard index for the maximally exposed individual (public) is 2.02×10^{-2}, and for workers onsite it is 1.26×10^{-2}. These values are several orders of magnitude under 1.0, the regulatory health limit. The maximum incremental cancer risk for the maximally exposed individual (public) is 2.11×10^{-14}, and for workers onsite it is 1.08×10^{-13}. These values are below the regulatory limit of 1.0×10^{-6}. This represents an increase in cancer risk of 1 in 480 billion to the public and about 1 in a million to onsite workers.				
Waste Management				
Low-Level				
Liquid (m^3)	5,866	4,685	3,770	1,852
Solid (m^3)	13,700	11,130	8,300	4,400
Mixed Low-Level				
Liquid (m^3)	668	1,296	2,300	2,800
Solid (m^3)	0	0	0	0
Hazardous				
Liquid (m^3)	1,048	1,228	1,528	1,672
Solid (m^3)	0	0	0	0

Table 2.4–2. Summary Comparison of Total Campaign[a] Incremental Environmental Impacts for the Disposition of Surplus Highly Enriched Uranium for Each Alternative—Continued

	Alternative 2 No Commercial Use 0/100 Fuel/Waste	Alternative 3 Limited Commercial Use 25/75 Fuel/Waste	Alternative 4 Substantial Commercial Use 65/35 Fuel/Waste	Alternative 5 Maximum Commercial Use 85/15 Fuel/Waste
Nonhazardous (Sanitary)				
Liquid (m^3)	1,712,000	1,378,000	836,000	568,000
Solid (m^3)	78,000	62,800	38,040	25,920
Nonhazardous (Other)				
Liquid (m^3)	72,800	60,400	40,600	30,400
Solid (m^3)	0	6	14	18
Solid Low-Level (m^3)[e]	8,453	6,802	5,297	2,774
Solid Nonhazardous (m^3)[e]	56,400	45,400	27,440	18,680
LEU Low-Level (m^3)[f]	39,010	29,340	13,720	5,900
Transportation Risk				
Accident-Free Operations				
Fatalities to the public from radiological effects	0.58	0.48	0.34	0.27
Fatalities to the crew from radiological effects	0.44	0.36	0.24	0.2
Fatalities to the public from nonradiological effects	5.5×10^{-2}	4.6×10^{-2}	3.4×10^{-2}	2.7×10^{-2}
Accidents				
Fatalities to the public from radiological effects[g]	1.88×10^{-2}	1.6×10^{-2}	1.2×10^{-2}	9.2×10^{-3}
Fatalities to the public from nonradiological effects	1.83	1.54	1.1	0.84
Fatalities to the crew from nonradiological effects	0.51	0.44	0.3	0.23
Total Fatalities	3.43	2.89	2.04	1.57

[a] Total campaign refers to the time required to complete blending disposition actions evaluated for Alternatives 2 through 5. Values shown represent total impacts over the life of campaign except for facility accidents for which maximum values are presented over the life of the campaign.

[b] Values shown for facility accidents represent maximum consequences that could possibly occur under each alternative.

[c] Values shown represent probability for the life of campaign which are calculated by multiplying annual frequency (10^{-4}) by the total number of years of operation.

[d] The noninvolved workers are workers on site but not associated with operations of the blending and conversion facilities. Involved workers, those that are near an accident, would likely be exposed to lethal doses of radiation, if such an accident were to occur.

[e] Process waste after treatment.

[f] End product waste as a result of blending includes irradiated fuel that is currently in the surplus HEU inventory (quantity is classified) which potentially could be disposed of as high-level waste.

[g] The transportation crew and the public are considered as one population for the purposes of radiological accidents.

Chapter 3
Affected Environment

3.1 DEFINITION OF RESOURCES

This chapter defines the existing conditions of various resources that may be affected by the implementation of any of the alternatives defined in Chapter 2. The potentially affected environment is determined by evaluating the various parameters or components of resources that make up the baseline for the environment, safety, and health of workers and the public. The natural and human resources, as well as the facility-related resources that may be affected by the proposed action, are grouped into the following areas for analysis in this EIS:

- Land resources
- Site infrastructure
- Air quality and noise
- Water resources
- Geology and soils
- Biotic resources
- Cultural resources
- Socioeconomics
- Public and occupational health
- Waste management

In addition, the existing conditions and potential environmental impacts of intersite transportation of materials associated with the proposed action are described in Section 4.4.

Land Resources. Land resources comprise all of the terrestrial areas available for economic production, residential or recreational use, governmental activities (for example, military bases), or natural resource consumption. Land resources may be characterized by their natural resource attributes, such as soil productivity or mineral content, or by their potential for the location of human activities (land use). Visual resources are also evaluated under land resources and are defined as natural and human-created features that give a particular landscape its visual aesthetic qualities. For the DOE sites, the visual resource assessment is based on the Bureau of Land Management Visual Resource Management (VRM) methodology. For the commercial sites, the degree of contrast between the proposed action and the existing visual landscape is qualitatively assessed. The use or development of land resources is subject to regulation and must conform to governmental plans, policies, and controls at the Federal, State, and local (municipal) levels.

Site Infrastructure. Site infrastructure includes those utilities and other resources required to support construction and operation of the facilities required for the mission. The resources described and analyzed in this EIS include electrical power and electrical load capacity requirements; water/steam supply requirements; natural gas, coal, and liquid fuel requirements; and transportation networks, including roads and rail interfaces. Site environmental regulatory settings and pollution prevention programs are described for each individual facility.

Air Quality and Noise. Air pollution refers to any substance in the air that could harm human or animal populations, vegetation, or structures, or that unreasonably interferes with the comfortable enjoyment of life and property. Pollutants may include almost any natural or artificial compound capable of being airborne. They may be in the form of solid particles, liquid droplets, gases, or combinations of these forms. Generally, they can be categorized as primary pollutants (those emitted directly from identifiable sources) and secondary pollutants (those produced in the air by interaction between two or more primary pollutants, or by reaction with normal atmospheric constituents, with or without photoactivation). Only outdoor air pollutants are addressed in this document. Ambient air quality in a given location is described as the concentration of various pollutants in the atmosphere compared to the corresponding standards. It is

affected by air pollutant emission characteristics, meteorology, and topography.

Noise is defined as unwanted sound that interferes or interacts with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment. EPA has developed guidelines for noise levels for different land-use classifications. Some States and localities have established noise control regulations or zoning ordinances that specify acceptable noise levels by land-use category. These guidelines and regulations are discussed in Appendix C, Section C.3.

Water Resources. Water resources comprise surface water and groundwater. Surface water includes marine or freshwater bodies that occur above the ground surface, such as streams, lakes, embayments, and oceans. Surface water bodies are classified based on designated uses that are to be protected (for example, drinking water supply and recreation). Federal, State, and local regulations set standards and criteria that apply to different classifications. Groundwater resources are defined as the aquifers underlying the site and their extensions down the hydraulic gradients to, and including, discharge points and/or the first major users. The quantity of groundwater an aquifer yields is directly related to its geologic properties. In general, the higher the porosity (a measure of void space) and permeability (the interconnectedness of the void space), the greater the aquifer yield. The recharge rate is the rate at which groundwater accumulates in the aquifer and represents the rate at which groundwater can be withdrawn from the aquifer without a net reduction in the quantity of groundwater in storage. Groundwater resources are specifically protected by Federal law under the *Safe Drinking Water Act* by the Sole Source Aquifer and Wellhead Protection programs. State and local regulations may provide additional classifications, standards, and criteria.

Geology and Soils. Geological resources include mineral resources (for example, energy resources such as coal, oil, and natural gas), unique geologic features, and geological hazards (for example, seismic activity [earthquakes], faults, volcanoes, landslides, and land subsidence). Soil resources are defined as the loose surface material of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

Biotic Resources. Biotic resources include terrestrial resources (flora and fauna), wetlands, aquatic resources, and threatened and endangered species. Biotic resources are defined as terrestrial and aquatic ecosystems characterized by the presence of native and naturalized flora and fauna. Wetlands and threatened and endangered species have been identified for separate analyses because of their special regulatory status.

Terrestrial resources are defined as those plant and animal species and communities that are closely associated with the land. For the purpose of this EIS, terrestrial resources include major plant communities present in a site or region and the vegetation, mammals, birds, reptiles, and amphibians found within them. Scientific names of those species (both terrestrial and aquatic) listed in the text are provided in Appendix D.

Wetlands are defined by the U.S. Army Corps of Engineers and EPA as 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 (33 CFR 328.3). Thus, wetlands are delineated based on the occurrence of characteristic vegetation, soils, and hydrology.

Aquatic resources are defined as those plant and animal species and communities that are closely associated with a water environment. For the purposes of this EIS, aquatic resources include the major habitats present in a site or region and the fish species associated with them.

Threatened species are defined as those species likely to be endangered within the foreseeable future. Endangered species are defined, under the *Endangered Species Act* of 1973, as those species in danger of extinction throughout all or a large portion of their range (Appendix D). The U.S. Fish and Wildlife Service may designate areas of critical habitat for threatened and endangered species. Critical habitat is defined as specific areas that contain physical and biological features essential to the conservation of species and that may require special management considerations or protection.

Species that are Federal proposed or candidates for listing as threatened or endangered species do not receive legal protection under the *Endangered Species Act*. However, the U.S. Fish and Wildlife Service recommends that impacts to these species be considered in project planning since their status can be changed to threatened or endangered in the foreseeable future. The U.S. Fish and Wildlife Service has recently changed the classification of species under review for listing as threatened or endangered (61 FR 7596). Proposed species include those plants and animals for which a proposed rule to list as threatened or endangered has been published. Candidate species include those plants and animals for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threat to support issuance of a proposed rule for listing as endangered or threatened. Candidate species previously included Category 1 (species appropriate for listing as protected) and Category 2 (species possibly appropriate for listing as protected). Due to the recent change, candidate species include only those that are appropriate for listing as protected species (that is, species formerly listed as Category 1). The Category 2 designation has been omitted. Most of the species previously identified as Federal candidate Category 2 in the HEU Draft EIS also have a State status and continue to be evaluated for potential impacts. However, due to the change in candidate classification described above, several species have been eliminated from proposed site threatened and endangered species lists. At the State level, protected species are classified in a variety of categories, including endangered, threatened, in need of management, of concern, in need of monitoring, or species of special concern.

Cultural Resources. Cultural resources are resources that involve human imprints on the landscape. For this EIS, cultural resources are divided into prehistoric, historic, and Native American resources. Paleontological resources also are considered in this EIS. These resources are important mainly for their potential to provide scientific information on paleoenvironments and the evolutionary history of plants and animals.

Prehistoric resources are physical properties that remain from human activities that predate written records. These resources are generally identified as either isolated artifacts, sites, or districts. Isolated artifacts may include stone or bone tools or remains of ceramic pottery. Sites may contain concentrations of artifacts (for example, stone tools and ceramic sherds), features (for example, remains of campfires, residences, or food storage pits), and plant and animal remains; all of these resources can be used to reconstruct life in a region or at a limited location. Depending on the age, complexity, integrity, and relationship to one another, sites may be important for, and capable of, yielding otherwise inaccessible information about past populations.

Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are considered to be those that date from 1492 onward. Historic resources include architectural structures or districts (for example, religious, commercial or residential structures, dams, and bridges), objects, and archaeological features (for example, foundations of mills or residences, trails, and trash dumps). Ordinarily, sites less than 50 years old are not considered historic for analytical purposes, but exceptions can be made for younger properties if they are of exceptional importance (for example, structures associated with World War II, the Manhattan Project, or Cold War themes) (36 CFR 60.4).

Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. Of primary concern are concepts of sacred space that create the potential for land-use conflicts. Native American resources can include cemeteries, geological or geographic elements (for example, mountains or creeks), certain species of animals or plants, and architectural structures (for example, pueblos, battlefields, or trails).

Paleontological resources are evaluated under cultural resources and are the physical remains, impressions, or traces of plants or animals from a former geological age. They include casts, molds, and trace fossils, such as burrows or tracks. Fossil localities typically include surface outcrops, areas where subsurface deposits are exposed by ground disturbance, and environments that favor preservation, such as caves, peat bogs, and tar pits.

Socioeconomics. Socioeconomics encompasses the study of the social, economic, and demographic

characteristics of a geographical region. A region's socioeconomic status is characterized using indicators such as population, size of civilian labor force, employment, unemployment rates, and income level. Additional indicators of socioeconomic conditions include level of community services (that is, health care, education, and public safety) and infrastructure development. The most recent available statistics are used in the analysis.

Public and Occupational Health. Public and occupational health issues include the determination of potentially adverse effects on human health that result from exposures to ionizing radiation and hazardous chemicals. The degree of hazard is directly related to the type and quantity of the particular radioactive or chemical material to which the person is exposed as a result of various alternatives assessed. The exposures are converted to potential fatal cancers and/or noncancer effects of an acute or a chronic nature. This is done for both normal operations and postulated accident situations.

Waste Management. Blending activities produce waste that requires collection, storage, characterization, destruction or stabilization, containment, transportation, and disposal. Waste management accepts waste produced by processing, manufacturing, remediation, decontamination and decommissioning, and research activities. The waste is managed using appropriate treatment, storage, and disposal technologies in compliance with all applicable Federal and State statutes and DOE orders. The following waste categories are expected from blending processes and are evaluated: low-level, mixed low-level, hazardous, and nonhazardous. Treated waste is waste that, following generation, has been altered chemically or physically to reduce its toxicity or prepare it for storage or disposal. Waste treatment can include volume reduction activities, such as incineration or compaction, which may be performed on waste prior to storage or disposal. Stored waste is waste that, following generation (and usually some treatment), is temporarily retained in a retrievable manner and monitored pending disposal. Disposed waste is waste that has been put in final emplacement to ensure its isolation from the environment, with no intention of retrieval. Deliberate action is required to regain access to the waste. Disposed wastes include materials placed in repositories and buried in landfills.

3.2 APPROACH TO DEFINING AFFECTED ENVIRONMENT

The HEU EIS describes the affected environment at each of the candidate sites to establish a baseline against which the projected impacts of the proposed alternatives can be compared. The baseline descriptions characterize those resources and the surrounding geographical areas that may be affected by the proposed action. These detailed descriptions provide a basis for understanding the direct, indirect, and cumulative effects of the proposed alternatives.

Discussions of each candidate site and its surrounding areas are included for land resources, site infrastructure, geology and soils, biotic resources, and cultural and paleontological resources, along with descriptions of the representative area within the site that could be affected. Information on existing conditions is obtained from recent environmental reports, consultations with the sites, and Federal, State, and local agencies.

Ambient conditions are described for air quality, noise, and water resources. Discussions focus on current air quality and noise level conditions at site boundaries and the quality, quantity, and availability of surface water and aquifers in the vicinity of the site. This information has been analyzed to obtain key air quality, noise, and water quality parameters, which then have been compared to regulatory standards to establish existing conditions at the candidate sites. Existing environmental documents and models developed and/or data generated for each candidate site were used or incorporated by reference to the maximum extent possible to develop the conditions of these resources as they currently exist.

The socioeconomic analysis focuses on the potential impacts of additional workers and their families on the economy, housing availability, community services, and infrastructure. Potential socioeconomic impacts are assessed using two geographic regions, a regional economic area (REA) and a region of influence (ROI). REAs are used to assess potential effects on the economy, and ROIs are used to assess

effects which are more localized in political jurisdictions surrounding the sites.

The REA for each site encompasses a broad market that involves trade among regional industrial and service sectors and is characterized by strong economic linkages between the communities located in the region. These linkages determine the nature and magnitude of multiplier effects of economic activity (for example, purchases, earnings, and employment) at each candidate site. REAs are defined by the U.S. Bureau of Economic Analysis as consisting of an economic node that serves as the center of economic activity and the surrounding counties that are economically related and include the places of work and residences of its labor force.

Other potential demographic impacts are assessed for the ROI, a smaller geographic area where the housing market and local community services would be the most affected. ROIs are determined to be those areas where approximately 90 percent of the current DOE, contractor, and commercial nuclear facility employees reside and the counties in which at least 5 percent of the current workforce lives. This residential distribution reflects existing commuting patterns and attractiveness of area communities for people employed at each site.

The most recent available data are used in the socioeconomic analyses. Data for the year 1992 or later were obtained from sources such as the U.S. Bureau of Census, Bureau of Economic Analysis, the Federal Bureau of Investigation, the American Medical Association, the American Hospital Association, State and local government publications, and telephone interviews with State and local government officials.

A description of the current radiological and chemical environments at each candidate site is provided to establish the radiological and hazardous chemical doses that workers and the public receive from exposures associated with both the natural background and with existing site operations. To characterize each site's operational record, an accident history and a discussion of past and ongoing health studies of people who work onsite or live in the vicinity are presented. A series of environmental and monitoring reports issued by candidate sites are used to develop existing site environmental descriptions. These reports present the levels of radioactivity and hazardous chemicals in various environmental media (for example, air, water, and vegetation) on and around the sites. The main source of information used to establish existing health impacts to workers, both individual and collective, is the compilation of occupational exposures issued annually by DOE and NRC. Accident histories and the results of epidemiological studies are obtained from many literature sources, including incidence reports and medical journals.

Waste management activities are described at each candidate site, including treatment, storage, and disposal technologies, and compliance with applicable standards and regulations. Both DOE and the commercial sites maintain waste management databases and publish documents as a reporting mechanism to disclose and gauge progress in meeting environmental regulatory requirements. These databases/reports were used as data sources for waste management. Other site-specific documents include Annual Waste Minimization and Generation Reports, Site Treatment Plans, Pollution Prevention and Waste Minimization Awareness Plans, Annual Environmental Reports, and Waste Management Plans.

3.3 OAK RIDGE RESERVATION, OAK RIDGE, TENNESSEE

The Oak Ridge Reservation was established in 1942. It occupies approximately 13,980 ha (34,500 acres) within the city boundaries of Oak Ridge, Tennessee. Of the three major facilities on ORR, the Y–12 Plant is the primary location of the Defense Program missions. The Y–12 assignments include the dismantlement of nuclear weapon components returned from the Nation's arsenal, maintenance of nuclear production capability and stockpile support, storage of special nuclear materials, and special manufacturing support to DOE. The location of the ORR site and its vicinity is shown in Figure 3.3–1.

The following sections describe the affected environment at ORR for land resources, site infrastructure, air quality and noise, water resources, geology and soils, biotic resources, cultural and paleontological resources, socioeconomics, public and occupational health, and waste management. Although the proposed action only involves the Y–12

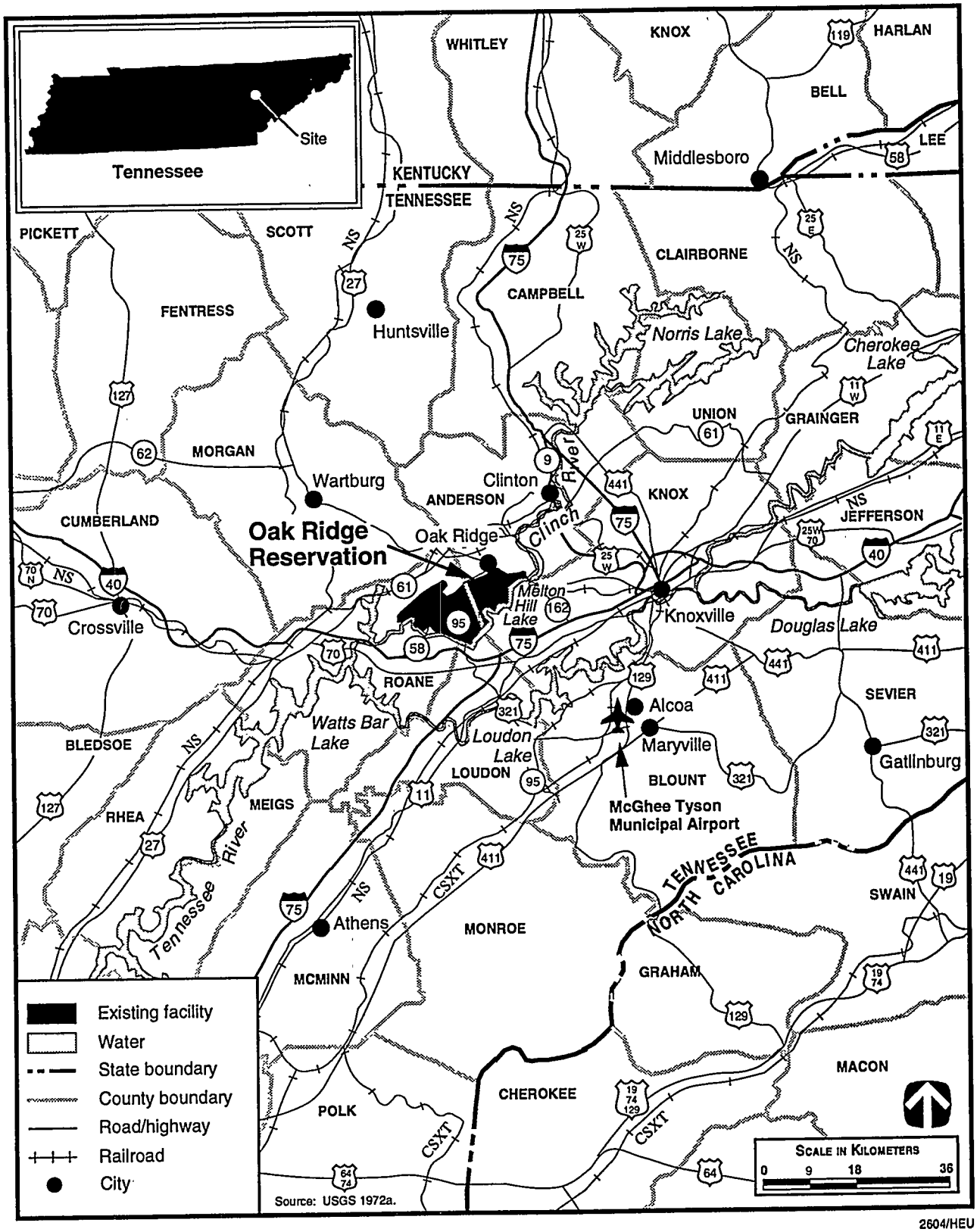


Figure 3.3–1. Oak Ridge Reservation, Tennessee, and Region.

Plant, baseline environmental conditions for the entire ORR are presented for the purpose of providing the relationship of the Y–12 Plant with ORR and the cumulative impact statements.

3.3.1 LAND RESOURCES

Land Use. The Oak Ridge Reservation is situated within the corporate limits of the city of Oak Ridge, roughly 19 km (12 mi) west of Knoxville, Tennessee. All the land within ORR is owned by the Federal Government and is administered, managed, and controlled by DOE. The regional location of ORR is illustrated in Figure 3.3–1.

Generalized land use at ORR and in the vicinity is shown in Figure 3.3.1–1. There are five major classifications of land use at ORR: residential, commercial, industrial, public/quasi public, and forest/undeveloped. Industrial land uses (which includes land area occupied by structures, pavement, facilities, and associated undeveloped land) comprise approximately 4,700 ha (11,600 acres) or approximately 33 percent of the total site acreage. About 500 ha (1,240 acres), approximately 4 percent, are used as a security buffer zone around various facilities. About 300 ha (741 acres), approximately 2 percent, are classified as public land and consist mainly of the 36-ha (89-acre) Clark Center Recreational Park, numerous small public cemeteries, and an onsite public road (OR DOE 1989a:5-10). The remaining area, about 8,500 ha (21,000 acres), approximately 61 percent, consists of forest/undeveloped land, a portion of which is managed as pine plantations for the production of pulpwood and saw timber. The DOE water treatment facility, which provides water to many ORR facilities and the city of Oak Ridge, is located just north of Y–12. There are no prime farmlands on ORR.

In 1980, DOE designated a portion of ORR's undeveloped land as a National Environmental Research Park (NERP). As of July 1994, the NERP consisted of segments totalling 5,008 ha (12,375 acres) spread over ORR. The NERP is used by the national scientific community as an outdoor laboratory for environmental science research on the impacts of human activities on the eastern deciduous forest ecosystem (DOE 1994u:37,51).

One public recreational facility, Clark Center Recreational Park, is situated on an embayment of Melton Hill Lake. Recreational facilities consist of a boat ramp and two softball fields (OR DOE 1989a:3-28). Other recreation opportunities include controlled deer hunts on designated portions of ORR, generally excluding the three major facilities and waste areas.

The Department of Energy has three primary complexes within ORR. These are the Oak Ridge Y–12 Plant, Oak Ridge National Laboratory (ORNL), and the K–25 Site. The Y–12 Plant occupies approximately 1,770 ha (328 ha fenced) (4,370 acres [811 acres fenced]). It was used in the fabrication of all of the uranium parts used in building U.S. nuclear weapons. It is also designated as the interim storage facility for unirradiated enriched uranium. Blending facilities at the Y–12 Plant also provide capabilities to blend HEU to LEU as UNH or molten metal.

The ORR site has other facilities planned, including proposed short-range projects (1995 through 1999). These include the Composite Materials Laboratory, Center for Biological Sciences, Mixed Waste Treatment Facility, Recycle and Materials Processing Facility, Process Waste Treatment Facility, Industrial Landfill Expansion and Upgrades, and Steam Plant Waste Water Treatment Facility. [Text deleted.] Figure 3.3.1–2 shows potential future facility areas in relation to existing ORR facilities.

Land bordering ORR is predominantly rural and used largely for residences, small farms, forest land, and pasture land. The city of Oak Ridge, along the northeastern portion of ORR, is characterized by an urban mix of residential, public, commercial, and industrial land uses. Four residential areas are situated along the northern boundary of ORR, each with several houses within 30 meters (m) (98 feet [ft]) of the boundary.

Visual Resources. The ORR landscape is characterized by a series of ridges and valleys which lie in a northeast-to-southwest direction. The vegetation of ORR is predominantly deciduous forest mixed with coniferous forest. Many of the open fields (about 2,000 ha [4,940 acres]) at ORR have been planted in shortleaf and loblolly pine; smaller areas have been planted in a variety of deciduous and

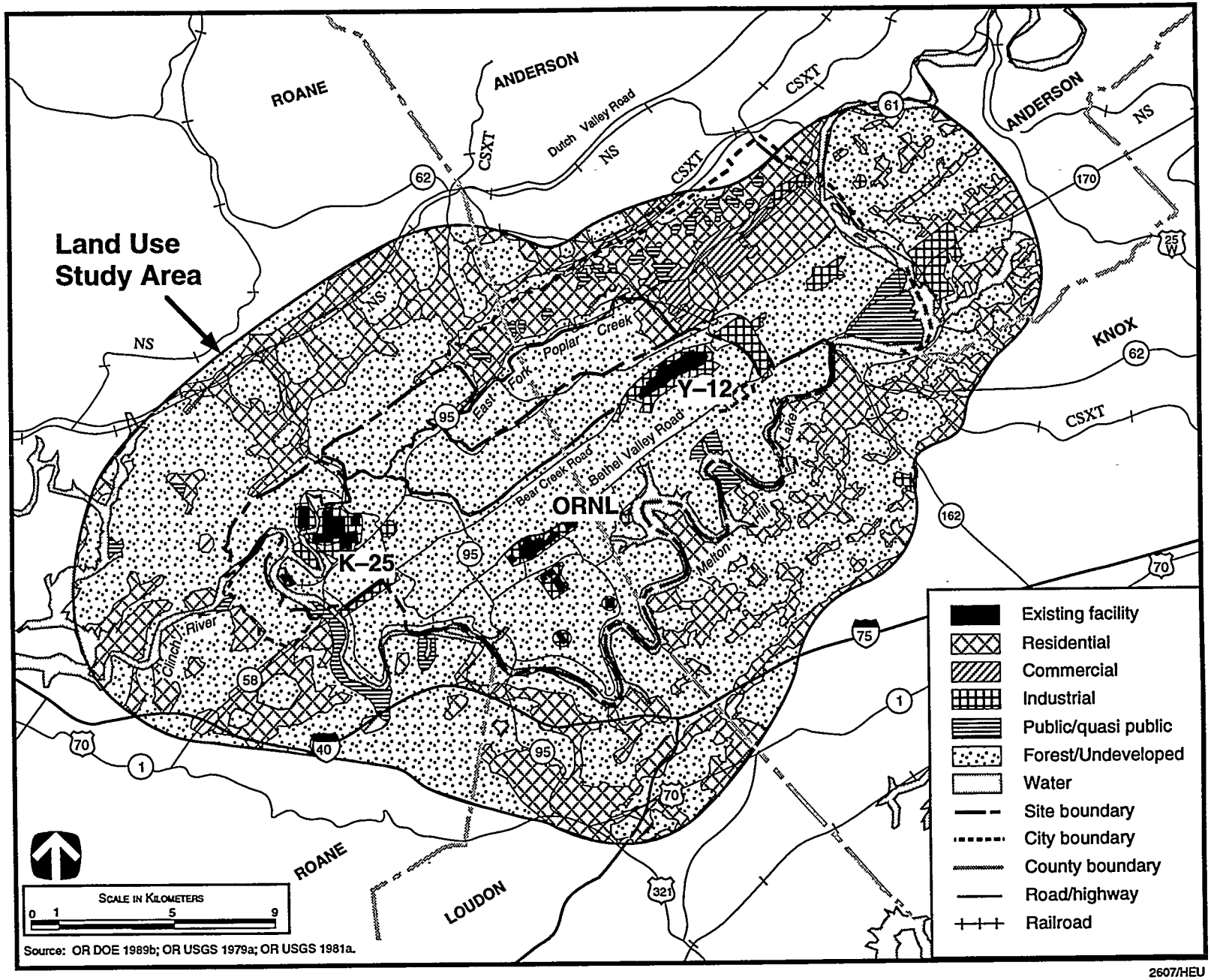


Figure 3.3.1–1. Generalized Land Use at Oak Ridge Reservation and Vicinity.

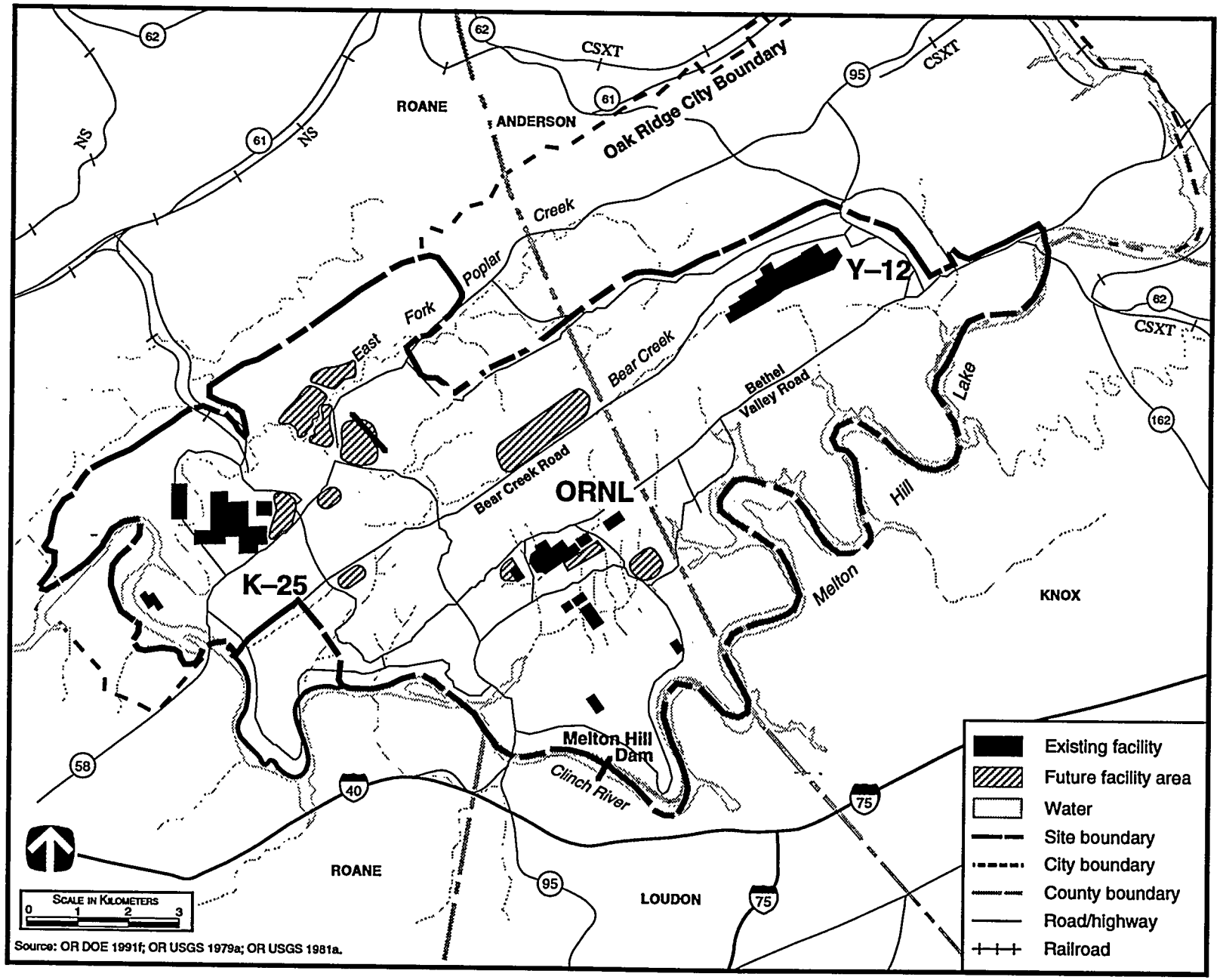


Figure 3.3.1–2. Primary Existing and Potential Future Facility Areas at Oak Ridge Reservation.

Table 3.3.2–1. Current Missions at Oak Ridge Reservation

Mission	Description	Sponsor
Weapons components	Maintain capability to fabricate uranium and lithium components and parts for nuclear weapons	Assistant Secretary for Defense Programs
Uranium and lithium storage	Store enriched uranium, DU, and lithium materials and parts	Assistant Secretary for Defense Programs
Dismantlement activities	Dismantle nuclear weapon components returned from the stockpile	Assistant Secretary for Defense Programs
Special nuclear material	Process uranium	Assistant Secretary for Defense Programs
Support services	Provide support to design agencies	Assistant Secretary for Defense Programs
Environmental restoration and waste management	Waste management and decontamination and decommissioning activities at ORNL, Y–12, and K–25	Assistant Secretary for Environmental Management
Research and development	ORNL basic research and development in energy, health, and environment	Office of Energy Research; Assistant Secretary for Environment, Safety and Health; Office of Nuclear Energy
Isotope production	ORNL produces radioactive and stable isotopes not available elsewhere	Office of Nuclear Energy
Educational and research programs	Oak Ridge Institute for Science and Education programs in the areas of health, environment, and energy	Office of Energy Research; Assistant Secretary for Environment, Safety and Health; Office of Nuclear Energy
Work for other Federal agencies	Projects to support other Federal programs	Department of Energy
Technology transfer	Programs to transfer unique technologies developed at ORR to private industry	Department of Energy
Meteorological research	Meteorological and atmospheric diffusion research	National Oceanic and Atmospheric Administration

clean up all former or current solid waste management units. In order to achieve a comprehensive remediation of ORR, DOE entered into a *Federal Facility Compliance Agreement* (FFCA) with EPA and the State of Tennessee in 1992 to coordinate RCRA and CERCLA cleanup activities. Based on this agreement, EPA and the State have allowed DOE to continue operations while taking actions to achieve full compliance with applicable Federal and State regulations.

The State of Tennessee has regulatory authority for air, water, solid waste, hazardous waste, and mixed waste (hazardous component only). DOE and the State of Tennessee have signed a Monitoring and Oversight Agreement intended to assure Tennessee citizens that their health, safety, and environment are being protected during ORR facility operations. Under this agreement and FFCA, DOE provides financial support to the State of Tennessee to carry out its commitment regarding cleanup activities.

The ORR facilities are being operated with a combination of RCRA Part B permits and interim status regulations. The RCRA Part B permit applications have been submitted for all of the active storage and treatment units listed on the Part A permit. The FFCA addresses ORR compliance with the Land Disposal Restriction of the Hazardous and Solid Waste Amendments of 1984, allowing ORR to continue to operate, generate, and store mixed wastes. This agreement and subsequent plans form the basis for the ORR site-specific treatment plan required by the FFCA of 1992.

The ORR underground storage tank program regulates approximately 49 tanks and includes some that are deferred or exempt from external regulation. The tanks store petroleum and hazardous substances. ORR is ahead of its schedule for upgrading and/or replacing the underground storage tanks to implement leak detection, spill and overflow protection, and corrosion protection on all regulated tanks by 1998.

The *Toxic Substances Control Act* (TSCA) requires that polychlorinated biphenyl (PCB) wastes be disposed of within 1 year of initial storage. However, some PCB wastes are not acceptable to the TSCA incinerator at K–25 and therefore have been stored in excess of 1 year. On June 11, 1992, DOE formally requested negotiation of an FFCA with EPA to allow development of a treatment and disposal schedule for ORR's radioactive PCB-contaminated waste and storage or disposal per the agreement.

Pollution Prevention. The Y–12 Pollution Prevention Awareness Program Plan describes the overall program in detail. The program is designed to maintain the flow of information pertaining to waste minimization and pollution prevention and to facilitate activities to implement real reductions in waste generation. A summary description of the four key elements of the Waste Minimization and Pollution Prevention Program includes a promotional campaign, information exchange, a waste tracking system, and waste assessment performance.

One goal of the program is to sustain an effective pollution prevention effort by improving the awareness of the employees of waste minimization opportunities and activities. Improved awareness is accomplished in many ways including training, posters, publications, seminars, promotional campaigns, and recognition of individuals and teams for activities that reduce generated waste and pollutants. Waste and pollution minimization activities at other ORR sites and other weapons sites provide useful input to the program. Using ideas developed by others is an important aspect that can save time and resources.

Tracking waste and pollution generation in a manner that lends itself to waste and pollution minimization reporting is a prerequisite to documenting successes or failures. Y–12 is improving its ability to record and track waste shipments and pollution generation. As an example, process waste assessments are being conducted as part of the ongoing program to identify, screen, and analyze options to reduce the generation of waste. This determines the amount of material in a workplace that is disposed of as waste during work operations. The assessment provides a summary of hazardous material usage and waste production and identifies those processes and operations that need to be improved or replaced to promote waste minimization.

Baseline Characteristics. To support the Defense Programs and other DOE assignments, ORR and Y–12 have developed an extensive infrastructure presented in Table 3.3.2–2 and described below. ORR is serviced by three major highways, the mainline of two railroads, a regional airport, and a barge facility on the Inland Waterway system.

Table 3.3.2–2. Baseline Characteristics for the Y–12 Plant

Current Characteristics	ORR	Y–12
Land		
Area (ha, fenced)	13,980	328
Roads (km)	71	42
Railroads (km)	27	11
Electrical		
Energy consumption (MWh/yr)	726,000	420,500
Peak load (MWe)	110	62
Fuel		
Natural gas (m3/yr)	95,000,000	66,000,000
Diesel/oil (l/yr)	416,000	0
Coal (t/yr)	16,300	2,940
Steam		
Generation (kg/hr)	150,000	99,000
Water Usage (l/yr)	14,210,000,000	7,530,000,000

Note: MWe=megawatt electric; MWh=megawatt hour; m^3=cubic meter; l=liter; kg=kilograms.

Source: OR MMES 1995i.

3.3.3 AIR QUALITY AND NOISE

The following describes existing air quality, including a review of the meteorology and climatology in the vicinity of ORR. More detailed discussions of the air quality methodologies, input data, and atmospheric dispersion characteristics are presented in Appendix C, Section C.1.4.

Meteorology and Climatology. The Cumberland and Great Smoky Mountains have a moderating influence on the climate at ORR. Winters are generally mild and summers are warm, with no noticeable extremes in precipitation, temperature, or winds.

The average annual temperature at ORR is 13.7 °C (56.6 °F); the average daily minimum temperature is -3.8 °C (25.1 °F) in January; and the average daily maximum temperature is 30.4 °C (86.7 °F) in July. The average annual precipitation is approximately 137 centimeters (cm) (53.8 inches [in]). Prevailing wind directions at ORR tend to follow the orientation of the valley: up valley, from west to southwest, or down valley, from east to northeast. The average annual wind speed is approximately 2 meters per second (m/s) (4.4 miles per hour [mph]) (NOAA 1994c:3). Additional information related to meteorology and climatology at ORR is presented in Appendix C, Section C.1.4.

Ambient Air Quality. The ORR facility is located in Anderson and Roane Counties, in the Eastern Tennessee-Southwestern Virginia Interstate Air Quality Control Region (AQCR). As of January 1995, the areas within this AQCR were designated as in attainment with respect to the National Ambient Air Quality Standards (NAAQS) (40 CFR 81.343). Applicable NAAQS and Tennessee State Ambient Air Quality Standards are presented in Appendix C, Section C.1.3.

One Prevention of Significant Deterioration (PSD) Class I area can be found in the vicinity of ORR. This area, Great Smoky Mountains National Park, is located approximately 50 km (31 mi) east of ORR. Since the promulgation of the PSD regulations (40 CFR 52.21) in 1977, no PSD permits have been required for any emissions source at ORR.

The primary emission sources of criteria pollutants are the steam plants at K–25, Y–12, and ORNL. Other emission sources include fugitive particulate matter from coal piles, the TSCA incinerator, other processes, vehicles, and temporary emissions from various construction activities. Appendix C, Section C.1.4 presents emissions of criteria and hazardous/toxic pollutants from ORR.

Table 3.3.3–1 presents the baseline ambient air concentrations for criteria and toxic/hazardous pollutants at ORR. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Concentrations of toxic/hazardous emissions that exceed 1 percent of Tennessee Department of Environment and Conservation (TDEC) air quality standards from existing sources at ORR are presented in Table 3.3.3–2. Concentrations of toxic/hazardous emissions are in compliance with TDEC guidelines.

Noise Conditions. The noise environment along the ORR site boundary in rural areas and at nearby residences away from traffic noise is typical of a rural location with day/night average sound levels (DNL) in the range of 35 to 50 decibel A-weighted (dBA) (EPA 1974a:B-4,B-5). Areas near the site that are within the city of Oak Ridge are typical of a suburban area with DNL in the range of 53 to 62 dBA. Major noise emission sources within ORR include various industrial facilities, equipment, and machines. The primary source of noise at the site boundary and at residences near roads is traffic. During peak hours, the plant traffic is a major contributor to traffic noise levels in the area. At the site boundary, noise emitted from the site is barely distinguishable from background noise levels.

The State of Tennessee has not established specific numerical environmental noise standards applicable to ORR. The city of Oak Ridge has specific acceptable sound levels at property lines as presented in Appendix C, Section C.3.2.1.

3.3.4 WATER RESOURCES

Surface Water. The major surface water body in the immediate vicinity of ORR is the Clinch River, which borders the site to the south and west. The Clinch River provides the regional control of both surface and groundwater flow from ORR. There are four major subdrainage basins at ORR that flow into

Table 3.3.3–1. Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at Oak Ridge Reservation

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Concentration at ORR Boundary ($\mu g/m^3$)	Percent of Regulations or Guidelines
Carbon monoxide (CO)	8 hours	10,000[a]	5	0.05
	1 hour	40,000[a]	11	0.03
Lead (Pb)	Calendar Quarter	1.5[a]	0.05	3.3
Nitrogen dioxide (NO_2)	Annual	100[a]	3	3
Particulate matter (PM_{10})	Annual	50[a]	1	2
	24 hours	150[a]	2	1.33
Sulfur dioxide (SO_2)	Annual	80[a]	2	2.5
	24 hours	365[a]	32	8.77
	3 hours	1,300[a]	80	6.15
Mandated by Tennessee				
Total suspended particulates (TSP)	24 hours	150[b]	2	1.3
Gaseous fluorides (as HF)	1 month	1.2[b]	0.2	16.7
	1 week	1.6[b]	0.3	18.8
	24 hours	2.9[b]	<0.6[c]	<20.7
	12 hours	3.7[b]	<0.6[c]	<16.2
	8 hours	250[b]	0.6	0.24

[a] Federal standard.

[b] State standard or guideline.

[c] Monitoring data for 24-hour and 12-hour gaseous fluorides concentrations are not available at Y–12; therefore, the 8-hour concentration was used.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; OR DOE 1993a; TN DEC 1994a; TN DHE 1991a.

Table 3.3.3–2. Estimated Concentrations of Toxic/Hazardous Pollutants That Exceed 1 Percent of the Tennessee Department of Environment and Conservation Air Quality Standards From Existing Sources at Oak Ridge Reservation

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Concentration at ORR Boundary ($\mu g/m^3$)	Percent of Regulations or Guidelines
Chlorine	8 hours	150	4.1	2.73
Hydrogen chloride	8 hours	750	57	7.6
Mercury	8 hours	5	0.06[a]	1.2
Nitric acid	8 hours	520	78	15
Sulfuric acid	8 hours	100	20	20

[a] Annual average.

[Text deleted.]

Source: OR DOE 1993a; TN DHE 1991a.

the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek (ORR 1992a:5). Several smaller drainage basins including Ish Creek, Grassy Creek, Bearden Creek, McCoy Branch, Kerr Hollow Branch, and Raccoon Creek drain directly into the Clinch River. Each drainage basin takes the name of the major stream flowing through the area. Within each basin is a number of small tributaries. The natural surface water bodies in the vicinity of ORR are shown on Figure 3.3.4–1.

The Y–12 Plant is located in the Bear Creek and East Fork Poplar Creek drainage basins of the Clinch River (OR DOE 1994d:6-5). The Bear Creek watershed has a drainage area of 31 square kilometers (km^2) (12 square miles [mi^2]). Headwaters of Bear Creek originate near the west end of the Y–12 Plant and flow westward through Bear Creek Valley before turning northward to flow into East Fork Poplar Creek. The East Fork Poplar Creek drainage basin has an area of 78 km^2 (30 mi^2). The headwaters of East Fork Poplar Creek consist of springs that originate on the northwest slope of Chestnut Ridge. West of the Y–12 Plant, East Fork Poplar Creek flows into Lake Reality and then to Poplar Creek, a tributary of the Clinch River (OR DOE 1994d:5-9).

The Clinch River and connected waterways supply all raw water for ORR. The Clinch River has an average flow of 132 cubic meters per second (m^3/s) (4,661 cubic feet per second [ft^3/s]) as measured at the downstream side of Melton Hill Dam at mile 23.1. The average flow of Bear Creek near Y–12 is 0.11 m^3/s (3.9 ft^3/s). The average flow at East Fork Poplar Creek is 1.3 m^3/s (46 ft^3/s). ORR uses approximately 14.2 billion liters (l)/yr (3.75 billion gallons per year [BGY]) of water, and Y–12 uses approximately 7.53 billion l/yr (1.99 BGY) of water (OR MMES 1995a:B-1); the ORR water supply system includes the DOE treatment facility and K–25 treatment facility, and has a capacity of 122 million l/day (32.2 million gallons per day [MGD]).

At Y–12, there are six wastewater treatment facilities with National Pollutant Discharge Elimination System (NPDES)-permitted outfalls to East Fork Poplar Creek. Y–12 also has a permit to discharge wastewater to the Oak Ridge Treatment Facility. At ORNL, three NPDES-permitted wastewater treatment facilities discharge into White Oak Creek basin. K–25 operates one sanitary sewage system, which discharges to East Fork Poplar Creek (OR DOE 1994c:4-17–4-19). Currently, approximately 1,856 million l/yr (491 million gallons per year [MGY]) of wastewater is being discharged from ORR activities.

Clinch River water levels in the vicinity of Y–12 are regulated by a system of dams operated by the Tennessee Valley Authority. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast sides of ORR. Watts Bar Dam, on the Tennessee River near the lower end of the Clinch River, controls the flow of the Clinch River along the southwest side of ORR.

The Tennessee Valley Authority has conducted flood studies along the Clinch River, Bear Creek, and East Fork Poplar Creek (OR TVA 1991a:1). Other than a few buildings, Y–12 facilities lie outside the 100- and 500-year floodplains of East Fork Poplar Creek, Bear Creek, and the Clinch River (Figure 3.3.4–2).

Surface Water Quality. The streams and creeks of Tennessee are classified by the TDEC and defined in the State of Tennessee Water Quality Standards. Classifications are based on water quality, designated uses, and resident aquatic biota. The Clinch River is the only surface water body on ORR classified for domestic water supply. Streams at ORR are classified for fish, aquatic life, and livestock watering; irrigation; recreation; and wildlife. White Oak Creek and Melton Branch are the only streams not classified for irrigation. Portions of Poplar Creek, East Fork Poplar Creek, and Melton Branch are not classified for recreation.

Both routine and NPDES-required surface water monitoring programs (over 225 sites) are performed at the Y–12 Plant to assess the impacts of the plant effluents upon natural receiving waters and to estimate the impacts of these effluents on human health and the environment. At Y–12, Bear Creek, McCoy Branch, Rogers Quarry, and East Fork Poplar Creek receive effluents from treated sanitary wastewater, industrial discharges, cooling water blowdown, stormwater, surface water runoff, and groundwater. The chemical water quality of Bear Creek has been affected by the infiltration of contaminated groundwater. Contaminants include high concentrations of dissolved salts, several metals, chlorinated solvents, and polychlorinated biphenyls

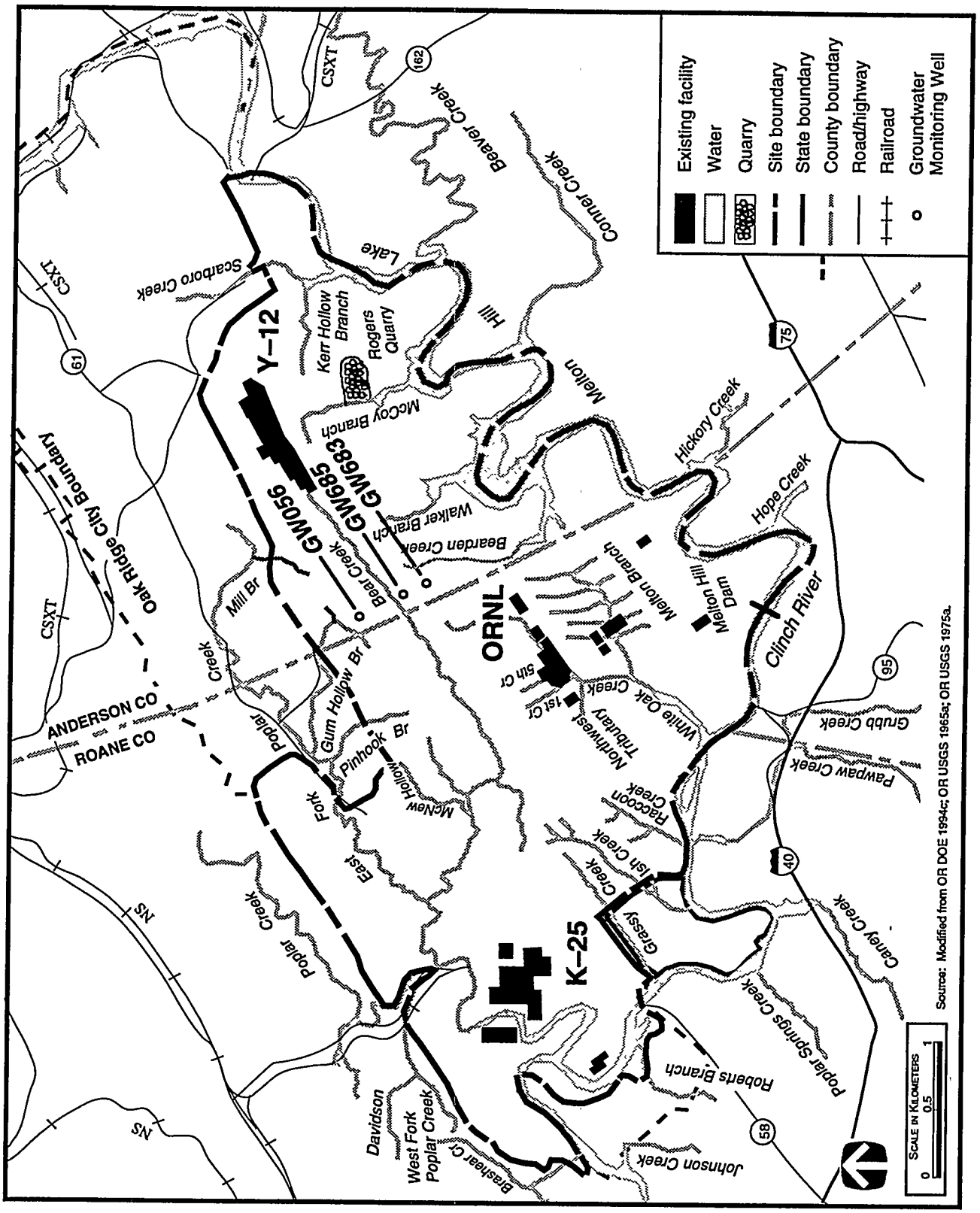


Figure 3.3.4–1. Surface Water Features at Oak Ridge Reservation.

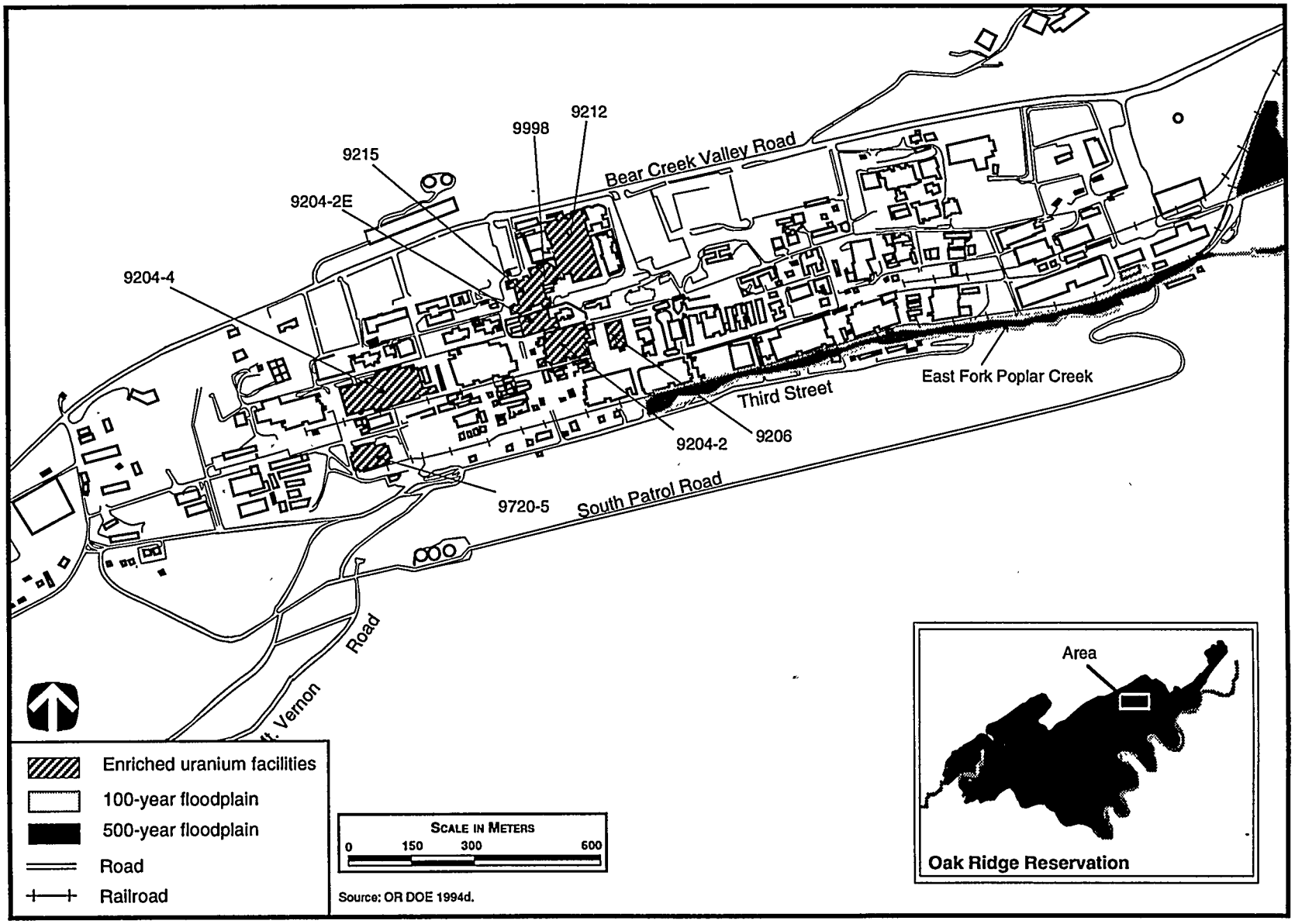


Figure 3.3.4–2. Location of 100- and 500-Year Floodplains at Y–12 Plant.

(PCBs) (OR DOE 1994d:5-9). DOE is currently involved with remediation of East Fork Poplar Creek under CERCLA, because the creek was contaminated by past releases from the Y–12 Plant. Significant cleanup activities are required on- and off-site. Contaminants in East Fork Poplar Creek include heavy metals (including mercury organics, PCBs, and radionuclides) (OR DOE 1994d:5-9).

There are 455 NPDES-permitted outfalls associated with the three major facilities at ORR; many of these are stormwater outfalls. Approximately 57,000 NPDES laboratory analyses were completed in 1993, with a compliance rate of over 99 percent (OR DOE 1994c:2-13). One Notice of Violation was issued by TDEC in 1993 for exceeding permit limits for total suspended solids at three outfalls at ORNL. An action plan was prepared addressing projects to mitigate the potential for future violations.

As shown in Table 3.3.4–1, no concentrations exceeded State water quality criteria where the Clinch River leaves ORR. Monitoring data from this sampling site were compared with data from the Melton Hill Dam sampling site located upstream of all ORR discharges and therefore are representative of background water quality. The concentrations downstream of ORR discharges were lower than concentrations upstream in all cases except gross beta, uranium, and total suspended solids. Concentrations at Melton Hill Dam were also well below applicable water quality criteria.

Surface Water Rights and Permits. In Tennessee, the State's water rights laws are codified in the *Water*

Table 3.3.4–1. Summary of Surface Water Quality Monitoring at Oak Ridge Reservation

Parameter	Unit of Measure	Water Quality Criteria[a]	Average Water Body Concentration	
			Clinch River[b]	Menton Hill Reservoir Above City of Oak Ridge Water Intake
Alpha (gross)	pCi/l	15[c]	0.85 ± 0.3	1.7 ± 0.46
Beta (gross)	pCi/l	50[d]	4.8 ± 0.54	2.9 ± 0.32
Cesium-137	pCi/l	119[d]	0.65 ± 1.2	NST
Chemical oxygen demand	mg/l	NA	<8.2	15
Fluoride	mg/l	4[c]	<0.1	NST
Manganese, Total	mg/l	0.05[e]	0.036	0.91
Nitrate	mg/l	10[c, f]	3.3	NST
pH	pH units	6.5 to 8.5[f]	8	8
Sodium	mg/l	NA	4.1	4.8
Sulfate	mg/l	250[e]	21	22
Suspended solids	mg/l	NA	<11	<6.6
Technetium-99	pCi/l	900[g]	2.9 ± 1.1	NST
Total dissolved solids	mg/l	500[e]	150	170
Tritium	pCi/l	20,000[c]	<8.6	NST
Uranium, Total	pCi/l	20[g]	1.6 ± 0.97	1.0 ± 0.5

[a] For comparison only, except for parameters which have Tennessee water quality criteria.

[b] 1993 Summary data for Clinch River kilometer 16, downstream from all DOE inputs.

[c] National Primary Drinking Water Regulations (40 CFR 141).

[d] Proposed National Primary Drinking Water Regulations, Radionuclides (56 FR 33050).

[e] National Secondary Drinking Water Regulations (40 CFR 143).

[f] Tennessee State Water Quality Criteria.

[g] DOE Derived Concentration Guides for Water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective dose equivalent of 100 mrem/yr; however, because the drinking water maximum contaminant level is based on 4 mrem/yr, the number listed is 4 percent of the Derived Concentration Guides.

Note: NA=not applicable; <=estimated values and/or detection limits were used in the calculation; NST=no sample taken; pCi=picocurie; mg=milligram.

Source: DOE 1993u; OR DOE 1994f; TN DEC 1991a.

Quality Control Act. The designated uses of a water body cannot be impaired. The only requirement to withdraw water from available surface water may be a U.S. Army Corps of Engineers permit to construct intake structures.

Groundwater. The ORR facility is located in an area of sedimentary rocks of widely varying hydrological characteristics. Groundwater on ORR occurs both in an unsaturated zone as transient, shallow subsurface storm flow and as an underlying, unconfined water table aquifer (over 30.5 m [100 ft] thick). The storm flow zone and the water table aquifer are separated by an unsaturated zone of variable thickness. In low-lying areas where the water table occurs near the surface, the storm flow zone and the saturated zone are indistinguishable.

Many factors influence groundwater flow on ORR. Generally, groundwater flow occurs in the upper 5 to 9 m (16 to 30 ft) of the saturated zone, and because of the topographic relief and a decrease in bedrock fracture density with depth, groundwater flow is restricted primarily to shallow depths and groundwater discharges to nearby surface waters within ORR (OR DOE 1994c:5-5). Depth to groundwater is generally 6 to 9 m (19.7 to 29.5 ft) but is as little as 1.5 m (4.92 ft) in the area of Bear Creek Valley near Highway 95.

Aquifers at ORR include a surficial soil and regolith unit and bedrock aquifers. The surficial aquifer consists of manmade fill, alluvium, and weathered bedrock. Bedrock aquifers occur in carbonates and low-yield sandstones, siltstones, and shales. Groundwater flow in the surficial aquifer is controlled by bedding planes, joints, fracture, and/or solution cavity distribution and orientation in limestones that store and transmit relatively large volumes of water. Bedding-plane and strike-parallel fracture orientation give rise to preferential groundwater movement along strike direction (OR DOE 1992c:5-7).

In the bedrock aquifer, essentially all groundwater occurs in fractures and in a few larger cavities within the formations. Enlarged fractures and cavities are the primary water producing and solute transport features and are supplied by seepage through fractures in the rock matrix. These fractures outnumber the enlarged fractures and cavities, are interconnected, and provide the continuity for groundwater flow paths. Movement of groundwater through fractures and solution conduits in some of the carbonate bedrock aquifers is quite rapid even where gradients are not particularly steep.

There are no Class I sole-source aquifers that lie beneath ORR. All aquifers are considered Class II aquifers (current potential sources of drinking water). Because of the abundance of surface water and its proximity to the points of use, very little groundwater is used at ORR. Only one supply well exists on ORR; it provides a supplemental water supply to an aquatics laboratory during extended droughts.

Recharge occurs over most of the area, but is most effective where overburdened soils are thin or permeable. In the area near Bear Creek Valley, recharge into the carbonate rocks is mainly along Chestnut Ridge (OR DOE 1992c:5-5). Shallow groundwater generally flows from the recharge areas to the center of Bear Creek Valley and discharges into Bear Creek and its tributaries.

Groundwater Quality. [Text deleted.] Groundwater samples are collected quarterly from over 1,000 monitoring wells throughout ORR and semiannually from offsite residential drinking water wells. Groundwater samples collected from the monitoring wells are analyzed for a standard suite of parameters and constituents, including trace metals, volatile organic compounds, radioactive materials, and pH. Background groundwater quality at ORR is generally good in the near-surface aquifer zones and poor in the bedrock aquifer at depths greater than 305 m (1,000 ft) due to high total dissolved solids. Groundwater quality at the Y–12 Plant has been affected by four types of contaminants: nitrates, volatile organic compounds (VOCs), metals, and radionuclides in various concentrations (OR DOE 1994d:6-3). The contamination is found in the first 76 m (250 ft) below the surface and is comprised of hazardous chemicals and radionuclides (mostly uranium) from past weapons production process activities. Effluents from current operations and waste management practices are regulated to protect and prevent discharges to the environment. The contaminated sites include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities (OR DOE 1994c: 7-11, 7-16, 7-23). The groundwater quality, as indicated by groundwater contamination monitoring wells near the HEU interim storage facility, is summarized in

Table 3.3.4–2 and sample locations are identified in Figure 3.3.4–1.

Groundwater Availability, Use, and Rights. Because of the abundance of surface waters and its proximity to the points of use, very little groundwater is used at ORR. Only one water supply well exists on ORR; it provides a supplemental water supply to an aquatics laboratory during extended droughts. Industrial and drinking water supplies in the area are primarily taken from surface water sources; however, single-family wells are common in adjacent rural areas not served by the public water supply system. Most of the residential supply wells in the immediate area of ORR are south of the Clinch River. Most wells used for potable water are in the deeper principal carbonate aquifers (up to 305 m [1,000 ft]), while the groundwater contamination at Y–12 is primarily found at a depth of 84 m (276 ft).

Groundwater rights in the State of Tennessee are traditionally associated with the Reasonable Use Doctrine (VDL 1990a:725). Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights reasonably in relation to the similar rights of others. [Text deleted.]

3.3.5 GEOLOGY AND SOILS

Geology. The ORR facility lies in the Valley and Ridge Province of east-central Tennessee. The topography consists of alternating valleys and ridges that have a northeast-southwest trend with most ORR facilities occupying the valleys. The HEU interim storage facilities are located at Y–12's Bear Creek Valley. Bear Creek Valley is underlain by rocks composed of siltstone, silty limestone, and shale with some sandstone. The present topography of the valley is the result of stream erosion of the softer shales and limestones.

The Y–12 Plant is cut by many inactive faults formed during the late Paleozoic Era. There is no evidence of capable faults in the immediate area of Oak Ridge within the definition of 10 CFR 100; the nearest are 482 km (300 mi) west in the New Madrid Fault zone.

The Oak Ridge area lies at the boundary between Seismic Zones 1 and 2, indicating that minor to moderate damage could occur as a result of earthquakes (Figure 3.3.5–1). Since the New Madrid earthquakes of 1811-1812, at least 26 other earthquakes with modified Mercalli intensity of III to VI (Table 3.3.5–1) have been felt in the Oak Ridge area; most of these have occurred in the Valley and Ridge Province. The nearest seismic event occurred in 1930, 8 km (5 mi) from ORR with a modified Mercalli intensity of V at the Oak Ridge site (OR EG&G 1991a:3.6.2). The most recent seismic event occurred in 1973, 32 km (20 mi) southeast from ORR. This earthquake had an estimated modified Mercalli intensity of VII at the epicenter and approximately a modified Mercalli intensity of V to VI in the Oak Ridge area. Recorded ground acceleration at ORR was less than 0.01 gravity. Although the Oak Ridge area experiences a moderate level of seismic activity, no deformation of recent surface deposits has been detected at ORR, and seismic shocks from the surrounding, more seismically active, areas are dissipated by distance from the epicenters. A maximum horizontal ground surface acceleration of 0.19 gravity at ORR is estimated to result from an earthquake that could occur once every 2,000 years (DOE 1996h:4.57). Most of the facilities that would be used meet the target performance to withstand an earthquake with an acceleration of 0.19 gravity with relative minor structural modifications. However, Buildings 9204-2 and 9995 would require more extensive modifications to bring the buildings into conformance with the target performance goal for new facilities (OR DOE 1994d:G-10). The area has not experienced volcanism within the last 230 million years; therefore, no present or future volcanic activity is expected.

Soils. Bear Creek Valley lies on well to moderately well-drained soils underlain by shale, siltstone, silty limestone, and sandstone. Developed portions of the valley are designated as urban land. Soil erosion from past land uses has ranged from slight to severe. Erosion potential is very high in those areas that have slopes greater than 25 percent and those areas that have been eroded in the past. Erosion potential is lowest in nearly flat-lying permeable soils that have a loamy texture. Additionally, wind erosion is slight, shrink-swell potential is low to moderate, and the soils are acceptable for standard construction techniques.

3.3.6 BIOTIC RESOURCES

Biotic resources at ORR include terrestrial resources, wetlands, aquatic resources, and threatened and

Table 3.3.4–2. Summary of Groundwater Quality Monitoring at Oak Ridge Reservation

Parameter	Unit of Measure	Water Quality Criteria and Standard[b]	Existing Conditions (1994)[a] Well No. GW-056	Well No. GW-683	Well No. GW-685
Alkalinity-CO_3	mg/l	NA	<1	<1	<1
Alkalinity-HCO_3	mg/l	NA	255	198	257
Alpha (gross)	pCi/l	15[c]	2.54	22.2	4.94
Aluminum	mg/l	0.05 to 0.2[d]	0.17	0.099	0.21
Barium	mg/l	2[c]	0.12	0.13	0.11
Beta (gross)	pCi/l	50[e]	3.66	34.3	11.4
Boron	mg/l	NA	0.048	0.082	0.038
Calcium	mg/l	NA	99	73	84
Chloride	mg/l	250[d]	79	13	45
Chromium	mg/l	0.05[f]	<0.01	<0.01	0.01
Copper	mg/l	1.3[c]	<0.004	<0.004	<0.004
Fluoride	mg/l	4[c]	0.1	0.2	0.1
Iron	mg/l	0.3[d]	1.2	0.036	1.2
Magnesium	mg/l	NA	21	20	<4
Manganese	mg/l	0.05[d]	0.45	0.0026	0.074
Nickel	mg/l	0.1[c, f]	0.11	<0.01	<0.01
Nitrate	mg/l	10[c, f]	0.2	12	4
pH	pH units	6.5 to 8.5[f]	7.4	7.3	7.5
Potassium	mg/l	NA	1.9	1.7	1.2
Sodium	mg/l	NA	46	9.6	23
Strontium	pCi/l	8[c]	0.16	0.14	<11.1
Sulfate	mg/l	250[d]	29	21	20
Total dissolved solids	mg/l	500[d]	422	278	358
Uranium, Total	pCi/l	20[g]	<0.015	0.08	<0.015
Vanadium	mg/l	NA	<0.005	<0.005	<0.005
Zinc	mg/l	5[d]	0.0056	0.0035	0.0061

[a] Well locations are shown in Figure 3.3.4–1.

[b] For comparison only.

[c] National Primary Drinking Water Regulations (40 CFR 141).

[d] National Secondary Drinking Water Regulations (40 CFR 143).

[e] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[f] Tennessee State Water Quality Standards.

[g] DOE Derived Concentrations for Water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective dose equivalent of 100 mrem/yr; however, because the drinking water maximum contaminant level is based on 4 mrem/yr, the number listed is 4 percent of the Derived Concentration Guide.

Note: NA=not applicable; <=estimated values and/or detection limits were used in the calculations; mg=milligram; pCi=picocurie.

Source: OR DOE 1995f; TN DEC 1991a.

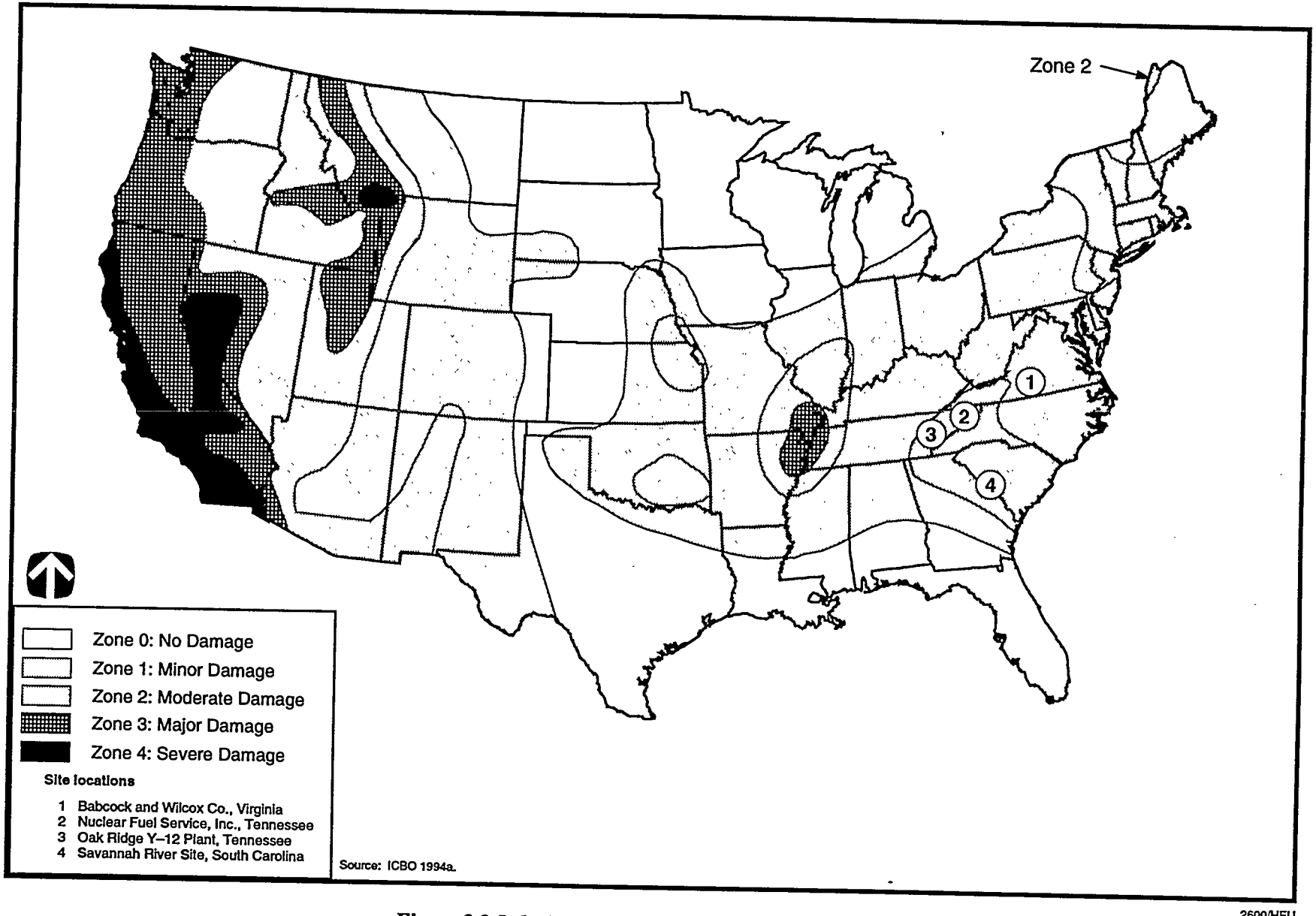


Figure 3.3.5–1. Seismic Zone Map of the United States.

Table 3.3.5–1. The Modified Mercalli Scale of 1931, With Approximate Correlations to Richter Scale and Maximum Ground Acceleration

Modified Mercalli Intensity[a]	Observed Effects of Earthquake	Approximate Richter Magnitude[b, c]	Maximum Ground Acceleration[d]
I	Usually not felt	2	negligible
II	Felt by persons at rest, on upper floors or favorably placed	2 to 3	<0.003g
III	Felt indoors; hanging objects swing; vibration like passing of light truck occurs; might not be recognized as earthquake	3	0.003 to 0.007g
IV	Felt noticeably by persons indoors, especially in upper floors; vibration occurs like passing of heavy truck; jolting sensation; standing automobiles rock; windows, dishes, and doors rattle; wooden walls and frames may creak	4	0.007 to 0.015g
V	Felt by nearly everyone; sleepers awaken; liquids disturbed and may spill; some dishes break; small unstable objects are displaced or upset; doors swing; shutters and pictures move; pendulum clocks stop or start	5	0.015 to 0.03g
VI	Felt by all; many are frightened; persons walk unsteadily; windows and dishes break; objects fall off shelves and pictures fall off walls; furniture moves or overturns; weak masonry cracks; small bells ring; trees and bushes shake	6	0.03 to 0.09g
VII	Difficult to stand; noticed by car drivers; furniture breaks; damage moderate in well built ordinary structures; poor quality masonry cracks and breaks; chimneys break at roof line; loose bricks, stones, and tiles fall; waves appear on ponds and water is turbid with mud; small earthslides; large bells ring	7	0.07 to 0.22g
VIII	Automobile steering affected; some walls fall; twisting and falling of chimneys, stacks, and towers; frame houses shift if on unsecured foundations; damage slight in specially designed structures, considerable in ordinary substantial buildings; changes in flow of wells or springs; cracks appear in wet ground and steep slopes		0.15 to 0.3g
IX	General panic; masonry heavily damaged or destroyed; foundations damaged; serious damage to frame structures, dams and reservoirs; underground pipes break; conspicuous ground cracks	8	0.3 to 0.7g
X	Most masonry and frame structures destroyed; some well built wooden structures and bridges destroyed; serious damage to dams and dikes; large landslides; rails bent		0.45 to 1.5g
XI	Rails bent greatly; underground pipelines completely out of service		0.5 to 3g
XII	Damage nearly total; large rock masses displaced; objects thrown into air; lines of sight distorted	8+	0.5 to 7g

[a] Intensity is a unitless expression to rank the severity of an earthquake by its effects on people and buildings.

[b] Magnitude is an exponential function of seismic wave amplitude, related to the energy released.

[c] Until the development of the Richter magnitude scale in 1935, the effects of an earthquake were measured by intensity scale.

[d] Acceleration is expressed in relation to the earth's gravitational acceleration (g).

Source: ICSSC 1985a; PPI 1994a.

endangered species. Within each biotic resource area, the discussion focuses first on ORR as a whole and then on the Y–12 Plant. Scientific names of species identified in the text are presented in Appendix D.

Terrestrial Resources. Plant communities at ORR are characteristic of the intermountain regions of central and southern Appalachia. Since it was withdrawn from public access, approximately 10 percent of ORR has been permanently disturbed and no longer provides natural habitat; the remainder of the site has reverted to or been planted with natural vegetation (OR DOE 1989a:3-5). The vegetation of ORR has been categorized into seven plant communities.

Pine and pine-hardwood forest is the most extensive plant community on ORR. Important species of this type include loblolly, shortleaf, and Virginia pine. Another abundant plant community is the oak-hickory forest, which is commonly found on ridges throughout ORR. Northern hardwood and hemlock-white pine hardwood forests are the least common forest community types on ORR. Forest resources on ORR are managed for maintaining the multiple use of forest land and sustaining the yield of quality timber products (OR DOE 1994b:2-113). There are 983 species, subspecies, and varieties of plants that have been identified on ORR (OR NERP 1993b:2).

Animals found on ORR include 39 species of mammals, 169 species of birds, 33 species of reptiles, and 26 species of amphibians (OR NERP nda:10-17). Animals commonly found on ORR include the American toad, eastern garter snake, Carolina chickadee, northern cardinal, white-footed mouse, and raccoon. Although the whitetail deer is the only species hunted onsite (OR DOE 1991c:4-6), other game animals are also present. Raptors, such as the northern harrier and great horned owl, and carnivores, such as the gray fox and mink, are ecologically important groups on ORR (ORNL 1981a:3.4-17). A variety of migratory birds has been found at ORR. Migratory birds, their nests, and eggs, are protected under the *Migratory Bird Treaty Act.*

Habitat within the vicinity of the Y–12 Plant is dominated by buildings, parking lots, and lawns; thus, little natural vegetation is present. A few small forested areas do exist within the plant boundary along the Chestnut Ridge. Animals within the Y–12 boundary are limited by the lack of large areas of natural habitat.

Wetlands. Wetlands on ORR include emergent, scrub-shrub, and forested wetlands associated with embayments of the Melton Hill and Watts Bar Reservoirs; riparian areas bordering major streams and their tributaries; old farm ponds; and groundwater seeps. Well-developed communities of emergent wetland plants in the shallow embayments of the two reservoirs typically intergrade with forested wetland plant communities, which extend upstream through riparian areas associated with streams and their tributaries. Old farm ponds on ORR vary in size and support diverse plant communities and fauna. Although most riparian wetlands on ORR are forested, areas within utility rights-of-way, such as those in Bear Creek and Melton Valleys, support emergent vegetation (OR NERP 1991a:18, 26, 41).

Aquatic Resources. Aquatic habitats on or adjacent to ORR range from small, free-flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction. These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small perennial streams, as well as seasonal and intermittent streams.

Sixty-four fish species have been collected on or adjacent to ORR. The minnow family has the largest number of species and is dominant in most streams. Fish species representative of the Clinch River in the vicinity of ORR are shad, herring, common carp, catfish, bluegill, crappie, and drum (ORNL 1981b:138, 139). The most important fish species taken commercially in the ORR area are common carp and catfish. Recreational species consist of crappie, bass, sauger, sunfish, and catfish.

Bear Creek, located west of the Y–12 Plant boundary, contains adequate physical habitat to maintain and propagate aquatic life throughout its length, with the lower reaches having increased habitat diversity; however, contamination (primarily from the Y–12 Plant) has affected species diversity and richness, especially in comparison with unaffected streams of similar size. East Fork Poplar Creek, also within the vicinity of the Y–12 Plant, contains several species of fish, as well as benthic and other organisms typical of aquatic habitats with characteristics ranging from limestone rip-rap to smooth and muddy stream bottoms; however, as in Bear Creek, contamination

from the Y–12 Plant and other sources has affected aquatic species diversity and abundance (OR DOE 1994d:5-13).

Threatened and Endangered Species. Eighty-four Federal- and State-listed threatened, endangered, and other special status species have been identified on and near ORR (Appendix D, Table D.1–2). The appendix indicates that 24 of these species have recent records of occurrence on ORR, none of which are Federal listed as threatened or endangered. Fifteen species are State listed as threatened or endangered, the majority of which are plant species located within the National Environmental Research Park. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on ORR.

There are no Federal-listed threatened or endangered species known to occur in the vicinity of the Y–12 Plant. The Tennessee dace is a State-listed species in need of management known to occur in Bear Creek near the Y–12 Plant (OR NERP 1993a:10). ORR lies within the geographic range of the gray and the Indiana bats, but suitable habitat for these species is not known to occur on or near the Y–12 Plant. Neither bat species was collected during a limited survey conducted in 1992 (OR TT 1993a). The peregrine falcon may occur in the area as a rare migrant or winter visitor. Hellbenders may occur in streams that drain the site. [Text deleted.]

3.3.7 Cultural Resources

Prehistoric Resources. More than 20 cultural resources surveys have been conducted on ORR. About 90 percent of ORR has received reconnaissance-level studies; however, less than 5 percent has been intensively surveyed. Most cultural resources studies have occurred along the Clinch River and adjacent tributaries. Prehistoric archaeological sites recorded at ORR include villages, burial mounds, camps, quarries, chipping stations, limited-activity locations, and shell scatters. Over 45 prehistoric sites have been recorded at ORR. At least 10 prehistoric sites may be considered potentially eligible for the National Register of Historic Places (NRHP); however, most of these sites have not yet been evaluated. One site (40RE86), which is located on the Clinch River near K–25, has been determined eligible for inclusion on the NRHP. No NRHP-eligible prehistoric sites have been identified at Y–12. One site (40AN6), a lithic scatter, was identified near Scarboro Road east of Y–12, outside the fences. A field review of Y–12 indicated that much of the area had been disturbed, and that the potential for NRHP-eligible prehistoric sites was low. Additional prehistoric sites may be identified in the unsurveyed portions of ORR. On May 6, 1994, a Programmatic Agreement concerning the management of historical and cultural properties at ORR was executed among the DOE Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation. This agreement was administered to satisfy DOE's responsibilities regarding Sections 106 and 110 of the *National Historic Preservation Act* and requires DOE to develop a cultural resources management plan for ORR and to conduct cultural resources surveys as required.

Historic Resources. Several historic resources surveys have been conducted at ORR. Historic resources identified at ORR include both archaeological remains and standing structures. Documented log, wood frame, or fieldstone structures include cabins, barns, churches, gravehouses, springhouses, storage sheds, smokehouses, log cribs, privies, henhouses, and garages. Archaeological remains consist primarily of foundations, roads, and trash scatters. Sixty-five pre-1942 cemeteries were located within the original ORR. Today, there are only 32 known cemeteries within ORR, because the size of the reservation has been reduced. More than 240 historic resources have been recorded at ORR, and 20 of those sites may be considered potentially eligible for the NRHP. Freel's Cabin and two church structures, George Jones Memorial Baptist Church and the New Bethel Baptist Church, are listed on the NRHP. These structures date from before the establishment of the Manhattan Project, which was established in 1942 as the Manhattan Engineering Works for the purpose of constructing atomic bombs. NRHP sites associated with the Manhattan Project include the Graphite Reactor, listed on the NRHP as a National Historic Landmark, and three traffic checkpoints, Bear Creek Road, Bethel Valley Road, and Oak Ridge Turnpike Checking Stations. None of these sites are located at Y–12. Many other buildings and facilities at ORR are associated with the Manhattan Project and may be potentially eligible for the NRHP. Historic building surveys were completed during fiscal year 1994 at K–25 and ORNL. A similar survey was completed at

Y–12 in fiscal year 1995 and the final document should be finished in fiscal year 1996. It is possible that as many as 100 buildings within Y–12 may be eligible for the NHRP as contributing properties to a Y–12 Historic District. Additional historic sites may be anticipated in the unsurveyed portions of ORR.

Native American Resources. The Overhill Cherokee occupied portions of the Tennessee, Hiwassee, Clinch, and Little Tennessee River Valleys by the 1700s. Overhill Cherokee villages consisted of a large townhouse, a summer pavilion, and a plaza; residences had both summer and winter structures. Subsistence was based on hunting, gathering, and horticulture. Most of the Cherokee people were relocated to the Oklahoma Territory during the 1830s as part of the Trail of Tears; some Cherokee later returned to the area. Resources that may be sensitive to Native American groups include remains of prehistoric and historic villages, ceremonial lodges, cemeteries, burials, and traditional plant-gathering areas. No Native American resources have been identified at Y–12.

Paleontological Resources. The majority of geological units with surface exposures at ORR contain paleontological materials. Paleontological materials consist of primarily invertebrate remains, and these assemblages have relatively low research potential.

3.3.8 SOCIOECONOMICS

Socioeconomic characteristics described for ORR include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 15 counties around ORR in the State of Tennessee (Appendix F, Table F.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a four-county area in which 91.3 percent of all ORR employees reside: Anderson County (33.1 percent), Knox County (36 percent), Loudon County (5.6 percent), and Roane County (16.6 percent) (Appendix F, Table F.1–2). Approximately 31.7 percent of the ORR employees reside in the city of Knoxville (Knox County). Supporting data are presented in Appendix F.

Regional Economy Characteristics. Between 1980 and 1990, the civilian labor force in the REA increased 16.2 percent to the 1990 level of 412,803. In 1994 unemployment in the REA was 4.9 percent, which was about the same as the rate for Tennessee. The region's per capita income of $17,652 in 1993 was approximately 4.3 percent less than the statewide per capita income of $18,439. Employment and regional economy statistics and projections for the proposed action period for the ORR REA are given in Appendix F, Table F.1–6, and selected statistics are summarized in Figure 3.3.8–1.

As shown in Figure 3.3.8–1, the composition of the REA economy parallels that of the statewide economy of Tennessee. During 1993, the services sector accounted for 26 percent of the region's total employment, followed by retail trade (19 percent) and manufacturing (18 percent). For the entire State, the services sector comprised 26 percent of total employment, while manufacturing accounted for 19 percent, and retail trade accounted for 17 percent.

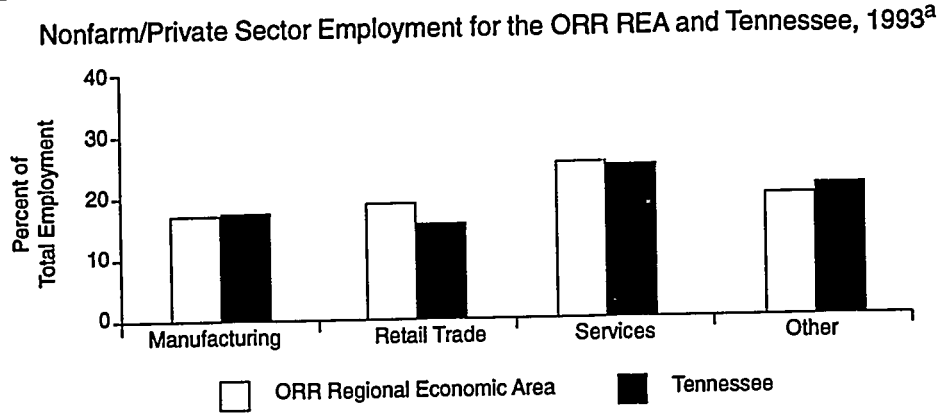
[Text deleted.]

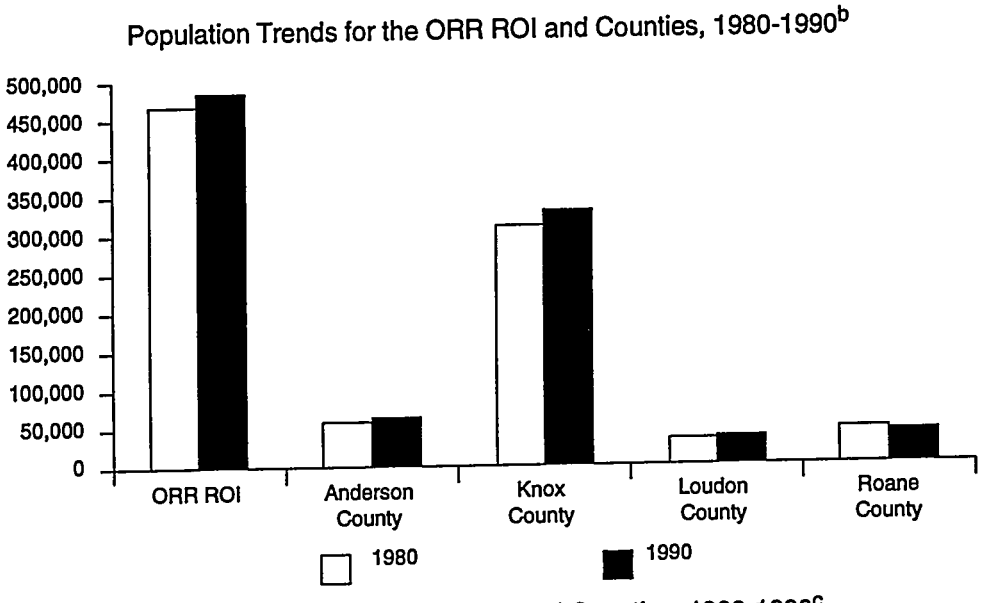
Population and Housing. In 1992, the ROI population totaled 499,444. From 1980 to 1990, the ROI population increased by 4 percent, compared to 6.2 percent for Tennessee. Within the ROI, Loudon County experienced the greatest population increase, 9.5 percent, while Roane County's population decreased by 2.5 percent. Population trends are summarized in Figure 3.3.8–1. [Text deleted.]

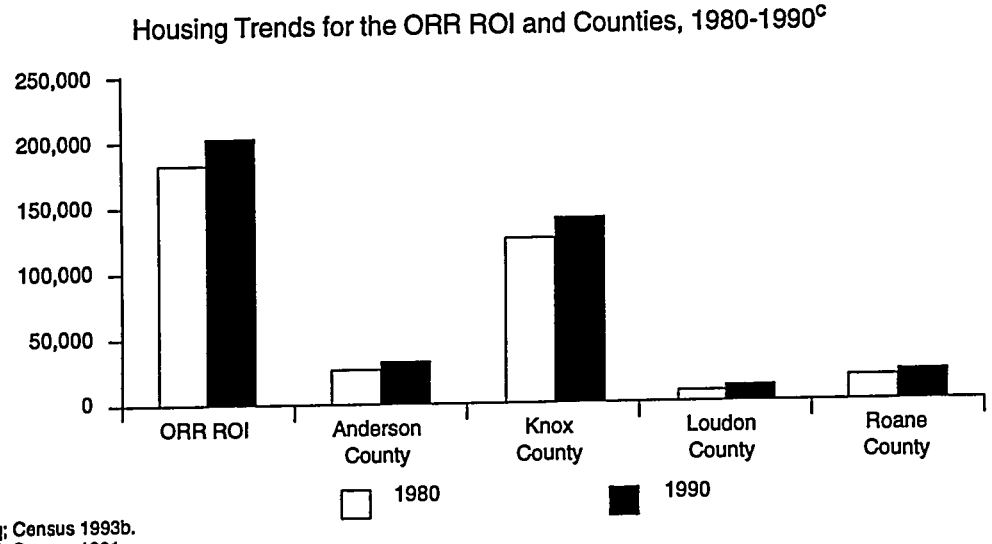
The number of total housing units in the ROI increased 13.8 percent between 1980 and 1990, reaching 206,234 in 1990. In comparison, the number of housing units in the State increased by almost 16 percent during the same period. The 1990 ROI homeowner and rental vacancy rates were 1.7 and 8.5 percent, respectively. These rates were comparable to the Statewide rates. (A full presentation of population and housing statistics and projections are provided in Appendix F, Tables F.1–10 and F.1–14, respectively.)

Community Services. Education, public safety, and health care characteristics are used to assess the level of community services in the ORR ROI. Figure 3.3.8–2 summarizes school district characteristics for the ORR ROI. Figure 3.3.8–3 summarizes public safety and health care services.

Education. In 1994, eight school districts provided public education services and facilities in the ORR

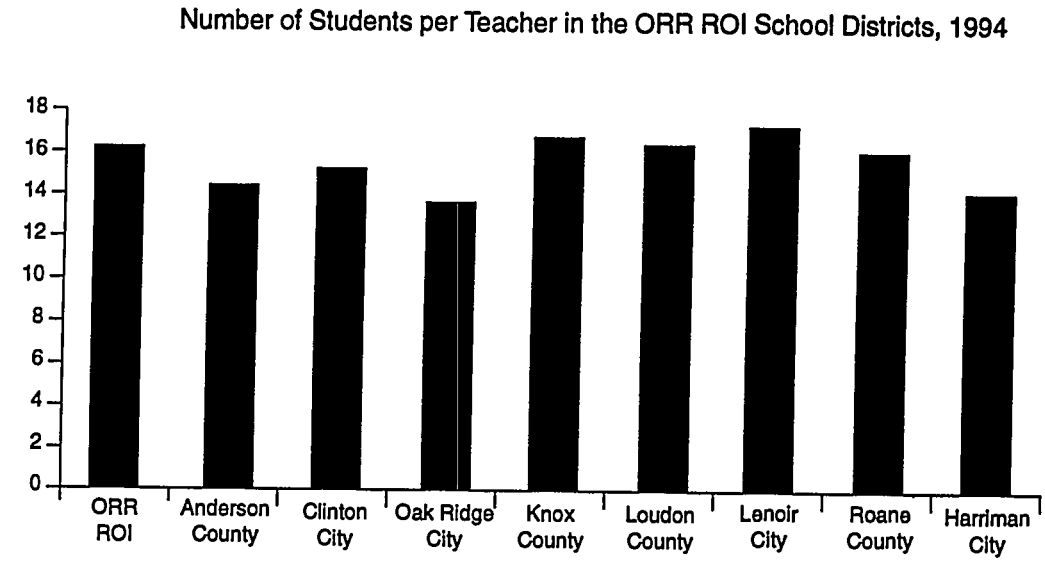


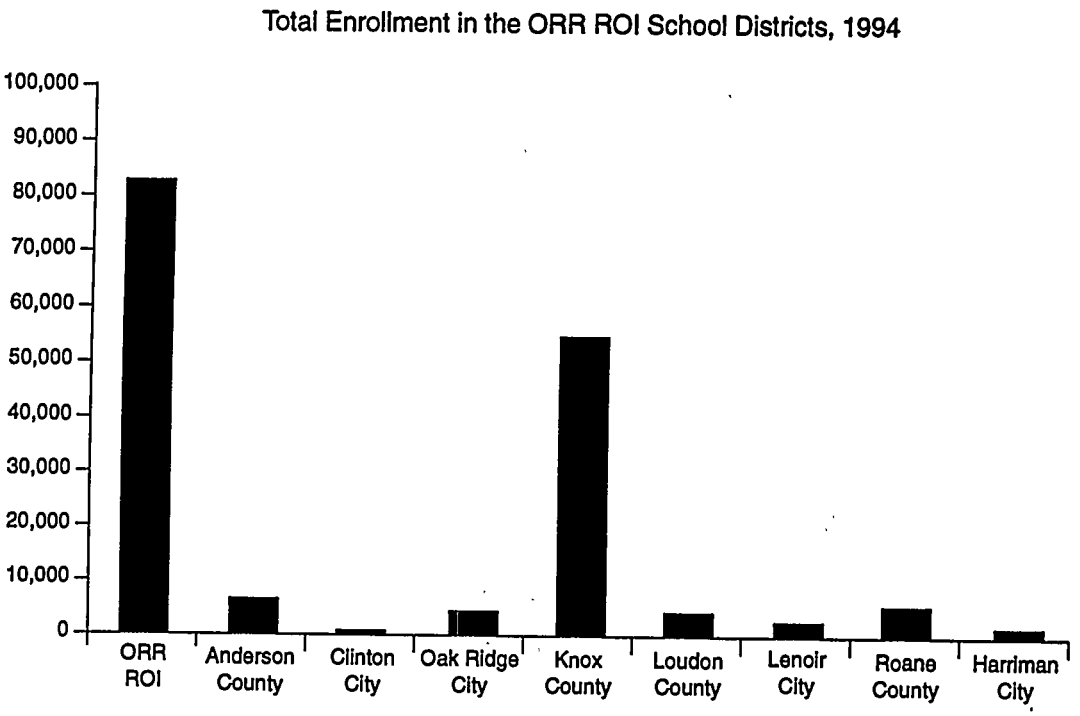




[a] DOC 1995a.
[b] Census 1983q; Census 1993b.
[c] Census 1982d; Census 1991c.

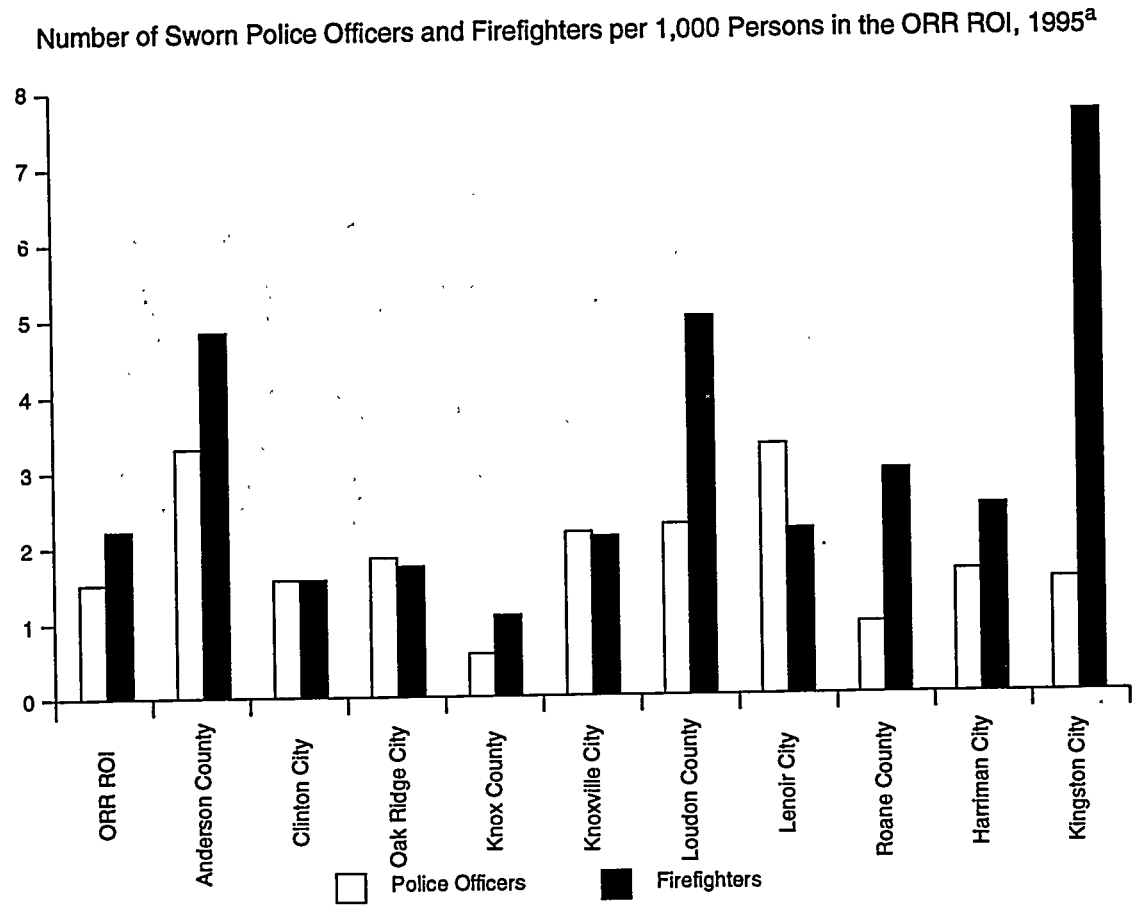
Figure 3.3.8–1. Economy, Population, and Housing for the Oak Ridge Reservation Regional Economic Area and Region of Influence.

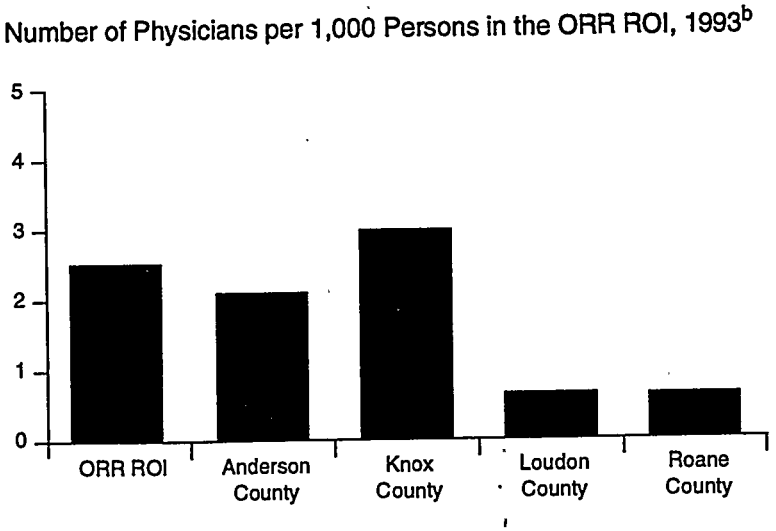




Source: OR School 1995a.

Figure 3.3.8–2. School District Characteristics for the Oak Ridge Reservation Region of Influence.





[a] Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j; OR Fire 1995a; OR Police 1995a.
[b] AMA 1994a; Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.
Note: Except for ROI cities, city sworn police officers and firefighters are included in the county totals.

Figure 3.3.8–3. Public Safety and Health Care Characteristics for the Oak Ridge Reservation Region of Influence.

ROI. As seen in Figure 3.3.8–2, these school districts ranged in enrollment size from 1,170 students in the Clinton City School District to 55,560 students in the Knox County School District. The average student-to-teacher ratio for the ROI was 16.2:1. The Lenoir City School District had the highest ratio at 17.2:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents of the ROI. In 1995, a total of 792 sworn police officers served the four-county area. The city of Knoxville employed the largest number of police officers (362), while Lenoir City had the highest officers-to-population ratio (3.4 officers per 1,000 persons). The average ROI officers-to-population ratio was 1.5 officers per 1,000 persons. Figure 3.3.8–3 compares police force strengths across the ROI.

Fire protection services in the ORR ROI were provided by 1,120 regular and volunteer firefighters in 1995. The fire department with the highest firefighters-to-population ratio is located in the city of Kingston (7.7 firefighters per 1,000 persons) as indicated in Figure 3.3.8–3. The city of Knoxville had the greatest number of active firefighters (357). The average active firefighters-to-population ratio in the ROI was 2.2 firefighters per 1,000 persons.

Health Care. There were nine hospitals serving the four-county ROI in 1993. Over 84 percent of the hospital bed capacity is located in six of the nine hospitals. These six hospitals were located in the city of Knoxville. During 1993, all nine hospitals operated below capacity, with bed occupancy rates ranging from 55.1 percent in Roane County to 72.8 percent in Knox County.

There were 1,269 practicing physicians in the ROI during 1993, with the majority (1,070) operating in Knox County. Figure 3.3.8–3 shows that the physicians-to-population ratio ranged from 0.6 physicians per 1,000 persons in Roane and Loudon County to 3 physicians per 1,000 persons in Knox County. The average ROI physicians-to-population ratio was 2.5 physicians per 1,000 persons.

Local Transportation. Interstate (I) and State Route (SR) highways provide access between ORR and metropolitan areas as illustrated in Figure 3.3–1. East-west highway I-40, located 2.4 km (1.5 mi) south of the reservation boundary, provides access to the cities of Nashville and Knoxville, Tennessee. North-south highway I-75, is located 4 km (2.5 mi) south of ORR and serves as a major route to the south, passing through the cities of Chattanooga, Tennessee, and Atlanta, Georgia.

Vehicular access to ORR is provided by three State Routes. SR-95 forms an interchange with I-40 and enters ORR from the south. SR-58 enters ORR from the west and passes just south of K–25. SR-162 extends from I-75/I-40 just west of Knoxville and provides eastern access to ORR.

Within ORR, several routes are used to transfer traffic from the State Routes to the main plant areas. Bear Creek Road, located north of the Y–12 Plant, flows in an east-west direction and connects Scarboro Road on the east end of the plant with SR-95 and SR-58. Bear Creek Road has restricted access around Y–12 and is not a public thoroughfare. Bethel Valley Road, a public roadway, extends from the east end of ORR at SR-62 to the west end at SR-95. Blair Road provides access to K–25 from the north. [Text deleted.] Oak Ridge has a part-time public transportation system (ORR 1995a:7). There are two current road improvement projects affecting access to ORR. The first is the construction of two box bridges on SR-61 near Oak Ridge. The second is the repavement of SR-62 from Tuskegee Drive to north of Union Valley Road. There are two planned road improvement projects that could affect access to ORR in the near future. The first is the reconstruction of SR-9 in Lake City. The second is the construction of SR-58 from I-40 to SR-95 in Oak Ridge (TN DOT 1995a:2).

Two main-line branches provide rail service for ORR. CSX Transportation (CSXT) line at Elza (just east of Oak Ridge) serves the Y–12 Plant and the Office of Scientific and Technological Information in east Oak Ridge. The Norfolk Southern (NS) main line from Blair provides access to K–25. The Clinch River has a barge facility located on the west end of ORR near K–25 and is occasionally used for the receipt of shipments that are too large or heavy to be transported by rail or truck (ORR 1995a:7). McGhee Tyson Airport, located approximately 37 km (23 mi) from ORR, is the nearest airport serving the region with major carriers providing passenger and cargo service. A private airport, Atomic Airport, Inc., is the closest air transportation facility to Oak Ridge (DOT 1992a).

3.3.9 PUBLIC AND OCCUPATIONAL HEALTH

Radiation Environment. All residents in the vicinity of ORR are exposed to background radiation from a variety of natural and man-made sources. The major sources of background radiation exposure to individuals in the vicinity of ORR are shown in Table 3.3.9–1. Background radiation doses to individuals in the vicinity of ORR are unrelated to ORR operations. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population.

Releases of radionuclides to the environment from ORR operations provide another source of radiation exposure to individuals in the vicinity of ORR. The radionuclides and quantities released from operations in 1993 are listed in the *Oak Ridge Reservation Annual Site Environmental Report for 1993* (ES/ESH-47, November 1994).The doses to the public resulting from these releases and direct radiation fall within radiological limits and are small in comparison to background radiation. Table 3.3.9–2 presents the doses to the general public resulting from releases and direct radiation.The releases listed in the 1993 report were used in the development of the reference environment's radiological releases at ORR for the public and occupational health segments within Section 4.3.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Appendix E), the fatal cancer risk to the maximally exposed individual (MEI) of the public due to radiological releases from ORR operations in 1993 is estimated to be approximately 1.0×10^{-6}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of ORR operations is 1 chance in 1 million. (It may take several years from the time of exposure for cancer to manifest.)

Based on the same risk estimator, 1.4×10^{-2} excess fatal cancers were estimated from normal operations in 1993 to the population living within 80 km (50 mi) of ORR. This number can be compared with the numbers of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers from all causes expected to occur during 1993 was 1,760 for the population living within 80 km (50 mi) of ORR. This number of expected fatal cancers is much higher than the estimated 1.4×10^{-2} fatal cancers that could result from ORR operations in 1993.

Table 3.3.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Oak Ridge Reservation Operations

Source	Committed Effective Dose Equivalent[a] (mrem/yr)
Natural Background Radiation	
Cosmic radiation	27
External terrestrial radiation	28
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	360

[a] NCRP 1987a; OR DOE 1993a.Value for radon is an average for the United States.

Workers at ORR receive the same dose as the general public from background radiation, but they receive an additional dose from working in the facilities. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Appendix E), the number of excess fatal cancers to ORR workers from operations in 1992 is estimated to be 2.7×10^{-2}. Table 3.3.9–3 presents the average, maximum, and total occupational doses to ORR workers from operations in 1992.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Oak Ridge Reservation Annual Site Environmental Report for 1993* (ES/ESH-47, November 1994). The concentrations of radioactivity in various

Table 3.3.9–2. Doses to the General Public From Normal Operations at Oak Ridge Reservation, 1993 (committed effective dose equivalent)

Receptor	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual[b]	Standard[a]	Actual[b]	Standard[a]	Actual[b]
Maximally exposed individual (mrem)	10	1.4	4	0.6[c]	100	2[d]
Population within 80 km[e] (person-rem)	None	26	None	2	100	28
Average individual within 80 km (mrem)[f]	None	3.0×10^{-2}	None	2.3×10^{-3}	None	3.2×10^{-2}

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[b] OR DOE 1994c.

[c] Includes a dose of 0.2 mrem from drinking water.

[d] An additional annual direct radiation dose of 1 mrem may be incurred to an individual at Poplar Creek or the Clinch River shoreline.

[e] In 1993, this population was approximately 880,000.

[f] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Table 3.3.9–3. Doses to the Onsite Worker From Normal Operations at Oak Ridge Reservation, 1992 (committed effective dose equivalent)

Receptor	Onsite Releases and Direct Radiation	
	Standard[a]	Actual[b]
Average worker (mrem)	None	4
Maximally exposed worker (mrem)	5,000	2,000
Total workers (person-rem)	None	68

[a] 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[b] DOE 1993n:7. The number of badged workers at ORR in 1992 was approximately 17,150.

environmental media (for example, air, water, and soil) in the site region (onsite and offsite) are also presented in the same report. ORR operations contribute small amounts of radioactivity to these media.

Chemical Environment. The background chemical environment important to human health is the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in previous sections of this EIS, particularly Sections 3.3.3 and 3.3.4.

Health impacts to the public can be minimized through effective administration and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (for example, air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations via inhalation of air containing pollutants released to the atmosphere by ORR operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in Section 3.3.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could

be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Appendix E, Section E.3.4.

Health impacts to ORR workers during normal operations may include the following: inhalation of the workplace atmosphere, drinking ORR potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker; however, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. ORR workers are also protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*) ensure that conditions in the workplace are as free as possible from recognized hazards; therefore, worker health conditions at ORR are expected to be substantially better than required by standards.

Health Effects Studies. Two epidemiologic studies (JAMA 1991a:1403-1407; TN DHE 1992a; NIH Publication No. 90-874, July 1990) were conducted to determine whether the ORR facility contributed to any excess cancers in the communities within 80 km (50 mi) of the facility. One study found no excess cancer mortality in the population living in counties surrounding ORR when compared to the control populations located in other nearby counties and elsewhere in the United States. The other study found a slight excess of cancer incidences of several types in the counties near ORR, but none of the excess risks were statistically significant.

A pilot study on mercury contamination conducted by the TDEC showed no difference in urine or hair mercury levels between individuals with potentially high mercury exposures and those with little potential for exposure; however, soil analysis showed that the mercury in soil was inorganic, which decreases the likelihood of bioaccumulation and health effects (IARC 1984a:57-63; JOM 1984a:817-821). Mercury exposures greater than or equal to 0.6 mg/l of mercury showed an association with clinical polyneuropathy related with the level of exposure but not with duration of exposure (AN 1988a:651-659). Studies are continuing on the long-term effects of exposure to mercury and other hazardous chemicals.

More epidemiologic studies have been conducted to assess the health of the population working at ORR than any other site reviewed for this document. Excess cancer mortalities have been reported and linked to specific job categories, age, and length of employment, as well as to the levels of exposure to radiation. All reviewed studies are presented in Appendix E, Section E.4.2.

Accident History. There have been no accidents with a measurable impact on offsite population during nearly 50 years of Y–12 operations at ORR. The most noteworthy accident in Y–12 history was a 1958 criticality accident. This accident resulted in radiation sickness for a few ORR employees. In 1989, there was a one-time accidental release of xylene into the ORR sewer system with no adverse offsite impacts. Accidental releases of anhydrous hydrogen fluoride have occurred in 1986, 1989, and 1992, with little onsite and negligible offsite impacts. The hydrogen fluoride system where these accidents occurred is being modified to reduce the probability of future releases and to minimize the consequences if a release does occur.

Emergency Preparedness. Each DOE site has established an emergency management program. These programs have been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management programs incorporate activities associated with emergency planning, preparedness, and response.

The Department of Energy has the overall responsibility for emergency planning and operations at ORR; however, DOE has delegated primary authority for event response to the operating contractor. Although the contractor's primary response is onsite, it does provide offsite assistance, if requested, under the terms of existing mutual aid agreements. If a hazardous materials event with

offsite impacts occurs at a DOE ORR facility, elected officials and local governments are responsible for the State's response efforts. The Governor's Executive Order No. 4 established the Tennessee Emergency Management Agency as the agency responsible for coordinating State emergency services. When a hazardous materials event occurring at DOE facilities is beyond the capability of local government and assistance is requested, the Tennessee Emergency Management Agency Director may direct State agencies to provide assistance to the local governments. The Director may cause the State Emergency Operations Center and Field Coordination Center to be activated to accomplish this task and ensure prompt initiation of emergency response actions. City or county officials may activate local emergency operation centers in accordance with existing emergency plans.

3.3.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for the three major operating industrial complexes within ORR: the Y–12 Plant, ORNL, and the K–25 Site. DOE is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR. DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed upon milestones.

The EPA placed ORR on the National Priorities List on November 21, 1989. DOE, EPA Region IV, and the TDEC completed an FFCA effective January 1, 1992. This agreement coordinated ORR inactive site assessment and remedial action. Portions of the FFCA are applicable to operating waste management systems. Existing actions are conducted under RCRA and applicable State laws, which minimize duplication, expedite response actions, and achieve a comprehensive remediation of the site.

ORR generates and manages the following waste categories: transuranic (TRU), low-level, mixed, hazardous, and nonhazardous. Table 3.3.10–1 through 3.3.10–3 present a summary of waste management for 1993 at the Y–12 Plant, ORNL, and K–25 site, respectively. A discussion of the waste management operations, associated with each of these categories follows:

High-Level Waste. ORR does not generate or manage HLW.

Transuranic Waste. ORNL is the only generator of TRU waste at ORR. Solid TRU waste consists of filters, paper, metals, and other items generated at ORNL through laboratory, pilot plant, and reactor operations in 1993. This includes both contact-handled and remote-handled TRU waste contaminated with lead and, in some cases, mercury. Contact-handled waste is TRU waste that contains mainly Pu, which emits alpha particles and low-energy photons. The packaging is designed to provide sufficient containment and shielding to minimize personnel exposure problems. Remote-handled TRU waste contains activation materials and fission products that decay by the emission of beta and gamma radiation with a resulting dose rate in excess of 200 millirem per hour (mrem/hr).

As of December 31, 1993, approximately 2,020 m^3 (71,300 ft^3) of TRU waste was in retrievable drum storage. The amount of remote-handled waste was about 564 m^3 (19,900 ft^3) (DOE 1994d:101-102). Current activities center around certification of contact-handled TRU waste, planning and design of a repackaging and certification facility for remote-handled TRU waste, and planning for the shipment of waste to the Waste Isolation Pilot Plant or another suitable repository that can provide for the disposal of TRU waste, pursuant to the provisions of 40 CFR 191 and 40 CFR 268.

Low-Level Waste. Solid LLW, consisting primarily of radioactively-contaminated construction debris, wood, paper, asbestos, trapping media, process equipment, and radionuclides removed from liquid and airborne discharges, is generated at ORR. ORNL operates the only LLW disposal facility at ORR. This disposal facility only accepts LLW generated at ORNL. Solid LLW is being stored at K–25 and Y–12 for future disposal. Contaminated scrap metal is stored above ground at the K–770 scrap metal facility and the Y–12 old salvage until further disposal methods are evaluated.

Table 3.3.10–1. Waste Management at Y–12 Plant

Waste Category	1993 Generation (m^3)	Treatment		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	Capacity (m^3)
Low-Level							
Liquid	1,030	Activated sludge	12,900[a]	Stored onsite	Included in liquid mixed LLW	NA	NA
Solid	4,730[b]	Compaction and stabilization, incineration and smelting by commercial vendor	19,300[c]	Stored onsite at Y–12 or K–25	16,200[d]	None–stored pending availability of offsite disposal or planned onsite LLW disposal facilities	NA
Mixed Low-Level							
Liquid	2,410	Neutralization, activated sludge, oxidation, adsorption, and incineration at K–25	12,300[e]	Tanks	2,660[f]	NA	NA
Solid	223	Incineration at K–25 or offsite commercial vendors	NA	Staged for shipment	11,700[g]	Offsite	NA
Hazardous							
Liquid	8,840	Managed as mixed LLW	30,300[h]	Tanks	751[i]	Offsite	NA
Solid	1,080[j]	Offsite	NA	Staged for shipment	170[k]	Offsite	NA
Nonhazardous (Sanitary)							
Liquid	2,460 m^3/day[l]	Offsite	5,300 m^3/day[m]	None	NA	Offsite	NA
Solid	43,900[n]	Compaction	43,900[o]	None	NA	Industrial and sanitary landfill and offsite at municipal site	1,100,000[p]

Table 3.3.10–1. Waste Management at Y–12 Plant—Continued

Waste Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Nonhazardous (Other)							
Liquid	Included in liquid sanitary	Evaporation, neutralization, and precipitation	251,000[q]	None	NA	Offsite–NPDES outfall	NA
Solid	Included in solid sanitary	None	NA	None	NA	Construction demolition landfill (onsite)[p]	119,000[p]

[a] West End Treatment Facility and Central Pollution Control Facility.

[b] Includes 2,340 m^3 of contaminated scrap metal.

[c] Waste Feed Preparation Facility and the Uranium Chip Oxidizer Facility (design feed rate).

[d] Includes the Depleted Uranium Oxide Storage Vaults, Above Grade Storage Facility, salvage yard, the Containerized Waste Storage Area, and the Sludge Basin.

[e] Includes Waste Coolant Processing Facility, Acid Waste Neutralization and Recovery Facility, Cyanide Treatment Facility, and Groundwater Treatment Facility. The West End Treatment Facility, the Plating Rinsewater Treatment Facility, and the Central Pollution Control Facility can process mixed waste and LLW.

[f] OD7, OD8, OD9, and OD10, Liquid Storage Facility, 9212 Tank Farm, and Building 9720–9 (western half).

[g] RCRA and PCB Container Storage Area (9720-58), Container Storage Facility (Bldg. 9720-12), PCB Drum Storage Facility (9407-7), Buildings 9201-4, 9206, 9212, and the West End Tank Farm.

[h] Plating Rinsewater Treatment Facility. Does not include Stream Plant Wastewater Treatment Facility.

[i] Building 9720-9 (eastern half).

[j] Currently all RCRA-hazardous wastes are stored at Y–12 or K–25 awaiting disposal.

[k] RCRA storage and staging area (Bldg. 9720-31).

[l] Does not include sewage waste.

[m] Oak Ridge Sewage Treatment Plant.

[n] Includes trash, debris, scrap metal, treatment residue, and classified waste.

[o] Assumed 1993 treatment rate at Building 9720-25 Baler Facility.

[p] Serves all three sites. Value provided is design capacity. Projected utilization rate is 39,600 m3/yr for Industrial and Sanitary Landfill V and 27,520 m3/yr for Construction Demolition Landfill VI.

[q] Approximate Central Pollution Control Facility, West End Treatment Facility, and Steam Plant Wastewater Treatment Facility NPDES permit annual discharge volume limits for East Fork Poplar Creek.

Note: NA=not applicable.

Source: DOE 1993a; DOE 1994n; DOE 1995gg; OR DOE 1992c; OR DOE 1995g; OR MMES 1995c; ORR 1993a:4.

Table 3.3.10–2. Waste Management at Oak Ridge National Laboratory

Waste Category	1993 Generation (m^3)	Treatment		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	Capacity (m^3)
Transuranic (Solid)							
Contact handled	111[a]	None	NA	Staged for shipment[b]	1,760	None (WIPP or alternate facility in future)	NA
Remote handled	7	None	NA	Staged for shipment[c]	856	None (WIPP or alternate facility in future)	NA
Low-Level							
Liquid	1,540	Ion exchange, filtration, solidification, and evaporation	390,000[d]	Stored onsite in tanks	3,230[e]	NA	NA
Solid	1,720[f]	Compaction, incineration, and smelting by commercial vendor	11,300[g]	Stored onsite	7,290[h]	Onsite	3,590[i]
Mixed Low-Level							
Liquid	None[j]	Incineration at K–25	Offsite	Tanks and drums	393[k]	None	NA
Solid	118[l]	Incineration at K–25 or offsite commercial vendor	Offsite	Staged for shipment	Included in liquid mixed LLW	Offsite	NA
Hazardous							
Liquid	23,800	Neutralization, sedimentation, and evaporation	Included in nonhazardous liquid (other)	Staged for shipment	Included in solid hazardous	Offsite	NA
Solid	354[l]	Open burning, treat offsite	Variable[m]	Staged for shipment	130[n]	Storage/incineration (K–25) and landfill (Y–12)	NA

Table 3.3.10–2. Waste Management at Oak Ridge National Laboratory—Continued

Waste Category	1993 Generation (m^3)	Treatment		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	Capacity (m^3)
Nonhazardous (Sanitary)							
Liquid	331,000	Extended aeration (activation sludge treatment)	414,000[o]	None	NA	NPDES outfall	NA
Solid	5,620	None[p]	NA	None	NA	Y–12 landfill, offsite to municipal site	Included in Y–12 table
Nonhazardous (Other)							
Liquid	28,000	Neutralization, precipitation, and filtration	1,510,000[q]	None	NA	Offsite	NA
Solid	Included in solid sanitary	None	NA	None	NA	Y–12 landfill and SWSA-6 burial	Included in sanitary

[a] Does not include 9 m^3 of mixed TRU waste.

[b] Stored in various Buildings 7826, 7834, 7842, 7878, 7879, and 7934.

[c] Stored in tanks, bunkers, and earthen trenches (Buildings 7855 and SWSA 5N trenches).

[d] Process Waste Treatment Plant, Melton Valley Low-level Waste Immobilization Facility, and Liquid Low-level Waste Evaporation Facility.

[e] Liquid Low-Level Waste System.

[f] Includes radioactive scrap metal and sludge from Sanitary Waste Treatment Plant.

[g] Waste Compactor Facility (Building 7831). ORNL never used this facility at 11,300 m^3/yr capacity. Current use is much lower because solid LLW is sent offsite.

[h] As of June 30,1994.

[i] Interim Waste Management Facility.

[j] Mixed waste oil projected to be generated in 1994.

[k] Buildings 7654, 7507w, 7823, and Tank 7830g.

[l] Includes PCB and asbestos waste.

[Text deleted.]

[m] The Chemical Detonation Facility treats small amounts of hazardous wastewater that would be dangerous to transport offsite. Explosives such as aged picric acid are detonated in this facility.

[n] Hazardous Waste Storage Facility (Building 7652 Part B permit - 57,200 l and Building 7507 Part A permit - 31,200 l, Building 7651 and Building 7653).

[o] Sanitary Waste Treatment Facility design capacity.

[p] Loaded in boxes and stored at Interim Waste Management Facility.

[q] NPDES discharge limit for ORNL Wastewater Treatment Plant.

Note: NA=not applicable; WIPP=Waste Isolation Pilot Plant.

Source: DOE 1994n; DOE 1995gg; OR DOE 1993a; OR DOE 1993b; OR DOE 1995g; OR MMES 1995c.

Table 3.3.10–3. Waste Management at the K–25 Site

Waste Category	1993 Generation (m^3)	Treatment		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	Capacity (m^3)
Low-Level							
Liquid	6	Incineration	15,700[a]	Stored onsite	Included in solid LLW[b]	None	NA
Solid	1,580[c]	Compaction, incineration, and smelting (offsite)	Offsite	Stored onsite	40,800[d]	None–stored pending availability of offsite disposal or planned onsite LLW disposal facilities	NA
Mixed Low-Level							
Liquid	81,800[e]	Neutralization and incineration	221,000[f]	Stored onsite	96,900[g]	NA	NA
Solid	619[h]	Incineration or offsite by commercial vendor	Offsite[i]	Stored onsite	120,000[j]	Offsite	1,280[k]
Hazardous							
Liquid	Included in liquid mixed low-level[l]	Treated as mixed LLW	Included in liquid mixed LLW	Treated as mixed LLW	Included in mixed LLW	Offsite	NA
Solid	Included in solid mixed low-level	Offsite	Planned	Treated as mixed LLW	Included in solid mixed LLW	Offsite	NA
Nonhazardous (Sanitary)							
Liquid	415,000	Extended aeration	829,000[m]	None	NA	NPDES outfall	NA
Solid	3,210[n]	None	NA	None	NA	Oak Ridge Landfill (offsite)	NA

Table 3.3.10–3. Waste Management at the K–25 Site—Continued

Waste Category	1993 Generation (m^3)	Treatment		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	Capacity (m^3)
Nonhazardous (Other)							
Liquid	71,000[o]	Neutralization, settling and filtration	Included in liquid mixed LLW	None	NA	NPDES outfall	NA
Solid	Included in solid sanitary	None	NA	Stockpiled at scrap yard	Unspecified capacity	Y–12 landfill and metal sold to public	Included in Y–12 table

[a] TSCA Incinerator (K–1435) normal operating capacity. Also treats mixed waste.

[b] Liquid LLW stored in K–1065c Facility, Building K–33, and K–25 Building vaults.

[c] Includes 42 m3 of contaminated scrap metal.

[Text deleted.]

[d] Solid LLW stored in K–25 Building, outside areas, K–1313A, and K–33.

[e] Includes TSCA wastewater density assumption equal to 1 kg/l or 1000 l/m^3.

[f] Central Neutralization Facility permitted operating capacity.

[g] Includes current permitted container (solid/sludges/liquid wastes) and tank (liquids) storage capacity.

[h] Includes contaminated asbestos/beryllium oxide (BeO), RCRA and State-regulated waste, and may include some PCB-tainted waste.

[i] Sludge Fixation Facility may be used after engineering problems are solved.

[j] Total current permitted waste pile unit storage capacity.

[k] Projected waste being sent to commercial vender in 1994.

[l] Hydrogen softener blowdown from the steam plant.

[Text deleted.]

[m] Sewage treatment plant capacity. (Building K–1203)

[n] Includes waste shipped to Y–12 Sanitary Landfill.

[Text deleted.]

[o] Includes nonhazardous Steam Plant wastewater.

Note: NA=not applicable.

Source: DOE 1995gg; OR DOE 1993a; OR MMES 1995c; ORR 1993a:4.

The primary facility generator of liquid mixed waste is the K–1435 TSCA Incinerator from the wet scrubber blowdown. This waste is currently being treated at the central neutralization facility, which provides pH adjustment and chemical precipitation. Treated effluent's are discharged through an NPDES outfall. The contaminated sludges are stored at K–25 as mixed waste.

[Text deleted.] The management of LLW at ORR has been affected by three recent events: declines in ORR disposal capacity, changes in regulatory and operational conditions, and evolution of the radioactive waste disposal-class concept. The previous strategy classified LLW according to its isotopic content, concentration, and the performance of a disposal facility. In some instances, these classifications are used to describe the type of LLW or a disposal technology. For example, L-I refers to low concentration LLW or a landfill disposal facility, while L-II refers to low to moderate concentration LLW or a tumulus disposal facility. A revised classification system has been proposed. Exempt LLW would have contaminant levels sufficiently low to be disposed of in a sanitary or industrial landfill with State concurrence. Disposable LLW would be suitable for disposal at ORR as determined by facility performance assessments. Offsite LLW would be that LLW which would not meet the criteria of exempt or disposable. The long-range strategy is to rely on the combination of onsite and offsite facilities. Plans for a replacement onsite disposal facility will continue to be pursued, with the most likely candidate site for a tumulus disposal facility being Bear Creek Valley. That portion of the LLW that cannot be disposed of onsite consistent with DOE Order 5820.2A, *Radioactive Waste Management*, will be stored until disposal offsite becomes available.

Mixed Low-Level Waste. Both RCRA mixed and radioactive land disposal-restricted wastes (including some nonradiological classified land disposal-restricted waste) are in storage at Y–12, K–25, and ORNL. Because prolonged storage of these wastes exceeded the 1-year limit imposed by RCRA, ORR entered into an FFCA for RCRA Land Disposal Restriction wastes with EPA on June 12, 1992. This agreement recognizes that DOE will continue to generate and store mixed waste subject to disposal restrictions. The agreement was terminated in late 1995 and was replaced by a State Commissioner Order that enforces the regulation of the 1992 *FFCA*.

Sludges contaminated with low-level radioactivity were generated at K–25 by settling and scrubbing operations and in the past were stored in K–1407-B and K–1407-C ponds at K–25. The contaminated sludges have been removed from these ponds and a portion has been fixed in concrete at the K–1419 Sludge Treatment Facility and stored above ground at the K–1417 casting and storage yard. The concreted sludges are being shipped offsite for disposal. The raw sludges are stored in the K–1065 Building pending further treatment. Mixed waste sludges are also generated at Y–12 in the treatment of nitrate waste from purification/recycling of uranium and in the treatment of plating shop waste.

The K–25 TSCA Incinerator has a design capacity to incinerate 909 kg/hr (2,000 lb/hr) of mixed liquid waste and up to 454 kg/hr (1,000 lb/hr) of solids and sludge (91 kg/hr [200 lb/hr] maximum sludge content). Currently, DOE guidance does not allow incineration of solids and/or sludges. Due to permit limits (TSCA, RCRA, State of Tennessee), the incinerator is not running at full capacity. In 1993, approximately 2,309 m^3 (610,000 gallon ([gal]) of mixed liquid waste was incinerated (OR MMES 1995c:7-9).

Uranium-contaminated PCB waste (that is, mixed waste) is being stored in excess of the 1-year limit imposed by TSCA because of the lack of treatment and disposal capacities. DOE and EPA have signed an FFCA, effective February 20, 1992, to bring the facility into compliance with TSCA regulations for use, storage, and disposal of PCBs. It also addressed the approximately 10,000 pieces of nonradioactive PCB-containing dielectric equipment associated with the shutdown of diffusion plant operations.

Hazardous Waste. Both RCRA-regulated and PCB wastes are generated by ORR in laboratory research, electroplating operations, painting operations, descaling, demineralizer regeneration, and photographic processes. Certain other wastes (for example, spent photographic processing solutions) are processed onsite into a nonhazardous state. Those wastes that are safe to transport and have been certified as having no added radioactivity are shipped offsite to RCRA-permitted commercial treatment/

disposal facilities. Small amounts of reactive chemical explosives that would be dangerous to transport offsite, such as aged picric acid, are processed onsite in the Chemical Detonation Facility at ORNL.

Nonhazardous Waste. Nonhazardous wastes are generated from ORR maintenance and utilities. For example, the steam plant produces nonhazardous sludge. Scrap metals are discarded from maintenance and renovation activated and are recycled when appropriate. Construction and demolition projects also produce nonhazardous industrial wastes. All nonradioactive medical wastes are autoclaved to render them noninfectious and are sent to Y–12 Sanitary Landfill. Remedial action projects also produce wastes requiring proper management. The State of Tennessee permitted landfill receives nonhazardous industrial materials such as fly ash and construction debris. Asbestos and general refuse are managed in the industrial and sanitary landfill located at Y–12.

3.4 SAVANNAH RIVER SITE, AIKEN, SOUTH CAROLINA

The SRS facility was established in 1950 as a nuclear materials production site. It occupies approximately 80,130 ha (198,000 acres), approximately 40 km (25 mi) southeast of Augusta, Georgia, and 32 km (20 mi) south of Aiken, South Carolina (SR DOE 1995e:5-11). The current Defense Program mission at SRS is to process tritium and conduct tritium recycling and filling in support of stockpile requirements. The location of SRS and its vicinity is shown in Figure 3.4–1.

The following sections describe the affected environment at SRS for land resources, site infrastructure, air quality and noise, water resources, geology and soils, biotic resources, cultural and paleontological resources, socioeconomics, public and occupational health, and waste management.

3.4.1 LAND RESOURCES

Land Use. The SRS facility is situated within portions of Aiken, Barnwell, and Allendale Counties in southwestern South Carolina. All land within SRS is owned by the Federal Government and is administered, managed, and controlled by DOE. The location of SRS within the South Carolina and Georgia region is illustrated in Figure 3.4–1.

Generalized existing land use at SRS and its vicinity is shown in Figure 3.4.1–1. There are three major categories of land use at SRS: forest/undeveloped, water, and developed facility locations. Forest/undeveloped lands (for example, open fields and pine/hardwood forests) comprise approximately 58,500 ha (144,500 acres) or 73 percent; water (for example, wetlands, streams, and lakes) comprises approximately 17,630 ha (43,500 acres) or 22 percent; and industrial use (for example, production and support areas, roads, and utility corridors) accounts for approximately 4,000 ha (9,900 acres) or 5 percent of the total land area of SRS (WSRC 1995d:7). A forest management program has been in effect at SRS since 1952, when it was formed through an interagency agreement between DOE, then the Atomic Energy Commission, and the U.S. Forest Service (WSRC 1993a:317). The majority of the woodlands area is in revenue producing, managed timber production. Soil map units that meet the soil requirements for prime farmland soils exist on SRS. However, United States Department of Agriculture Natural Resources Conservation Service does not identify these lands as prime farmland due to the nature of site use (SR USDA 1995a:1).

In 1972, DOE designated the entire SRS site as a NERP. The NERP is used by the national scientific community to study the impacts of human activities on the cypress swamp and southeastern pine and hardwood forest ecosystems (DOE 1985a:1).

Recreational opportunities are available at SRS. Three walking trails exist onsite for employee use during work and nonwork hours. SRS hosts the annual Georgia-Carolina Boy Scout Council Fall Camporee. The Crackerneck Wildlife Management Area, which comprises 1,930 ha (4,770 acres) of SRS adjacent to the Savannah River, is open to the public for hunting and fishing. In addition, controlled hunts of deer and feral hogs are offered each fall at SRS, although recreation is not the primary purpose (WSRC 1995d:48). Offsite, the Operations Recreation Association owns and operates an 85-ha (210-acre) recreation complex approximately 8 km (5 mi) northwest of SRS. For the use of SRS employees, contractors, and their families, the complex includes athletic fields, a gun range, and a fishing area.

Land use bordering SRS is primarily forest and agricultural, although there is a substantial amount of open water and nonforested woodland along the Savannah River Valley. Incorporated and industrial areas are the only other significant land uses in the vicinity. Some urban and residential development borders SRS. The closest residences include several structures located to the west, north, and northeast that are within 61 m (200 ft) of the site boundary.

Visual Resources. The SRS landscape is characterized by wetlands and upland hills. The vegetation is composed of bottomland hardwood forests, scrub oak, pine woodlands, and wetland forests. DOE facilities are scattered throughout SRS and are brightly lit at night. The developed areas and utility corridors (that is, transmission lines and aboveground pipelines) of SRS are consistent with VRM Class 5 designation. The remainder of SRS generally ranges from VRM Class 3 to Class 4.

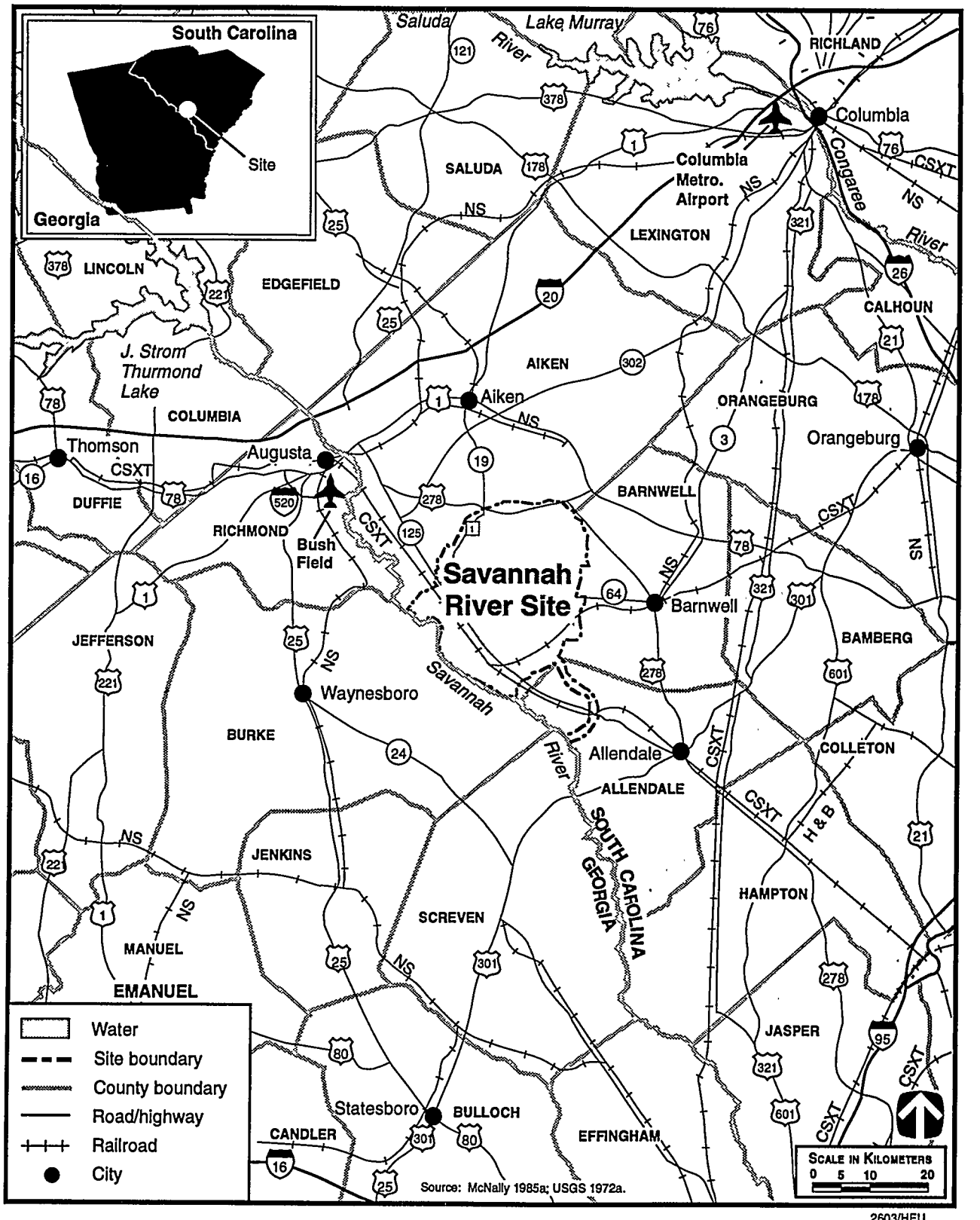


Figure 3.4–1. Savannah River Site, South Carolina, and Region.

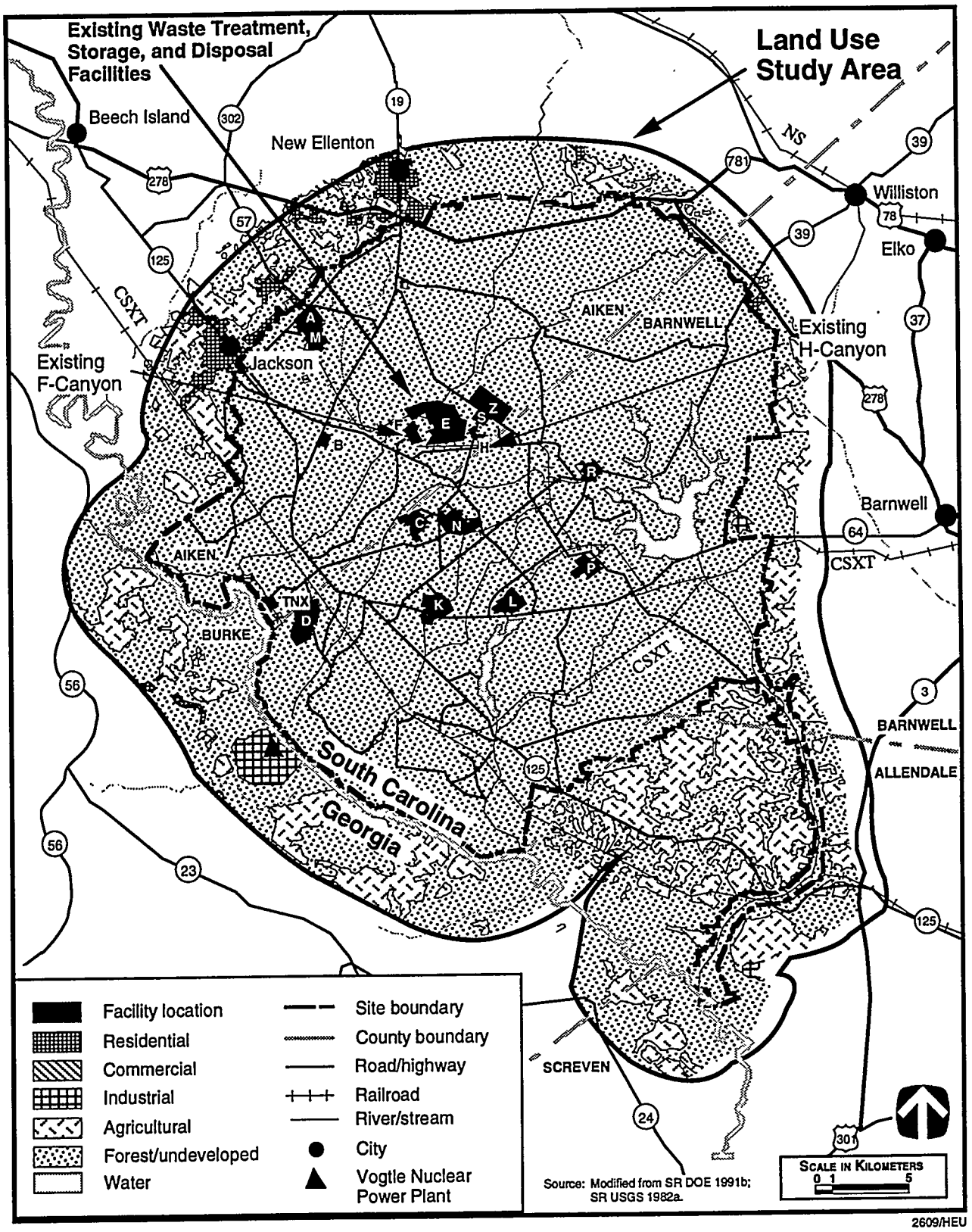


Figure 3.4.1–1. Generalized Land Use at Savannah River Site and Vicinity.

The visual landscape consists mainly of agricultural and heavily forested land, with some limited residential and industrial areas. Views are limited by rolling terrain, normally hazy atmospheric conditions, and dense vegetation. DOE facilities are generally not visible from offsite. The only areas with high-visual sensitivity levels impacted by DOE facilities are the view corridors of SR-125 and SRS Road 1. The few other areas that have views of SRS facilities are distant, 8 km (5 mi) or more, and have low-visual sensitivity levels.

3.4.2 SITE INFRASTRUCTURE

Site Description. The major nuclear facilities at SRS include fuel and target fabrication facilities, nuclear material production reactors, chemical separation plants used for the recovery of Pu and uranium isotopes, a uranium fuel processing area, and the Savannah River Technology Center that provides process support. Tritium recycling facilities at SRS empty tritium from expired reservoirs, purify it to eliminate the helium decay product, and fill replacement reservoirs with specification tritium for nuclear stockpile weapons. Filled reservoirs are delivered to the Pantex Plant in Amarillo, Texas, for weapons assembly or stockpile maintenance as well as directly to the Department of Defense as replacements for expired reservoirs. Historically, DOE has produced tritium at SRS; however, DOE has not produced new tritium since 1988.

Pu and spent nuclear fuel processing at SRS have been terminated. Tritium recycling operations will continue with the replacement tritium facility conducting the majority of these operations. As part of the earlier nonnuclear consolidation, SRS received some of the tritium processing functions formerly performed at the Mound Plant in Miamisburg, Ohio.

The current missions at SRS are shown in Table 3.4.2–1. These activities can be categorized as Defense Programs, Environmental Management, Nuclear Energy, and other activities. Figure 3.4.2–1 depicts primary facilities located in SRS.

Department of Energy Activities. In the past, the SRS complex was operated under the direction of the Assistant Secretary for Defense Programs for the production of nuclear materials. It consisted of five reactors (C-, K-, L-, P-, and R-Reactors) in addition to a fuel and target fabrication plant, two target and spent nuclear fuel chemical separation plants, a tritium-target processing facility, a heavy water rework facility, and waste management facilities. Recently, the K-Reactor, the last operational reactor, was put into cold standby status with no planned provision for restart. This ended all tritium and special isotope production capabilities. SRS is still conducting tritium recycling operations in support of stockpile requirements using retired weapons as the tritium supply source. F- and H-Canyons, large separations facilities that were constructed in the

Table 3.4.2–1. Current Missions at Savannah River Site

Mission	Description	Sponsor
Tritium recycling	Operate H-Area tritium facilities	Assistant Secretary for Defense Programs
Stabilize targets, spent nuclear fuels, and other nuclear materials	Operate F- and H-Canyons	Assistant Secretary for Environmental Management
Waste management	Operate waste processing facilities	Assistant Secretary for Environmental Management
Environmental monitoring and restoration	Operate remediation facilities	Assistant Secretary for Environmental Management
Research and development	Savannah River Technology Center technical support of Defense Programs, Environmental Management, and Nuclear Energy programs	Assistant Secretary for Defense Programs; Assistant Secretary for Environmental Management; Office of Nuclear Energy
Space program support	Provide Pu-238 for space program missions	Office of Nuclear Energy
Other non-DOE missions	Various, as described in text	Various

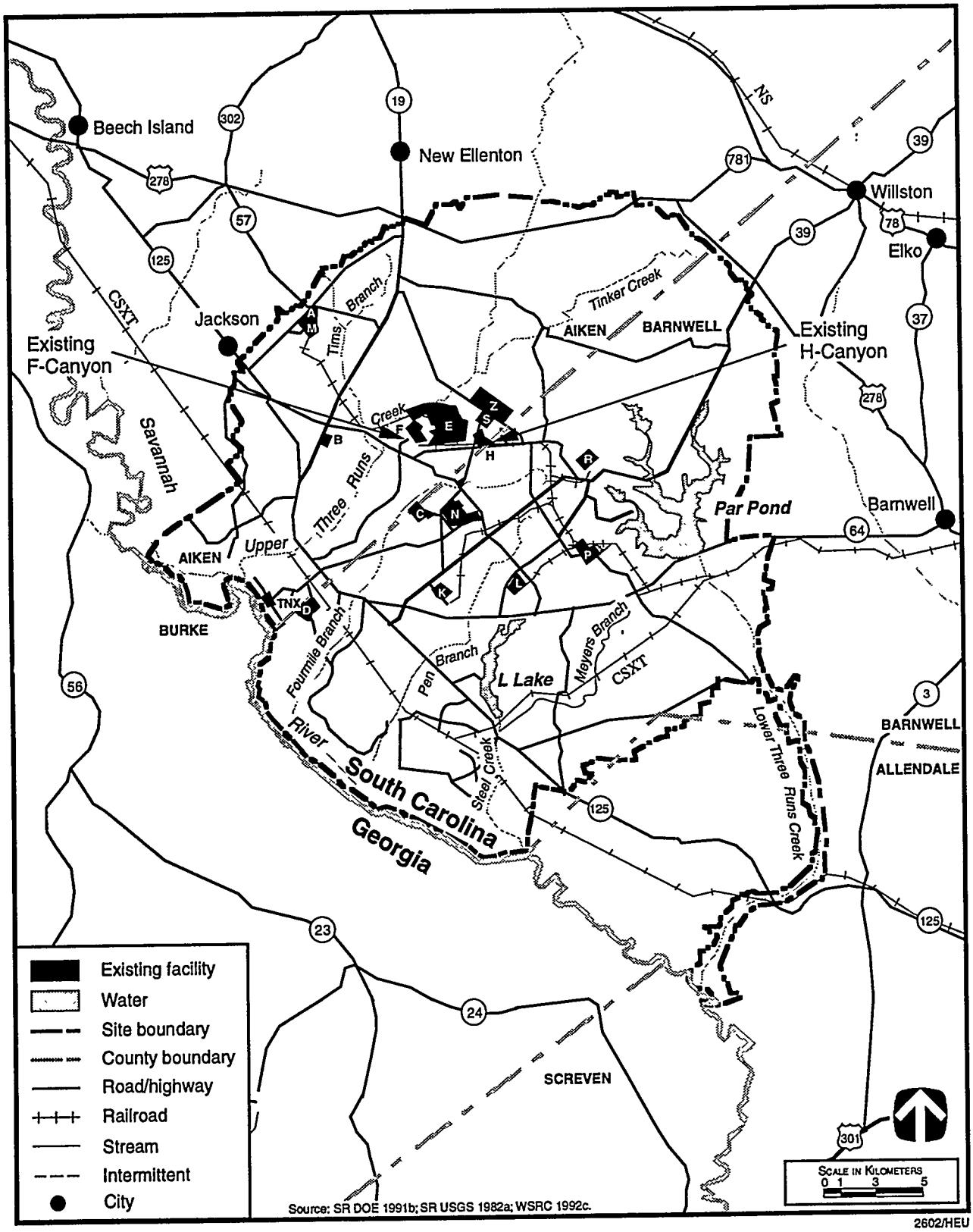


Figure 3.4.2–1. Primary Facilities at Savannah River Site.

early 1950s, are currently shut down pending assessment of their capability of operations for material stabilization and until onsite backlogs of fuel and target elements are processed. Upon completion of material stabilization activities, these facilities will be shutdown permanently. Further deposition of F-Canyon would have to take into account the fact that the structure supports the Pu storage facility and the FB-Line storage vaults.

The Department of Energy's Office of Environmental Management is pursuing a 30-year plan to achieve full compliance with all applicable laws, regulations, and agreements; treat, store, and dispose of existing waste; reduce generation of new wastes; clean up inactive waste sites; remediate contaminated groundwater; and dispose of surplus facilities.

The Savannah River Technology Center provides technical support to all DOE operations at SRS. In this role, it provides process engineering development to reduce costs, waste generation, and radiation exposure. SRS continues to provide Pu-238 required to support space programs and has an expanding mission to transfer unique technologies developed at the site to industry. SRS is also an active participant in the Strategic Environmental Research and Development Program formulated to develop technologies to mitigate environmental hazards at Department of Defense and DOE sites.

Non-Department of Energy Activities. There are several non-DOE facilities and operations at SRS that include the Savannah River Forest Station, the Savannah River Ecology Station, and the Institute of Archaeology and Anthropology. The Savannah River Forest Station is an administrative unit of the U.S. Forest Service, which provides timber management, research support, soil and water protection, wildlife management, secondary roads management, and fire management to DOE. The Savannah River Forest Station manages about 62,300 ha (154,000 acres), which is approximately 80 percent of the site area. It has been responsible for reforestation and manages an active timber business. The Savannah River Forest Station assists with the development and updating of sitewide land use and provides continual support with site layout and vegetative management. It also assists in long-term wildlife management and soil rehabilitation projects.

The Savannah River Ecology Laboratory is operated for DOE by the University of Georgia's Institute of Ecology. It has established a center of ecological field research where faculty, staff, and students perform interdisciplinary field research and provide an understanding of the impact of energy technologies on the ecosystems of the southeastern United States. This information is communicated to the scientific community, Government agencies, and the general public. In addition to Savannah River Ecology Laboratory studies, the Institute of Archaeology and Anthropology is operated by the University of South Carolina to survey the archaeological resources of SRS. This survey is used by DOE when planning new facility additions or modifications and is referred to in the operations management of the site.

Environmental Regulatory Setting. The Department of Energy is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at SRS. DOE is engaged in several activities to bring its operations into full regulatory compliance. A brief description of the environmental regulatory setting at SRS follows.

The State of South Carolina has regulatory authority for air, water, solid waste, hazardous waste, and mixed waste. DOE and the State of South Carolina have signed a Memorandum of Agreement whereby SRS agrees to abide by South Carolina environmental laws the same as any other industry in the State, and also to implement an environmental management plan and report regularly on the progress of that plan.

The EPA placed SRS on the National Priorities List effective December 21, 1989. DOE entered into an FFCA with EPA and the State of South Carolina, effective August 16, 1993, to coordinate CERCLA and RCRA cleanups under one comprehensive strategy. This strategy builds on the ongoing RCRA Facility Investigation Program and governs the corrective/remedial action process from site investigation through site remediation, including schedules for producing work plans and facilitating public involvement in decisionmaking processes.

The FFCA signed by EPA and DOE on March 13, 1991, addresses SRS compliance with the Land Disposal Restrictions of the Hazardous and Solid Waste Amendments of 1984, allowing SRS to

continue to operate, generate, and store mixed wastes. This agreement was amended on April 24, 1992, to include mixed wastes whose treatment standards are outlined in the Land Disposal Restrictions Third Thirds Rule (40 CFR 268.35) and an alternative treatment strategy for M-Area waste. This amended agreement forms the basis for the SRS mixed waste site-specific treatment plan required by the FFCA of 1992.

According to TSCA, PCB wastes are required to be disposed of within 1 year of their initial storage. Due to the radioactive nature of PCB-contaminated equipment and materials, treatment capability for these wastes is not currently available. DOE is developing this treatment capability and working with the State of South Carolina to approve a treatability study to remove the PCB contamination and return the radioactive materials to SRS as LLW.

Pollution Prevention. Pollution prevention, previously driven by best management practices and economics, is now mandated by statutes, regulations, and agency directives. The SRS Waste Minimization and Pollution Prevention Program is designed to achieve continuous reduction of wastes and pollutant releases to the maximum extent feasible and in accordance with regulatory requirements while fulfilling national security missions. The SRS Waste Minimization and Pollution Prevention Awareness Plan addresses wastes and potential pollutants of all types and establishes priorities for accomplishing waste minimization and pollution prevention through source reduction, recycling, treatment, and environmentally safe disposal.

Baseline Characteristics. SRS contains extensive production, service, and research facilities. Not all of these facilities are operational. To support current missions and functions, an extensive infrastructure exists as shown in Table 3.4.2–2.

3.4.3 Air Quality and Noise

The following describes existing air quality, including a review of the meteorology and climatology, in the vicinity of SRS. More detailed discussions of the air quality methodologies, input data, and atmospheric dispersion characteristics are presented in Appendix C, Section C.1.5.

Table 3.4.2–2. Savannah River Site Baseline Characteristics

Current Characteristics	Value
Land	
Area (ha)	80,130
Roads (km)	230
Railroads (km)	103
Electrical	
Energy consumption (MWh/yr)	659,000
Peak load (MWe)	130
Fuel	
Natural gas (m^3/yr)	0
Diesel/oil (l/yr)	28,400,000
Coal (t/yr)	210,000
Steam	
Generation (kg/hr)	85,400
Water Usage (l/yr)	153,687,000,000

Note: MWh=megawatt hour; MWe=megawatt electric.
Source: SRS 1995a:2.

Meteorology and Climatology. The SRS region has a temperate climate with short, mild winters and long, humid summers. Throughout the year, it is frequently affected by warm and moist maritime air masses. The average annual temperature at SRS is 17.3 °C (63.2 °F); average daily temperatures vary from 0 °C (32 °F) in January to 33.2 °C (91.7 °F) in July. The average annual precipitation at SRS is 113 cm (44.5 in). Precipitation is distributed fairly evenly throughout the year, with the highest precipitation in summer and the lowest in autumn. There is no predominant wind direction at SRS. The average annual wind speed is 2.9 m/s (6.5 mph) (NOAA 1994c:3). Additional information related to meteorology and climatology at SRS is presented in Appendix C, Section C.1.5.

Ambient Air Quality. The SRS facility is located near the center of the Augusta-Aiken Interstate AQCR. As of January 1995, all of the areas within SRS and its surrounding counties were designated as attainment areas with respect to NAAQS (40 CFR 81.311, 40 CFR 81.341). Applicable NAAQS and the ambient air quality standards for South Carolina and Georgia are presented in Appendix C, Section C.1.3.

Since the promulgation of the PSD regulations (40 CFR 52.21) in 1977, PSD permits have not been required for any of the new SRS emission sources,

nor modifications required to existing permits. There are no known PSD Class I areas in the vicinity of SRS.

Historically, the primary emission sources of criteria air pollutants at SRS are the nine coal-burning and four fuel oil-burning boilers that produce steam and electricity (A-, D-, H-, K-, and P-Areas), the fuel and target fabrication facilities (M-Area), and processing facilities (F- and H-Areas). Other emissions and sources include fugitive particulates from coal piles and coal processing facilities, vehicles, and temporary emissions from various construction-related activities.

Criteria pollutant concentrations resulting from operations at SRS were estimated based on a 1990 emissions inventory of the site. Table 3.4.3–1 presents the estimated concentrations of criteria pollutants and those regulated by the State of South Carolina along with the applicable standard. The percent of the applicable standard is also presented in the table. The criteria pollutant concentrations are in compliance with applicable guidelines and regulations.

Toxic/hazardous air pollutant standards have been adopted by the State of South Carolina Department of Health and Environmental Control. No ambient standards for toxic/hazardous air pollutants have been proposed or established by the State of Georgia. SRS has emission sources for 139 of the 257 air toxins regulated by the State of South Carolina. Estimates of maximum 24-hour average ground-level concentrations of toxic/hazardous air pollutants that exceed 1 percent of the standard at the SRS boundary are listed in Table 3.4.3–2. These estimated concentrations are in compliance with applicable standards.

Noise Conditions. Major noise emission sources at SRS are primarily located in developed or active areas and include various industrial facilities, equipment, and machines. Noise emitted from the

Table 3.4.3–1. Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at Savannah River Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Concentration at SRS Boundary ($\mu g/m^3$)	Percent of Regulations or Guidelines
Carbon monoxide (CO)	8 hours	10,000[a,b]	22	0.2
	1 hour	40,000[a,b]	171	0.4
Lead (Pb)	Calendar Quarter	1.5[a]	0.0004	0.03
Nitrogen dioxide (NO_2)	Annual	100[a]	5.7	5.7
Particulate matter (PM_{10})	Annual	50[a]	3	6
	24 hours	150[a]	50.6	33.7
Sulfur dioxide (SO_2)	Annual	80[a]	14.5	18.1
	24 hours	365[a,b]	196	53.7
	3 hours	1,300[a,b]	823	63.3
Mandated by South Carolina				
Total suspended particulates (TSP)	Annual	75[c]	12.6	16.8
Gaseous fluorides (as HF)	1 month	0.8[c]	0.09	11.3
	1 week	1.6[c]	0.39	24.4
	24 hours	2.9[c]	1.04	35.9
	12 hours	3.7[c]	1.99	53.8

[a] Federal standard.

[b] Concentrations not to be exceeded more than once a year.

[c] State standard or guideline.

Note: Ozone, as a criteria pollutant, was not evaluated since it is not directly emitted or monitored by the candidates sites.

Source: 40 CFR 50; SC DHEC 1992b; WSRC 1994e.

Table 3.4.3–2. Estimated Concentrations of Toxic/Hazardous Pollutants That Exceed 1 Percent of South Carolina Department of Health and Environmental Control Air Quality Standards From Existing Sources at Savannah River Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Concentration at SRS Boundary ($\mu g/m^3$)	Percent of Regulations or Guidelines
3,3-Dichlorobenzidine	24 hours	0.15	0.002	1.3
Acrolein	24 hours	1.25	0.016	1.3
Benzene	24 hours	150	31.711	21.1
Bis (chloromethyl) Ether	24 hours	0.03	0.002	6.7
Cadmium oxide	24 hours	0.25	0.021	8.4
Chlorine	24 hours	75	7.63	10.2
Chloroform	24 hours	250	4.957	2
Cobalt	24 hours	0.25	0.206	82.4
Formic acid	24 hours	225	2.42	1.1
Manganese	24 hours	25	0.821	3.3
Mercury	24 hours	0.25	0.014	5.6
Nickel	24 hours	0.5	0.271	54.2
Nitric acid	24 hours	125	50.96	40.8
Parathion	24 hours	0.5	0.007	1.4
Phosphoric acid	24 hours	25	0.462	1.9

[Text deleted.]

Source: SC DHEC 1991a; WSRC 1994e.

site is barely distinguishable from background noise levels at the SRS boundary. Major noise emission sources outside of activity areas consist primarily of vehicles and rail operations. These are also the major sources of offsite noise that can be attributed to SRS activities and would have an effect on noise levels along site access highways through the nearby towns of New Ellenton and Jackson.

Traffic from SRS operations is an important contributor to noise levels along site access highways through the nearby towns of New Ellenton, Jackson, and Aiken. Noise measurements recorded during 1989 and 1990 along SR-125 in the town of Jackson at a point about 15 m (50 ft) from the roadway indicate that the 1-hour equivalent sound level from traffic ranged from 48 to 72 dBA. The estimated DNL average along this route was 66 dBA for summer and 69 dBA for winter. Similarly, noise measurements along SR-19 in the town of New Ellenton at a point about 15 m (50 ft) from the roadway indicate that the 1-hour equivalent sound level from traffic ranged from 53 to 71 dBA. The estimated average DNL along this route was 68 dBA for summer and 67 dBA for winter (SR NUS 1990a:C-1–C-4, D-1–D-12).

The States of Georgia and South Carolina and the counties in which SRS is located have not established any noise regulations that specify acceptable community noise levels, with the exception of a provision in the Aiken County Zoning and Development Standards Ordinance that limits daytime and nighttime noise by frequency band. The Aiken County maximum allowable noise levels are presented in Appendix C, Section C.3.2.2.

3.4.4 WATER RESOURCES

Surface Water. The most prominent hydrologic feature at SRS is the Savannah River bordering the site for 32 km (19.9 mi) to the southwest (Figure 3.4.4–1). Six major streams flow through SRS to the Savannah River: Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. Upper Three Runs Creek has two tributaries, Tims Branch and Tinker Creek; Pen Branch has one tributary, Indian Grave Branch; and Steel Creek has one tributary, Myers Branch. Surface waters in the vicinity of F- and H-Areas flow into Upper Three Runs Creek and Fourmile Branch. Shallow groundwater in the vicinity recharges both Upper Three Runs Creek and Fourmile Branch (SR DOE 1995e:3-8).

The SRS facility withdraws surface water from the Savannah River mainly for industrial water cooling purposes. A small quantity is also removed for drinking water supplies. In 1994, 140.4 billion l/yr or 37.1 BGY was supplied from the Savannah River (SRS 1995a:1). Most of the water that is withdrawn is returned to the Savannah River through its onsite tributaries. Streams, especially Fourmile Branch, that received discharges from reactors in the past, are still recovering from scouring or erosion impacts. The average flow of the Savannah River is 282 m^3/s (9,959 ft^3/s). The lowest recorded flow, 152 m^3/s (5,368 ft^3/s), occurred during a drought period from 1985 to 1988 (SR DOE 1990a:3-18). The proposed HEU facility could affect the Fourmile Branch drainage basin, which also receives effluents from C-, F-, and H-Areas; however, Pen Branch also could receive discharges. The minimum flow of Fourmile Branch is 0.16 m^3/s (5.8 ft^3/s).

Average annual treated sanitary discharge volume to the Savannah River is about 2 million l/day (528,000 gallons per day [GPD]), which is about 50 percent of the new centralized sanitary wastewater treatment capacity. Wastewater from the treatment plant is discharged to Fourmile Branch. The F/H Effluent Treatment Facility treats industrial wastewater in F- and H-Areas, where the HEU blending facility will be located. The treated wastewater stream is released to Upper Three Runs Creek. The design capacity of Effluent Treatment Facility is approximately 600 million l/yr (159 MGY); however, the maximum permitted treatment capacity for the Effluent Treatment Facility is about 400 million l/yr (105 MGY). Currently, the Effluent Treatment Facility treats approximately 16 million l/yr (4.22 MGY).

The Savannah River also supplies potable water to several municipalities (SR DOE 1995e:3-8). Upstream from SRS, the Savannah River supplies domestic and industrial water needs to Augusta, Georgia; and North Augusta, South Carolina. The river also receives sewage treatment plant effluent from Augusta, Georgia; North Augusta, Aiken, and Horse Creek Valley, South Carolina; and, as described above, from a variety of SRS operations via onsite stream discharges. Approximately 203 km (126 mi) downstream from SRS, the river supplies domestic and industrial water needs for the Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia, and for Beaufort and Jasper Counties in South Carolina.

There are two man-made water bodies on SRS: L-Lake, which discharges to Steel Creek, and Par Pond, which empties into Lower Three Runs Creek. There are approximately 190 Carolina bays scattered throughout the site. Carolina bays are naturally occurring closed depressions that may hold water. There are no direct discharges to the bays; however, some do receive stormwater runoff.

The proposed HEU blending facility is to be located in either F- or H-Canyon, which is located outside of the 100-year floodplain (see Figure 3.4.4–2). Sitewide information concerning 500-year floodplains at SRS is not available. [Text deleted.]

Surface Water Quality. In the vicinity of SRS, the Savannah River and onsite streams are classified as fresh water suitable for the following: primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the South Carolina Department of Health and Environmental Control; fishing and the survival and propagation of a balanced indigenous and aquatic community of fauna and flora; and industrial and agricultural uses (SC DHEC 1992a:29). Table 3.4.4–1 lists the surface water monitoring results for 1993 for the Savannah River downstream of SRS. No parameters exceeded the South Carolina Water Quality Criteria for the Savannah River. However, iron and manganese do exceed the National Secondary Drinking Water

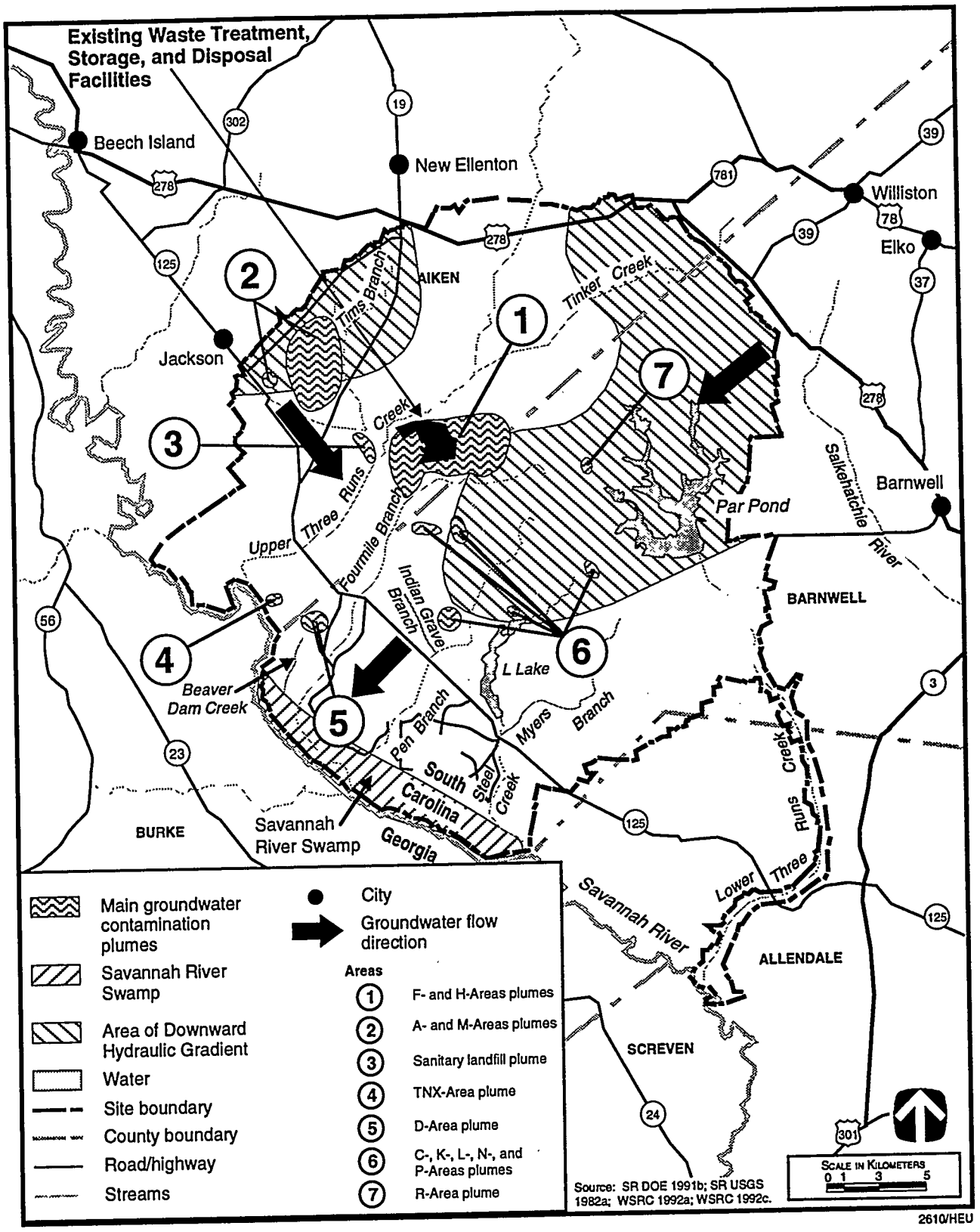


Figure 3.4.4–1. Surface Water Features and Groundwater Contamination Areas at Savannah River Site.

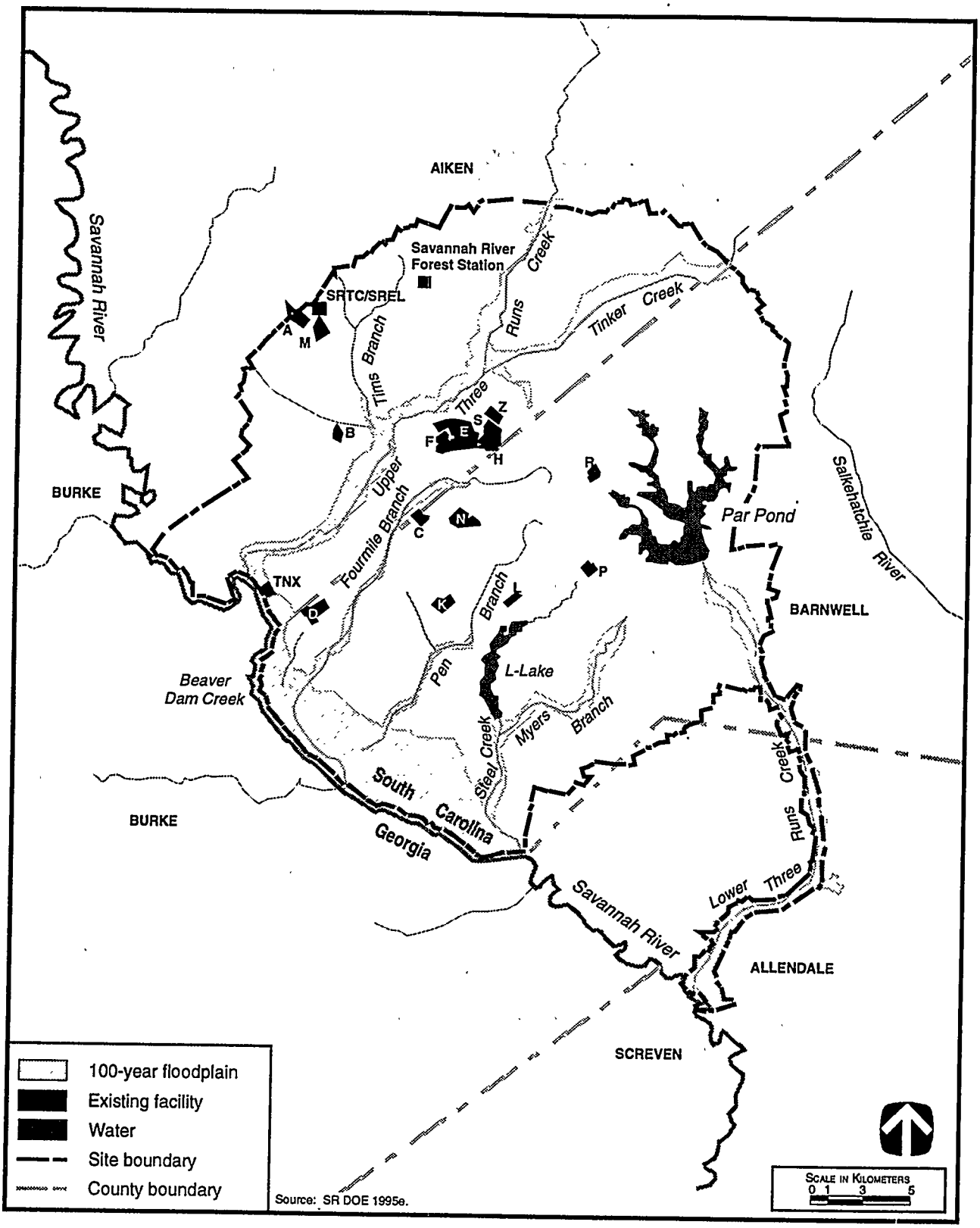


Figure 3.4.4–2. 100-Year Floodplain and Major Stream Systems at Savannah River Site.

Table 3.4.4–1. Summary of Surface Water Quality Monitoring at Savannah River Site

Parameter	Unit of Measure	Water Quality Criteria[a]	Water Body Concentration Receiving Water: Savannah River, 1993	
			High	Low
Alkalinity	mg/l	NA	24	13
Alpha (gross)	pCi/l	15[b]	0.51	-0.2[c]
Aluminum	mg/l	0.05 to 0.2[d]	0.838	0.182
Ammonia nitrogen	mg/l	NA	0.11	0.02
Beta (gross)	pCi/l	50[e]	3.41	0.9
Calcium	mg/l	NA	5.09	3.25
Chemical oxygen demand	mg/l	NA	ND	ND
Chromium	mg/l	0.1[b]	ND	ND
Conductivity	µohms/cm	NA	106	54
Dissolved oxygen	mg/l	>5[f]	10.5	6.2
Iron	mg/l	0.3[d]	1.15	0.516
Lead	mg/l	0.015[d, f]	0.003	ND
Magnesium	mg/l	NA	1.34	1.11
Manganese	mg/l	0.05[d, f]	0.064	0.04
Nitrogen (as NO_2/NO_3)	mg/l	NA	0.31	0.18
pH	pH units	6.5 to 8.5[f]	6.7	6
Phosphate (P)	mg/l	NA	ND	ND
Plutonium-238	pCi/l	1.6[g]	0.001	-0.001[c]
Plutonium-239	pCi/l	1.2[g]	0.001	0.0009
Sodium	mg/l	NA	12.7	5.28
Strontium-89, 90	pCi/l	8[b]	0.24	0.0017
Sulfate	mg/l	250[d]	9	4
Suspended solids	mg/l	NA	16	5
Temperature	°C	32.2[f]	25.7	9.1
Total dissolved solids	mg/l	500[d]	90	49
Tritium	pCi/l	20,000[b]	5,690	-147[c]
Turbidity	turbidity unit	1 to 5[d]	28	3.6
Zinc	mg/l	5[d]	0.012	ND

[a] For comparison only, except for parameters which have South Carolina Water Quality Criteria.

[b] National Primary Drinking Water Regulations (40 CFR 141).

[c] A negative number represents concentration below upstream background values.

[d] National Secondary Drinking Water Regulations (40 CFR 143).

[e] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[f] South Carolina State Water Quality Criteria.

[g] DOE's Derived Concentration Guides for water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective dose equivalent of 100 mrem/yr; however, because the drinking water maximum contaminant level is based on 4 mrem/yr, the number listed is 4 percent of the Derived Concentration Guides.

Note: All nonradiological data from station R-10, downstream of SRS; all radiological data from station R-38 (below Vogtle); NA=not applicable; ND=none detected; mg=milligrams, pCi=picocuries; µohms/cm=microohms per centimeter.

Source: WSRC 1994d; WSRC 1994f.

Regulations. The exceedance would only affect the aesthetics of the water, but would not change any health effects.

In addition to water quality monitoring, SRS conducts monitoring to ensure compliance with NPDES permit limits. SRS has two NPDES permits that cover 81 outfalls as part of the permit requirements and one general stormwater discharge permit that covers 48 outfalls. In 1993, the major releases of radionuclides to surface waters were 12,700 (curies [Ci]) of tritium, 0.477 Ci of strontium-89 and -90, and 0.246 Ci of cesium-137, resulting in less than 2 percent of EPA and DOE standards for public water supplies and less than 0.2 percent of the DOE dose standard from all pathways. Of the 8,000 analyses performed at the industrial outfalls in 1993, 10 exceeded permit limits, 99.9 percent of the analyses were in compliance with the SRS NPDES permit (SR DOE 1995e:3-10). Noncompliances were noted for pH, and total suspended solids with one noncompliance each for oil and grease and biological oxygen demand. In all cases, either corrective actions or an administrative review were taken to prevent future noncompliances (WSRC 1994d:4-75).

Surface Water Rights and Permits. Surface water rights for the Savannah River are determined by the Doctrine of Riparian Rights. Under this doctrine, users of water must not adversely impact quantity or quality of water availability for downstream users.

Groundwater. Several aquifer system naming schemes have been used at SRS. For this document, the most shallow aquifer will be called the water table. The water table is supported by the leaky "green clay" aquitard, which confines the Congaree aquifer. Below the Congaree aquifer is the leaky Ellenton aquitard, which contains the Cretaceous (or also, previously, the Tuscaloosa) aquifer. In general at SRS, groundwater flows slowly toward streams and swamps and into the Savannah River at rates ranging from centimeters to several hundred meters per year. The depth to which the onsite streams cut into the soils controls the horizontal movement of groundwater. The valleys of the smaller perennial streams allow discharge from the shallow saturated geologic formations. The valleys of major tributaries of the Savannah River (that is, Upper Three Runs Creek) drain formations of intermediate depth, and the valley of the Savannah River drains deep formations.

Groundwater flow at some locations on the site (that is, F-, H- and certain sections of K-Areas) is upward from the lower to the upper sediments (Figure 3.4.4–1). In other areas, including A-, M-, L-, and P-Areas, groundwater flow is downward. Horizontal groundwater flow occurs at M-Area (to the west–northwest in the shallow aquifer and subsequent flow to the south toward Upper Three Runs Creek in the intermediate aquifer), K-Area disassembly basin (toward Pen Branch and L-Lake), P-Area disassembly basin (toward Steel Creek), F-Canyon Building (toward Upper Three Runs Creek and Fourmile Branch), and H-Canyon Building (toward Upper Three Runs Creek and its tributaries).

The Cretaceous aquifer is an abundant and important water resource for the SRS region. Some of the local cities (for example, Aiken) also obtain groundwater from the Cretaceous, but most of the rural population in the SRS region gets its water from the Congaree or water table. All groundwater at SRS is classified by EPA as a Class II water source. Depth to groundwater ranges from at or near the ground surface (near streams) to approximately 46 m (150 ft) below the ground surface.

Groundwater Quality. Groundwater data have been obtained from SRS monitoring wells for the past several years. Groundwater quality at SRS ranges from excellent (soft and slightly acidic) to below EPA drinking water standards on several constituents in the vicinity of some waste sites. Industrial solvents, metals, tritium, and other constituents used or generated at SRS have contaminated the shallow aquifers beneath 5 to 10 percent of SRS (SR DOE 1995e:3-10). These aquifers are not used for SRS operations and drinking water; however, they do discharge to site streams and eventually to the Savannah River. Most contaminated groundwater at SRS flows beneath a few facilities; contaminants reflect the operations and chemical processes performed at those facilities. At F- and H-Areas, contaminants in the groundwater include tritium and other radionuclides, metals, nitrates, and chlorinated and volatile organics. Area plumes are shown in Figure 3.4.4–1. At A- and M-Areas, contamination includes chlorinated volatile organics, radionuclides, metals, and nitrates. At the reactors (K-, L-, and P-Areas), tritium, other radionuclides, and lead are in the groundwater (SR DOE 1995e:3-11). At D-Area, contaminants include VOC, chromium, sulfate, and tritium; and at the TNX-Area, volatile organic compounds, lead, nitrate, and uranium are present.

Radioactive constituents (tritium, cesium-137, iodine-131, ruthenium-106, and strontium-89 and -90) above drinking water standards have occurred in F-Area monitoring wells. Studies of flow directions, infiltration rates, and operating history indicate that this contamination is from an isolated incident that occurred more than 35 years ago (SR DOE 1995e:3-11). Groundwater contamination found beneath H-Canyon reflects the widespread use of tritium in H-Area. The tritium is not directly from H-Canyon activities, but rather results from past use of the nearby H-Area seepage basins with subsequent transport beneath the canyon. Results of groundwater quality measurements from two monitoring wells located in the H-Canyon area and comparison with standards or criteria for selected groundwater quality parameters are presented in Table 3.4.4–2.

Groundwater Availability, Use, and Rights. Groundwater is a domestic, municipal, and industrial water source throughout the Upper Coastal Plain. Most municipal and industrial water supplies in Aiken County are from the Cretaceous aquifer. Domestic water supplies are primarily from the Congaree aquifer and the water table. In Barnwell and Allendale Counties, the Congaree aquifer supplies some municipal users. At SRS, most groundwater production is from the Cretaceous aquifer, with a few wells pumping from the Congaree aquifer. Every major operating area at SRS has groundwater wells; total groundwater production from these wells is approximately 13,249 million l/yr (3,500 MGY), which is similar to the volume pumped for industrial and municipal production within 16 km (9.9 mi) of the site (SRS 1995a:1).

Groundwater rights in South Carolina are traditionally associated with the absolute ownership rule. Originating in English common-law doctrine, the owners of land overlying a groundwater resource are allowed to withdraw from their wells all the water they wish for whatever purpose they desire. The water withdrawn can be used for any purpose on or off the owner's land (VDL 1990a:725). However, the *Water Use Reporting and Coordination Act* requires all users of 379,000 l (100,000 gal) or more per day

Table 3.4.4–2. Summary of Groundwater Quality Monitoring at Savannah River Site, 1994

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Characterization Well No. HAA-4B	Characterization Well No. HCA-4C
Alpha (gross)	pCi/l	15[b]	2.1	-0.5[c]
Barium	mg/l	2[b]	0.0397	0.0695
Beta (nonvolatile)	pCi/l	50[d]	0.2	0.7
Chloride	mg/l	250[e]	2.69	1.75
Iron	mg/l	0.3[f]	0.004	0.0057
Lead	mg/l	0.015[b]	0.003	0.003
Manganese	mg/l	0.05[f]	0.002	0.0052
Nitrate	mg/l	10[b]	0.333	0.74
pH	pH units	6.5-8.5[f]	8.1	9.03
Phenols	mg/l	22[d]	0.005	0.005
Sulfate	mg/l	250[f]	2.54	3.08
Total dissolved solids	mg/l	500[f]	132	39
Total organic halogens	mg/l	NA	0.005	0.0072
Total phosphates	mg/l	NA	0.05	0.462
Tritium	pCi/l	20,000[b]	6,300	1,600

[a] For comparison only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] A negative number represents concentrations below upstream background values.
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] South Carolina State Water Quality Criteria.
Note: NA=not applicable; mg=milligrams; pCi=picocuries.
Source: SRS 1995a:11.

(138.3 million l/yr or 36.4 MGY) of water to report their withdrawal rates to the South Carolina Water Resources Commission. SRS groundwater use exceeds this amount, and SRS reports its withdrawal rates to the commission.

3.4.5 GEOLOGY AND SOILS

Geology. The SRS facility lies in the Aiken Plateau portion of the Upper Atlantic Coastal Plain southeast of the Fall Line, a major physiographic and structural feature that separates the Piedmont and the Atlantic Coastal Plain in southeastern South Carolina. The plateau is highly dissected, with narrow, steep-sided valleys separated by broad, flat areas.

In the immediate region of SRS, there are no known capable faults within the definition of 10 CFR 100. Subsurface mapping and seismic surveys suggest the presence of six faults beneath SRS: Pen Branch, Steel Creek, Advanced Tactical Training Area, Crackerneck, Ellenton, and Upper Three Runs Faults. The closest of these to the H-Canyon Area is the Upper Three Runs Fault. The Steel Creek Fault, which passes through L–Area, and the Pen Branch Fault, which passes through K-Area, are the closest faults to the areas that store nuclear materials (SR DOE 1995e:3-4); however, there is no evidence of movement within the last 38 million years along this fault.

Since SRS lies within Seismic Zone 2, moderate damage could occur as a result of earthquakes (Figure 3.3.5–1). Since 1985, only three earthquakes, all less than Richter magnitude 3.2 (Table 3.3.5–1), have occurred within the immediate vicinity of SRS (two within the SRS boundary and one located 16.1 km [10 mi] east of the city of Aiken). None of these earthquakes produced any damage at SRS. Historically, there have been two large earthquakes within 300 km (186 mi) of SRS. The largest of these two, the Charleston earthquake of 1886, had an estimated Richter magnitude of 7.5. The SRS area experienced an estimated peak horizontal acceleration of 0.1 gravity (SR DOE 1995e:3-7). Earthquakes capable of producing structural damage to any buildings are not likely to occur in the vicinity of SRS because SRS design basis for earthquakes is 0.2 gravity, which is twice as much as the historical earthquake horizontal acceleration (SR DOE 1995e:3-4). There is no volcanic hazard at SRS. The area has not experienced volcanism within the last 230 million years.

Soils. The soils at the HEU facility are mainly sands and sandy loams. The somewhat excessively drained soils have a thick, sandy surface layer that extends to a depth of 203 cm (80 in) or more in some areas. Many of the soils are subject to slight to moderate water and wind erosion, flooding, ponding, and cutbank caving (SR USDA 1990a:17-25). Several soil units that cover approximately 17 percent of the SRS plant property have been designated as prime farmland. All the soils have low shrink-swell potential and have slight water and wind erosion. The H–Canyon area lies on the upland soils of Fuquay-Blanton-Dothan Soil Association. This soil unit has been designated as prime farmland, but the area is not presently under cultivation. The soils at SRS are considered acceptable for standard construction techniques.

3.4.6 BIOTIC RESOURCES

Biotic resources at SRS include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each biotic resource area, the discussion focuses first on SRS as a whole and then on the area of the proposed activities. Scientific names of species identified in the text are presented in Appendix D.

Terrestrial Resources. Most of SRS has remained undeveloped since it was established in 1950. Only about 5 percent of the site is occupied by DOE facilities. Five major plant communities have been identified at SRS. Of these, the largest is the loblolly, longleaf, and slash pine community that covers approximately 65 percent of SRS. This community type, as well as the upland hardwood and scrub oak community, occurs primarily in upland areas. Swamp forests and bottomland hardwood forests are found along the Savannah River and the numerous streams that traverse SRS. More than 1,300 species and varieties of vascular plants have been identified on the site (DOE 1992e:4-126; DOE 1995p:4-47).

Because of the variety of plant communities on the site, as well as the region's mild climate, SRS supports a diverse and abundant wildlife including 54 mammal species, 213 bird species, 58 reptile species, and 43 amphibian species. Common species at SRS include the slimy salamander, eastern box turtle, Carolina chickadee, common crow, eastern cottontail, and gray fox (DOE 1992e:4-128; WSRC 1993b:3-5, 3-39). A number of game animals are found on SRS; however, only the whitetail deer and

feral hog are hunted onsite (DOE 1992e:4-128). Raptors, such as Cooper's hawk and black vulture, and carnivores, such as the gray fox and raccoon, are ecologically important groups on SRS. A variety of migratory birds have been found at SRS. Migratory birds, their nests, and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Wetlands. The SRS facility has extensive, widely distributed wetlands, comprising approximately 19,800 ha (49,000 acres). Most are associated with floodplains, streams, and impoundments. Wetlands on the site may be divided into the following categories: bottomland hardwoods, cypress-tupelo, scrub-shrub, emergent, and open water. The most extensive wetland type on SRS is swamp forest associated with the Savannah River floodplain. Approximately 3,800 ha (9,400 acres) of these wetlands are found on SRS. Past releases of cooling water effluent into site streams and the Savannah River swamp have resulted in shifts in plant community composition. Changes have included replacement of bald cypress by scrub-shrub and emergent vegetation in the swamp and reduction in bottomland forests along streams (DOE 1992e:4-130; WSRC 1989e:3-4).

Carolina bays, a type of wetland unique to the southeastern United States, are also found on SRS. Approximately 190 Carolina bays have been identified at SRS. These shallow depressions occur on interstream areas of SRS and range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or swamp forests (SR NERP 1989a:9).

Aquatic Resources. Aquatic habitat on SRS includes artificial ponds, Carolina bays, reservoirs, and the Savannah River and its tributaries. There are more than 50 artificial impoundments located throughout the site that mainly support populations of bass and sunfish (SRS 1992a:8). Fewer than 10 percent of the Carolina bays on SRS have permanent fish populations. Species present in these bays include redfin pickerel, mud sunfish, lake chubsucker, and mosquitofish (SR NERP 1983a:15; SR NERP 1989a:37). Par Pond and L-Lake support similar fish populations including largemouth bass, black crappie, and various species of pan fish (SRS 1992a:8). Recreational fishing is not allowed on SRS. The Savannah River is used for both commercial and sport fishing. Important commercial species are American shad, hickory shad, and striped bass; all are anadromous. The most important warm-water game fish species of the Savannah River are bass, pickerel, crappie, bream, and catfish. In the past, water intake structures for C- and K-Reactors and the D-Area powerhouse caused annual estimated entrainment of approximately 10 percent of the fish eggs and larvae passing the intake canals during the spawning season. In addition, estimated impingement losses were approximately 7,600 fish per year (SR DOE 1987b:3-31, C-61).

Threatened and Endangered Species. Sixty-one Federal- and State-listed threatened, endangered, and other special status species have been identified on and in the vicinity of SRS (Appendix D, Table D.1–3). The appendix indicates that 57 of these species have records of occurrence on SRS. Twelve of these are Federal- and/or State-listed threatened or endangered species. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on SRS. The smooth coneflower is the only listed endangered plant species found on SRS. Two colonies exist on SRS, but suitable habitat for this species occurs throughout the site. Bald eagles nest near Par Pond and L-Lake and forage on these reservoirs. Wood storks forage in the Savannah River swamp and the lower reaches of Steel Creek, Pen Branch, Beaver Creek Dam, and Fourmile Branch. Red-cockaded woodpeckers inhabit open pine forests with mature trees (older than 70 years for nesting and 30 years for foraging). Peregrine falcons have been reported in the past as rare winter visitors on SRS. The American alligator is a common inhabitant of Par Pond, Beaver Dam Creek, and the Savannah River swamp. The shortnose sturgeon spawns in the Savannah River both up and downstream of SRS. This fish has not been collected in the tributaries of the Savannah River that drain SRS (SR DOE 1995b:3-44). The State-listed Rafinesque's big-eared bat and Appalachian Bewick's wren occur on SRS. [Text deleted.]

F- and H-Areas contain no habitat for any of the Federal-listed threatened or endangered species found on SRS. Red-cockaded woodpeckers nest in old growth pine trees, and there are no suitable nesting sites in the vicinity of F- or H-Area. Smooth coneflower also is not found in F- or H-Area. The

Southern bald eagle and the wood stork feed and nest near wetlands, streams, and reservoirs, and thus would not be attracted to the highly disturbed F- or H-Area. Shortnose sturgeon, typically residents of large coastal rivers and estuaries, have never been collected in Fourmile Branch or any of the tributaries of the Savannah River that drains SRS (DOE 1995p:4-51).

3.4.7 CULTURAL RESOURCES

Prehistoric Resources. Prehistoric site types on SRS consist of villages, base camps, limited-activity sites, quarries, and workshops. An extensive archaeological survey program began at SRS in 1974 and includes numerous field studies such as reconnaissance surveys, shovel test transects, and intensive site testing and excavation. More than 60 percent of SRS has received some level of cultural resource evaluation. Over 1,000 sites have been identified at SRS. Of these, over 800 prehistoric sites or sites with prehistoric components have been identified; however, fewer than 8 percent have been evaluated for eligibility to the NRHP. To date, 67 prehistoric and historic sites are considered potentially eligible for listing on the NRHP. Cultural resources surveys have been conducted within F- and H-Areas, and some prehistoric material has been found a few miles from H-Canyon. Some prehistoric sites that may be NRHP-eligible have been identified within F- and H-Areas. Most of H-Area has been disturbed through grading and construction. No NRHP sites are within the facility.

A Programmatic Agreement was signed by the DOE Savannah River Operations Office, the South Carolina State Historic Preservation Officer, and the Advisory Council on Historic Preservation on August 24, 1990. Its purpose is to ensure that appropriate measures are taken to inventory, evaluate, protect, and enhance archaeological sites on SRS. In addition, an Archaeological Resource Management Plan for SRS is in place.

Historic Resources. Types of historic sites include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, dams, cattle pens, ferry locations, towns, churches, schools, cemeteries, and commercial building locations. Approximately 400 historic sites or sites with historic components have been identified within SRS; approximately 10 percent have been evaluated for NRHP nomination.

Most historic structures were demolished during the initial establishment of SRS in 1951. Two 1951 buildings are currently in use. [Text deleted.]

Native American Resources. Native American groups with traditional ties to the area include the Apalachee, Cherokee, Chickasaw, Creek, Shawnee, Westo, and Yuchi. At different times, each of these groups was encouraged by the English to settle in the area to provide protection from the French, Spanish, or other Native American groups. Main villages of both the Cherokee and Creek groups were located southwest and northwest of SRS, and both groups may have used the area for hunting and gathering activities. During the 1830s, most of the remaining Native Americans residing in the region were relocated to the Oklahoma Territory as part of the Trail of Tears.

Native American resources in the region include remains of villages or townsites, ceremonial lodges, burials, cemeteries, and areas containing traditional plants used for religious ceremonies. Literature reviews and consultations with Native American representatives reveal that there are some concerns related to the *American Indian Religious Freedom Act* within the central Savannah River Valley; however, no specific sites at SRS have been identified. The Yuchi Tribal Organization, the National Council of the Muskogee Creek, the Indian People's Muskogee Tribal Town Confederacy, the Pee Dee Indian Association, the Ma Chis Lower Alabama Creek Indian Tribe, and the United Keetoowah Band of the Cherokees have expressed concerns for sensitive Native American resources at SRS. The Yuchi and the Muskogee Creek expressed concern for areas containing several plants traditionally used in ceremonies (SR DOE 1991e:19,21).

Paleontological Resources. Paleontological materials at SRS include fossil plants, numerous invertebrate fossils, deposits of giant oysters (*Crassostrea gigantissima*), mollusks, and bryozoa. All paleontological materials from SRS are marine invertebrate deposits and, with the exception of the giant oysters, are relatively common fossils and are widespread; therefore, the assemblages have relatively low research potential.

3.4.8 SOCIOECONOMICS

Socioeconomic characteristics described for SRS include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 15 counties around SRS in the States of South Carolina and Georgia (Appendix F, Table F.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a six-county area in which 90.1 percent of all SRS employees reside. These counties include Aiken County (51.9 percent), Allendale County (1.1 percent), Bamberg County (1.7 percent), and Barnwell County (7.3 percent) in the State of South Carolina; and Columbia County (10.6 percent) and Richmond County (17.5 percent) in the State of Georgia (Appendix F, Table F.1–3). Supporting data are presented in Appendix F.

Regional Economy Characteristics. Between 1980 and 1990, the civilian labor force in the REA increased 21.4 percent to the 1990 level of 248,239. In 1994, unemployment in the REA was 6.7 percent, which was approximately 0.4 and 1.5 percent higher than South Carolina and Georgia, respectively. The region's per capita income of $17,212 in 1993 was approximately 2.1 percent greater than South Carolina's per capita income of $16,861 and 10.6 percent lower than Georgia's per capita income of $19,249. Employment and regional economy statistics and projections for the proposed action period for the SRS REA are given in Appendix F, Table F.1–7 and summarized in Figure 3.4.8–1.

In 1993, as shown in Figure 3.4.8–1, the percentage of total employment involving the private sector activity of retail trade was similar in the REA (16 percent) and the two States. Service sector employment in the region (22 percent of total employment) represented a 3 percent smaller share of the regional economy than in the economy of Georgia and was similar to that of South Carolina. The manufacturing sector's share of the economy was similar in the REA (21 percent) and South Carolina (20 percent), but represented a 6 percent larger share of the economy than in Georgia (15 percent).

[Text deleted.]

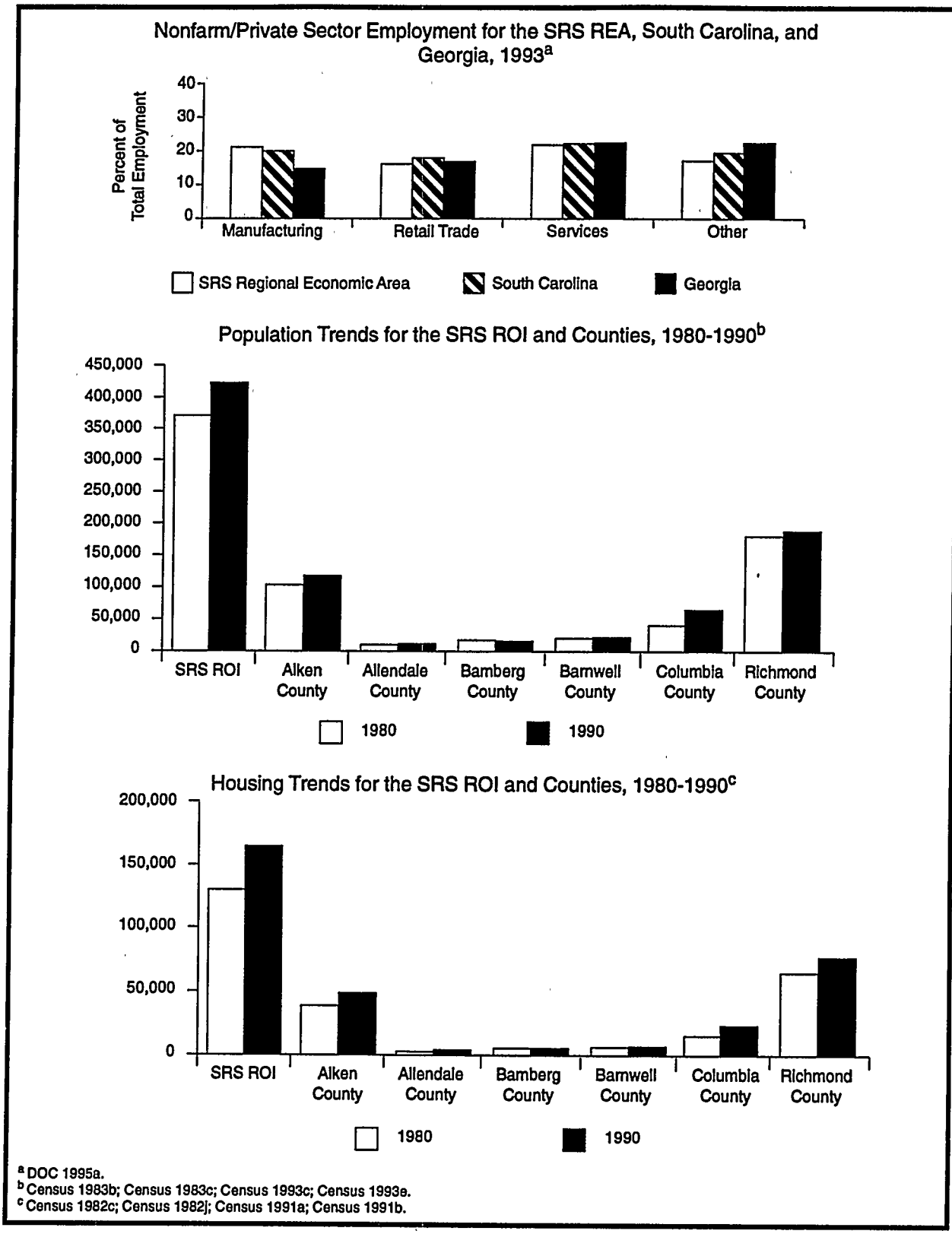
Population and Housing. In 1992, the ROI population totaled 453,824. From 1980 to 1990, the ROI population increased by 13.2 percent, compared to 18.6 percent for Georgia and 11.7 percent for South Carolina. Within the ROI, Columbia County experienced the largest increase at 65 percent, while Bamberg County's population decreased by 6.7 percent. Population trends are summarized in Figure 3.4.8–1. [Text deleted.]

The number of housing units in the ROI increased by 23.8 percent between 1980 and 1990, totaling 168,803 units in the latter year. The percent increase was comparable to South Carolina but 6 percent smaller than in Georgia. The 1990 homeowner vacancy rate in the ROI, 2.2 percent, was similar to those experienced by South Carolina and Georgia. The rental vacancy rate for the ROI counties, nearly 10 percent, was approximately 2 percent less than the rental vacancy rates for both states. (A full presentation of population and housing statistics and projections is provided in Appendix F, Tables F.1–11 and F.1–15, respectively.)

Community Services. Education, public safety, and health care characteristics will be used to assess the level of community service in the SRS ROI. Figure 3.4.8–2 presents school district characteristics for the SRS ROI. Figure 3.4.8–3 presents public safety and health care characteristics.

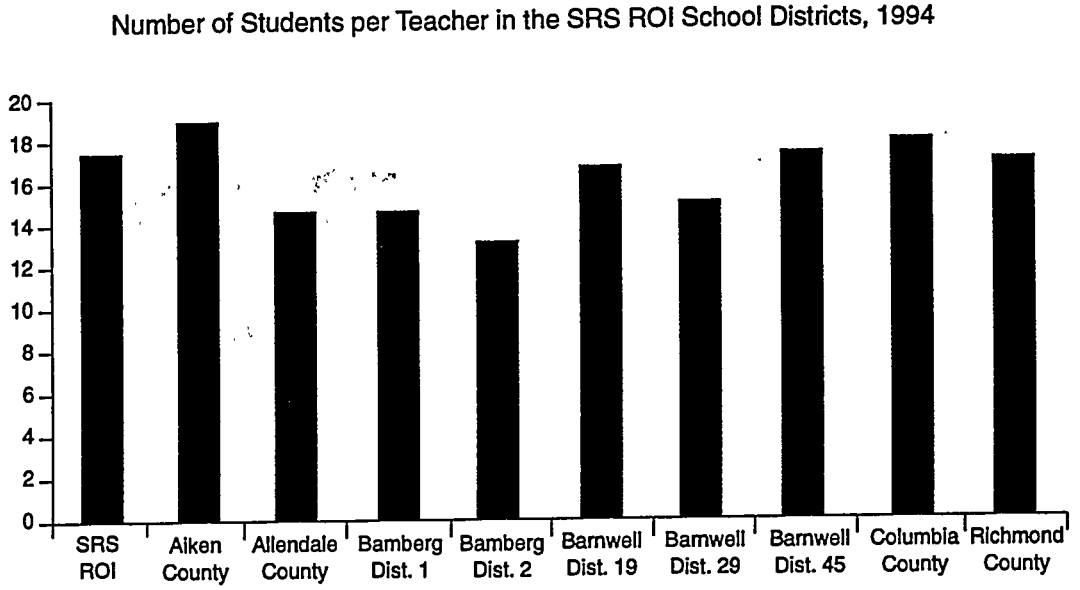
Education. In 1994, nine school districts provided public education services and facilities in the SRS ROI. As shown in Figure 3.4.8–2, these school districts ranged in enrollment size from 1,017 students in District 29 (located in Barnwell County) to 34,907 students in the Richmond County School District. The average students-to-teacher ratio for the ROI was 17.5:1. The Aiken County School District had the highest ratio at 19:1.

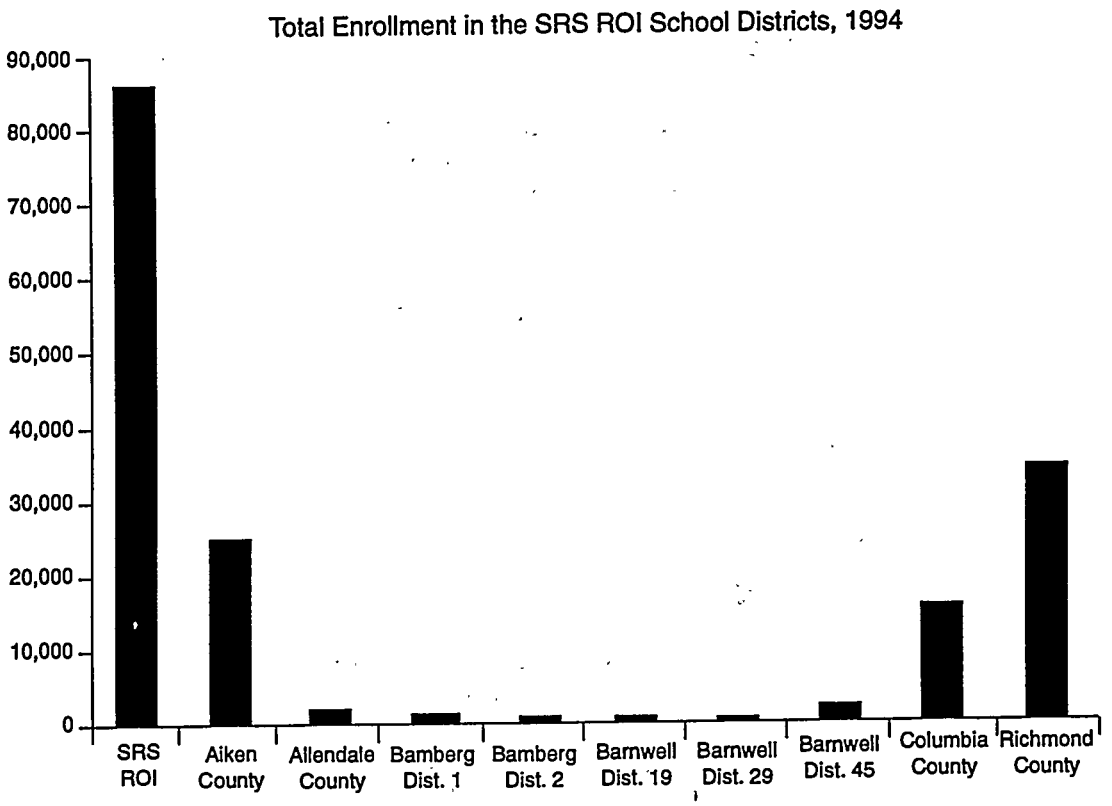
Public Safety. City, county, and State law enforcement agencies provided police protection to the residents in the ROI. In 1993, a total of 924 sworn police officers served the six-county ROI. Richmond County employed the greatest number of sworn police officers (323), while the cities of Aiken and Augusta had the highest police officers-to-population ratios (3.7 officers per 1,000 persons). The average ROI sworn police officers-to-population ratio was 2



[a] DOC 1995a.
[b] Census 1983b; Census 1983c; Census 1993c; Census 1993e.
[c] Census 1982c; Census 1982j; Census 1991a; Census 1991b.

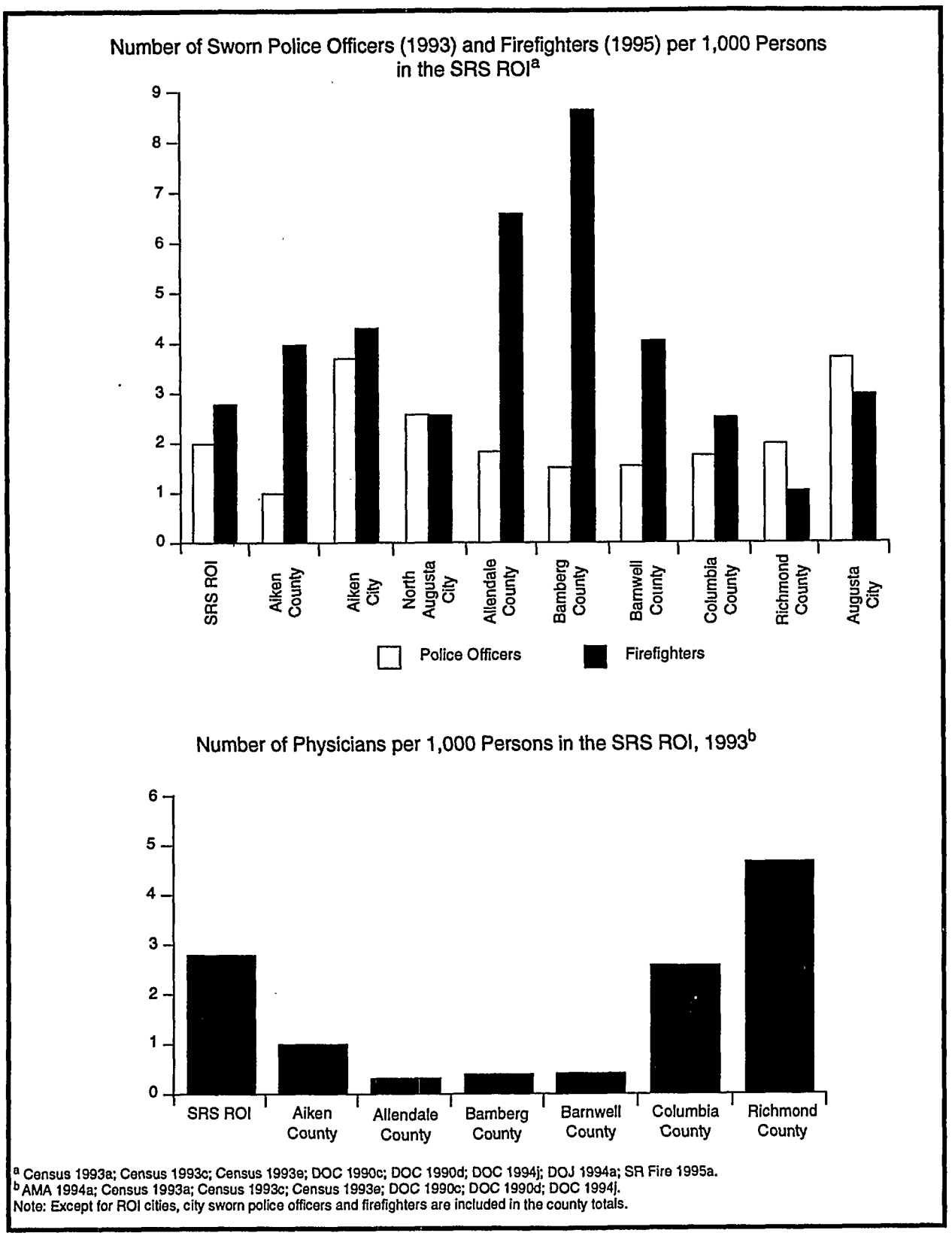
Figure 3.4.8–1. Economy, Population, and Housing for the Savannah River Site Regional Economic Area and Region of Influence.





Source: SR School 1995a.

Figure 3.4.8–2. School District Characteristics for the Savannah River Site Region of Influence.



[a] Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j; DOJ 1994a; SR Fire 1995a.
[b] AMA 1994a; Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j.
Note: Except for ROI cities, city sworn police officers and firefighters are included in the county totals.

Figure 3.4.8–3. Public Safety and Health Care Characteristics for the Savannah River Site Region of Influence.

officers per 1,000 persons. Figure 3.4.8–3 compares police force strengths across the ROI.

Fire protection services in the SRS ROI were provided by 1,363 regular and volunteer firefighters in 1995. The fire department with the highest firefighters-to-population ratio is located in Bamberg County (8.7 firefighters per 1,000 persons) as indicated in Figure 3.4.8–3. Aiken County had the greatest number of active firefighters (375). The average firefighters-to-population ratio in the ROI was 2.9 per 1,000 persons.

Health Care. There were eight hospitals serving the six-county ROI in 1993. All eight hospitals were operating at below capacity, with hospital occupancy rates ranging from 29.4 percent in Allendale County to 64.8 percent in Richmond County.

In 1993, a total of 1,325 physicians served the ROI with the majority (979) located in Richmond County. Figure 3.4.8–3 shows that the physicians-to-population ratio ranged from 0.3 physicians per 1,000 persons in Allendale County to 4.8 physicians per 1,000 persons in Richmond County. The average ROI physicians-to-population ratio was 2.9 physicians per 1,000 persons.

Local Transportation. U.S. and State Routes provide access between SRS and metropolitan areas as illustrated in Figure 3.4–1. SR-19, north of the site, provides access to New Ellenton and Aiken, South Carolina. West of the site, SR-125 provides access to Augusta. U.S. 278, located northwest of the site, provides access to the East Coast and Augusta.

Several routes provide direct access to SRS. From the northwest and north, access is provided by SR-125 and SR-19, respectively. Both highways are open to through traffic. From the northeast, SR-39 and SR-781 pass inside the SRS boundary. Access from the east is by SR-64 and from the southeast by SR-125. Public access is provided by U.S. 278, SR-125, and SR-19, but only SRS employees are permitted access to the site on the other routes. There are no road improvement projects under construction or planned in the near future in Barnwell and Aiken Counties that would affect SRS access (SC DOT 1995a:1). There is no local public transportation directly serving SRS. Rail service in the ROI is provided by NS and CSX Transportation. SRS has provided rail access via Robbins Station on the CSX Transportation line. In addition, SRS maintains 103 km (64 mi) of onsite track for internal uses. Waterborne transportation is available via the Savannah River. Currently, the Savannah River is used primarily for recreation (SRS 1995a:12). Columbia Metropolitan Airport, in the city of Columbia, and Bush Field, in the city of Augusta, receive jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located in the ROI (DOT 1992a).

3.4.9 PUBLIC AND OCCUPATIONAL HEALTH

Radiation Environment. All residents in the vicinity of SRS are exposed to background radiation from a variety of natural and man-made sources. The major sources of background radiation exposure to individuals in the vicinity of SRS are shown in Table 3.4.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population.

Table 3.4.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Savannah River Site Operations

Source	Committed Effective Dose Equivalent (mrem/yr)[a]
Natural Background Radiation	
Cosmic radiation	29
External terrestrial radiation	29
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	363

[a] NCRP 1987a; WSRC 1994d. Value for radon is an average for the United States.

Releases of radionuclides to the environment from SRS operations provide another source of radiation

exposure to individuals in the vicinity of SRS. The radionuclides and quantities released from SRS operations in 1993 are listed in the *Savannah River Site Environmental Report for 1993* (WSRC-TR-94-075).

The releases listed in the 1993 report were used in the development of the reference environment's radiological releases at SRS for the public and occupational health segments within Section 4.3. The doses to the public resulting from these releases fall within radiological limits and are small in comparison to background radiation (DOE Order 5400.5). Table 3.4.9–2 presents the doses to the public resulting from releases at SRS.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Appendix E), the fatal cancer risk to the MEI of the public due to radiological releases from SRS operations in 1993 is estimated to be approximately 1.6×10^{-7}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of SRS operations is less than 2 chances in 10 million. (It may take several years from the time of exposure to radiation for cancer to manifest.)

Based on the same risk estimator, 1.1×10^{-2} excess fatal cancers were estimated from normal operations in 1993 to the population living within 80 km (50 mi) of SRS. This number can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national mortality rate, the number of fatal cancers from all causes expected during 1993 in the population living within 80 km (50 mi) of SRS was 1,240. This number of expected fatal cancers is much higher than the estimated 1.1×10^{-2} fatal cancers that could result from SRS operations in 1993.

Workers at SRS receive the same dose as the general public from background radiation, but receive an additional dose from working in the facilities. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Appendix E), the number of excess fatal cancers to SRS workers from operations in 1992 is estimated to be 0.14. Table 3.4.9–3 includes the average, maximum, and total occupational doses to SRS workers from operations in 1993.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Savannah River Site Environmental Report for 1993* (WSRC-TR-94-075). The concentrations of radioactivity in various environmental media (for

Table 3.4.9–2. Doses to the General Public From Normal Operations at Savannah River Site, 1993 (committed effective dose equivalent)

Receptor	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual[b]	Standard[a]	Actual[c]	Standard[a]	Actual
Maximally exposed individual (mrem)	10	0.18	4	0.14	100	0.32
Population within 80 km[d] (person-rem)	None	20	None	1.5	100	21.5
Average individual within 80 km[e] (mrem)	None	3.2×10^{-2}	None	2.4×10^{-3}	None	3.5×10^{-2}

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[b] WSRC 1994d.

[c] The actual dose value given in the column under liquid releases conservatively includes all water pathways, not just the drinking water pathway. The population dose includes contributions to Savannah River users downstream of SRS to the Atlantic Ocean.

[d] In 1993, this population was approximately 620,100.

[e] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Table 3.4.9–3. Doses to the Onsite Worker From Normal Operations at Savannah River Site, 1993 (committed effective dose equivalent)

Receptor	Onsite Releases and Direct Radiation	
	Standard[a]	Actual[b]
Average worker (mrem)	None	17.9
Maximally exposed worker (mrem)	5,000	3,000
Total workers (person-rem)	None	350

[a] 10 CFR 835. DOE's goal is to maintain radiological exposures ALARA.

[b] DOE 1993n:7. The number of badged workers in 1992 was approximately 19,500.

example, air, water, soil) in the site region (onsite and offsite) are also presented in this reference.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in Sections 3.4.3 and 3.4.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (for example, air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at SRS via inhalation of air containing pollutants released to the atmosphere by SRS operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in Section 3.4.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Appendix E, Section E.3.4.

Health impacts to SRS workers during normal operation may include those from inhalation of the workplace atmosphere, drinking SRS potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to accurately summarize these impacts; however, the workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. SRS workers are also protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*) ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm; therefore, worker health conditions at SRS are expected to be substantially better than required by the standards.

Health Effects Studies. Two epidemiologic studies on the general population in communities within 80 km (50 mi) of SRS resulted in three publications (ED 1982a:135-152; JAMA 1991a:1403-1407; NIH Publication 90-874, July 1990). One study (JAMA 1991a; 1403-1407; NIH Publication 90-874) found no evidence of excess cancer mortality; whereas, the other study (ED 1982a:135-152) reported an excess in leukemia and lung cancer deaths along with other statistically nonsignificant excess deaths.

An excess in leukemia deaths has been reported among hourly workers at SRS. A more detailed description of the studies and findings reviewed is included in Appendix E, Section E.4.3.

Accident History. From 1974 through 1988, there were 13 inadvertent tritium releases from the tritium facilities at SRS. These releases have been traced to

aging equipment in the tritium processing facility and are one of the reasons contributing to the construction of a replacement tritium facility at SRS. Detailed descriptions and studies of these incidents and their consequences to the offsite population have been documented by SRS. The most significant occurred in 1981, 1984, and 1985, when 32,934, 43,800, and 19,403 Ci, respectively, of tritiated water vapor were released (WSRC 1991a:41). In the period from 1989 through 1992, there were 20 inadvertent releases, all with little or no offsite dose consequences. The largest of these recent releases occurred in 1992 when 12,000 Ci of tritium were released (WSRC 1993a:11-260).

Emergency Preparedness. Each DOE site has established an emergency management program. These programs have been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management programs incorporate activities associated with emergency planning, preparedness, and response.

The emergency preparedness facility at SRS provides overall direction and control for onsite responses to emergencies and coordinates with Federal, State, and local agencies and officials on the technical aspects of the emergency.

The SRS emergency operations facility consists of several centers, described below, that provide distinct emergency response support functions.

- The SRS operations center coordinates the initial response to all SRS emergencies and is equipped to function as the heart of SRS's emergency response communications network.
- The technical support center provides command and control of emergency response activities for the affected facility or operational area.
- The emergency operations center provides command and control of emergency response activities for SRS locations outside of the affected area.
- The security management center coordinates activities relating to the security and safeguarding of materials by providing security staff in the affected area and contractor management in the emergency operations center.
- The dose assessment center is responsible for assessing the health and environmental consequences of any airborne or aqueous releases of radioactivity or toxic chemicals and recommends onsite and offsite protective actions to other centers.

3.4.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory and ongoing waste management activities for SRS. DOE is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at SRS. DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed upon milestones. These agreements have been reviewed to ensure that proposed actions are allowable under the terms of the agreement.

The EPA has placed SRS on the National Priorities List and has identified approximately 150 potential operable units. In accordance with CERCLA, DOE entered into an FFCA with EPA and the State on January 15, 1993, to coordinate cleanup activities at SRS under one comprehensive strategy. The FFCA combines the RCRA Facility Investigation Program Plan with a CERCLA cleanup program entitled *RCRA Facility Investigation Remedial Investigation Program Plan.*

[Text deleted.] SRS has a waste minimization program that is improving the liquid and solid waste generation, treatment, and storage practices. A disciplined approach to these activities is being developed based on technology and experience from the commercial nuclear industry. This approach has reduced the generation of TRU waste (48 percent), LLW (13 percent), mixed waste (96 percent), and

hazardous waste (58 percent) (DOE 1993e:I-18). Table 3.4.10–1 presents a summary of waste management at SRS for 1993. A discussion of the waste management activities at SRS follows. SRS manages the following waste categories: high-level, TRU, low-level, mixed, hazardous, and nonhazardous.

High-Level Waste. Liquid HLW at SRS is comprised of many waste streams generated during the recovery and purification of TRU products and unburned fissile materials from spent reactor fuel elements. These wastes are separated according to waste form, radionuclide, and heat content; and transferred to underground tanks in the F- and H-Area Tank Farms. Processes used to treat liquid HLW include separation, evaporation, and ion exchange. Evaporation produces a cesium-contaminated condensate. Cesium-137 is removed from the condensate, resulting in a low-level waste stream that is treated in the Effluent Treatment Facility. The remaining high-level waste stream salts are precipitated, and some can be decontaminated. The decontaminated salt solution is sent with residues from the Effluent Treatment Facility to the Defense Waste Processing Z–Area Saltstone Facility where it is mixed with a blend of cement, flyash, and blast furnace slag to form grout. The grout is pumped into disposal vaults where it hardens for permanent disposal as LLW. The remaining high-level salt and sludge will be permanently immobilized as a glass solid cast in stainless steel canisters at the Defense Waste Processing Facility Vitrification Plant. The stainless steel canisters will be welded closed, decontaminated to DOT standards, and temporarily stored onsite for eventual transport to a permanent Federal repository for disposal. Future HLW generation could result from the processing and stabilization of spent fuel for long-term storage as a result of 60 FR 28680 (amended by 61 FR 9441, March 8, 1996), and from remediation or materials recovery activities performed in F- and H-Canyons.

Transuranic Waste. Under the FFCA on RCRA Land Disposal Restrictions signed by EPA and DOE on March 13, 1991, SRS is required to prepare TRU waste for shipment. [Text deleted.] SRS will begin discussions with the State of South Carolina Department of Health and Environmental Control on alternative treatment options in January 1998 if the Secretary of Energy does not decide to operate the Waste Isolation Pilot Plant by that time. If a delayed opening date for the Waste Isolation Pilot Plant is determined, DOE will propose modifications to the SRS site treatment plan for approval by the State of South Carolina. Status of the Waste Isolation Pilot Plant readiness schedule will be included in the updates. Certified TRU waste is stored on TRU waste storage pads until it can be shipped to a TRU waste disposal facility. Should additional treatment be necessary for disposal at the Waste Isolation Pilot Plant, SRS would develop the appropriate treatment capability. All TRU waste currently generated is stored in containers on aboveground pads.

The Experimental TRU Waste Assay/Certification Facility began operations in 1986 to certify newly generated TRU waste. It since has been shut down. A new TRU Waste Characterization/Certification facility is planned that would provide extensive containerized waste processing and certification capabilities. The facility is needed to prepare TRU waste for treatment and to certify TRU waste for shipment to the Waste Isolation Pilot Plant. Drums certified for shipment to the Waste Isolation Pilot Plant are placed in interim storage on concrete pads in E–Area. Buried and stored wastes containing concentrations of transuranic nuclides between 10 and 100 nanocuries per gram (nCi/g) (referred to as alpha-contaminated LLW) is managed like TRU waste because its physical and chemical properties are similar, and because similar procedures will be used to determine its final disposition. Because all of the TRU waste placed on the aboveground pads prior to January 1990 is suspected of having hazardous constituents, RCRA Part B permit application has been submitted for the TRU waste storage pads and the Experimental TRU Waste Assay Certification Facility. The waste is currently being stored under RCRA interim status.

Low-Level Waste. The bulk of liquid LLW is aqueous process waste including effluent cooling water, decontaminated salt solutions, purge water, water from irradiated fuel and target storage basins, distillate from the evaporation of waste streams, and surface water runoff from areas where there is a potential for contamination. Liquids are processed to remove and solidify the radioactive constituents and the decontaminated liquids are discharged within

Table 3.4.10–1. Waste Management at Savannah River Site

Waste Category	1993 Generation (m^3)	Treatment		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	Capacity (m^3)
High-Level							
Liquid	1,561	Settle, separate, and evaporate	53,700	F- & H-Area Tank Farm	133,000	None[a]	None
Solid	None[b]	Vitrification	18,800	Air-cooled, shielded facility	4,572 HLW canisters	To repository	NA
Transuranic							
Liquid	None	NA	NA	NA	NA	NA	NA
Solid	391	None	None	Pads and buildings	14,600	None (Federal repository in the future)	None
Low-Level							
Liquid	None	Adsorption, evaporation, filtration, neutralization, and saltstone	104,000	Ponds and tanks (awaiting processing)	NA	NA	NA
Solid	14,100	Compaction	52,000	NA	NA	Trench and caissons	2,578,000
Mixed Low-Level							
Liquid	115	Stabilization, adsorption, neutralization, precipitation, filtration, ion exchange, and evaporation	889,000	RCRA permit Bldgs. E, 600, 700, M-Area Liquid Effluent Treatment Facility	11,500	None	None
Solid	18	None	NA	RCRA permit Bldg. 600	1,990	None	None
Hazardous							
Liquid	None	None	None	DOT containers	Included in solid	Offsite	NA
Solid	74	None	None	DOT containers	860	Offsite	NA

Table 3.4.10–1. Waste Management at Savannah River Site—Continued

Waste Category	1993 Generation (m^3)	Treatment		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	Capacity (m^3)
Nonhazardous (Sanitary)							
Liquid	700,000[c]	Filter, settle, strip	994,000	Flowing ponds	NA	Permitted discharge	Varies by each permitted outfall
Solid	6,670	Compaction	Expandable, as required	NA	NA	Landfill (onsite and offsite)	Expandable, as required
Nonhazardous (Other)							
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary

[a] Treatment removes the high-level constituents (salt and sludge) from the liquids; the salt and sludge are vitrified.

[b] Facility started operation in 1995.

[c] 1991 data.

Note: NA=not applicable; DOT=Department of Transportation.

Source: DOE 1995kk; SR DOE 1993c; SR DOE 1994b; SR DOE 1994c; SR DOE 1995b; SR DOE 1995c; SR MMES 1993a; SRS 1995a:1; WSRC 1995a.

standards established by the regulatory permit. Solid LLW includes operating plant and laboratory waste, contaminated equipment, reactor and reactor fuel hardware, spent lithium-aluminum targets, and spent deionizer resin from reactor coolant treatment. Solid LLW is separated by radiation levels into low and intermediate categories. Solid LLW that radiates less than 200 mrem/hr at 5 cm (2 in) from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem/hr at 5 cm (2 in), it is considered intermediate activity waste. The disposal method for solid LLW is disposal in earthen trenches and concrete vaults. Saltstone generated in the solidification of decontaminated salts extracted from HLW is disposed of as LLW in separate vaults, and is the highest volume of LLW disposed of at SRS. Disposal facilities are projected to meet solid LLW storage and disposal requirements (for example LLW from offsite DOE facilities such as Pinellas) for the next 20 years.

Mixed Low-Level Waste. The FFCA, signed by EPA and DOE on March 13, 1991, addresses SRS compliance with RCRA land disposal restrictions pertaining to past, ongoing, and future generation of mixed LLW (mostly solvents, dioxin, and California list wastes contaminated with tritium). SRS is allowed to continue to operate, generate, and store mixed waste subject to land disposal restrictions; in return, SRS will report to EPA the characterization of all solid waste streams disposed of in land disposal units at SRS and has submitted its waste minimization plan to EPA for review. Schedules for measures to provide compliance through construction of the Consolidated Incineration Facility and the Hazardous Waste/Mixed Waste Storage Facility are included in the FFCA.

The Consolidated Incineration Facility will treat mixed LLW and liquid hazardous waste. The hazardous waste/mixed waste disposal vaults are scheduled to be available in 2002. Mixed waste will be in interim storage in the E–Area waste disposal facility and in two buildings in G–Area until completion of the Consolidation Incineration Facility and the Hazardous Waste/Mixed Waste Storage Facility. The FFCA of 1992 required DOE facilities storing mixed waste to develop site treatment plans and to submit the plans for approval. The FFCA formed the basis for the SRS *Proposed Site Treatment Plan.*

Hazardous Waste. Lead, mercury, cadmium, 1,1,1-trichloroethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents are typical hazardous wastes generated at SRS. All hazardous wastes are stored onsite in Department of Transportation-approved containers in RCRA-permitted facilities in three RCRA-permitted hazardous waste storage buildings and on three interim status storage pads in B– and N–Areas. Most of the waste is shipped offsite to commercial RCRA-permitted treatment and disposal facilities using Department of Transportation-certified transporters. Eight to nine percent of the hazardous waste (organic liquids, sludge, and debris) will be incinerated in the Consolidated Incineration Facility. Hazardous chemicals are stripped from aqueous liquids collected during groundwater monitoring in the M–Area Air Stripper, with the treated wastewater discharged in accordance with NPDES criteria.

Nonhazardous Waste. In 1994 the centralization and upgrading of the sanitary wastewater collection and treatment systems at SRS were completed. The program included the replacement of 14 of 20 aging treatment facilities scattered across the site with a new 3,977 m^3/day (1.05 MGD) central treatment facility and connecting them with a new 29 km (18 mi) primary sanitary collection system. The 29 km (18 mi) collection system intercepts wastewater at points prior to discharge into old sanitary wastewater treatment facilities. The new central treatment facility treats sanitary wastewater by the extended aeration activated sludge process utilizing the oxidation ditch method. The treatment facility separates the wastewater into two forms, clarified effluent and sludge. The liquid effluent is further treated by non-chemical methods of ultraviolet light disinfection to meet NPDES discharge limitations. The sludge goes through a volume reduction process to reduce pathogen levels to meet proposed land application criteria (40 CFR 503). The remaining existing sanitary wastewater treatment facilities are being upgraded as necessary to meet demands by replacing existing chlorination treatment systems with non-chemical ultraviolet light disinfection systems to meet NPDES limitation. [Text deleted.] SRS-generated municipal

solid waste is sent to a permitted offsite disposal facility. DOE is evaluating a proposal to [Text deleted.] participate in an interagency effort to establish a regional solid waste management center at SRS. SRS addressed the offsite shipments in *Environmental Assessment for the Transportation and Disposal of Savannah River Site Generated Municipal Solid Waste at an Off-Site Disposal Facility* (DOE/EA-0989, August 1994) and described the environmental impacts of a regional center in *Environmental Assessment for the Construction and Operation of the Three Rivers Authority Waste Management Center at the Savannah River Site* (DOE/EA-1079, October 1995).

3.5 BABCOCK & WILCOX FACILITY, LYNCHBURG, VIRGINIA

The B&W NNFD was established in 1956. B&W is an operating company of McDermott, Inc., a subsidiary of McDermott International, Inc. It occupies approximately 212 ha (524 acres), approximately 8 km (5 mi) east of Lynchburg, Virginia. B&W NNFD operations primarily support the U.S. Navy propulsion program by fabricating unirradiated HEU into complete core assemblies for nuclear reactor fuel components, including fuel loading and subsequent refueling of ship reactors. They also provide fuel for Government and university research reactors. NNFD also performs recovery of scrap uranium. The location of the B&W site and its vicinity is shown in Figure 3.5–1.

The following sections describe the affected environment at B&W for land resources, site infrastructure, air quality and noise, water resources, geology and soils, biotic resources, cultural and paleontological resources, socioeconomics, public and occupational health, and waste management.

3.5.1 LAND RESOURCES

Land Use. The B&W facility is located in the northeastern portion of Campbell County in central Virginia (Figure 3.5–1). The site is bordered by an oxbow of the James River along the north, east, and west site boundaries. The region is characterized by mixed land use consisting of small farms (crop and pasture) interspersed with large tracts of forested land. The Internet Foundry, which manufactures light machine parts of iron and steel, is 0.4 km (0.25 mi) from the southern boundary of the site. Other industrial activities are located within 4.8 km (3 mi) of the site, with the major industries in the general area near or within the city of Lynchburg (BW NRC 1991a:43).

There are three major classifications of land at the B&W site: agricultural/meadow (approximately 47 percent), undeveloped forest (approximately 48 percent), and industrial (approximately 5 percent) (BW NRC 1991a:44). Generalized land uses at the B&W site and its vicinity are presented in Figure 3.5.1–1. Three facilities are located at B&W: NNFD, Lynchburg Technology Center, and the Commercial Nuclear Fuel Plant (CNFP), which is owned by B&W Fuel Company, a conglomerate of French companies that includes Framatome (BW NRC 1991a:30). NNFD is located in the center of the site within an approximately 13.2-ha (32.6-acre) fenced area. The main manufacturing complex is contained in a separately fenced, approximately 8-ha (19-acre), area (see Figure 3.5.1–2 for B&W facility map). Bays 12A, 13A, and 14A of the NNFD facility would be the principal bays used for recovery and blending operations. There is no prime agricultural land on the site (BW USDA 1979a). The closest residence is approximately 1,100 m (3,610 ft) west-southwest from the NNFD stacks (BW NRC 1991a:73).

There are no formal public recreational facilities located on B&W; however, a softball field is available for the use of plant workers. Minimal swimming, boating, and other shoreline activities occur along the James River south of Lynchburg. While several small-scale recreational facilities (for example, playgrounds and athletic fields) are in the immediate vicinity of B&W, there are no prime or generally recognized recreational destination sites within the immediate area (BW 1974a:2-2-6).

Visual Resources. The landscape of B&W is characterized as gently rolling land dominated by a hill located approximately at the center of the property. The site also includes a large area of relatively flat floodplain adjacent to the James River. Mt. Athos, with an elevation of approximately 271 m (890 ft) above mean sea level, is the highest point near the site. The vegetation at B&W is predominately deciduous forest mixed with coniferous species (oak-hickory-pine). The undeveloped portions of the site consist of second-growth forests and grasslands, with a portion of the forest occurring within the James River floodplain. Wetlands are associated with the James River (BW NRC 1991a:56,59).

The visual character of B&W facilities may be described by individual facility. NNFD is contained within a fenced area. Manufacturing operations and support areas, office space, and a liquid waste treatment facility occupy a footprint of approximately 60,850 square meters (m^2) (655,000 square feet [ft^2]) (BW NRC 1991a:40). The NNFD main facility and parking lot remain brightly lit throughout the night. The Lynchburg Technology Center is located adjacent to NNFD and

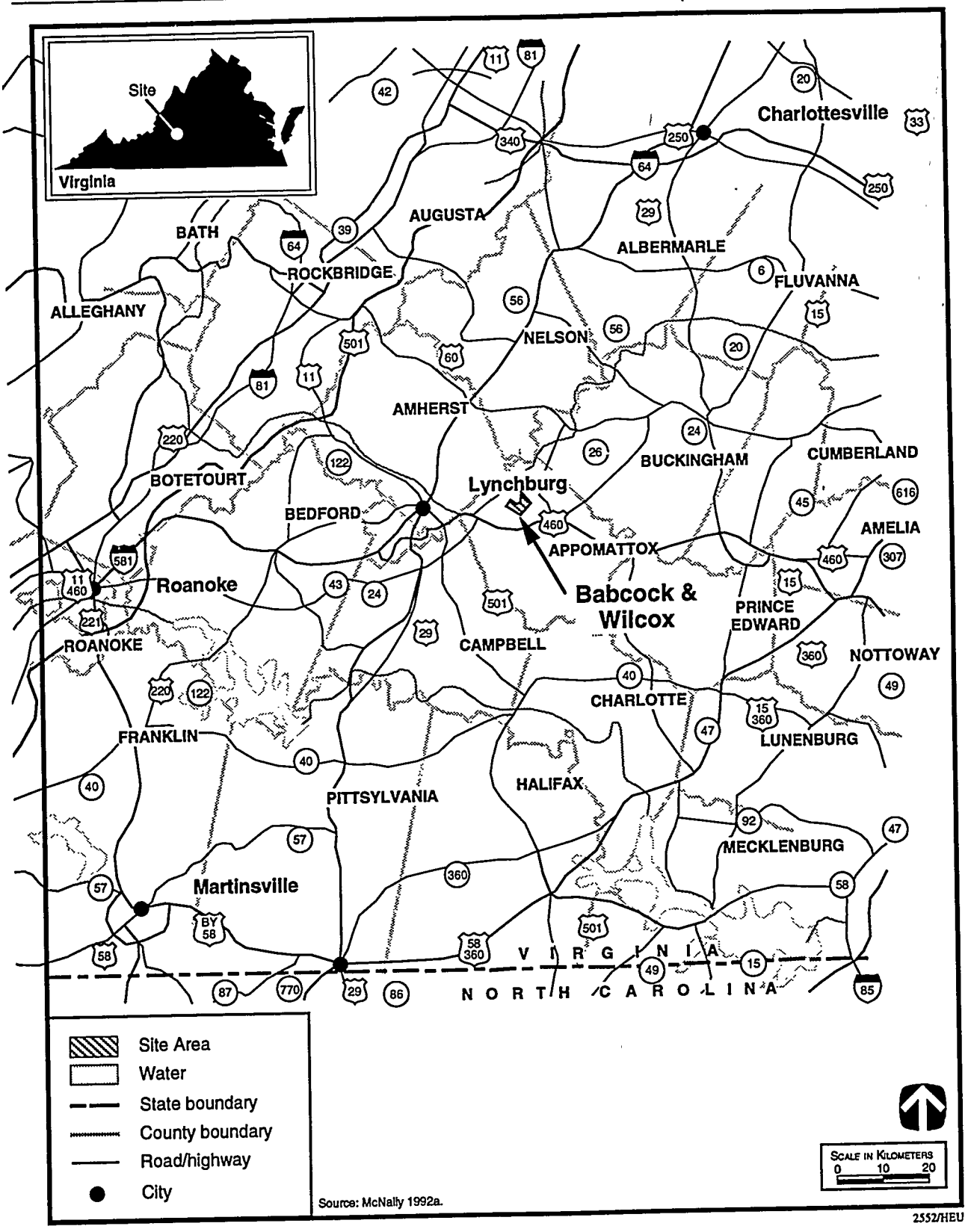


Figure 3.5–1. Babcock & Wilcox Site, Virginia, and Region.

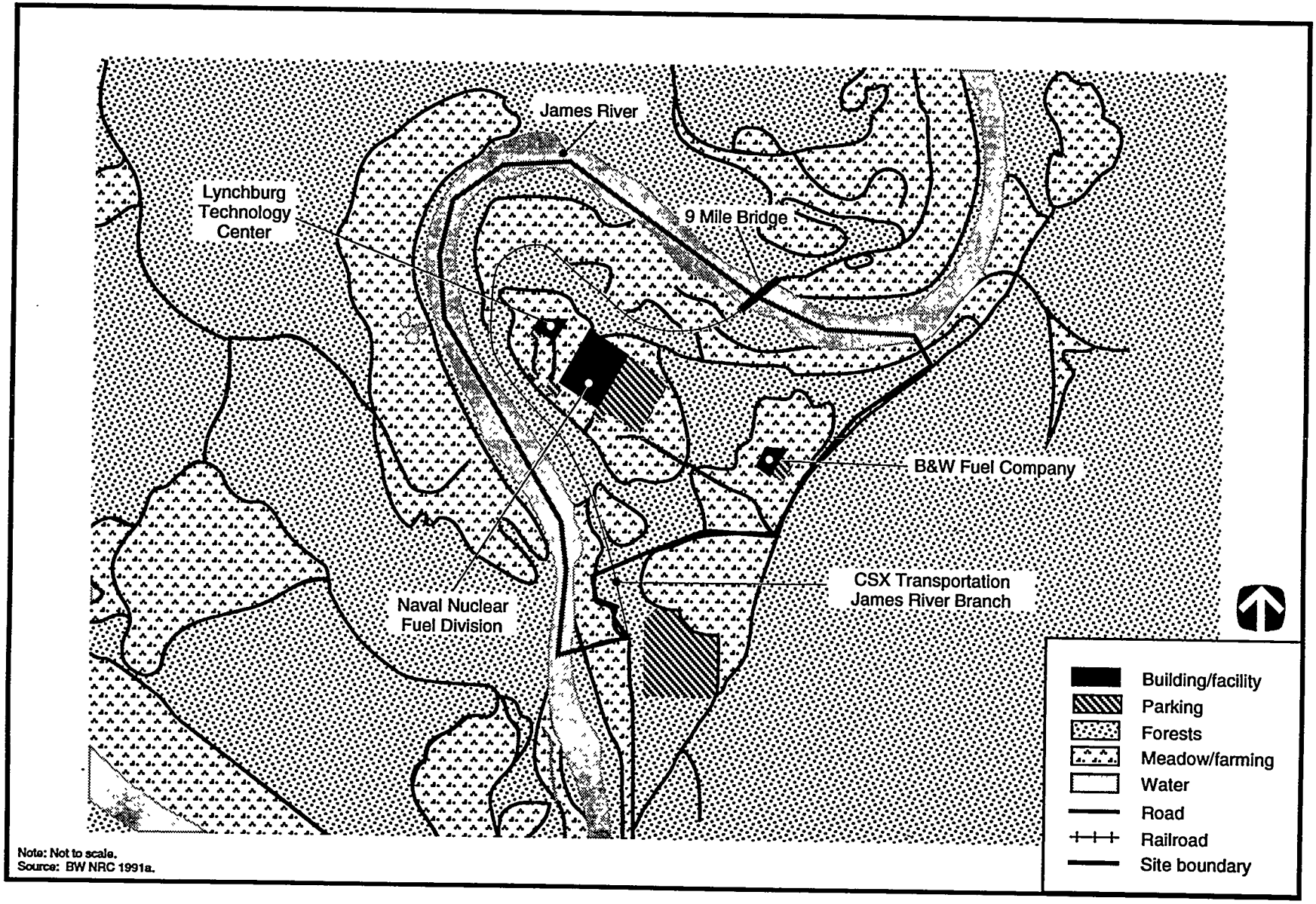


Figure 3.5.1–1. Generalized Land Uses at the Babcock & Wilcox Site and Vicinity.

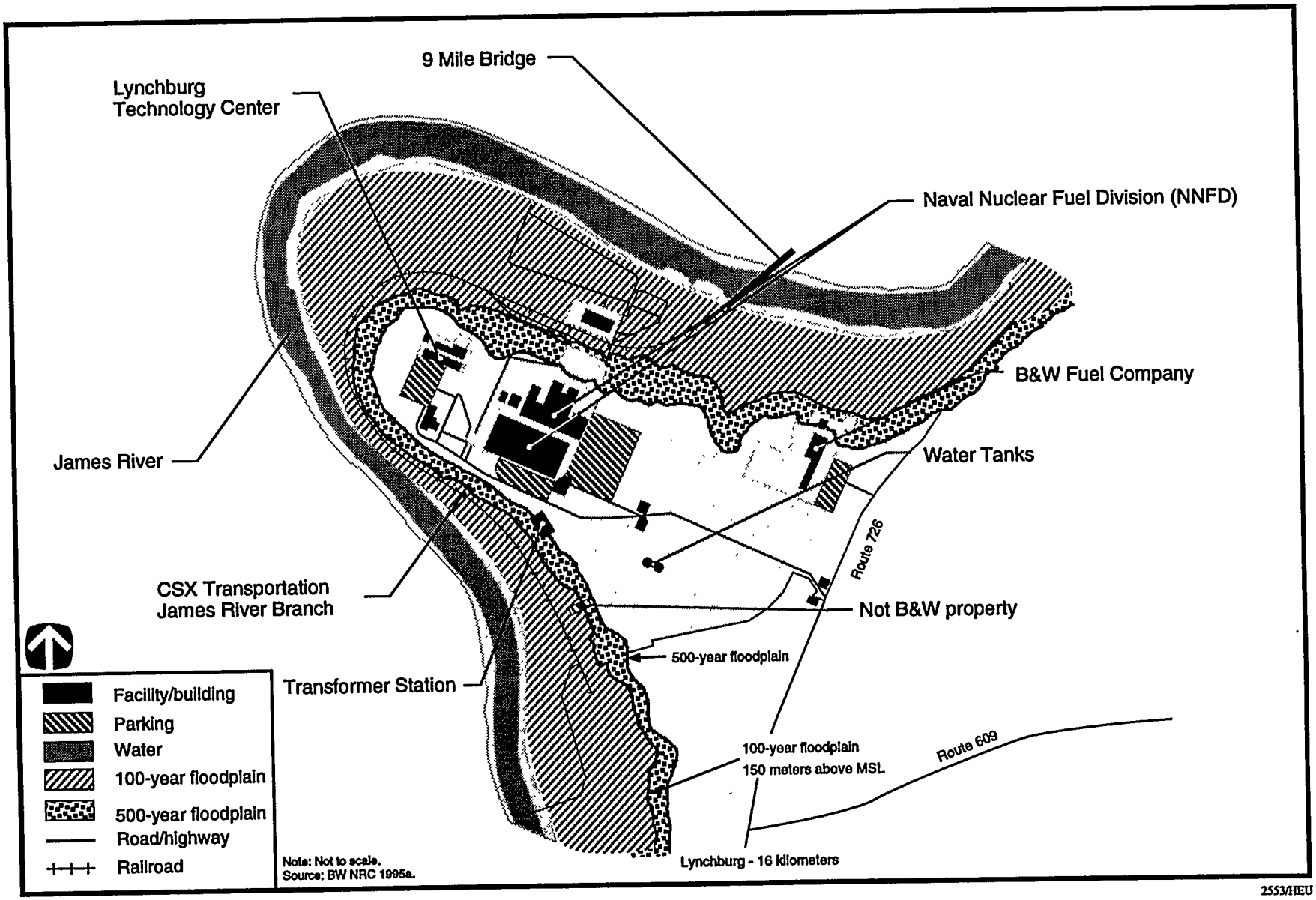


Figure 3.5.1–2. Primary Facilities at the Babcock & Wilcox Site.

is similar in appearance. The facility footprint is approximately 10,500 m^2 (113,000 ft^2), with the structures varying from one to three stories in height. The *Environmental Report for the Babcock & Wilcox Commercial Nuclear Fuel Plant, Lynchburg, Virginia* (BAW-1412, December 1974) describes the area associated with the CNFP as landscaped and maintained to present a park-like appearance. The main plant building is a windowless, metal-paneled structure with a light tan and white, baked enamel finish. The footprint of the main plant building and machine shop wing is approximately 4,030 m^2 (43,400 ft^2) and has an average roof height of 7.3 m (24 ft). Support facilities are of metal construction. The plant site is surrounded by a 1.8-m (5.9-ft) chain-link security fence.

The visual landscape consists of rural character with farmland and woodland use. The city of Lynchburg is the nearest and largest population center. Offsite views of B&W facilities are greatly limited due to hilly terrain, forested areas, and limited access; however, agricultural and forested lands on the opposite side of the James River may be in view of the site. From U.S. 460, SR-726 provides the only access to the site. B&W facilities are not visible from U.S. 460 and are visible for only a short distance from SR-726 due to a hill that blocks the view of NNFD and the Lynchburg Technology Center. SR-726 ends in a private logging road approximately 3 km (1.9 mi) beyond the CNFP facility (BW 1974a:3-1-1).

3.5.2 Site Infrastructure

Site Description. The proposed action would add process equipment in existing buildings used by NNFD. This division is collocated with CNFP (B&W Fuel Company) and the Lynchburg Technology Center on B&W. The three functions on B&W's property are separately regulated by NRC. The laboratory supports NNFD operations, and NNFD processes sanitary waste and LLW for the laboratory.

The primary mission of NNFD is the fabrication of highly enriched nuclear fuel elements and assembly of these elements into complete reactor cores for the U.S. Navy. Other activities include fabrication of elements or cores for research and testing activities, research related to manufacturing of fuel elements, recovery of uranium from scrap materials, and recovery of uranium from fuel elements. The fuel manufacturing process includes classified techniques that are unique to the Naval Reactor Program.

Fuel elements are manufactured and assembled in two steel-frame buildings that have a total floor area of 46,400 m^2 (500,000 ft^2). Enriched uranium is processed into fuel elements and then assembled into complete reactor cores. Support activities, conducted in separate buildings, include fuel recovery, recovery of scrape zirconium and copper, waste compaction, waste processing, and research related to the recovery of uranium. The locations of these buildings are shown in Figure 3.5.2–1.

Incoming materials include HEU; zirconium, copper, nitric, and hydrofluoric acids; aluminum nitrate; aluminum; fuel oil; cutting oil; water; and natural gas. Exit streams include: product fuel elements and assemblies; recovered metals; and gaseous, liquid, and solid waste streams.

The B&W facility can be reached from SR-726 which connects with SR-609 and U.S. 460. U.S. 460 is a major link between the Roanoke/Lynchburg area and the eastern portion of the State. NNFD is also serviced by a spur of CSX Transportation that runs through the B&W property.

Environmental Regulatory Setting. The NNFD facility of B&W is regulated by NRC, who issued a 10-year license renewal to B&W in 1991. NRC provides compliance with CEQ regulations (40 CFR 1500-1508) by preparing an EA in support of the license issuance. While NNFD operates in compliance with its license, NRC regulates on the basis of the reduction of emissions of radionuclides to a level of as low as reasonably achievable (ALARA).

Radioactive material is released to the atmosphere through 27 stacks at NNFD and 2 stacks at Lynchburg Technology Center. While the weighted average release falls within the limits of 10 CFR 20 for concentration at an unrestricted area, NRC had concerns about untreated stack effluents, and so recommended the reduction of radionuclide emissions as part of the most recent license renewal conditions.

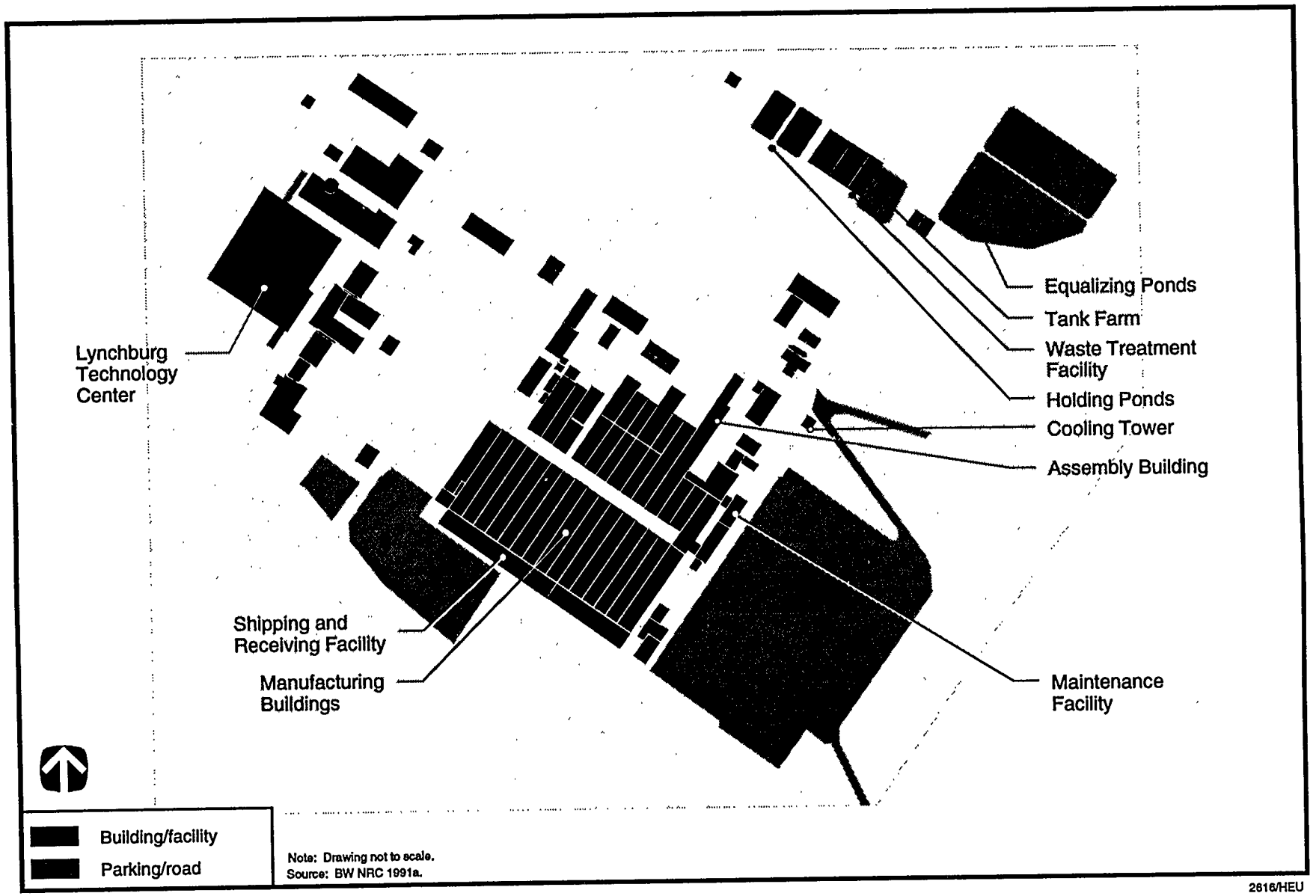


Figure 3.5.2–1. Building Locations at the Babcock & Wilcox Site.

Liquids discharged from NNFD enter the James River through three NPDES-permitted outfalls. The effluent is monitored to ensure compliance with provisions of the permit, which in turn ensure compliance with the *Clean Water Act* (CWA) and 10 CFR 20 for radionuclide content for discharge to unrestricted areas. In addition, NRC requires the facility to demonstrate compliance with the CWA and recommends that the licensee notify NRC within 30 days if the State of Virginia revokes, supersedes, conditions, modifies, or otherwise nullifies the effectiveness of the State-issued NPDES permit. In addition, the licensee must notify NRC within 30 days of any violation of permit.

[Text deleted.] The Commonwealth of Virginia Department of Environmental Quality classified an NNFD pickling process as an etching process. The Virginia Department of Environmental Quality's classification resulted in the filter cake generated from the neutralization of the pickle acid as an F006 listed waste. This classification retroactively affected the onsite landfills and the disposal of a portion of the filter cake that was generated after the determination. F006 filter cake initially was also determined to be contaminated with very low levels of special nuclear material and therefore was classified as a mixed waste.

The B&W facility has identified and successfully implemented a disposal strategy for the filter cake solids generated after the Virginia Department of Environmental Quality classification. The material in the onsite landfills is being addressed with NRC and the EPA. B&W initiated an aggressive program of pollution prevention and waste minimization that effectively eliminated the generation of mixed waste. Legacy mixed waste generated by B&W NNFD is being addressed under an agreement with the Virginia Department of Environmental Quality. Low-level radioactive, hazardous, and solid nonhazardous wastes are staged onsite for shipment to offsite disposal facilities. The Virginia Department of Environmental Quality provides monitoring for compliance with RCRA regulations.

Pollution Prevention. Pollution prevention at NNFD is mandated by statutes, regulations, and governmental agency directives. The NNFD pollution prevention program is designed to achieve continuous reduction of wastes and pollutant releases to the maximum extent feasible in accordance with regulatory requirements. A comprehensive effluent and environmental monitoring program is conducted onsite to measure progress toward pollution prevention goals and to ensure compliance with appropriate environmental protection standards and to provide, where possible, site-specific data to assist in the prediction of environmental impacts.

Baseline Characteristics. The Naval Nuclear Fuel Division contains extensive production, research, and waste processing capabilities. To support current missions and functions, an infrastructure exists as shown in Table 3.5.2–1. The site is accessed by CSX Transportation and SR-726, which is 3.2 km (2 mi) from U.S. 460.

Table 3.5.2–1. Babcock & Wilcox Naval Nuclear Fuel Division Baseline Characteristics

Current Characteristics	Value
Land	
Area (ha)	212[a]
Roads (km)	<1
Railroads (km)	0.305
Electrical	
Energy consumption (MWh/yr)	64,700
Peak load (MWe)	14.3
Fuel	
Natural gas (m^3/yr)	2,850,000
Diesel/oil (l/yr)	470,000
Coal (t/yr)	0
Steam	
Generation (kg/hr)	1,460
Water Usage (l/yr)	195,000,000

[a] Although the total size of the B&W site is 212 ha, the NNFD portion of the site is 7.7 ha.

Note: MWh=megawatt hour; MWe=megawatt electric.

Source: BW 1995b:1; BW NRC 1991a; BW NRC 1995a.

3.5.3 AIR QUALITY AND NOISE

The following describes existing air quality, including a review of the meteorology and climatology, in the vicinity of B&W. More detailed discussions of air quality methodologies, input data, and atmospheric dispersion characteristics are presented in Appendix C, Section C.1.6.

Meteorology and Climatology. The climate of the area surrounding B&W is influenced by cold and dry polar continental air masses in the winter and humid gulf maritime air masses in the summer. Extremes in weather conditions in the area are rare.

The average annual temperature at B&W is 13.3 °C (55.9 °F); the average daily minimum temperature is -4.1 °C (24.7 °F) in January; and the average daily maximum temperature is 30 °C (86 °F) in July. The average annual precipitation is approximately 104 cm (40.9 in). The monthly precipitation rates are nearly uniform throughout the year except for a slightly higher rate during the summer months. Prevailing wind directions at B&W are predominantly from the southwest, with a mean speed of 3.4 m/s (7.7 mph) (NOAA 1994b:3). Additional information related to meteorology and climatology at B&W is presented in Appendix C, Section C.1.6.

Ambient Air Quality. The B&W facility is located in Campbell County, in the Central Virginia Intrastate AQCR. As of January 1995, the areas within this AQCR were designated as in attainment with respect to NAAQS (40 CFR 81.347). Applicable NAAQS and Virginia State ambient air quality standards are presented in Appendix C, Section C.1.3.

One PSD Class I area can be found in the vicinity of B&W. This area, James River Face National Wilderness Area, is located approximately 40 km (24.9 mi) northwest of B&W. Since the promulgation of regulations (40 CFR 52.21) in 1977, no PSD permits have been required for any emissions source at B&W.

Tables 3.5.3–1 and 3.5.3–2 present the baseline ambient air concentrations for criteria and toxic/hazardous pollutants at B&W, respectively. As shown in the tables, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise Conditions. The noise environment near B&W is typical of a rural location with DNL in the range of 35 to 50 dBA (EPA 1974a:B-4, B-5). Major noise emission sources within B&W include various industrial facilities, equipment, and machines. The primary source of noise at the site boundary and at residences near roads is expected to be traffic. During peak hours, the plant traffic may be a major contributor to traffic noise levels in the area. At the site boundary, some noise on site may be audible above the background sound levels. The impact of onsite noise sources has not been documented.

The Commonwealth of Virginia has not yet established noise regulations that specify acceptable community noise levels that would be applicable to B&W. Campbell County has established a maximum sound level limit of 65 dBA, which is applicable at a property boundary of the receiving land for the hours 10 p.m. to 6 a.m., but it is not applicable to construction and industrial activities.

3.5.4 WATER RESOURCES

Surface Water. The major surface water body in the immediate vicinity of B&W is the James River, which borders the site on three sides. Northern Campbell County is drained by the James River and its primary tributaries: Blackwater Creek, Opossum Creek, Beaver Creek, and Archer Creek. The James River flows generally southeast from the Valley and Ridge Province to the Atlantic Ocean. Just east of Lynchburg, the river makes an abrupt turn northeastward following the zone of faulted rocks for about 64 km (39.8 mi), then resumes its southeasterly course across the Piedmont Province. The annual average flow of the James River at the site is estimated to be about 107 m^3/s (3,800 ft^3/s) (BW 1974a:2-5-3). The minimal flow rate of the James River is 12.7 m^3/s (448 ft^3/s). The natural surface water body in the vicinity of the B&W facility is shown in Figure 3.5.1–2.

[Figure deleted.]

The B&W facility withdraws water from the James River and treats it before distribution to the various users. Total water supplied from the James River is approximately 735 million l/yr (194 MGY) with a withdrawal design capacity of approximately 1,193 million l/yr (315 MGY) (BW NRC 1995a:3). A recycled water system is also used at the facility to provide water for noncontact cooling, firefighting, sanitary sewage, and other uses that do not require high-purity water. The system receives make-up water from the James River. The recycled water system has become contaminated with low levels of radioactive material (uranium). The major source of

Table 3.5.3–1. Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at the Babcock & Wilcox Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Concentration at B&W Boundary ($\mu g/m^3$)	Percent of Regulations or Guidelines
Carbon monoxide (CO)	8 hours	10,000[a]	4	<1
	1 hour	40,000[a]	13.1	<1
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	3.5	3.5
Particulate matter (PM_{10})	Annual	50[a]	0.02	<1
	24 hours	150[a]	0.16	<1
Sulfur dioxide (SO_2)	Annual	80[a]	0.34	<1
	24 hours	365[a]	2.28	<1
	3 hours	1,300[a]	11.8	<1
Mandated by Virginia				
Total suspended particulates (TSP)	Annual	60[c]	0.03	<1
	24 hours	150[c]	0.22	<1

[a] Federal standard.

[b] No emissions from existing sources.

[c] State standard or guideline.

Note: Ozone, as a criteria pollutant, was not evaluated since it is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; VA APCB 1993a; VA DEQ 1995b.

Table 3.5.3–2. Estimated Concentrations of Toxic/Hazardous Pollutants From Existing Sources at the Babcock & Wilcox Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines[a] ($\mu g/m^3$)	Concentration at B&W Boundary ($\mu g/m^3$)	Percent of Regulations or Guidelines
Copper compounds	Annual	2	0.04	2
	1 hour	50	4.65	9.3
Nitric acid	Annual	10.4	0.04	0.4
	1 hour	250	4.55	1.8
Sulfuric acid	Annual	2	0.01	0.5
	1 hour	75	1.13	1.5
Trichloroethylene	Annual	538	2.44	0.5
	1 hour	13,425	313.6	2.3

[a] State standard or guideline.

Source: BW EPA 1995a; VA APCB 1993a.

the uranium contamination is believed to be fallout from recovery stack emissions and the subsequent drainage of rainwater from the roof areas that entered the recycle system in stormwater used for make-up at that time. Currently, an action plan to remedy the contamination problem has been implemented (BW NRC 1991a:5).

The U.S. Department of Housing and Urban Development has conducted flood studies along the James River. The northwest, north, and northeast property boundaries of B&W lie within the 100-year floodplain of the James River (Figure 3.5.1–2). The James River has flooded the plant site 11 times between the years 1771 and 1985. The 1795 flood had the highest flood stage and was measured at 160 m (525 ft) above mean sea level at Lynchburg and estimated at 151 m (495 ft) above mean sea level at the site. The largest most recent flood occurred in 1985, with a flood stage of 150 m (492 ft) above mean sea level at the site (BW NRC 1991a:43). Upstream flood control facilities have been designed to reduce the probability that the largest historic flood stages will be exceeded. The U.S. Army Corps of Engineers has developed flood criteria for a maximum probable flood and a standard project flood for the James River. According to these criteria, maximum probable flood and standard project flood discharges would produce a discharge rate of 10,700 m^3/s (378,000 ft^3/s) and a flood stage of 153 m (502 ft) above mean sea level at the site. The 500-year flood is estimated to have a discharge of 8,200 m^3/s (290,000 ft^3/s) and a stage of 152 m (499 ft) above mean sea level at the site (BW 1974a:2-5-4).

Surface Water Quality. The James River has been designated a Class A river at the site by the Virginia Department of Environmental Quality–Water Division (formerly known as the Virginia State Water Control Board). Classification A requires that the water must be generally satisfactory for use as public or municipal water supply and for secondary contact recreation, propagation of fish and aquatic life, and other beneficial uses. Several communities, including the city of Lynchburg, use the James River as their primary source of drinking water. The major water consumers downstream from the plant are Scottsville and Richmond (approximately 100 and 200 km [62 and 120 mi], respectively, in distance) (BW 1974a:2-5-6).

The B&W facility has three outfalls regulated by its NPDES permit. Effluents from the sanitary, radioactive and nonradioactive pickle acid treatment plants, and the Imhoff System have been combined to Outfall 001 (BW NRC 1995a:21). Discharges from Outfall 001 are discharged through a diffuser located in the middle of the river to allow mixing with James River water and to mitigate any potential impacts. Effluents from the stormwater overflowing the noncontact cooling tower and recycle reservoir are discharged through Outfall 002. The overflows from the noncontact cooling water system and the stormwater pond are discharged through Outfall 003. All three outfalls from the site discharge into the James River at a rate of approximately 65 million l/yr (17 MGY) (BW NRC 1991a:50). The parameters regulated by the NPDES permit are identified in Table 3.5.4–1, which lists the surface water monitoring results for the James River. Between 1989 and 1993, the NPDES permit was noncompliant two times at B&W: one for fecal coliform and one for fluoride (BW NRC 1995a:3).

Surface water samples are collected semiannually at six locations throughout the site by NNFD. The samples are analyzed for alpha activity and total uranium content. The action level for surface water are 15 picocuries per liter (pCi/l). The levels of uranium in surface water is well below action level, indicating that there has been minimal impact from operations (BW NRC 1991a:23).

Surface Water Rights and Permits. Surface water rights and allocations for the Commonwealth of Virginia are determined by the common law Doctrine of Riparian Rights. Under this doctrine, users of water must not adversely impact quantity or quality of water for downstream users, and the water must be used for beneficial purposes. Virginia statutory laws direct the Virginia Department of Environmental Quality–Water Division to formulate State water resources policies and regulations that maintain the quality of the State's waters.

In December 1981, the Virginia State Water Control Board adopted Regulation II, which became effective March 1, 1982. This regulation requires the reporting of withdrawals of surface or groundwater when the daily average rate exceeds 0.038 million l/day (0.01 MGD) during any single full month of the year; excluded are withdrawals for crop irrigation,

Table 3.5.4–1. Summary of Surface Water Quality Monitoring at the Babcock & Wilcox Site

Parameter	Unit of Measure	Receiving Water: James River, 1993 Water Quality Criteria[a]	Receiving Water: James River, 1993 Average Water Body Concentration[b]
Arsenic	mg/l	0.05[c]	0.003
Beryllium	mg/l	0.004[c]	0.001
Biological oxygen demand	mg/l	NA	2
Cadmium	mg/l	0.006[c]	0.006
Chemical oxygen demand	mg/l	NA	12
Chromium	mg/l	0.1[c, d]	0.009
Chloride	mg/l	250[e]	15
Copper	mg/l	1.3[c, d]	0.0012
Fluoride	mg/l	4[c, d]	0.13
Lead	mg/l	0.015[c, d]	0.008
Manganese	mg/l	0.05[e]	0.073
Nickel	mg/l	0.1[c]	0.012
Nitrate as nitrogen	mg/l	10[c]	0.015
Nitrite as nitrogen	mg/l	0.025[f]	0.316
pH	pH units	6-9[d]	7.75
Selenium	mg/l	0.05[c]	0.001
Sulfate	mg/l	250[e]	22
Thallium	mg/l	NA	0.001
Zinc	mg/l	5[e]	0.02

[a] For comparison only.

[b] Results from the 6-21-93 sampling effort.

[c] National Primary Drinking Water Regulations (40 CFR 141).

[d] Virginia Surface Water Quality Standards (VR 680-21-01.2B).

[e] National Secondary Drinking Water Regulations (40 CFR 143).

[f] Virginia Groundwater Quality Standard (VR 680-21-04).

Note: NA=not applicable.

Source: VA DEQ 1993a.

withdrawals of saline surface waters, withdrawals from mines or quarries for the sole purpose of dewatering, withdrawals for the sole purpose of hydroelectric power generation, and withdrawals by Federal agencies. Also exempt from the regulatory mechanisms are users who do not withdraw their water but obtain it from other users.

Groundwater. Metamorphic rocks of the Evington Group occupy the main portion of the B&W site. These rocks have very little porosity and are practically impermeable. Since these rocks generally slope in a northerly direction toward the James River, the main groundwater body (confined or unconfined) also follows the surfaces of the impervious layers. Because the thin layer of topsoil is underlain by impermeable cohesive soils such as silt and clay, runoff that penetrates into the topsoil is blocked by the cohesive soils and forms an unconfined groundwater source. The main portion of groundwater under the property is found in confined aquifers (BW 1974a:2-5-8). Although metamorphic rocks are usually poor aquifers, the wells on the B&W property produce adequate amounts of groundwater. Upper aquifer groundwater levels determined in a site survey range from 151 to 144 m (495 to 472 ft) above mean sea level. The higher levels are observed at the center of the site, and the lower levels are observed near the riverbank. The measured levels are all above the normal river elevation (BW NRC 1991a:53). The aquifer is recharged from the rainwater that falls in the B&W drainage basin.

Groundwater Quality. Groundwater is monitored quarterly by B&W's Environmental Engineering at 24 monitoring wells for pH, fluoride, nitrate, VOCs, and radioactivity. B&W's Environmental Engineering monitors for potential releases and tracks three trichloroethylene plumes under an EPA RCRA consent order. Annual sampling for primary and secondary metals is also conducted at these wells. In addition, sampling of the seven groundwater supply wells is also conducted for pH and radioactivity. Table 3.5.4–2 shows groundwater quality for selected groundwater monitoring wells. The action level for radioactivity in groundwater is 15 pCi/l, well in excess of observed levels (not shown in Table 3.5.4–2), indicating that the facility operations have not affected radiological quality of the groundwater. Levels reported for some primary and secondary metals are below maximum contaminant levels defined as primary drinking water standards. However, most exceed State groundwater contaminate levels.

[Text deleted.] The three groundwater plumes are contaminated with trichloroethylene (TCE), tetrachloroethylene (PCE), and related degradation constituents above the drinking water limit of

Table 3.5.4–2. Summary of Groundwater Quality Monitoring at the Babcock & Wilcox Site

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	FEP–3[b]	FEP–1[c]
Aluminum	mg/l	0.05-0.2[d]	155.075	3.5375
Cadmium	mg/l	0.006[e]	0.01635	0.016
Chromium	mg/l	0.1[e, f]	0.238	0.0356
Copper	mg/l	1.3[e, f]	0.55825	0.04
Cyanide	mg/l	0.2[e]	0.005	0.005
Fluoride	mg/l	1.4[f]	1.6925	2.15
Foaming agents	mg/l	0.05[f]	0.0725	0.23
Lead	mg/l	0.015[e, f]	0.1	0.026
Nitrogen	mg/l	0.025[f]	1.415	1.07
Nitrate as nitrogen	mg/l	10[e, f]	1	802.5
Nitrite as nitrogen	mg/l	0.025[f]	0.064	0.58
pH	pH units	5.5-8.5[f]	6.8	6.5
Silver	mg/l	0.1[d]	0.0169	0.0139
Sodium	mg/l	270[f]	12.075	1,764.625
Total organic carbon	mg/l	10[f]	8.285	3.7613
Total toxic organics	mg/l	2.13[f]	0.01	0.01
Zinc	mg/l	5[d]	0.66825	0.04713

[a] For comparison only, except for parameters with Virginia groundwater standards.

[b] FEP–3 monitors background water quality upgradient to the Final Effluent Ponds (FEP). Data represent the average of groundwater monitoring for 1993.

[c] Well is located downgradient of the Final Effluent Ponds. The number shown is an average value.

[d] National Secondary Drinking Water Regulations (40 CFR 143).

[e] National Primary Drinking Water Regulations (40 CFR 141).

[f] Virginia Groundwater Quality Standards (VR 680-21-04).

Source: BW 1994a.

0.005 parts per million (ppm) (BW NRC 1995a:32). The largest plume, 28 ha (70 acres), is located beneath the NNFD plant and has an average concentration of 0.1 ppm for TCE. The second plume is located beneath the CNFP, and is approximately 10 ha (25 acres) with an average concentration of 0.01 ppm for TCE. The third plume is located on the western portion of the site where the former uranium recovery building was buried. The plume has an average concentration of 0.1 ppm for TCE and 0.1 ppm for PCE and is approximately 2 ha (5 acres) (BW NRC 1995a:32). The plumes are each migrating toward the James River, where dilution and evaporation reduce contaminant concentrations to acceptable levels (BW NRC 1991a:23-27). Upon EPA Region III approval of the Remedial Feasibility Investigation (RFI) report, B&W will proceed with the corrective measures study, where alternatives for corrective action will be evaluated (BW NRC 1995a:32).

Groundwater Availability, Use, and Rights. Approximately 165 million l/yr (43.6 MGY) of groundwater are obtained for potable and industrial process applications (BW 1996a:1). The groundwater is pumped from seven wells located in the northeast portion of the facility at an average rate of 322 l/minute (85 gal/minute), with a maximum capacity of 492 l/minute (130 gal/minute) (BW NRC 1995a:6). Groundwater without prior treatment is used as potable water and is routed to wastewater treatment following use. Groundwater used as process water is treated prior to use and is routed to wastewater treatment following use (BW NRC 1991a:5).

Groundwater rights in Virginia are traditionally associated with the American or Reasonable Use Doctrine. Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights reasonably in relation to the

similar rights of others. Furthermore, the owner's use of groundwater for off-lying land may be unreasonable and therefore unlawful if the withdrawals for the off-lying land impair a neighbor's groundwater usage (VDL 1990a:725).

3.5.5 GEOLOGY AND SOILS

Geology. The B&W facility lies in the western region of the Piedmont metamorphic physiographic province, which is characterized by complex folding and faulting (BW USDA 1977a:118). The Piedmont Plateau, a landform of gently rolling to rolling topography, is underlain mainly by metamorphic rock formations and, to a lesser extent, by sedimentary and igneous rock formations. The surficial geology is composed of Quaternary-age alluvium below the 150-m (500-ft) contour elevation and Quaternary or older terrace gravels at higher elevations up to the base of Mt. Athos (BW NRC 1995a:25).

At B&W, metamorphic rocks (muscovite, schist, and phyllite) of the Candler Formation are exposed west of SR-726. East of SR-726, bedrock under the site is the metamorphic graphitic schist member of the overlying Archer Creek Formation. Both the Candler and Archer Creek Formations are part of the Evington Group of rock, which consists of tight isoclinal folds that have been faulted by high-angle reverse faults as a result of the James River Synclinorium regional structure (BW NRC 1991a:53).

Babcock & Wilcox lies within Seismic Zone 1, indicating that minor damage could occur as a result of earthquakes (Figure 3.3.5–1). Since the Virginia earthquake of 1758, 121 earthquakes with epicenters in Virginia have been reported. The largest earthquake occurred in 1897, 161 km (100 mi) west of B&W; it has been estimated that it had a modified Mercalli intensity of V to VI (Table 3.3.5–1) at the site and an intensity of VIII at the epicenter. In 1875, an earthquake with a modified Mercalli intensity of VII occurred 81 km (50.3 mi) east-northeast of the site. No earthquake activity has occurred at the site with intensities greater than the 1875 or 1897 occurrences (BW NRC 1991a:56). A maximum horizontal ground surface acceleration of 0.1 gravity at B&W is estimated to result from an earthquake that could occur once every 2,000 years (BW 1996a:1). The facilities at B&W that would be used were designed and constructed to meet the target performance to withstand an earthquake with an acceleration of 0.1 gravity (BW 1996a:1).

Soils. Most of the soil cover at B&W is formed by weathered products of the metamorphic rock formations and, to a lesser extent, by sedimentary and igneous rocks of the Piedmont Plateau. The Cullen-Wilkes Soil Association, found at the B&W site, is generally characterized as deep and moderately deep, well-drained, gently sloping to steep, and a predominantly clayey subsoil is found primarily in upland areas (BW USDA 1977a:4). This association accounts for approximately 25 percent of the area of Campbell County. It is specifically composed of 43-percent Cullen soils, 17-percent Wilkes soils, and 40-percent less extensive soils (BW NRC 1991a:56). The soils at B&W are considered acceptable for standard construction techniques.

Soil samples are collected semiannually by NNFD at 14 locations throughout the site and analyzed for alpha activity and total uranium content. B&W has continuously monitored the levels of uranium in the site's sediment and soils over the past 13 years. These results have been reported to the NRC. The NRC in the B&W EA dated June 1995 and FONSI published in the *Federal Register* (60 FR 46630, September 7, 1995) concluded that the environmental impacts associated with proposed license renewal for continued operation of B&W's NNFD/Lynchburg Technology Center facility are insignificant (BW 1996a:1). The action level identified for sediment and soil with the exception of the hot equalization pond sediment is 10 pCi/g. The action level for the radioactive equalization pond sediment is 500 pCi/g. Levels of uranium in selected sediments and soil are significant fractions of the action levels (BW NRC 1991a:23). An action plan was implemented in 1993 and 1994 to remedy the contamination problem related to fallout from recovery stack emissions and the subsequent drainage from the roof. Fallout from the recovery stack is no longer an issue because recovery scrubber system modifications and improvements were made. All potentially contaminated effluents have been routed through treatment systems through permitted discharge points.

3.5.6 BIOTIC RESOURCES

Biotic resources at B&W include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each resource area, the discussion describes B&W as a whole. Scientific names of species identified in the text are presented in Appendix D.

Terrestrial Resources. Plant communities at B&W are characteristic of intermountain regions of central and southern Appalachia. Natural climax vegetation in the region is classified as oak-hickory-pine forest. Common species include white oak, post oak, hickory, and pine.

Approximately 48 percent of the site is second-growth forest and 47 percent is maintained as grassy areas. Approximately 5 percent has been developed. A portion of the forested area lies in the floodplain, adjacent to the James River (BW NRC 1991a:44).

There are approximately 24 species of mammals, 160 species of birds, 19 species of reptiles, and 17 species of amphibians expected to occur in the Lynchburg area. Economically important species in the vicinity of the site include big game mammals (for example, whitetail deer and black bear); small game mammals (for example, eastern gray squirrel and eastern cottontail); furbearers (for example, raccoon, mink, river otter, red fox, and beaver); upland game birds (for example, wild turkey, northern bobwhite, and mourning dove); and several species of waterfowl (BW NRC 1991a:59).

Wetlands. The B&W site contains several small areas of wetlands. An abandoned sewage lagoon and a fire pond and its associated wetland habitats are located near the B&W Fuel Company along with an area of wetlands associated with the river floodplain (BW NRC 1991a:50). Surface drainage at NNFD runs into one small onsite creek. Minor wetland habitats are associated with this drainage system.

Aquatic Resources. Aquatic habitats on or adjacent to B&W range from the nearby James River to several small artificial impoundments. The aquatic biota of the James River in the vicinity of B&W is characteristic of a moderately polluted flowing river. The benthic community of the James River near the site consists of both flowing and backwater areas. Fish common to the James River and found in the vicinity of B&W primarily include American shad, striped bass, common carp, and a variety of perch (BW NRC 1991a:59). These species have both commercial and recreational value.

Threatened and Endangered Species. Thirty-one Federal- and State-listed threatened, endangered, and other special status species that potentially occur on or in the vicinity of B&W are presented in Appendix D, Table D.1–4. The occurrence of these species on B&W is currently unknown. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on B&W. Federal- and State-listed threatened and endangered species that may be present at B&W include the bald eagle, peregrine falcon, Indiana bat, Virginia big-eared bat, and eastern cougar (BW NRC 1991a:59). There are no species of rare or endangered fish or mollusks known to occur in the James River in the vicinity of the site.

3.5.7 CULTURAL RESOURCES

Prehistoric Resources. Two prehistoric archaeological sites have been identified within the boundary of B&W. One site yielded historic kaolin pipestems and prehistoric stone tool manufacturing waste material; the other can be dated to the Archaic Period (ca. 8000-1000 B.C.). None of these sites is eligible for the NRHP. Prehistoric groups that lived during this time period were mobile hunters and gatherers who collected wild plants and hunted wild animals, such as white-tail deer or rabbit. The kaolin pipestem fragments are historic and probably date to the 18th century A.D. Other prehistoric resources that may exist within B&W include limited-activity hunting camps, longer-term multipurpose occupation camps, and stone tool manufacturing locations.

Historic Resources. No NRHP historic archaeological sites are located at the B&W site. Two nearby sites, the Mansion Truss Bridge, which crosses the James River to the north of B&W, and Mt. Athos, which is located east of the site on Mt. Athos, are on the NRHP. The Mt. Athos site includes the ruins of the manor house of Buffalo Lick Plantation. The house was built in 1796 by Colonel William J. Lewis. The plantation area includes gravesites, a tobacco barn, and stone cisterns. The mansion itself was destroyed by fire in 1876.

Remains of the Kanawha Canal still exist on the property and are located north of the railroad tracks and the facility structures. This canal was constructed during the early 19th century and played a role in the rural economy, transporting agricultural goods such as tobacco and wheat. During the Civil War, the canal was used by the Confederacy to transport war materials. Approximately six additional historic sites that date to the 19th century have been identified on the property. The historic component of the site previously described indicates remains of a circa 18th-century visit or occupation by European-Americans.

Native American Resources. Native Americans have lived in the Piedmont area and along the James River for thousands of years. In the early 17th century, a number of tribes that spoke Siouan dialects, including the Manahoacs, Monacans, Occaneechis, and Saponis, lived in the Piedmont region. These groups participated in a loose confederacy and can be referred to generally as Monacans. They were described by both Captain John Smith and by John Lederer in the early and late 17th century. They were hunter-gatherers of wild animals and plants, practiced agriculture, and lived in villages and hamlets. Five Monacan villages were identified on a 1607 map drawn by Captain John Smith. One of these villages was located near present-day Wingina, downstream from the site on the James River, approximately 56 km (34.8 mi) northeast of B&W.

Although most of these people were either removed, died, or left the area in the 18th and 19th centuries, the descendents of those who remained still live in the area. In 1833, Piedmont Indians purchased 162 ha (400 acres) of land on Bear Mountain in Amherst County, some 25 km (15.5 mi) north of B&W. The Monacan Indian Tribe in Amherst County is officially recognized by the State of Virginia, and most Monacans live in Amherst County and in Lynchburg. No Native American resources have been identified within B&W.

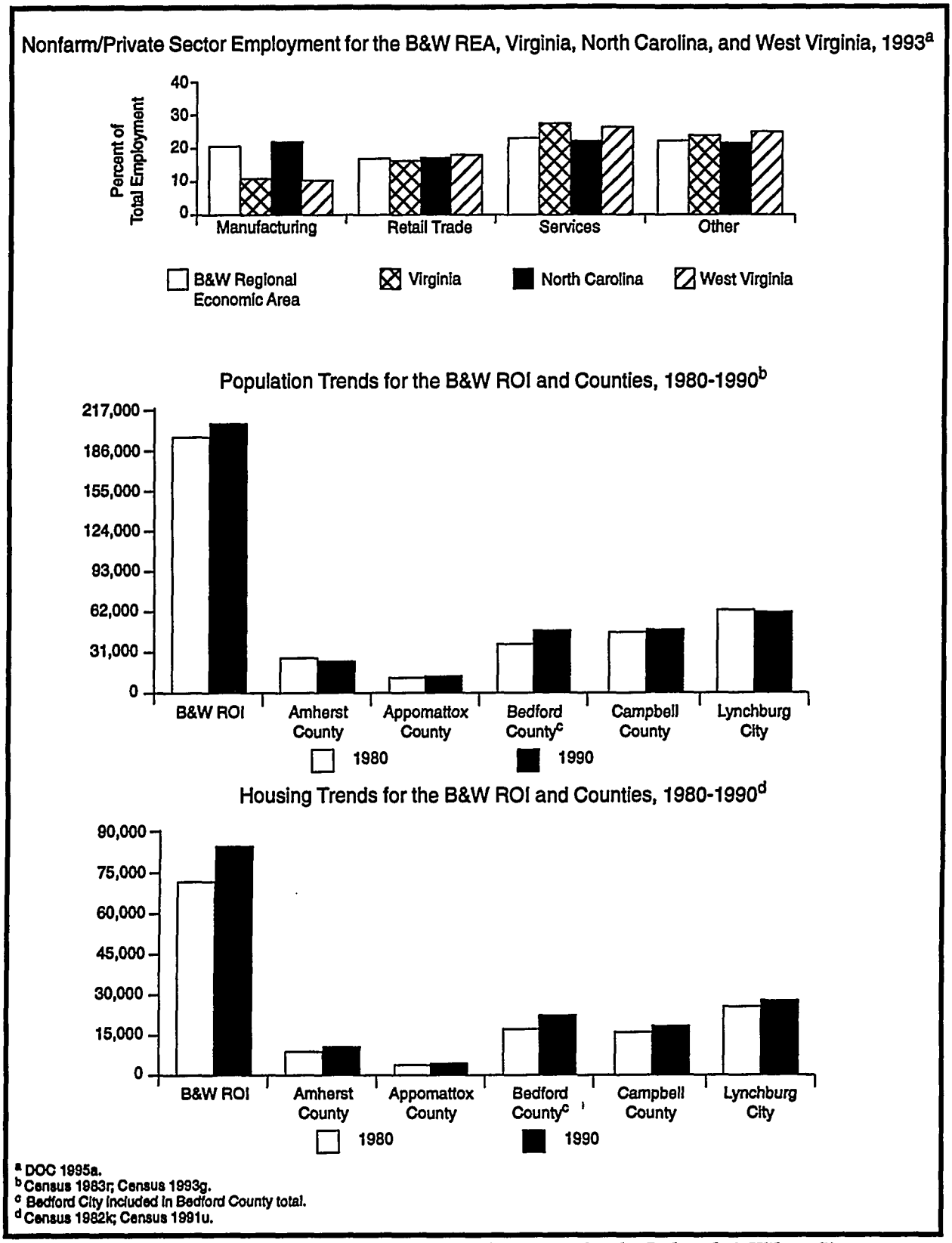
Paleontological Resources. The stratigraphy of the B&W landscape consists of two formations, the Candler Formation and the Archer Creek Formation, as described in Section 3.5.5. Outcrops of metamorphic rocks (muscovite, schist, and phylite) are located west of the main facility road. No surveys or excavations of paleontological resources have been conducted at B&W facilities because the probability of identification of significant or rare resources is low.

3.5.8 SOCIOECONOMICS

Socioeconomic characteristics described for B&W include employment, regional economy, population, housing, community services, and local transportation. Employment and regional economy statistics are presented for the REA that encompasses 18 counties around B&W in the States of Virginia, North Carolina, and West Virginia (Appendix F, Table F.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a four-county area located in Virginia (including the independent city of Lynchburg) where 91 percent of all B&W employees reside: Amherst County (11.9 percent), Appomattox County (9.6 percent), Bedford County (14.1 percent), Campbell County (18.5 percent), and Lynchburg (36.9 percent) (Appendix F, Table F.1–4). Supporting data are presented in Appendix F.

Regional Economy Characteristics. Between 1980 and 1990, the civilian labor force increased 16.7 percent to the 1990 level of 382,857. In 1994 unemployment for the REA was 4.9 percent, comparable to Virginia's unemployment rate, but 0.5 percent higher than North Carolina's, and 4 percent lower than West Virginia's. The region's per capita income of $17,552 in 1993 was approximately 19 percent lower than the per capita income of $21,653 for Virginia, 6 percent lower than the per capita income of $18,670 in North Carolina, and 8.3 percent higher than the per capita income of $16,200 for West Virginia. Employment and regional economy statistics and projections for the proposed action period for the B&W REA are given in Appendix F, Table F.1–8 and selected statistics are summarized in Figure 3.5.8–1.

In 1993, as shown in Figure 3.5.8–1, manufacturing accounted for 21 percent of the region's total employment. By comparison, the manufacturing sector makes up 11, 11, and 21 percent, respectively, of Virginia's, West Virginia's, and North Carolina's total employment. The service sector provided 24 percent of the region's employment. The percent was similar to North Carolina but less than the percentage in Virginia (28 percent) and West Virginia (26 percent). The retail trade sector comprised 17 percent



[a] DOC 1995a.
[b] Census 1983r; Census 1993g.
[c] Bedford City included in Bedford County total.
[d] Census 1982k; Census 1991u.

Figure 3.5.8–1. Economy, Population, and Housing for the Babcock & Wilcox Site Regional Economic Area and Region of Influence.

of the region's total employment, a percentage comparable to the retail sector's contribution to North Carolina's economy, but slightly lower than the contribution to the economies of Virginia and West Virginia.

[Text deleted.]

Population and Housing. In 1992, the ROI population totaled 210,935. From 1980 to 1990, the ROI population increased by 5.2 percent, a rate that was significantly less than the approximately 16-percent population growth for Virginia. Within the ROI, Bedford County experienced the greatest population increase, 31 percent, while Amherst County's population decreased by 1.9 percent. Population trends are summarized in Figure 3.5.8–1.

[Text deleted.]

The percent increase in total housing units in the ROI between 1980 and 1990, 16 percent, was nearly 8 percent less than the increase in total housing units for the entire State. In 1990, the estimated total number of housing units in the ROI was 84,018. The 1990 ROI homeowner and rental vacancy rates were 1.5 percent and 7.2 percent, respectively. These rates were comparable to the Statewide rates. (A full presentation of population and housing statistics and projections are provided in Appendix F, Tables F.1–12 and F.1–16, respectively.)

Community Services. Education, public safety, and health care characteristics are used to assess the level of community service in the B&W ROI. Figure 3.5.8–2 summarizes public school district statistics for the B&W ROI, and Figure 3.5.8–3 summarizes public safety and health care services.

Education. During 1994, five school districts provided public education services in the B&W ROI. As seen in Figure 3.5.8–2, these school districts ranged in enrollment size from 2,332 students in the Appomattox County School District to 9,489 students in the Bedford County School District (includes Bedford City). The average students-to-teacher ratio for the ROI was 14.2:1. The Bedford County School District had the highest ratio at 15.4:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to residents of the ROI. In 1993, a total of 348 sworn police officers served the four-county area. Lynchburg employed the largest number of police officers (134), and also had the highest officers-to-population ratio (2 officers per 1,000 persons). The average ROI officers-to-population ratio was 1.6 officers per 1,000 persons. Figure 3.5.8–3 presents police force strengths in the ROI.

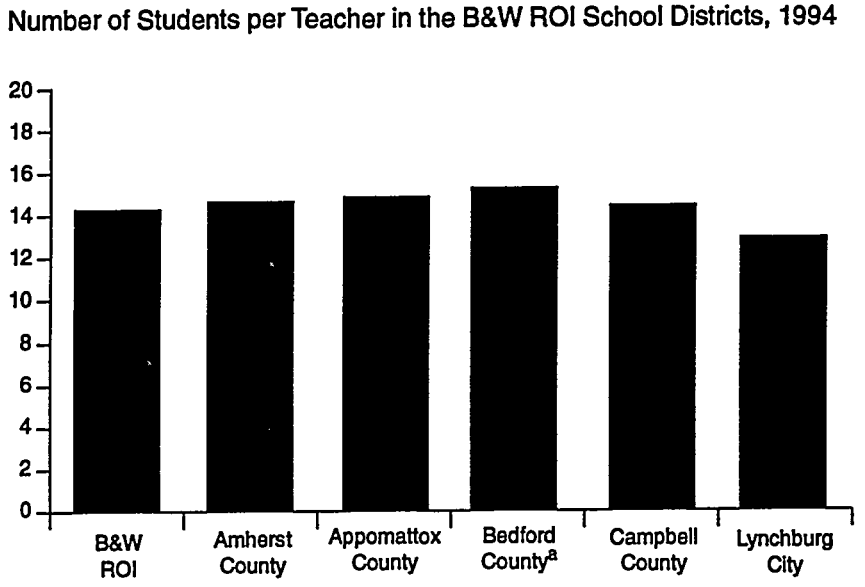
Firefighting protection services in the ROI were provided by 960 regular and volunteer firefighters in 1995. The fire department with the highest firefighters-to-population ratio is located in Bedford County, 6 firefighters per 1,000 persons, as indicated in Figure 3.5.8–3 (includes Bedford City firefighters). Bedford County had the greatest number of active firefighters (343). The average firefighters-to-population ratio in the ROI was 4.4 firefighters per 1,000 persons.

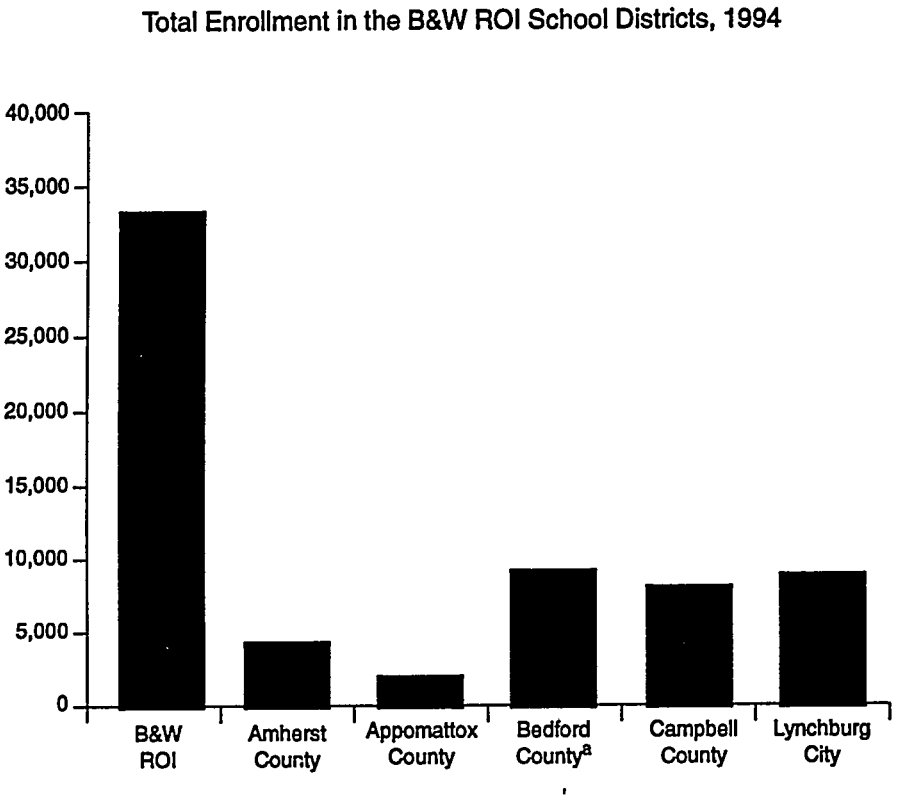
Health Care. There were three hospitals serving the four-county ROI in 1993. All three hospitals operated below capacity with hospital occupancy rates ranging from 40 percent in Bedford County to 72 percent in Campbell County.

There were 291 practicing physicians in the ROI during 1993, with the majority (229) practicing in Lynchburg. Figure 3.5.8–3 shows that the physicians-to-population ratio ranged from 0.2 physicians per 1,000 persons in Campbell County to 3.4 physicians per 1,000 persons in Lynchburg. The average ROI physicians-to-population ratio was 1.4 physicians per 1,000 persons.

Local Transportation. The B&W site is located approximately 8 km (5 mi) east of Lynchburg. U.S. highways and State Routes provide access between B&W and metropolitan areas (Figure 3.5–1). The east-west highway, U.S. 460, provides access to the cities of Roanoke and Farmville to the west and east, respectively. U.S. 460 East connects to U.S. 360, providing access to the city of Richmond. The north-south highway, U.S. 29, is located west of the facility providing access to the cities of Charlottesville to the northeast and Danville to the south.

Vehicular access to B&W is provided by SR-726, which connects with SR-609 and U.S. 460. No improvements to highways accessing the facility are currently underway or planned (VA DOT 1995a:1).

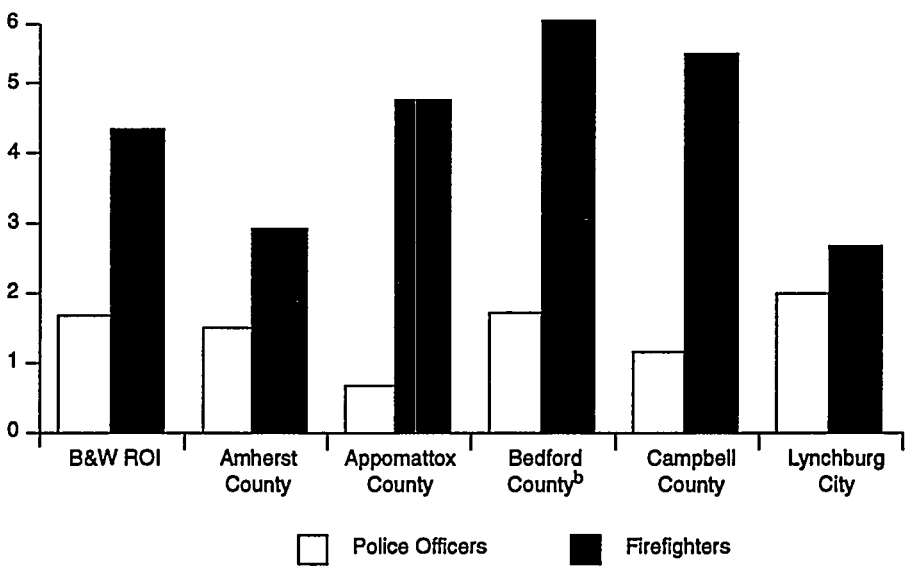


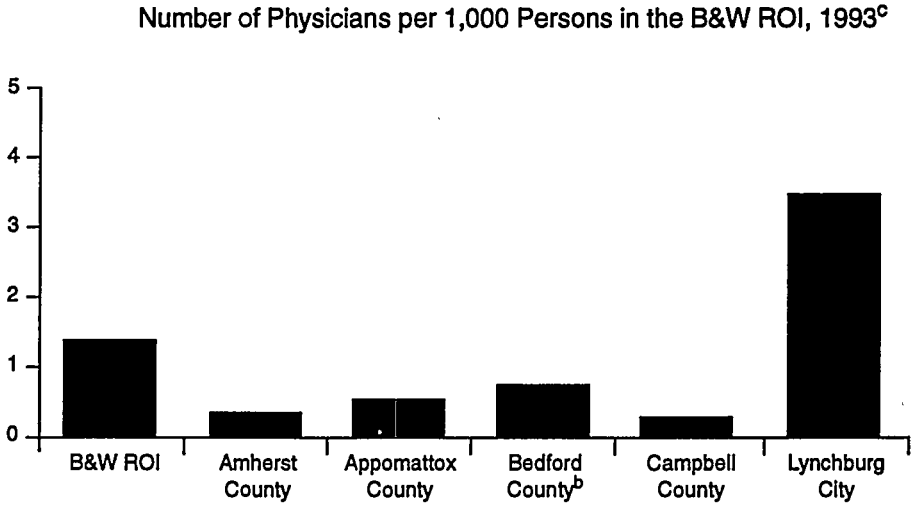


[a] Bedford City included in Bedford County total.

Source: BW School 1995a.

Figure 3.5.8–2. School District Characteristics for the Babcock & Wilcox Site Region of Influence.





[a] BW Fire 1995a; Census 1993a; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j; DOJ 1994a.
[b] Bedford City included in Bedford County total.
[c] AMA 1994a; Census 1993a; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j.
Note: Except for ROI cities, city sworn police officers and firefighters are included in the county totals.

Figure 3.5.8–3. Public Safety and Health Care Characteristics for the Babcock & Wilcox Site Region of Influence.

There are no public transportation systems providing service to the site (LCC 1995a:1). Onsite rail transport for some materials is provided by a spur of CSX Transportation that runs through B&W. The facility is bordered by an oxbow of the James River on the north, east, and west. The James River is not used by the facility for transportation purposes. Lynchburg Municipal (Preston Glen) Airport in the city of Lynchburg provides jet passenger and cargo service for the region from major and national carriers (DOT 1992a).

3.5.9 PUBLIC AND OCCUPATIONAL HEALTH

Radiation Environment. All residents in the vicinity of NNFD are exposed to background radiation from a variety of natural and man-made sources. The major sources of background radiation exposure to individuals in the vicinity of the B&W site are shown in Table 3.5.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population.

Table 3.5.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Babcock & Wilcox Site Operations

Source	Committed Effective Dose Equivalent (mrem/yr)[a]
Natural Background Radiation	
Cosmic radiation	43
External terrestrial radiation	46
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	394

[a] BWNRC 1991a; NCRP 1987a. Value for radon is an average for the United States.

[Text deleted.]

Releases of radionuclides to the environment from B&W facility operations provide another source of radiation exposure to individuals in the vicinity of the site. These radionuclides and their representative associated release quantities for normal operations are presented in site-specific environmental reports. The doses to the public resulting from these releases and direct radiation fall within radiological limits and are small in comparison to background radiation. The doses to the public resulting from these releases and direct radiation are presented in Table 3.5.9–2. Furthermore, these radiological releases were used in the development of the reference environment's radiological releases at B&W for the public and occupational health segments within Section 4.3.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public, the fatal cancer risk to the MEI of the public, because of representative annual radiological releases from B&W facility operations, is estimated to be approximately 2.5×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of the B&W facility operations is less than three chances in 100 million. (It may take several years from the time of exposure for cancer to manifest.)

Based on the same risk estimator, 1.8×10^{-4} excess fatal cancers to the population living within 80 km (50 mi) of the B&W facility are estimated for a normal operating year. This number can be compared with the numbers of fatal cancers expected in this population from all causes. The average mortality rate associated with cancer for the entire U.S. population is presently 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers from all causes expected to occur annually is 1,050 for the population living within 80 km (50 mi) of the B&W site. This number of expected fatal cancers is much higher than the estimated 1.8×10^{-4} fatal cancers that could result from present-day annual B&W facility operations.

Workers at the B&W site receive the same dose as the general public from background radiation, but they receive an additional dose from working at the facility. Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers, the number of excess fatal cancers to B&W facility workers from operations in 1994 is estimated to be 7.2×10^{-3}. Table

Table 3.5.9–2. Representative Annual Doses to the General Public From Normal Operation of the Babcock & Wilcox Naval Nuclear Fuel Division and Commercial Nuclear Fuel Plant (committed effective dose equivalent)

Receptor	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual[b]	Standard[a]	Actual[b]	Standard[a]	Actual
Maximally exposed individual (mrem)	10	4.6×10^{-2}	4	4.0×10^{-3}	25	5.0×10^{-2}
Population within 80 km[c] (person-rem)	None	0.3	None	0.05	None	0.35
Average individual within 80 km[d] (mrem)	None	5.7×10^{-4}	None	9.5×10^{-5}	None	6.6×10^{-4}

[a] The standards for individuals are given in 40 CFR 61, 141, and 190. As discussed in these regulations, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 25 mrem/yr is the limit from all pathways combined.

[b] BW 1995b:1; BW NRC 1991a.

[c] In 1990, this population was approximately 525,000.

[d] Obtained by dividing the population dose by the number of people living within 80 km of the site.

3.5.9–3 presents the average, maximum, and total occupational doses to B&W facility workers from operations in 1994. These doses fall within radiological limits (10 CFR 20).

Table 3.5.9–3. Doses to the Onsite Worker From Normal Operation of the Babcock & Wilcox Naval Nuclear Fuel Division, 1994 (committed effective dose equivalent)

Receptor	Onsite Releases and Direct Radiation	
	Standard[a]	Actual[b]
Average worker (mrem)	None	10
Maximally exposed worker (mrem)	5,000	3,300
Total workers (person-rem)	None	18

[a] 10 CFR 20. NRC's goal is to maintain radiological exposure ALARA.

[b] BW 1995b:1; NRC 1995b. The number of badged workers in 1993 was approximately 1,800.

Chemical Environment. The background chemical environment important to human health consists of the following: atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in previous sections of this EIS, particularly Sections 3.5.3 and 3.5.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (for example, air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations via inhalation of air containing pollutants released to the atmosphere by B&W facility operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in Section 3.5.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Appendix E, Section E.3.4.

Health impacts to B&W facility workers during normal operations may include those from the

following: inhalation of the workplace atmosphere, drinking B&W site potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to accurately summarize these impacts; however, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. B&W facility workers also are protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded.

Health Effects Studies. Data searches have been made for studies and/or information on the epidemiology in communities near the B&W site; however, no literature or database information has been identified. In addition, the Campbell County Health Department had no reports available. No epidemiologic information was available from the Campbell County Health Department, the Virginia State Office of Health Hazardous Control, or the Virginia State Department of Environmental Quality.

Accident History. The B&W site is a nuclear fuel manufacturing facility and is heavily inspected by Federal, State, and local agencies. Incidents over the last 10 years have included a few localized (onsite) minor chemical spills, all of which were cleaned up. There have been no reported incidents of radiological exposures or releases. There have been four reported incidents of occupational injuries that required treatment; all of the injuries were transient.

Emergency Preparedness. Sites that are licensed to operate by NRC are required to have extensive emergency preparedness programs, including plans and resources to deal with any emergency situation that may occur. Adequate resources must be available to protect the workers, the public, and the environment from unlikely hazards that may occur during a facility's lifetime.

3.5.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities at B&W NNFD. To meet the requirements of its current NRC license, NNFD ensures compliance with Federal and State regulations for water, air, and land disposal in addition to facility permits. Agencies responsible for enforcement and inspection at NNFD include NRC, the Virginia State Department of Environmental Quality, the Department of Health-Division of Radiological Health, the Air Pollution Control Board, and the Waste Management Control Board.

Wastes produced at this facility are categorized as low-level, mixed low-level, hazardous, and nonhazardous. Activities at NNFD that generate waste include uranium recovery, recovery of scrape zirconium and copper, waste compaction, waste processing, and research related to the recovery of uranium. Incoming materials to the facility include uranium, zirconium, copper, HEU, nitric acid, hydrofluoric acid, water, and natural gas. Exit streams from the facility include product fuel elements and assemblies; recovered metals; and gaseous, liquid, and solid waste.

The low-level, process, and sanitary liquid wastes produced are each treated in a different element of the waste treatment facility where they will result in an effluent suitable for environmental release. A discussion of the waste management activities at B&W is presented below:

High-Level Waste. The B&W site does not generate or manage HLW.

Transuranic Waste. The B&W site does not generate or manage TRU waste.

Low-Level Waste. Operations at B&W produce both liquid and solid LLW. Liquid LLW is produced in the manufacturing, recovery, and gaseous emission cleanup operations. Manufacturing process liquid waste includes acid pickling solution for metal parts, low level acid solutions from uranium dissolution, wash water from the laundry and personnel stations, analytical laboratory liquids, and scrubber water from the acid treatment operations. The total daily volume of these liquid wastes is 76 m^3 (20,000 gal) (BW NRC 1995a:8). Liquid LLW from recovery operations includes scrap dissolution liquids and scrubber solutions from gaseous emission control equipment. The total daily volume of liquid waste produced from recovery operations is approximately

57 m^3 (15,000 gal). Additionally, 3.8 m^3/day (1,000 gal/day) of LLW are produced from the NNFD Research Laboratory. This liquid waste stream is treated prior to release from the laboratory to comply with 10 CFR 20 requirements concerning release to an unrestricted area (BW NRC 1995a:10).

The LLW streams produced are treated in the liquid LLW treatment system. Treatment methods include acid neutralization, precipitation of metals, liquid clarification (using microfiltration system), and sludge filtration. This batch-mode system is designed to process 246 m^3/day (65,000 gal/day). The LLW stream from the NNFD Research Laboratory is transferred directly to the neutralization tank in batches of 3.8 m^3 (1,000 gal) (BW NRC 1995a:10). The liquid and sludge effluent separated in the clarifier are processed independently. After the complete treatment process, final dried solids are produced that have a uranium content of 6 milligrams (mg)/l (BW NRC 1995a:10). The solids are transferred to 208-l (55-gal) drums for offsite disposal at a licensed LLW disposal facility. Liquid effluents from the process undergo hot acid equalization and chlorination and are ultimately released into the James River in accordance with the NPDES permit (BW NRC 1995a:10).

Solid LLW results from manufacturing, liquid waste management, and incineration, and includes paper, small pieces of equipment, and miscellaneous trash. A fraction of the solid waste produced is incinerated and the remaining is packaged for offsite disposal. A supercompactor exists onsite that compacts 208-l (55-gal) drums containing LLW. During past operations at NNFD, the total solid LLW volume has been approximately 620 m^3/yr (22,000 ft^3/yr). [Text deleted.] Compaction reduces the solid LLW volume to approximately 283 m^3/yr (10,000 ft^3/yr) with an average radionuclide content of 118 becquerel per cubic centimeter (Bq/cm^3) (90 microcuries per cubic feet [µCi/ft^3]) (BW NRC 1995a:16).

Mixed Low-Level Waste. The Naval Nuclear Fuel Division processes uranium-containing F-listed solvents using distillation. The sludge bottoms from this process are categorized as mixed LLW. The mixed LLW is packaged and stored onsite at a dedicated facility (15.8 m^3 or 76 drums with a 55-gal capacity) until disposal becomes feasible (BW NRC 1995a:2-10). The volume of mixed LLW generated annually decreased from 28.3 m^3 to 14 m^3 (1,000 ft^3 to 500 ft^3) from 1990 to 1995 (BW NRC 1995a:16).

Hazardous Waste. Liquid hazardous waste is produced from acid pickling, metals cleaning, and emissions control operations at the rate of 151 m^3/day (40,000 gal/day) (BW NRC 1995a:10). Solid hazardous waste is produced through the liquid hazardous waste treatment operations. The primary methods for treating the liquid hazardous waste are acid neutralization, dissolved solids precipitation, liquid clarification, and sludge filtration. Liquid effluent from the treatment system is ultimately discharged to the James River in accordance with the facility's NPDES permit. Prior to 1990, the resulting sludge from the nonradioactive wastewater treatment system was buried in an onsite landfill. Currently, sludges from this process are packaged and disposed of offsite. [Text deleted.] These neutralization filter cake solids were categorized by the Virginia Department of Environmental Quality as an F-listed hazardous waste. The filter cake solids generated from the acid pickling operations are stored onsite for less than 90 days and processed at an offsite facility to render them nonhazardous.

Nonhazardous Waste. Process liquid waste is generated at the rate of 1,400 m^3 (370,000 gal) per day and is treated prior to release. Sanitary liquid waste is generated at the rate of 178 m^3/day (47,000 gal/day) and processed in a section of the waste treatment facility (BW NRC 1995a:10-13). The primary processes for this facility are size reduction, aeration, clarification, and chlorination, with a capacity of 606 m^3/day (160,000 gal/day) (BW NRC 1995a:2-11). As with the other treatment processes, the effluent is ultimately discharged into the James River in accordance with the facility's NPDES permit. Solid nonhazardous waste generated at the rate of 1,700 m^3/yr (60,010 ft^3/yr) includes miscellaneous trash and paper, classified paper, and scrap zirconium and copper (BW NRC 1995a:16). Approximately 455 t of paper are sold for offsite recovery each year. Scrap zirconium and copper are also recovered and sold for recycling. Miscellaneous trash is sorted, incinerated if appropriate, and packaged for offsite disposal at the Lynchburg Sanitary landfill.

3.6 NUCLEAR FUEL SERVICES, INC., ERWIN, TENNESSEE

The NFS facility has been in operation since 1958. It occupies 25.5 ha (63 acres) within the city limits of Erwin, Tennessee. The NFS plant produces nuclear reactor fuel for the U.S. Naval Reactor Program, processes scrap materials to recover uranium, and develops other nuclear fuels containing enriched uranium. The affected environment includes operations data for the processing of U.S. Naval Reactor Program material in 1994. The location of NFS and its vicinity is shown in Figure 3.6–1.

The following sections describe the affected environment at NFS for land resources, site infrastructure, air quality and noise, water resources, geology and soils, biotic resources, cultural and paleontological resources, socioeconomics, public and occupational health, and waste management.

3.6.1 LAND RESOURCES

Land Use. The NFS site is located in Unicoi County in the city of Erwin and immediately northwest of the unincorporated community of Banner Hill (Figure 3.6–1). The site is situated upon relatively level land in a long, narrow mountain valley (Indian Creek Valley). The valley is bounded on both sides by the Appalachian Mountains, which rise to elevations of 900 to 1,500 m (2,950 to 4,920 ft) within several kilometers of the site. Offsite land use within 4.8 km (3.0 mi) of NFS is shown in Figure 3.6.1–1. This total area of 7,320 ha (18,100 acres) consists primarily of residential (1,010 ha [2,500 acres] or 13.8 percent), industrial (322 ha [796 acres] or 4.4 percent), commercial uses (81 ha [200 acres] or 1.1 percent), agricultural/suburban residential (527 ha [1,300 acres] or 7.2 percent), and mountainous forest land (5,380 ha [13,300 acres] or 73.5 percent). The mountainous areas adjoining the valley consist of the Cherokee National Forest. The U.S. Natural Resources Conservation Service has estimated that there are 132 ha (326 acres) of prime and unique farmland within 4.8 km (3 mi) of the site (NF NRC 1991a:3-11). Although the soil conditions on a portion of the NFS site would meet prime farmland soil requirements, given the current site land use, the land would not be available for agricultural use; therefore, the U.S. Natural Resources Conservation Service has determined that no prime farmlands exist on the NFS site (NF USDA 1995a:1). About 60 percent of NFS is developed and occupied by buildings and associated grounds, parking lots, waste ponds, and solid waste burial grounds. The remainder of the site, approximately 40 percent, is undeveloped and includes open fields, brushland, shrub swamp, and woods (NF NRC 1991a:3-9). NFS is bounded in part by Banner Hill Road to the southeast, CSX Transportation to the northwest, and Martin Creek to the northeast (Figure 3.6.1–2). The nearest residences are located within the Banner Hill community immediately southeast of the site, with individual residences located approximately 250 m (820 ft) from the facility main stack (NF NRC 1991a:2-4,3-6).

The only recreational facility located within the NFS site is a softball field outside the secured area for NFS employee use. Nearby recreational opportunities center on water-based recreation. Recreational uses along the section between the origin and mouth of the Nolichucky River at Douglas Lake include swimming, rafting, boating, canoeing, picnicking, and other similar activities. Along the 24-km (14.9-mi) stretch of river downstream of NFS, recreational activities include canoeing, rafting, and using developed riverside recreational facilities, such as picnic tables and parks. Recreational fishing in the short stretch of Martin Creek near NFS is infrequent because limited access roads make it inaccessible to the public (NF NRC 1991a:3-15,3-16).

Visual Resources. The NFS landscape is characterized by relatively level topography. NFS lies within a valley oriented in a southwest-to-northeast direction. Although the original NFS site vegetation has been cleared, the predominant vegetation within the region is deciduous forest mixed with coniferous. The major forest types are the oak-hickory and oak-pine associations and the white pine (NF NRC 1991a:3-32).

The elevation of the developed portion of the site is about 9 m (29.5 ft) above the nearest point on the Nolichucky River. The visual character of the NFS site facilities may be described as consisting of numerous small buildings located within dual chain-link security fencing. The administration building and the guard house are constructed of local brick and the process buildings are predominantly cement block, painted white. Metal "Butler" buildings are

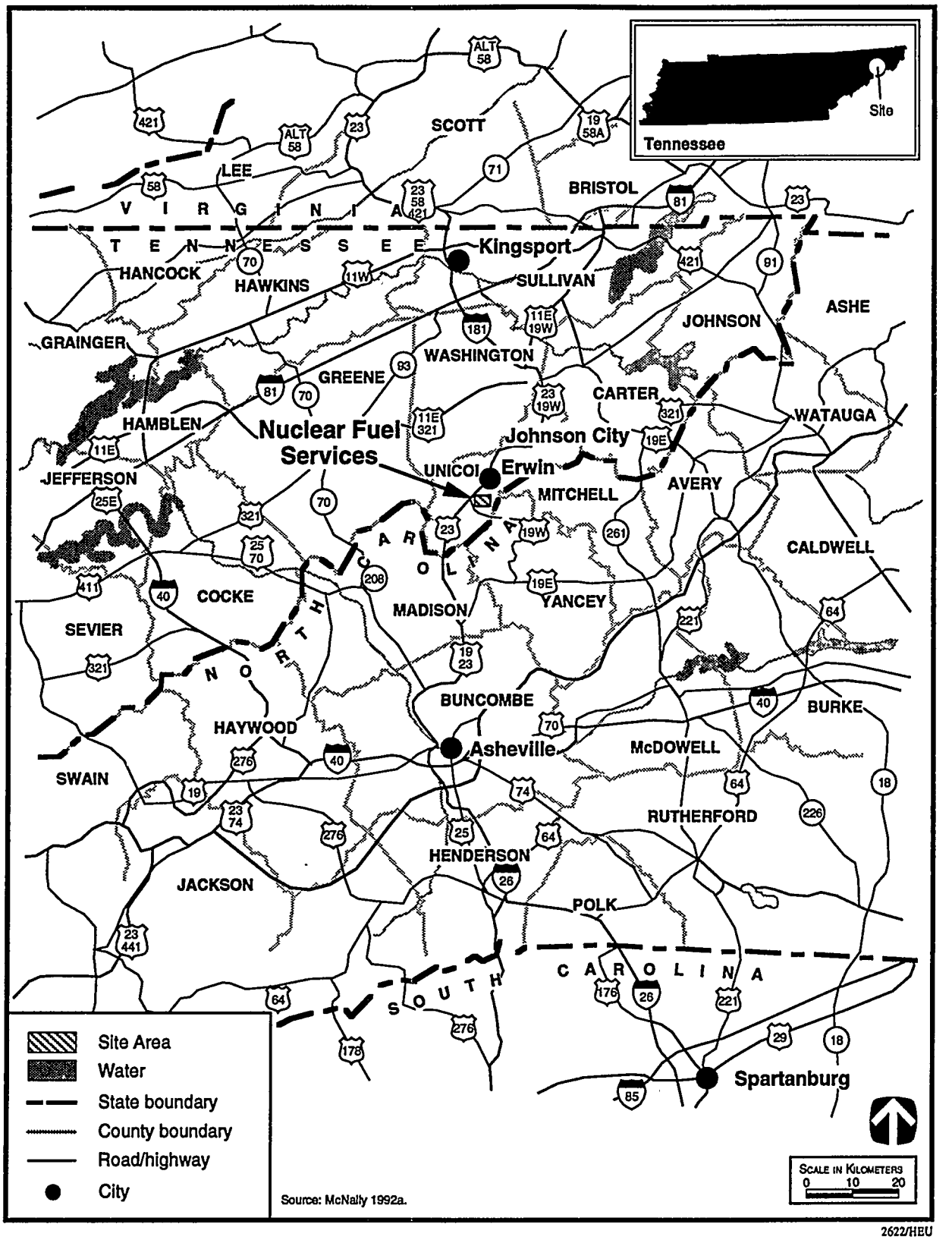


Figure 3.6–1. Nuclear Fuel Services Site, Tennessee, and Region.

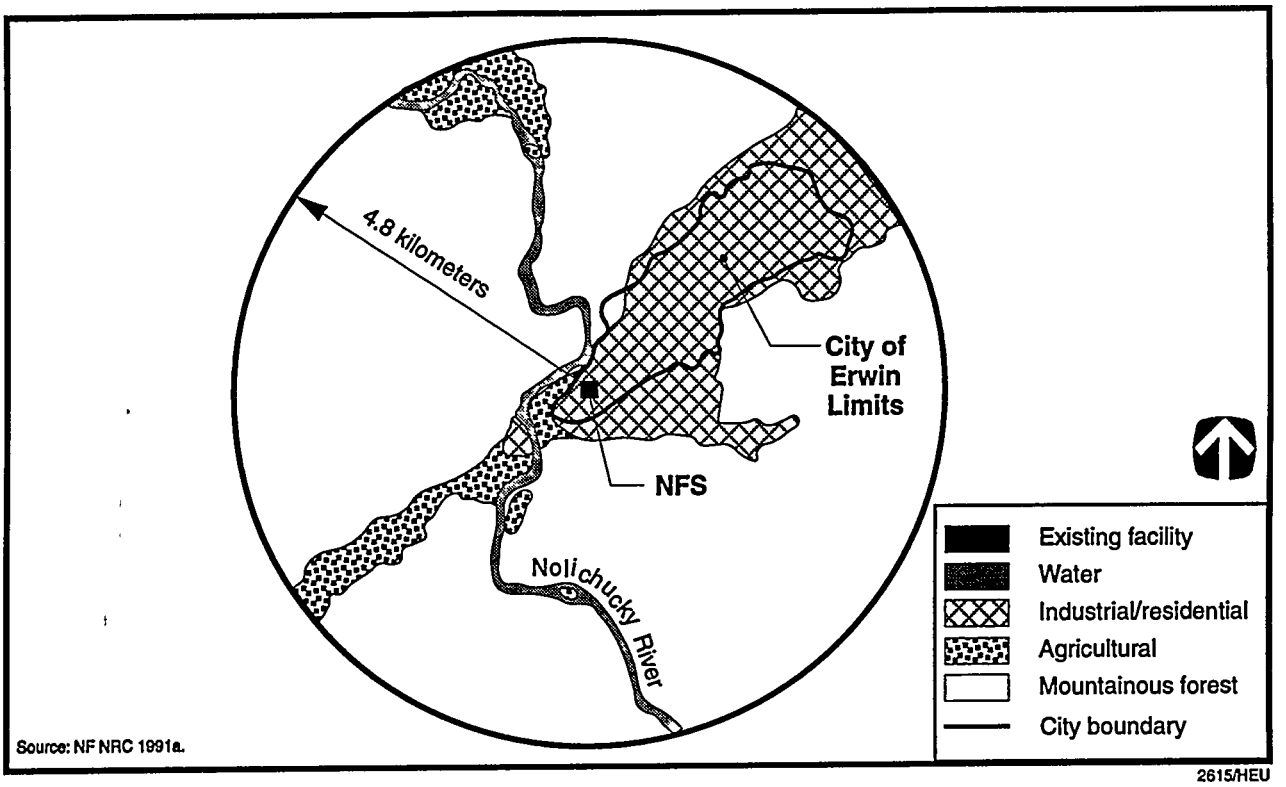


Figure 3.6.1–1. Generalized Land Use at Nuclear Fuel Services Site and Vicinity.

used for storage of equipment and supplies. The majority of the facilities are one to three levels. Retention ponds, radioactive solid waste burial grounds, and contaminated soil piles also are located within the perimeter fence (NF NRC 1991a:2-1).

The visual landscape consists of residential and industrial use. The city of Erwin is the closest population center and Johnson City, approximately 27 km (16.8 mi) north of the site, is the largest nearby population center (NF NRC 1991a:3-7). The facility and its perimeter are brightly lit at night and are highly visible to offsite lands due to the close proximity of development, particularly residential development along Carolina Avenue/Banner Hill Road.

3.6.2 SITE INFRASTRUCTURE

Site Description. The site is surrounded mostly by privately owned property and is bounded in part by Banner Hill Road to the southeast, CSX Transportation to the northwest, and Martin Creek to the northeast. About 60 percent of the site is or has been used for activities associated with the nuclear materials operations licensed by NRC, and is occupied by plant buildings, building grounds, outdoor storage areas, settling ponds, solid waste burial grounds, and a parking lot. The remainder of the site includes woods, brushland, shrub swamp, and open fields.

The primary mission of NFS operation is to convert HEU into a classified product used in the Naval Reactor Program. The classified production procedures are unique to the U.S. Naval Reactor Program. In addition, NFS is involved in research and development of improved manufacturing techniques, recovery and purification of scrap uranium, removal and/or recovery of material generated in manufacturing waste streams to prevent environmental degradation, operation of a chemistry lab, and decommissioning of unused facilities.

The facility consists of numerous small buildings within dual chain-link security fencing (Figure 3.6.1–2). Remediated retention ponds, formerly used for liquid waste, are also within the security fence immediately northeast of the facility buildings. Burial grounds that

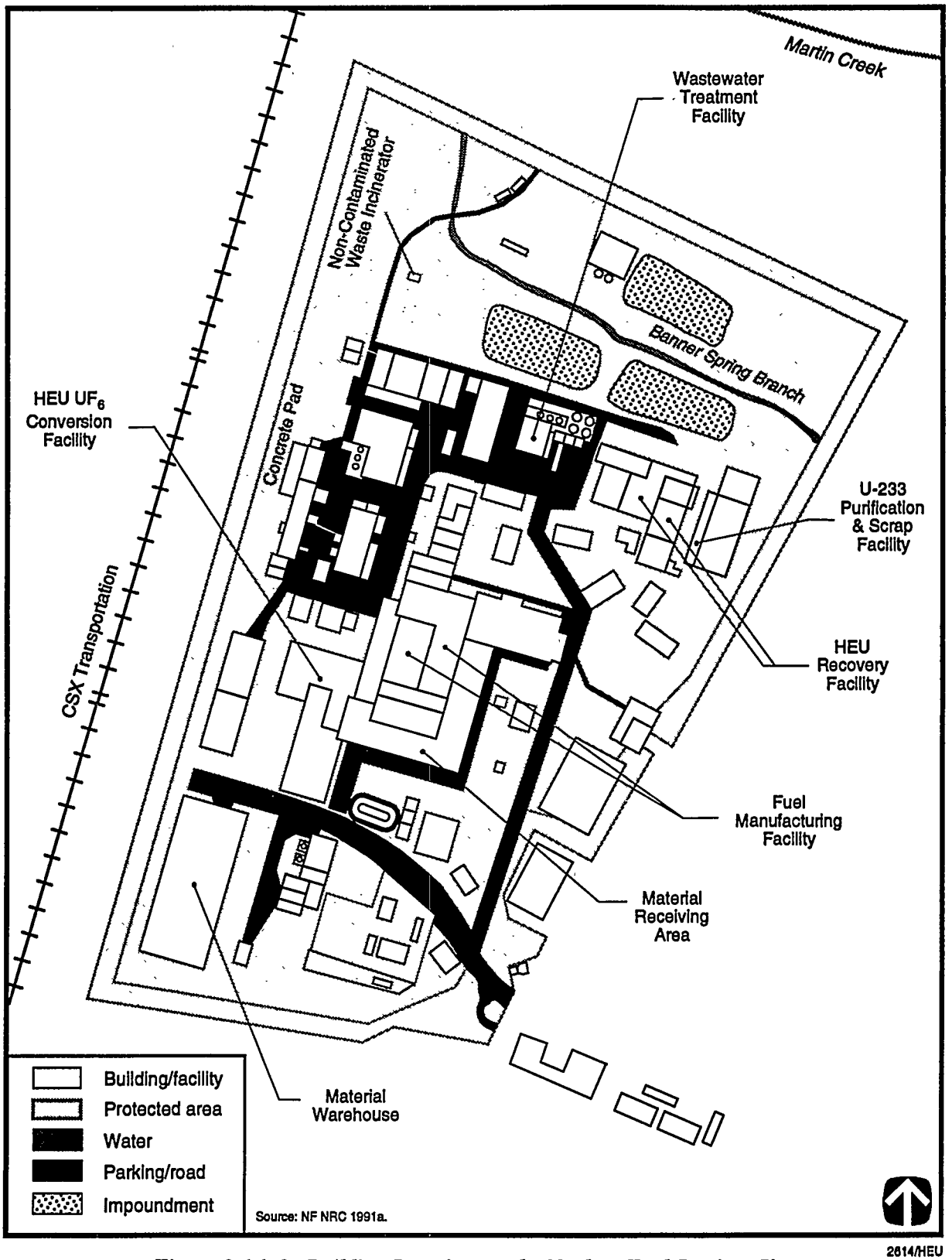


Figure 3.6.1–2. Building Locations at the Nuclear Fuel Services Site.

were used for radioactive solid waste are outside the security fence, north of the retention ponds, but inside a chain-link fence. The principal production area of NFS consists of several buildings where highly enriched UF_6 is converted in a series of steps into a classified nuclear fuel product. Process steps in which ammonia and fluoride may be present are vented through a packed-bed scrubber. In addition to being scrubbed, certain process steps that have a high dust potential are vented through high-efficient particulate air (HEPA) filters. Gaseous effluents from these devices are discharged into the 300-Complex ventilation system.

Nuclear Fuel Services has decommissioned buildings that once fabricated reactor fuel elements that contained a mixture of uranium and Pu. A Pu decommissioning plan for these buildings was approved in 1989, with decommissioning being completed in 1994.

Environmental Regulatory Setting. The NFS facility at Erwin, Tennessee, is regulated by NRC, who issued a 4-year license renewal to NFS in June 1992. NRC provides compliance with CEQ regulations (40 CFR 1500-1508) by issuing an EA and a FONSI of the license issuance (NF NRC 1991a:1-6). While the NFS facility operates in compliance with its license, NRC regulates on the basis of the reduction of emission of radionuclides to ALARA levels; therefore, it may request the reduction of emissions below the regulated level when such reductions can be reasonably achieved. A request for license renewal has been submitted by NFS since their license expires in June 1996. The NRC has placed NFS in a "timely renewal" which allows the site to continue operating until the NRC has completed a new EA and the licencing process.

A request for license renewal has been submitted by NFS since their license expires in June 1996. The NRC has placed them on a "timely renewal" status which allows the site to operate until the NRC has completed a new EA and the licensing process.

Radioactive material is released to the atmosphere through stacks at the NFS facility. The main plant stack discharges approximately 90 percent of the gaseous emissions, with the remaining emissions distributed through short stacks and roof vents. Nonradioactive air emissions are regulated by the TDEC-Division of Air Pollution Control. The site is in compliance with 10 CFR 20 for radionuclide emissions to unrestricted areas and with the *Clean Air Act* for hazardous and solid constituents.

Liquids discharged from NFS enter the Nolichucky River through a single NPDES-permitted outfall. Three other outfalls that do not empty into the Nolichucky are described in Section 3.6.4. The effluent is monitored to ensure compliance with 10 CFR 20 for radionuclide content discharged to unrestricted areas and for chemicals described in the NPDES permit. In addition, NRC requires the facility to demonstrate compliance with CWA and recommends that the licensee notify NRC within 30 days if the TDEC-Division of Water Pollution Control, revokes, supersedes, conditions, modifies, or otherwise nullifies the effectiveness of the State-issued NPDES permit. In addition, the licensee must notify NRC within 30 days of any violation of the permit. NFS also samples sewage sent to the Erwin, Tennessee, Public Owned Treatment Works (POTW) and reports gross alpha activity, isotopic uranium concentrations, and flow rates. Sewage discharges have met 10 CFR 20.2003 (previously 10 CFR 20.303) limits for radionuclides, but in the past, uranium was concentrated in the treatment plant sludge. Since that time, NFS reduced the volume of uranium entering the sewer by 98 percent, and now treats most of its waste onsite.

Low-level, hazardous, and nonhazardous solid wastes are staged onsite for shipment to offsite disposal facilities. The TDEC-Divisions of Water Pollution Control and Solid Waste Management review NFS operation for compliance with CWA and RCRA regulations. Solid waste disposal practices are in compliance with all applicable regulations. Prior to 1977, process wastewater was allowed to settle in unlined ponds. These ponds have not been utilized since the late 1970s, and NFS has removed all sediment through its ongoing decommissioning efforts. This decommissioning plan was incorporated into NFS' NRC license by amendment. In addition, low-level and mixed low-level solid wastes were disposed of onsite. These burial sites have been partially remediated to prevent migration of hazardous and radiological constituents, and are monitored regularly. Decommissioning plans and the financial commitment to remediate these sites have been incorporated into NFS' license.

Pollution Prevention. Pollution prevention at NFS is mandated by various statutes, regulations, and governmental agency directives. The NFS pollution prevention program is designed to achieve continuous reduction of wastes and pollutant releases to the maximum extent feasible, in accordance with regulatory requirements. A comprehensive effluent and environmental monitoring program is conducted onsite to demonstrate compliance with appropriate environmental protection standards and to provide, where possible, site-specific data to assist in the prediction of environmental impacts. The site's environmental monitoring program monitors radiological releases; airborne discharges from stacks; and nonradiological pollution of surface water, groundwater, cooling water, soil, and vegetation.

Baseline Characteristics. NFS contains extensive production, research, and waste processing capabilities. To support current missions and functions, an infrastructure exists as shown in Table 3.6.2–1. The site is accessed by CSX Transportation, I-181, and I-81. The spur from CSX Transportation was removed, but replacement is planned for 1996.

Table 3.6.2–1. Nuclear Fuel Services Baseline Characteristics

Current Characteristics	Value
Land	
Area (ha)	25.5
Roads (km)	3
Railroad (km)	0
Electrical	
Energy consumption (MWh/yr)	21,800
Peak load (MWe)	3.5
Fuel	
Natural gas (m^3/yr)	12,900
Diesel/oil (l/yr)	36,000
Coal (t/yr)	0
Steam	
Generation (kg/hr)	6,260
Water Usage (l/yr)	57,000,000

Note: MWh=megawatt hour; MWe=megawatt electric.
Source: NF NRC 1991a; NFS 1995b:2.

3.6.3 AIR QUALITY AND NOISE

The following describes existing air quality, including a review of the meteorology and climatology, in the vicinity of the NFS site. More detailed discussions of the air quality methodologies, input data, and atmospheric dispersion characteristics are presented in Appendix C, Section C.1.7.

Meteorology and Climatology. The climate in the vicinity of NFS is characterized by warm, humid summers and relatively mild winters. Cooler, drier weather in the area is usually associated with polar continental air masses, whereas warmer, wetter weather is associated with gulf maritime air masses.

The average annual temperature at NFS is 13.1 °C (55.5 °F); the average daily minimum temperature is -4.3 °C (24.3 °F) in January; and the average daily maximum temperature is 29.2 °C (84.6 °F) in July. The average annual precipitation is approximately 103 cm (40.7 in). Prevailing wind directions at NFS tend to follow the southwest to northeast orientation of the valley (NF NRC 1991a:3-1). The annual average windspeed is approximately 2.5 m/s (5.5 mph) (NOAA 1994c:3). Additional information related to meteorology and climatology at NFS is presented in Appendix C, Section C.1.7.

The NFS facility is located in Unicoi County, in the Eastern Tennessee-Southwestern Virginia Interstate AQCR. As of January 1995, the areas within this AQCR were designated as in attainment with respect to the NAAQS (40 CFR 81.343). Applicable NAAQS and Tennessee State Ambient Air Quality Standards are presented in Appendix C, Section C.1.3.

One PSD Class I area can be found in the vicinity of NFS. This area, Great Smoky Mountains National Park, is located approximately 75 km (46.6 mi) southwest of NFS. Since the promulgation of the PSD regulations (40 CFR 52.21) in 1977, no PSD permits have been required for any emission source at NFS.

The primary emission source of criteria pollutants at NFS is the heating plant. Other emission sources include chemical processes, vehicles, diesel-powered emergency generators, and incinerators (NF NRC 1991a:2-10). Appendix C, Section C.1.7 presents

emissions of criteria and hazardous/toxic pollutants from NFS.

Tables 3.6.3–1 and 3.6.3–2 present the baseline ambient air concentrations for criteria and toxic/hazardous pollutants at NFS, respectively. As shown in the tables, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise Conditions. The noise environment near NFS is typical of a rural location with DNL in the range of 35 to 50 dBA (EPA 1974a:B-4,B-5). Major noise emission sources within NFS include various industrial facilities, equipment, and machines. The primary source of noise at the site boundary and at residences near roads is expected to be traffic. During peak hours, the plant traffic may be a major contribution to traffic noise levels in the area. At the site boundary, some noise sources onsite may be audible above the background sound levels. The impact of onsite noise sources has not been documented. The State of Tennessee and Unicoi County have not established specific numerical environmental noise standards applicable to NFS..

3.6.4 WATER RESOURCES

Surface Water. There are four major surface water bodies in the immediate vicinity of the NFS Erwin Plant: Banner Spring Branch, North Indian Creek, Martin Creek, and the Nolichucky River (Figure 3.6.4–1). The Banner Spring Branch lies entirely within the site; North Indian Creek is located north of the site boundary; Martin Creek is just outside the site's north boundary; and the Nolichucky River is located west of the site boundary.

Banner Spring Branch is a small spring-fed stream that flows in a northerly direction at a rate of 0.01 to 0.02 m^3/s (0.35 to 0.71 ft^3/s) and empties into Martin Creek at the site boundary. The stream is approximately 366 m (1,200 ft) in length from the spring source to the confluence with Martin Creek. In the past, approximately 0.004 m^3/s (0.141 ft^3/s) of water was used as industrial water for noncontact cooling operations at NFS. When operational, noncontact cooling water was discharged back to this stream at a rate of 0.004 m^3/s or 0.141 ft^3/s (NF NRC 1991a:4-27). Other inputs to the stream from NFS include surface runoff and overflow. Martin Creek is fed from mountain springs, rain, and snow melt drainage from Martin Creek Hollow. The width varies from 2.4 to 4.6 m (7.9 to 15.1 ft) and the depth from a few inches to pools of 0.9 to 1.2 m (3 to 3.9 ft). The flow of the creek varies seasonally from 0.06 to 0.31 m^3/s (2.11 to 11.0 ft^3/s). Martin Creek empties into North Indian Creek approximately 1,220 m (4,000 ft) north of the NFS site, and North Indian Creek discharges into the Nolichucky River about 500 m (1,640 ft) downstream of the site.

The Nolichucky River is formed by the North Toe and Cane Rivers in Yancey and Mitchell Counties. The river flows west from North Carolina and southwest through Tennessee to join the French Broad River, whose watershed forms part of the upper Tennessee River Basin. The average flow of the river onsite is approximately 39 m^3/s (1,380 ft^3/s).

Currently, no surface water is being used on the site. Approximately 57 million l/yr (15 MGY) of water is are being supplied to the site from the city, which obtains its waters from springs located northeast of the site. In the past, the noncontact cooling loop utilized surface water at a rate of 0.004 m^3/s (0.141 ft^3/s). The Nolichucky River is used as a source of both agriculture and drinking water in the surrounding communities. The city of Jonesborough, located 13 km (8.1 mi) downstream of NFS, is the closest municipal user of water from the Nolichucky River.

The northern third of the NFS site, which contains the HEU recovery area, is located on the 100-year floodplain of the Nolichucky River, where the greatest recorded flood elevation was 501 m (1,643 ft) above mean sea level before NFS was built in 1956. The Tennessee Valley Authority has developed flood criteria for a maximum probable flood for the Nolichucky River. According to these criteria, maximum probable flood discharges would produce a discharge rate of 5,380 m^3/s (190,000 ft^3/s) and a flood stage of 501 m (1,644 ft) above mean sea level at the site. However, flood insurance rate maps and flood profiles published by the Federal Emergency Management Authority (FEMA) have determined the 100-year flood elevation at the site to be at 499.5 m (1,639 ft) above mean sea level (NF FEMA 1984a:20P). In addition, FEMA has estimated the 500-year floodplain to have a discharge of 4,899 m^3/s (173,000 ft^3/s) and a flood stage of

Table 3.6.3–1. Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at the Nuclear Fuel Services Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	NFS Contribution ($\mu g/m^3$)	Percent of Regulations or Guidelines
Carbon monoxide (CO)	8 hours	10,000[a]	1.97	<1
	1 hour	40,000[a]	2.52	<1
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	0.62	<1
Particulate matter (PM_{10})	Annual	50[a]	0.03	<1
	24 hours	150[a]	0.21	<1
Sulfur dioxide (SO_2)	Annual	80[a]	0.02	<1
	24 hours	365[a]	0.15	<1
	3 hours	1,300[a]	0.35	<1
Mandated by Tennessee				
Total suspended particulates (TSP)	24 hours	150[c]	0.21	<1
Gaseous fluorides (as HF)	1 month	1.2[c]	0.02	1.7
	1 week	1.6[c]	<0.06[d]	<3.8
	24 hours	2.9[c]	0.06	2.1
	12 hours	3.7[c]	0.1	2.7
	8 hours	250[c]	0.11	0.04

[a] Federal standard.

[b] No emissions from existing sources.

[c] State standard or guideline.

[d] The ISCST2 code does not calculate weekly concentrations; therefore, the 24-hour concentration was used.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; NF DEC nda; TN DEC 1994a; TN DHE 1991a.

Table 3.6.3–2. Estimated Concentrations of Toxic/Hazardous Pollutants From Existing Sources at the Nuclear Fuel Services Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines[a] ($\mu g/m^3$)	NFS Contribution ($\mu g/m^3$)	Percent of Regulations or Guidelines
Ammonia	8 hours	1,700	129	7.6
Nitric acid	8 hours	520	3.3	0.6

[a] State standard.

Source: NF EPA 1994a; TN DHE 1991a.

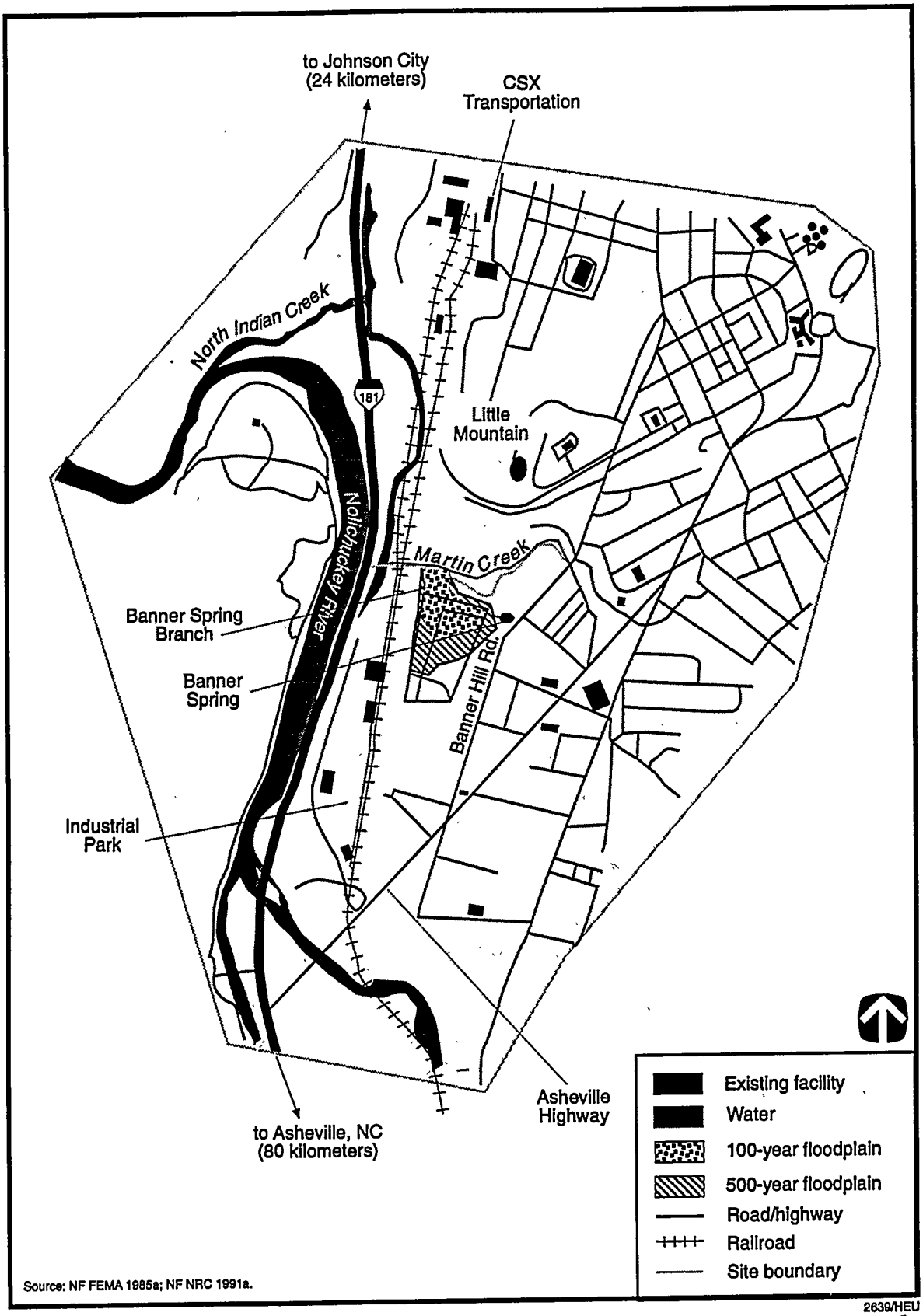


Figure 3.6.4–1. Surface Water Features and Location of 100- and 500-Year Floodplain Area at the Nuclear Fuel Services Site.

500 m (1,641 ft) above mean sea level at the site (NF FEMA 1984a:20P). Elevations of the building floors are between 500 and 510 m (1,640 to 1,670 ft) above mean sea level. The construction of the highway between the site and the river, the rechanneling of the river associated with the highway construction, and the rerouting of Martin Creek to enter the Nolichucky farther downstream from the site have slightly lowered the previously expected flood levels at the site. A significant flood (not reaching 100-year flood levels) on the Nolichucky River in November 1977 did not result in the flooding of any buildings on NFS; however, damage to homes, roads, and bridges was reported in the city of Erwin. Warning devices and systems are in place along the river to warn the public and the plant of the chance of possible flooding. The NFS site has Emergency Plans in place to contact the city of Jonesborough Water Treatment Facility as well as other local, State, and national committees, and inform them when any accidental releases from the plant have occurred. During flooding or because of accidental releases to surface water, the Jonesboro Water Treatment Plant closes off the water intake valves, so no contamination to the public water supply occurs.

Surface Water Quality. The streams and creeks of Tennessee are classified by the TDEC and defined in the State of Tennessee Water Quality Standards. Classifications are based on water quality, designated uses, and resident aquatic biota. Banner Spring Branch, Martin Creek, and the Nolichucky River are all classified for fish and aquatic life, livestock watering and wildlife, irrigation, and recreation. The Nolichucky River is also classified for domestic water supply.

Nuclear Fuel Services has four outfalls (001, 002, 003, and 004) regulated by NPDES permit, pretreatment permit, or stormwater NPDES permit. Approximately 18.9 million l/yr (5 MGY) of effluents from the wastewater treatment plant are discharged through Outfall 001 to the Nolichucky River. This outfall has the permitted capacity to discharge 38.6 million l/yr (10.2 MGY). Currently, no noncontact cooling water from the site is being discharged through Outfall 002 to Banner Spring Branch; however, when operational, this outfall has the capacity to discharge 0.004 m^3/s (0.141 ft^3/s). Approximately 38 million l/yr (10 MGY) of sanitary waste is discharged to Erwin Public Owned Treatment Works. This outfall has no permitted capacity. Stormwater is discharged to Banner Spring Branch through Outfall 004 and subsequently flows to Martin Creek, North Indian Creek, and then to the Nolichucky River. Sluice gates are in place along the flow path and could be closed should a spill occur.

The radiological water quality characteristics of Martin Creek are typical of background levels found in surface waters, and Banner Spring Branch is slightly higher than the background levels. The nonradiological water quality characteristics of Banner Spring Branch are typical of the area. The spring is monitored on a daily (Monday through Friday) basis downstream of the discharge for pH and flow. Ammonia, nitrate, fluoride, and mercury levels in the branch are analyzed weekly by NFS. With the exception of nitrate, all parameters analyzed are comparable to background levels and are within acceptable parameters for protection of water quality and aquatic life. The source of elevated nitrate in the branch may be from septic tanks or offsite fertilization of lawns and gardens east of Banner Hill Spring (NF NRC 1991a:4-27).

The nonradiological water quality of Martin Creek has not been determined upstream of the NFS site; however, the quality of the water in the creek has probably been affected by the flow through the Erwin Fish Hatchery located approximately 180 m (591 ft) upstream from NFS. The water quality of the Nolichucky River is influenced by runoff and silt from mica and feldspar tailings generated during previous mineral mining at Spruce Pine, North Carolina, located over 200 km (124 mi) to the east of NFS. No gauging or water quality stations are located upstream of NFS; however, samples were taken during the NFS effluent toxicity study and are provided in Table 3.6.4–1.

Surface Water Rights and Permits. The State of Tennessee's water rights laws are codified in the *Water Quality Control Act*. The water rights are similar to riparian rights in that the designated usages of a water body cannot be impaired. The only requirement to withdraw water from available supplies would depend on intake location. Construction may require a 26 A permit from Tennessee Valley Authority, review by the Watts Bar Inter-Agency Working Group, a State Aquatic Resources Alteration Permit, or a U.S. Army Corps of Engineers permit to construct intake structures.

Table 3.6.4–1. Summary of Surface Water Quality Monitoring at the Nuclear Fuel Services Site

Parameter	Unit of Measure	Water Quality Criteria and Standard[a]	Nolichucky River[b]	Banner Spring Branch[c]
Ammonia	mg/l	NA	0.06	0.02
Arsenic	mg/l	0.05[d]	<0.001	0.001
Barium	mg/l	2[d]	<0.01	0.01
Bio oxygen demand	mg/l	NA	<1	1
Boron	mg/l	NA	<0.2	0.01
Cadmium	mg/l	0.006[d]	<0.001	0.001
Chemical oxygen demand	mg/l	NA	99	5
Chloride	mg/l	250[e]	1	2
Chromium	mg/l	0.05[f]	<0.001	0.001
Cobalt	mg/l	NA	<0.01	0.01
Copper	mg/l	1.3[d]	0.006	0.006
Dissolved oxygen	mg/l	NA	9	7.3
Fluoride	mg/l	4[d]	0.1	0.12
Iron	mg/l	0.3[e]	1	0.23
Lead	mg/l	0.015[d]	<0.01	0.01
Magnesium	mg/l	NA	1	6.6
Manganese	mg/l	0.05[e]	18	1
Mercury	mg/l	0.002[f]	<.0002	0.0002
Molybdenum	mg/l	NA	<0.01	
Nickel	mg/l	0.1[d]	0.01	0.02
Nitrate and Nitrite	mg/l	10[d]	0.45	2.2
Phosphate	mg/l	NA	0.04	0.03
Potassium	mg/l	NA	1	
Settleable residue	mg/l	NA	0.1	0.1
Silver	mg/l	0.1[e]	<0.001	0.02
Sodium	mg/l	NA	1.4	4
Sulfate	mg/l	250[e]	4	12
Suspended residue	mg/l	NA	19	2
Temperature	°C	NA	14.5	23.3
Total organic carbon	mg/l	NA	<1	1
Total residue	mg/l	NA	57	103
[Text deleted.]				
Zinc	mg/l	5[e]	<0.009	0.006

[a] For comparison only.

[b] Chemical and physical characteristics of 1983 water samples from the Nolichucky River upstream of the NFS discharge.

[c] Chemical and physical characteristics of 1983 waters samples from the Banner Spring Branch noncontact cooling water discharge.

[d] National Primary Drinking Water Regulation (40 CFR 141).

[e] National Secondary Drinking Water Regulation (40 CFR 143).

[f] Tennessee State Water Quality Standard.

Note: NA=not applicable.

Source: NF NRC 1991a.

Groundwater. Shallow unconfined groundwater at NFS is contained in the alluvium of the Nolichucky River and its tributaries and in residual soils developed on the Shady and Honaker Dolomites and Rome Formation (Section 3.6.5). Deeper groundwater is contained in solution cavities and fractures of the Shady and Honaker Dolomites and in fractures in the Rome Formation and the basal clastics.Only the dolomites are considered to be deep well sources of municipal and industrial water. In addition, numerous springs yielding large quantities of water are located in the dolomitic rocks of the Shady and Honaker Dolomites and in the Rome Formation near the contact with the underlying Shady Dolomite. Depth to groundwater varies from the ground level where the springs contact the surface to approximately 4.2 m (13.8 ft) at NFS.

Aquifer discharge and recharge take place readily through the alluvium of the Nolichucky River and its tributaries. The heterogeneous mixture of sand, gravel, and boulders in the alluvium is highly permeable, permitting rapid recharge to deeper aquifers through open solution cavities or fractures.

There are no Class I, sole-source aquifers that lie beneath NFS. All aquifers are considered Class II aquifers (current potential sources of drinking water). Because of the abundance of surface water, no groundwater is used for NFS operations. All water is supplied by the Erwin Public Utility System, which obtains water from springs and groundwater wells located northeast of the site. Approximately 57 million l/yr (15.1 MGY) of water is supplied to the site.

Groundwater Quality. Water quality in the area is generally good. The principal dissolved constituents of the groundwater are calcium, magnesium carbonate, and bicarbonate, regardless of the production zone geology. This reflects the regional influence of dolomitic host rocks on groundwater quality. Some nitrate was present (0 to 12 ppm), and total dissolved solids ranged from 90 to 189 ppm. There is no early record of well completions in the Quaternary alluvium; therefore, baseline groundwater quality in that unit is unknown.

Currently, groundwater contamination occurs in the Quaternary alluvium adjacent to the settling ponds, beneath the buried holding tanks, and beneath the radioactive solid waste burial ground (NF NRC 1991a:4-32). There is also slightly contaminated groundwater beneath the CSX Transportation right-of-way. This area is the only documented offsite area of groundwater contamination. Banner Hill Spring is not presently contaminated; however, it is not known whether the Quaternary alluvium northeast of the site is contaminated. NFS currently analyzes groundwater samples for a number of nonradiological parameters on a routine basis. In the past, samples were analyzed for ammonia, nitrate, fluoride, mercury, and pH. As part of the hydrogeologic characterization for the pond decommissioning, groundwater samples were analyzed for general chemicals, heavy metals, radiochemicals, and organic chemicals. Samples collected near the ponds exhibit significant chemical contamination (NF NRC 1991a:4-29). NFS currently has 10 pump-and-treat wells in place in the ponds' vicinity and treats the groundwater prior to discharge to the sanitary sewer.

At Banner Hill Spring (on the NFS facility), nitrate and total dissolved solids were actually lower in 1980 than in 1948. Also, the gross alpha content was below that of Erwin Utilities municipal water supply and the Birchfield well located several thousand feet downstream from the NFS facility. Recent groundwater quality data for Erwin Utilities springs and wells are presented in Table 3.6.4–2.

Groundwater Availability, Use, and Rights. No groundwater is used onsite. All drinking water is obtained from the city of Erwin. Municipal drinking water supplies in the area are primarily taken from groundwater wells and from springs: O'Brien Spring, Birchfield Spring, and three springs collectively referred to as the Anderson-McInturff Spring located northeast of the site. Groundwater rights in Tennessee are traditionally associated with the Reasonable Use Doctrine. Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights reasonably in relation to the similar rights of others (VDL 1990a:725). Additionally, the owner's use of groundwater for off-lying land may be unreasonable, and therefore unlawful, if the withdrawals for the off-lying land impair a neighbor's water supply or usage.

Table 3.6.4–2. Summary of Groundwater Quality Monitoring at the Nuclear Fuel Services Site

Parameter	Unit of Measure	Water Quality Criteria and Standard[a]	Existing Conditions: Banner Hill Spring 12/80	O'Brien Spring 6/78	Birchfield Spring 6/78	Anderson-McInturff Springs 6/78	Composite[b] 8/78	Birchfield Well 8/84
Alpha (gross)	pCi/l	15[c]	0.4	NA	NA	NA	0.1	0.6
Arsenic	mg/l	0.05[c]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/l	2[c]	0.03	0.05	0.05	0.03	0.06	<0.1
Cadmium	mg/l	0.006[c]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloride	mg/l	250[d]	5.3	3.5	4.5	4.7	5.7	3
Chromium	mg/l	0.05[e]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/l	1.3[c]	0.03	0.026	0.013	0.011	0.052	0.023
Fluoride	mg/l	4[c]	0.28	0.86	1.02	0.26	0.81	<0.2
Hardness	mg/l	NA	88	49	85.7	81.8	80	NA
Iron	mg/l	0.3[d]	0.05	0.011	0.011	0.005	0.023	0.268
Lead	mg/l	0.015[c]	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Manganese	mg/l	0.05[d]	0.029	0.001	0.003	0.001	0.003	0.02
Mercury	mg/l	0.002[e]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate	mg/l	10[c]	1.78	0.77	0.81	0.87	0.22	0.74
pH	pH units	6.5-8.5[e]	NA	NA	NA	NA	NA	NA
Selenium	mg/l	0.05[c]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	mg/l	0.1[d]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium	mg/l	NA	10.2	0.4	1.6	1.4	1.3	1.5
Sulfate	mg/l	250[d]	1.9	<0.2	2.8	<0.2	1.3	2
Total dissolved solids	mg/l	500[d]	99	115	190	189	94	158
Zinc	mg/l	5[d]	0.009	0.018	0.055	0.02	0.068	0.013

[a] For comparison only.

[b] Municipal water mixed from O'Brien, Birchfield, and Anderson-McInturff Springs.

[c] National Primary Drinking Water Regulations (40 CFR 141).

[d] National Secondary Drinking Water Regulations (40 CFR 143).

[e] Tennessee State Water Quality Standard.

Note: NA=not applicable.

Source: NF NRC 1991a.

3.6.5 GEOLOGY AND SOILS

Geology. The NFS site lies in the Valley and Ridge physiographic province of northeastern Tennessee. The stratigraphy of the area is very complex because much folding and faulting has occurred. The topography consists of a series of alternating valleys and ridges that have a northeast-southwest trend, with NFS occupying a valley. Three dolomite formations underlie the valley: the Shady, Knox, and Honaker Formations. They are associated with a large band of sandstone, siltstone, shale, dolomite, and limestone called the Rome Formation (NF USDA 1985a:1). Large areas of these formations are covered by deep soils found in colluvium from the adjacent mountains and alluvium from the larger streams. The present topography of the valleys is the result of stream erosion of the softer shales and limestones; the ridges are underlain by the more resistant shale, sandstone, and quartzite. Metamorphic and intrusive rocks of the Blue Ridge physiographic province lie southwest and southeast of NFS.

The NFS site lies in the moderately active Appalachian Tectonic Belt which is located in Seismic Zone 2, indicating that moderate damage could occur as a result of earthquakes (Figure 3.3.5–1). NFS is cut by many inactive faults formed during the late Paleozoic Era. There is no evidence of capable faults in the immediate area of NFS within the definition of 10 CFR 100; the nearest capable faults are located 100 km (62.1 mi) southwest and 200 km (124 mi) northeast of the site. Strong earthquakes over time originating in more active regions southwest of the site (New Madrid, Missouri, and Charleston, South Carolina) have been felt in eastern Tennessee, but no damage has been experienced at the site. A maximum horizontal ground surface acceleration of 0.18 gravity at NFS is estimated to result from an earthquake that could occur once every 2,000 years. The facilities at NFS that would be used for blending would meet the target performance to withstand an earthquake with an acceleration of 0.18 gravity (NFS 1996a:1).

Soils. The NFS facility lies on the Buncombe and Cotaco soil series. These soils consist of deep, moderately well-drained to excessively drained sandy and loamy soils on floodplains and terraces bordering stream channels (for example, Nolichucky River). These soils were formed in recent alluvium washed from mountainous areas and from soils underlain by quartzite, granite, and gneiss (NF USDA 1985a:47,49). Slopes range from 0 to 2 percent. Water and wind erosion (0.009 tons per acre-year) is low to moderate and shrink-swell potential is low. Permeability ranges from moderate to rapid, and available water capacity is low to high. The U.S. Department of Agriculture rates the Cotaco and the Buncombe soil series as having severe soil limitations and being poorly suited for construction because of the rapid permeability and the flood hazard (NF USDA 1985a:80).

At NFS, bedrock strata are consolidated, making firm foundations for buildings that lie directly on the strata or that are supported by footings; however, structures that are constructed on the unconsolidated alluvium from the floodplain and terraces of the Nolichucky River are subject to settlement during the first 2 to 3 years after construction (NF NRC 1991a:3-25,3-27).

The Cotaco soils that underlie the southwest portion of NFS have been designated by the U.S. Department of Agriculture as prime farmland, but the area is not presently under cultivation (NF USDA 1985a:29). The U.S. Department of Agriculture has estimated that there are 132 ha (326 acres) of prime and unique farmland within 5 km (3.1 mi) of the NFS plant (NF NRC 1991a:3-11). Important crops include tobacco, hay, corn, tomatoes, and strawberries.

Soil samples are collected quarterly from several locations on the site and analyzed for gross alpha radioactivity. Multi-year averages during 10 years (1979 to 1989) indicate that the alpha and beta activities are slightly elevated when compared to background samples; however, the samples are well below the limit of 30 pCi/g of enriched uranium for soil allowed for disposal with no restrictions on method of burial (NF NRC 1991a:4-21).

3.6.6 BIOTIC RESOURCES

Biotic resources at NFS include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each biotic resource area, the discussion describes NFS as a whole. Scientific names of species identified in the text are presented in Appendix D.

Terrestrial Resources. Plant communities at NFS are characteristic of the intermountain regions of central and southern Appalachia. Major forest types in the Erwin area are oak-hickory, oak-pine, and white pine. Valley floors, mountains, and mountain coves have their individual characteristic vegetation types. The natural vegetation of NFS is a forest community dominated by red oak or white oak with subdominants including yellow poplar, hickories, other oaks, and some southern pine species (NF NRC 1991a:3-32). NFS lies within Indian Creek Valley. Plant communities consist of second growth forests and open grassy areas. Most of NFS is occupied by buildings, building grounds, and open fields. A limited area consists of woods, shrub, swamp, and brush; however, nearby mountainous areas are largely undisturbed and support extensive forest and wildlife resources.

The fauna of the Erwin region includes a large number of vertebrate species including 70 mammals, 140 birds, 35 reptiles, and 34 amphibians; however, most of these species would not be expected to occur in Indian Creek Valley because of extensive disturbance and lack of natural habitats. The woods, swamps, and brushy areas onsite or in the vicinity are likely to support more species. Common species include European starling, northern cardinal, mourning dove, Carolina chickadee, opossum, eastern cottontail, and house mouse. The most important game species of the region include whitetail deer, eastern gray squirrel, ruffed grouse, and wild turkey, which occur in the forests of the surrounding mountains but are not common onsite. Eastern cottontails, mourning doves, and northern bobwhites are present in most areas within Indian Creek Valley (NF NRC 1991a:3-34). Carnivores, such as the gray fox, and raptors, such as the red-tailed hawk, are ecologically important groups in the NFS vicinity.

Wetlands. Wetlands at NFS include streams and shrub swamps (riverine and palustrine wetland types, respectively). The streams include Martin Creek, just outside the site's northeast boundary, and Banner Spring Branch, which flows through the site. A small shrub swamp located near Banner Spring is less than 1 ha (2.47 acres) in size (NF NRC 1991a:3-11, 3-12).

Aquatic Resources. Aquatic habitat on or adjacent to NFS ranges from the Nolichucky River to several small streams. Banner Spring Branch is a small onsite stream that contains several species of minnows and some trout in its lower reaches. Martin Creek is typical of creeks in eastern Tennessee. The stream bed is composed of sand, pebbles, rocks, and some organic matter. A State-operated fish hatchery is located on a tributary to Martin Creek approximately 180 m (591 ft) upstream of NFS. The Nolichucky River in the Erwin vicinity contains a substrate of rocks, sand, boulders, and little aquatic moss. Riffles and large pools provide good smallmouth bass habitat. Other fish species present in the Nolichucky River include olive darters, catfish, largemouth and spotted bass, central stonerollers, and white crappie.

Threatened and Endangered Species. Twenty Federal- and State-listed threatened, endangered, and other special status species that potentially occur on and in the vicinity of NFS are presented in Appendix D, Table D.1–5. No Federal-listed threatened or endangered species are known to occur onsite. In addition, no Federal-listed aquatic species occur in the Nolichucky River, in the immediate vicinity, or downstream of NFS; however, the highfin carpsucker and sharphead darter, listed as species in need of management by the TDEC, are found in the Nolichucky River in the Erwin vicinity. Several plant species listed rare by the TDEC have been recorded in the vicinity of NFS (NF NRC 1991a:3-36, 3-37, C-1).

3.6.7 CULTURAL RESOURCES

Prehistoric Resources. No cultural resources surveys or excavations have been conducted within NFS; therefore, no prehistoric archaeological sites have been identified within the facility. No NRHP sites are within the facility; however, because of its location along the floodplain of the Nolichucky River, there is the likelihood that some sites that are potentially eligible for inclusion on the NRHP may exist within the facility. These sites may include remains of short- or long-term occupations such as hearths, food storage pits, stone tools, or ceramic potsherds.

Historic Resources. No historic archaeological sites had been identified within NFS by 1996. One abandoned, deteriorated farmhouse is still standing. Some historic archaeological sites may exist, such as

remains of residential structures or outbuildings and associated artifacts. No NRHP historic sites are located within the facility. There are two NRHP sites within Unicoi County. One is the Clarksville Iron Furnace on Tennessee State Highway 107 in the Cherokee National Forest, approximately 16 km (9.9 mi) west of the facility. The other is the Clinchfield Depot in Erwin. The depot was built in 1925 by the Carolina, Clinchfield, and Ohio Railroad.

Native American Resources. The Overhill Cherokee once lived in the vicinity of NFS. Most Overhill Cherokee villages were located along the Little Tennessee and Hiwassee Rivers, 128 km (79.5 mi) southwest of NFS, but they may have used the area for hunting and gathering activities. The Cherokee were allied with the British during the Revolutionary War. After the war, they remained in the region and became farmers and landowners. During the 1830s, most of the Cherokee were removed from this region to Oklahoma as part of the Trail of Tears. Some Native American resources may be located within the boundaries of NFS.

Paleontological Resources. The stratigraphy at NFS consists of siltstone, silty limestone, and shale with some sandstone. No paleontological surveys or excavations have been conducted at NFS, and no paleontological resources are known within the facility. Some invertebrate fossils may exist in the limestone and shale strata; however, these are probably common rather than rare or significant fossils. The probability of significant or rare paleontological resources existing at NFS is low.

3.6.8 SOCIOECONOMICS

Socioeconomic characteristics described for NFS include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses nine counties around NFS in the States of Tennessee and Virginia. (Appendix F, Table F.1–1). As stated in Section 3.2, the geographic region comprising the REA is determined by Bureau of Economic Analysis and is based on economic links between communities in the region. Statistics for population, housing, community services, and local transportation are presented for the ROI, a four-county area, located in the State of Tennessee, in which 91.7 percent of all NFS employees reside: Carter County (8.3 percent), Sullivan County (2.8 percent), Unicoi County (40.9 percent), and Washington County (39.7 percent) (Appendix F, Table F.1–5). It should be noted that there are no counties in North Carolina where significant numbers of NFS employees reside; therefore, neither the REA nor the ROI contain North Carolina jurisdictions. Supporting data are presented in Appendix F.

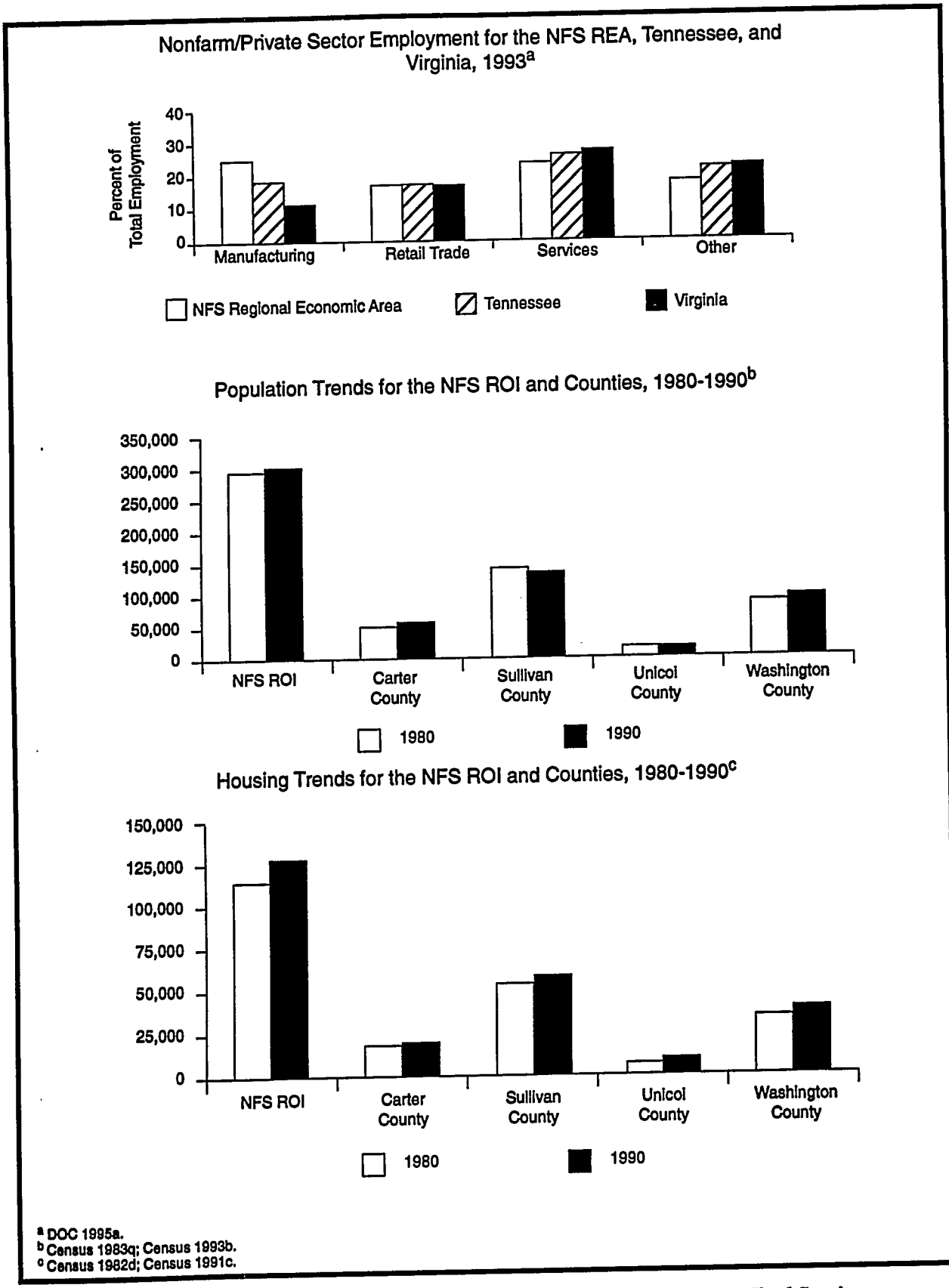
Regional Economy Characteristics. Between 1980 and 1990, the civilian labor force in the REA increased 10.6 percent to the 1990 level of 252,178. In 1994 unemployment in the REA was 5.9 percent, which was approximately 1 percent greater than both Tennessee and Virginia. The region's per capita income of $16,309 in 1993 was 11.5 and 24.7 percent less than the per capita incomes of $18,439 in Tennessee and $21,653 in Virginia, respectively. Employment and local economy statistics and projections for the proposed action period for the NFS REA are presented in Appendix F, Table F.1–9 and summarized in Figure 3.6.8–1.

In 1993, as shown in Figure 3.6.8–1, the percentage of total employment involving the private sector activity of retail trade was similar in the REA (17 percent) and the two States. Manufacturing in the region (25 percent of total employment) represented a greater share of the economy than in the States of Tennessee (19 percent) and Virginia (11 percent). Services in the REA (22 percent) represented a 4 percent smaller share of the economy than in Tennessee and a 6 percent smaller share of the economy than in Virginia.

[Text deleted.]

Population and Housing. In 1992, the ROI population totaled 310,430. From 1980 to 1990, the ROI population increased by 1.6 percent compared to 6.2 percent for Tennessee. Within the ROI, Washington County experienced the largest increase at 4 percent, while Sullivan County's population decreased by 0.3 percent. Population trends are summarized in Figure 3.6.8–1. [Text deleted.]

The total number of housing units between 1980 and 1990 increased 12 percent, nearly 4 percent less than the increase in housing units for the entire State. In



[a] DOC 1995a.
[b] Census 1983q; Census 1993b.
[c] Census 1982d; Census 1991c.

Figure 3.6.8–1. Economy, Population, and Housing for the Nuclear Fuel Services Regional Economic Area and Region of Influence.

1990, the total number of housing units was 127,856. The 1990 homeowner vacancy rate in the ROI was 1.6 percent, which was similar to the vacancy rate for Tennessee. The rental vacancy rate for the ROI counties was 5.6 percent, approximately 4 percent less than the rental vacancy rate for the entire State. (A presentation of population and housing statistics and projections is presented in Appendix F, Tables F.1–13 and F.1–17, respectively.)

Community Services. Education, public safety, and health care characteristics are used to assess the level of community service in the NFS ROI.

Education. In 1994, eight school districts provided public education services and facilities in the NFS ROI. These school districts ranged in enrollment size from 2,547 students in the Elizabeth City School District to 14,550 students in the Sullivan County School District. The average students-to-teacher ratio for the ROI was 18:1. The Washington County School District had the highest ratio at 19.2:1. Figure 3.6.8–2 presents school district characteristics for the NFS ROI.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents in the ROI. In 1993, a total of 542 sworn police officers served in the four-county area. Sullivan County employed the greatest number of sworn police officers (307) and had the highest officers-to-population ratio (2.1 officers per 1,000 persons). The average ROI officers-to-population ratio was 1.7 officers per 1,000 persons. Figure 3.6.8–3 presents police force strengths for the ROI.

Fire protection services in the NFS ROI were provided by 1,201 regular and volunteer firefighters in 1995. The fire department with the highest firefighters-to-population ratio is located in Sullivan County, with 4.6 firefighters per 1,000 persons. Sullivan County also employed the greatest number of firefighters (694). The firefighters-to-population ratio in the ROI was 3.7 firefighters per 1,000 persons. Figure 3.6.8–3 presents fire protection service characteristics for the ROI.

Health Care. There were eight hospitals serving the four-county ROI in 1993. All eight hospitals operated below capacity with hospital occupancy rates ranging from 31 percent in Carter County to 68 percent in Sullivan County.

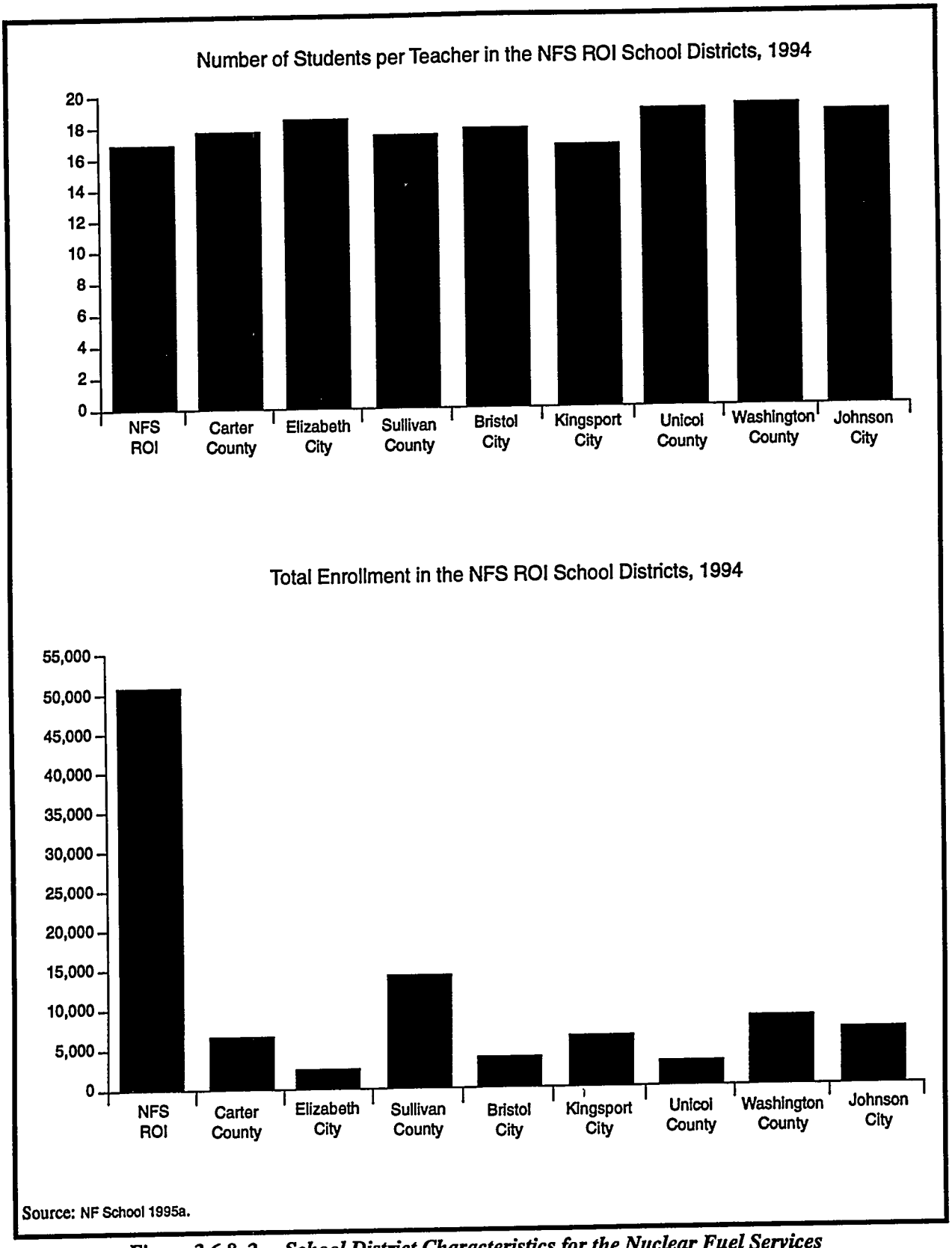
There were 848 practicing physicians in the ROI during 1993, with most (415) practicing in Sullivan County. The physicians-to-population ratio ranged from 0.6 physicians per 1,000 persons in Carter and Unicoi Counties to 4.1 physicians per 1,000 persons in Washington County. The average ROI physicians-to-population ratio was 2.7 physicians per 1,000 persons. Figure 3.6.8–3 presents health care characteristics for the ROI.

Local Transportation. Interstate highways, U.S. highways, and State Routes provide access between NFS in Erwin, Tennessee, and metropolitan areas illustrated in Figure 3.6–1. The north-south highway, I-181, is located west of the facility and provides access to Johnson City, Tennessee. I-81 is northwest of NFS and connects to east-west highway SR-107, providing access to Greenville, Tennessee, via U.S. 321. Access to Asheville, North Carolina, is provided by north-south highway U.S. 19W/23, located to the south of NFS.

Vehicular access to NFS is provided by U.S. 19W/23. I-181 has been extended to the North Carolina State line. This should improve traffic conditions around Erwin. The expansion of I-181 does not currently interfere with local traffic near Erwin. There are no road projects planned in the near future that will affect access to NFS directly (TN DOT 1995a:1).

There are no public transportation systems providing service to the site. The site is accessed by CSX Transportation. The spur from CSX Transportation was removed, but replacement is planned for 1996. There is no access to NFS by navigable waterway.

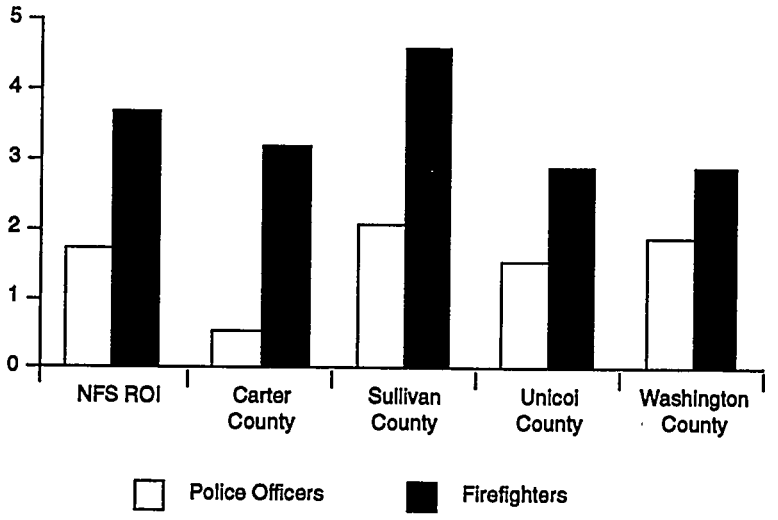
The Tri-Cities Regional Airport, located north of Johnson City, is the nearest airport serving the region with major carriers providing passenger and cargo service (DOT 1992a).



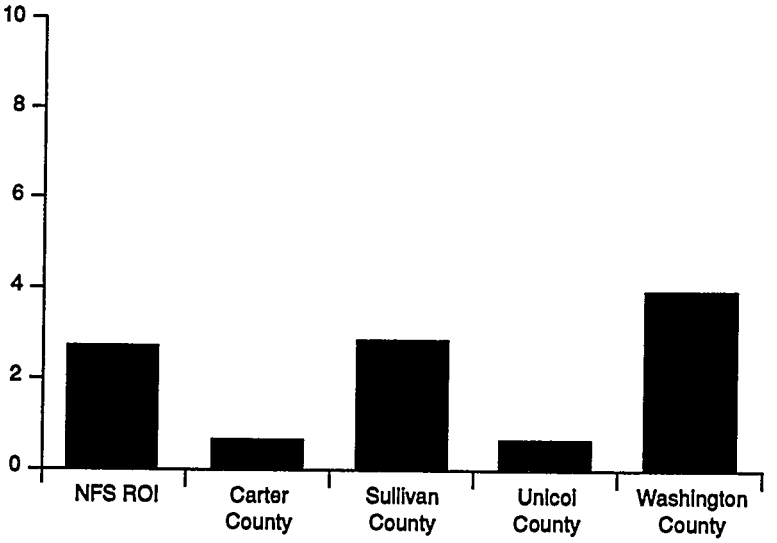
Source: NF School 1995a.

Figure 3.6.8–2. School District Characteristics for the Nuclear Fuel Services Region of Influence.

Number of Sworn Police Officers (1993) and Firefighters (1995) per 1,000 Persons in the NFS ROI[a]



Number of Physicians per 1,000 Persons in the NFS ROI, 1993[b]



[a] Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j; DOJ 1994a; NF Fire 1995a.
[b] AMA 1994a; Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.
Note: Except for ROI cities, city sworn officers and firefighters are included in the county totals. Kingsport Fire Department in Sullivan County and Limestone Cove Volunteer Fire Department in Unicoi County were excluded from the NFS ROI total because firefighter data were unobtainable.

Figure 3.6.8–3. Public Safety and Health Care Characteristics for the Nuclear Fuel Services Region of Influence.

3.6.9 PUBLIC AND OCCUPATIONAL HEALTH

Radiation Environment. All residents in the vicinity of the NFS facility are exposed to background radiation from a variety of natural and man-made sources. The major sources of background radiation exposure to individuals in the vicinity of NFS are shown in Table 3.6.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population.

Releases of radionuclides to the environment from NFS facility operations provide another source of radiation exposure to individuals in the vicinity of the site. These radionuclides and their representative associated release quantities for normal operations are presented in site-specific environmental reports. The doses to the public resulting from these releases and direct radiation are presented in Table 3.6.9–2. These doses fall within radiological limits and are small in comparison to background radiation.

Table 3.6.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Nuclear Fuel Services Facility Operations

Source	Committed Effective Dose Equivalent (mrem/yr)[a]
Natural Background Radiation	
Cosmic radiation	45
External terrestrial radiation	70
Internal terrestrial radiation	25
Radon in homes (inhaled)	200
Other Background Radiation	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	405

[a] NCRP 1987a; NFNRC 1991a. Value for radon is an average for the United States.

Furthermore, these radiological releases were used in the development of the reference environment's radiological releases at NFS for the public and occupational health segments within Section 4.3.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public, the fatal cancer risk to the MEI of the public due to representative annual radiological releases from NFS site operations is estimated to be approximately 1.6×10^{-8}. That is, the estimated probability of this person dying of cancer in the future from radiation exposure associated with 1 year of NFS operations is less than 2 chances in 100 million. (It may take several years from the time of exposure for cancer to manifest.)

Based on this same risk estimator, approximately 1.0×10^{-4} excess fatal cancers to the population living within 80 km (50 mi) of NFS are estimated from a normal operating year. This number can be compared with the numbers of fatal cancers expected in this population from all causes. The average mortality rate associated with cancer for the entire U.S. population is presently 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers from all causes expected to occur annually is 1,840 for the population living within 80 km (50 mi) of NFS. This number of expected fatal cancers is much higher than the estimated 1.0×10^{-4} fatal cancers that could result from present-day annual NFS facility operations.

Workers at NFS receive the same dose as the general public from background radiation, but receive an additional dose from working at the facility. These doses fall within radiological limits (10 CFR 20). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers, the number of excess fatal cancers to NFS facility workers from operations in 1994 is estimated to be 6.5×10^{-3}. Table 3.6.9–3 presents the average, maximum, and total occupational doses to NFS facility workers from operations in 1994.

Chemical Environment. The background chemical environment important to human health consists of the following: the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example,

Table 3.6.9–2. Representative Doses to the General Public From Normal Operation of the Nuclear Fuel Services Fuel Fabrication Facilities, 1994 (committed effective dose equivalent)

Receptor	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual[b]	Standard[a]	Actual[b]	Standard[a]	Actual
Maximally exposed individual (mrem)	10	3.2×10^{-2}	4	9.0×10^{-4}	25	3.3×10^{-2}
Population within 80 km[c] (person-rem)	None	0.2	None	1.4×10^{-3}	None	0.2
Average individual within 80 km[d] (mrem)	None	2.2×10^{-4}	None	1.5×10^{-6}	None	2.2×10^{-4}

[a] The standards for individuals are given in 40 CFR 61, 141, and 190. As discussed in these regulations, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 25 mrem/yr is the limit from all pathways combined.

[b] NF NRC 1991a; NFS 1995b:1.

[c] In 1990, this population was approximately 921,400.

[d] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Table 3.6.9–3. Doses to the Onsite Worker From Normal Operation of the Nuclear Fuel Services Fuel Fabrication Facilities, 1994 (committed effective dose equivalent)

Receptor	Onsite Releases and Direct Radiation	
	Standard[a]	Actual[b]
Average worker (mrem)	None	50
Maximally exposed worker (mrem)	5,000	470[c]
Total workers (person-rem)	None	16.3

[a] 10 CFR 20. NRC's goal is to maintain radiological exposure ALARA.

[b] NFS 1995b:2; NRC 1995b. The number of badged workers in 1994 was approximately 325.

[c] NFS 1995b:2; NRC 1995b. From one-half year of operation.

surface waters during swimming and soil through direct contact, or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are presented in previous sections of this EIS, particularly Sections 3.6.3 and 3.6.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (for example, air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations via inhalation of air containing pollutants released to the atmosphere by NFS facility operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in Section 3.6.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Appendix E, Section E.3.4.

Health impacts to NFS facility workers during normal operations may include inhalation of the workplace atmosphere, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to accurately summarize these impacts; however, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. NFS facility workers also are protected by adherence to occupational standards that limit workplace

atmospheric concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded.

Health Effects Studies. Data searches have been made for studies and/or information on the epidemiology in communities near the NFS site; however, no literature or database information has been identified. In addition, the Unicoi County Health Department had no reports available. The TDEC was requested to provide reports or information from epidemiologic studies conducted on area residents; the TDEC Epidemiology Program Office was not aware of any studies conducted by local or State personnel.

Database/literature searches have produced one study on kidney disease among plant workers, with guards, and local dairy farmers used as the comparison groups (NIOSH 1988a:1). NFS employees showed a higher prevalence of kidney stones than guards but lower than dairy workers. Although there was greater prevalence of urinary tract infections for workers at NFS than for the cohort groups, the authors did not link this finding to occupational hazards at NFS. Details of the study are presented in Appendix E, Section E.4.5.

Accident History. NFS is a nuclear fuel manufacturing facility and is heavily inspected by Federal, State, and local agencies. As such, NFS has maintained an exemplary record relating to strict compliance to all applicable regulations. NFS has never experienced a fatality resulting from work-related activities, nor has a criticality accident ever occurred at NFS. NFS has never been cited by the Occupational Safety and Health Administration (OSHA) or the Tennessee OSHA for any infraction, and within the past 7 years, NFS has had no reportable radiological over-exposures and no reportable offsite chemical releases.

Emergency Preparedness. Sites that are licensed to operate by NRC are required to have extensive emergency preparedness programs, including plans and resources to deal with any emergency situation that may occur. Adequate resources must be available to protect the workers, the public, and the environment from unlikely hazards that may occur during a facility's lifetime.

3.6.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities at NFS. NFS's waste management operations are in compliance with their NRC license; with Federal regulations for water, air, and land disposal; and with State of Tennessee and city of Erwin regulations.

All process waste is treated and discharged to the Nolichucky River through an NPDES-permitted outfall. The TDEC governs air pollution control, water pollution control, and solid and hazardous waste management at NFS. Hazardous and solid LLW are shipped offsite for disposal. NFS has disposed of LLW in the past in onsite burial grounds. Contaminated soil has been removed and placed in a controlled area on the site. Radiological measurements indicate no subsurface migration or groundwater contamination from previously used waste disposal sites (NF NRC 1991a:2-6). Waste management activities at NFS are discussed below.

High-Level Waste. NFS does not generate or manage HLW.

Transuranic Waste. Pu and mixed Pu-uranium fuel materials have been processed in the past; however, those facilities have been decontaminated. There is currently no TRU waste generation, though future decommissioning activities may produce some TRU waste from the removal of residual Pu contamination.

Low-Level Waste. Liquid and solid LLW is generated at NFS. Liquid LLW is generated at the rate of 18,900 m^3/yr (5,000,000 gal/yr) and solid LLW is generated at the rate of 3,000 m^3/yr (106,000 ft^3/yr) (NFS 1995b:2). The bulk of liquid LLW is aqueous process waste. Liquid effluents are treated in the Waste Water Treatment Facility to remove the radioactive constituents, and the treated effluents are discharged within standards established by the State of Tennessee in the NPDES permits and 10 CFR 20. Liquid LLW process facilities have the capacity to treat 38,700 m^3/yr (10,000,000 gal/yr) of liquid waste (NFS 1995b:2). Solid LLW includes operating plant and laboratory waste, Waste Water Treatment Facility sludge, HEPA filters, and

contaminated equipment. Solid LLW is shipped offsite for disposal.

Mixed Low-Level Waste. Mixed waste is generated at the rates of 0.45 m^3/yr (119 gal/yr) for liquids and 0.03 m^3/yr (1.05 ft^3/yr) for solids (NFS 1995b:2). Mixed waste is segregated, packaged, labeled, and managed in accordance with all applicable NRC, EPA, State, and Department of Transportation requirements. Mixed waste may be treated within 90 days of the accumulation start date in compliance with EPA and State of Tennessee regulations; however, if treatment is not feasible, the waste is stored in the NFS RCRA Part B-permitted storage facility until treatment capacity becomes available.

Hazardous Waste. Hazardous waste is segregated, packaged, labeled, and managed in accordance with all applicable EPA, State, and Department of Transportation regulations. The waste is moved to a 90-day storage facility prior to disposal at a permitted hazardous waste disposal facility. Twenty liters (5.3 gal) of liquid and 0.1 m^3 (4.0 ft^3) of solid hazardous waste are generated each year (NFS 1995b:2). [Text deleted.]

Nonhazardous Waste. Process wastewater is treated in the Waste Water Treatment Facility on a batch basis. Treatment includes pH adjustment, precipitation, air stripping, and chlorination. Each batch is analyzed for gross alpha and beta radioactivity before it is discharged to the Nolichucky River through a NPDES permit issued by the State of Tennessee. Thirty-seven thousand eight hundred cubic meters (10,000,000 gal) of liquid sanitary waste and 18,900 m^3 (5,000,000 gal) of liquid process waste are generated each year (NFS 1995b:2).

Sanitary waste is discharged to a sewer system that delivers it to the city of Erwin POTW. Current sanitary waste consists of groundwater treatment facilities effluent and restroom and shower output. A proportional sampling system in the line collects daily samples that are analyzed for gross alpha and beta contamination. Monthly composites of the daily samples are analyzed for uranium isotopes. There are 2,300 m^3 (81,000 ft^3) of solid nonhazardous wastes generated each year (NFS 1995b:2). Solid nonhazardous waste is packaged for offsite disposal.

Surface drainage is controlled and can be stopped along the drainage path in the event that hazardous constituents are detected in the flow. This allows for cleanup of hazardous constituents before the offsite release occurs.

Chapter 4
Environmental Consequences

4.1 METHODOLOGIES

The environmental impact assessment methodologies discussed in this section address the full range of natural and human resource and issue areas pertinent to the sites considered for the EIS alternatives. These resource areas are land resources, air quality and noise, water resources, geology and soils, biotic resources, cultural resources, and socioeconomics. Also included in the discussion are additional issue areas that are not specifically resources but are important to consider in assessing the environmental effects of the alternative blending processes. These issue areas are facilities operation/site infrastructure, intersite transport of HEU and LEU (see Section 4.4), waste management, radiological and hazardous chemical effects during normal operation and accidents, and cumulative effects (see Section 4.6).

As part of the impact assessment process, the analysis includes mitigation measures that are part of the alternatives (for example, part of the facility or process) and provides mitigation measures for DOE facilities that could be used to reduce and minimize potential impacts as appropriate.

4.1.1 LAND RESOURCES

Land resource analysis involves an assessment of the patterns and densities of land use and visual resources. [Text deleted.] The potential for resource impacts are analyzed within the context of related Federal legislation and Executive orders.

Chapter 3 provides a description of land and visual resources for each site. Information was researched by data calls and facility site development/land-use plans, local zoning ordinances and comprehensive plans, and aerial photographs. Site-specific information published in recent NEPA documents is incorporated by reference where appropriate.

A baseline (no action) description of land resources is presented for each site. It discusses current and projected patterns and densities of land use and visual quality at these sites. No action information is assembled from any combination of existing NEPA documents, data calls, direct site contacts, and site visits. Key issues and public concerns pertaining to land resources provide a baseline to establish a framework for environmental consequences discussions.

An analysis of environmental consequences is performed to estimate the magnitude and extent of potential impacts to existing patterns and densities of land use from the alternatives under consideration. Land use analysis assesses the following: availability of adequate land area to operate an HEU building facility; compatibility of the facility with current and projected land use as designated by applicable plans, policies, and controls; potential impacts to prime and unique agricultural lands, wild and scenic rivers, public lands, and other environmentally sensitive lands; qualitative assessment of potential land-use changes in the locale caused by project-induced in-migration; and qualitative assessment of recreational lands lost or impacted. Potential changes to the existing facility layout that may impact land use are assessed.

Visual resource analysis classifies visual resources and assesses potential impacts to the visual environment that could result from the implementation of the alternatives. A methodology for visual resource assessment is based on the Bureau of Land Management VRM methodology. The existing landscape is assigned a VRM classification that ranges from one (a pristine area, including designated wilderness and wild and scenic rivers) to five (an area where the natural character of the landscape has been disturbed to the point that rehabilitation is necessary). [Text deleted.]

Visual resource impacts are assessed using the degree of visual contrast between the proposed facilities or activities and the existing landscape character as seen from viewpoints accessible to the public. Sensitivity levels of viewpoints, and viewpoints and visibility of the affected area are taken into consideration.

4.1.2 SITE INFRASTRUCTURE

Site infrastructure assessment evaluates the change in resource requirements imposed by the proposed alternatives at each site. Site infrastructure impacts are determined by comparing the infrastructure requirements of each alternative with each site's baseline (no action) requirements. Impact assessments focus on electrical power, road and rail networks, fuel requirements, water usage, and steam generation. Site-specific data information documents, site development plans, DOE planning documents, EISs, and EAs were used to determine site infrastructure conditions. Tables depicting current resource requirements and requirements needed at each site for each alternative are presented.

Chapter 3 presents baseline conditions at each site. For the DOE sites, ORR and SRS, the affected environments are the same as the no action alternatives. For the commercial sites B&W and NFS, the affected environments are the same as the no action alternatives, which are based on the most current site information available and their NRC-licensed activities. It is assumed that existing facilities would operate in compliance with their current licenses and permits.

4.1.3 AIR QUALITY AND NOISE

Air Quality. The air quality assessment evaluates the consequences of criteria pollutants associated with each alternative at each site. Air quality impacts are evaluated within the context of EPA's Regulations on National Primary and Secondary Ambient Air Quality Standards (40 CFR 50), the 1990 *Clean Air Act*, National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61), and State-proposed or -adopted standards or guidelines. The assessment of radiological air emission impacts is discussed in the public and occupational health sections. Air quality concentrations from modeling current site emission rates are used to determine baseline concentrations of pollutants at each site. [Text deleted.]

This EIS presents the estimated impacts on air quality based on baseline air quality conditions at all sites and the projected impacts resulting from each of the alternatives. It compares the total concentrations to the most restrictive Federal or State ambient air quality standards and guidelines.

The modeling of site-specific emissions is performed in accordance with EPA's *Guideline on Air Quality Models (Revised)*, EPA-450/2-78-027R, July 1986. The EPA-recommended Industrial Source Complex Short-Term Model (Version 2) is the most appropriate model to perform the air dispersion modeling analysis for this EIS because it allows for the estimation of dispersion from a combination of point, area, and volume sources. More technical information can be found in EPA's *User's Guide for the Industrial Source Complex (ISC2) Dispersion Models*, EPA-450/4-92-008a, March 1992. For source characteristics that are not available, characteristics are assumed based on similar source configurations at sites employing similar processes.

Toxic air pollutants are addressed in both the air quality and noise sections and the public and occupational health sections for each of the candidate sites. In the air quality sections, the maximum concentration of toxic air pollutants at or beyond the site boundary is compared with a Federal, State, or local standard to determine compliance. In the Public and Occupational Health sections, a health risk is calculated based upon chemical concentration and toxicity compared to the Reference Concentration for the public and the Permissible Exposure Level for workers for noncancer causing chemicals and slope factors for the public and workers for cancer causing chemicals. The cancer effects are a risk that is based on the slope factor (cancer potency) for chemicals that are regulated as carcinogens.

These differences in analytical method result in the different pollutants between the air quality analysis and the public and occupational health analysis. In the air quality analysis, toxic pollutants with low emission rates in most cases will result in extremely low concentrations at the site boundary and therefore are not presented in the air quality analysis. In the public and occupational health analysis, many of these same chemical pollutants may expose an onsite worker located 100 m (328 ft) from the emission source to a health risk, and therefore are presented in this analysis. The hazardous chemical pollutants used by these two disciplines to evaluate impacts will be different. Compliance to standards does not consider what health effects are expected nor the interaction between several chemicals that may together cause

adverse health responses even if they separately are at below standard concentrations.

Noise. The onsite and offsite acoustical environments may be impacted during facility modification and operation. Generic noise sources that may affect nearby residents are briefly discussed for the no action baseline and each of the proposed alternatives.

A description of current conditions for DOE and commercial sites is provided. For each of the alternatives, a qualitative discussion of operation noise sources and the potential for onsite and offsite impacts is provided in the EIS. This discussion is prepared using information available on the potential types of noise sources.

Since most nontraffic noise associated with the operation of HEU facilities is located at a sufficient distance from offsite noise sensitive receptors, the contribution to the offsite noise level is expected to be small.

4.1.4 WATER RESOURCES

The assessment of potential impacts to water resources, which includes surface water, floodplains, and groundwater, addresses the following: 1) whether there is sufficient water available for the project and domestic consumption, 2) whether the water quality is degraded or will be further degraded, 3) whether the proposed actions challenge legislative or regulatory compliance, and 4) whether actions are threatened by flooding.

Surface Water Availability. Surface waters include rivers, streams, lakes, ponds, and reservoirs. An inventory of surface water resources in the project ROI, a description of areas in the ROI currently using surface water, general flow characteristics, reservoirs, and an identification of classifications applicable to the surface water is used to determine the affected environment at each site. Emphasis is placed on those water bodies potentially impacted during the facility modification or operation phases of the alternatives. Current potable and process water supplies and systems, water rights, agreements and allocations, and wastewater treatment facilities also are described as baseline.

For all the blending sites, the rate of water consumption associated with each alternative is compared with each site's baseline availability of water to determine potential effects on water supply. For all the blending sites, potential effects on the availability of water are determined if the proposed project: 1) increases withdrawals either by exceeding the current stream low flow, 2) decreases the stream flow rate to the point where downstream commitments cannot be met, or 3) violates existing water rights, agreements, allocations, or supply limits.

Surface Water Quality. [Text deleted.] The assessment of potential water quality impacts includes evaluation of the type (that is, wastewater effluent), rate, and concentration of potential discharge constituents. Parameters with the potential to further degrade existing water quality or that are in violation of existing NPDES permit limits are identified. Environmental consequences may result if: 1) the surface water flow rate is decreased to the point where the capacity of the stream to assimilate discharges is noticeably diminished, 2) the proposed increases in discharge cannot comply with NPDES permit limits on flow rates or specific constituent contributions, 3) the proposed increases in discharges contribute constituents to receiving waters already identified as exceeding applicable surface water quality criteria, or 4) the proposed increases in effluent cannot comply with pretreatment limits on flow rates or specific constituent contributions.

Floodplains. Floodplains include any lowlands that border a stream and encompass areas that may be covered by the stream's overflow during flood stages. As part of the affected environment discussion at each site, floodplains are identified from maps and environmental documents. Any facility within a 100-year floodplain or a critical action in a 500-year floodplain is considered an environmental consequence. The 500-year floodplain evaluation is of concern for activities determined to be critical actions for which even a slight chance of flooding would be intolerable.

Groundwater Availability. Groundwater includes water that occurs below the water table in saturated, nonconsolidated geologic material (sand or gravel) and in fractured and porous rock. Aquifers are saturated strata containing groundwater. Availability

of groundwater will vary widely over the various sites because it is a function of both the hydraulic characteristics of the aquifers and the rate at which groundwater is withdrawn by other users.

[Text deleted.]

The potential effects to groundwater availability are assessed for each alternative at each candidate site by evaluating whether the proposed project: 1) increases groundwater withdrawals in areas already experiencing overdraft and other related problems (that is, land subsidence), 2) potentially decreases groundwater levels, causing a substantial depletion of the resource, 3) exceeds the water requirement allotment, water rights, or available supply limits, if present, or 4) reduces or ceases the flow of one or more major springs. Suitable mitigation measures to reduce impacts are identified and discussed.

Groundwater Quality. [Text deleted.] The potential groundwater quality environmental consequences are associated with pollutant discharges during facility modification and operation phases (that is, process wastes and sanitary wastes) and are examined for each site to determine if a direct input to groundwater occurs. The results of the groundwater quality projections are then compared to Federal and State groundwater quality standards, effluent limitations, and safe drinking water standards to assess the acceptability of each alternative. Parameters with the potential to further degrade existing groundwater quality are identified for each alternative.

4.1.5 GEOLOGY AND SOILS

The impact assessments for geology and soil resources identify resources that may be affected by the project and the presence of natural conditions that may affect the integrity and safety of the project. Geology resources include mineral resources (that is, energy resources such as coal, oil, and natural gas), unique geologic features, and geologic hazards (that is, earthquakes, faults, volcanoes, landslides, and land subsidence). Soil resources include natural earth materials in which plants grow (usually consisting of disintegrated rock, organic matter, and soluble salts), and prime and unique farmland. Several Federal, State, and local laws have been passed that protect geology and soil resources.

[Text deleted.]

A number of aspects of geology and soil resources are identified as potentially important in the EIS analyses for all sites. Unique or scenic topographic features may be impacted by project activities. Rock units, which may have scenic or other important values or contain mineral or energy resources, may have their condition or accessibility altered. Mineral and energy resources are evaluated from records of past production and reports assessing the potential for future exploitation.

Earthquake potential is evaluated from past events of effective peak velocity-related acceleration, by seismic zone, and by the location of capable faults. Areas of past mass movements and conditions favorable to mass movements, such as excessive slopes and the presence of water, are identified.

Soil units are evaluated for soil erosion potential and characteristics. Prime and unique farmlands that may limit facility operation are evaluated for each site using existing maps and records.

The impact assessments for each site involve locating geologic and soil features of concern and determining how many of those features would be influenced. Impacts of project activities are identified if, during operations, there is destruction or damage to important geological features and if erosion and the potential for subsidence or slope failure is increased. Impacts also are identified if a site is located within any prime or unique farmland or unique geological feature that would be subject to irreversible physical disturbance by the project. Potential operational activities conducted in areas prone to geologic or natural hazards (for example, landslides or earthquakes) are determined and presented. The geology and soil impacts are discussed qualitatively for each alternative, with the exception of presenting the amount of land that would be disturbed or affected during operation of the blending facilities. Mitigation measures to reduce potential impacts to or from geology and soil resources are identified and discussed.

4.1.6 BIOTIC RESOURCES

The assessment of potential impacts to biological resources is performed for terrestrial resources,

wetlands, aquatic resources, and threatened and endangered species. Each category has elements that are important from an ecological, recreational, scientific, and/or commercial standpoint. In addition, several laws specifically protect biological resources. Important legislation and Executive orders include, but are not limited to, the following: the *Endangered Species Act* of 1973; Section 404 permit requirements of CWA; the *Coastal Zone Management Act*, Wetlands Executive Order 11990; the *Migratory Bird Treaty Act;* and the *Fish and Wildlife Coordination Act.* Additional guidance is contained in CEQ's *Incorporating Biodiversity Considerations into Environmental Impact Analysis under NEPA* (January 1993).

Biological impacts are assessed by evaluating changes to the baseline environment (no action) that could result from action associated with each alternative. The baseline conditions at these sites are descriptive and qualitative in nature. Impacts resulting from facility modification or operational activities use the number of acres lost and/or the amount of water consumed or discharged as a basis for assessment. A summary comparison of the blending alternatives and their associated environmental consequences at each site also is provided. In addition, mitigation and monitoring strategies are discussed as appropriate.

Terrestrial Resources. Potential impacts to terrestrial resources include loss and disturbance of wildlife and wildlife habitats, as well as exposure of flora and fauna to air emissions. Two important considerations in assessing the impact of habitat loss are the presence and regional importance of affected habitats and the size of habitat area disturbed, temporarily or permanently.

Impacts on terrestrial plant communities resulting from project activities are evaluated by comparing regional vegetation data to proposed land requirements for both construction and operation. Impacts to wildlife are based to a large extent 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. This EIS evaluates disturbance, displacement, and loss of wildlife in accordance with the wildlife protection laws listed above.

Wetlands. Some potential impacts to wetlands are related to displacement of wetlands. Other impacts could be caused by activities outside of wetland areas (for example, soil erosion, siltation, and sedimentation). Operational impacts may occur from liquid emissions, from surface or groundwater withdrawals, or from the creation of new wetlands. Existing wetlands are described on a site-specific basis.

Impacts to wetlands resulting from proposed alternatives are addressed in a fashion similar to that for terrestrial plant communities. Impacts on wetlands are evaluated and compared to State and Federal regulations under the CWA.

Aquatic Resources. Impacts to aquatic resources depend on the nature of the water body and the aquatic life present. Impacts from loss of habitat, increased water demand, sedimentation, increased flows, and the introduction of waste heat and chemicals are evaluated as described for wetlands. Descriptions include streams, creeks, ponds, and nearby surface water that could be affected. Impacts resulting from operation are evaluated based on both short- and long-term impacts.

Threatened and Endangered Species. Impacts to threatened and endangered species, including critical habitat, are assessed. Information on species, areas of occurrence, and critical habitats are obtained from the U.S. Fish and Wildlife Service. Impacts are determined in a manner similar to that described for terrestrial and aquatic resources, since the sources of potential impacts are similar. Consultations with U.S. Fish and Wildlife Service, as well as State wildlife agencies, are conducted at the site-specific level as necessary. These consultations ensure that HEU blending activities would not adversely impact threatened and endangered species. Loss of biodiversity is assessed in accordance with guidelines from CEQ's *Incorporating Biodiversity Considerations into Environmental Impact Analysis under NEPA* (January 1993).

4.1.7 CULTURAL RESOURCES

The assessment of potential impacts to cultural and paleontological resources involves evaluation of the projected effects to prehistoric, historic, Native American, and paleontological resources. A

description of the baseline (no action) environment based on the identification of resources within a potentially affected site is developed. This description is compiled using reports of previous cultural and paleontological resources studies and surveys. The potential impacts to these resources are discussed, based primarily on acreage disturbed or interference to viewsheds due to a specific alternative.

Prehistoric Resources. Prehistoric resources consist of the physical remnants of human activities that predate written records. They include, but are not limited to, chipped stone tools and the remains of hearths and structures.

Historic Resources. Historic resources consist of the physical remnants of human activities that post-date written records. They include, but are not limited to, residential and commercial structures and trails. In the United States, these are resources that date, in general, from 1492 onward.

Prehistoric and historic resources are primarily protected through the *National Historic Preservation Act* of 1966, the *Archaeological and Historic Preservation Act* of 1979, the *Archaeological Resources Protection Act* of 1979, and their implementing regulations. These laws and regulations establish procedures for the identification, evaluation, and protection of cultural resources.

The prehistoric and historic resources sections discuss how existing resources could be affected at each site. The discussion includes the acreage, if any, that could potentially be disturbed during the implementation of each alternative, the potential to reduce access to these areas, and the potential loss or destruction of these resources. Previous cultural resources studies, including surveys and excavations and the possible presence of sites that are on or are eligible for listing on the NRHP, also are discussed to provide a baseline environment for evaluation of each alternative's potential impacts. Consequences of the no action alternative are discussed. Potential mitigation measures are presented where applicable.

Native American Resources. Native American resources are sites and materials important to Native Americans for religious or heritage reasons. These include, but are not limited to, sacred spaces, cemeteries and burial grounds, and traditional plant gathering areas.

Native American resources are protected under the *American Indian Religious Freedom Act* of 1978 and the *Native American Graves Protection and Repatriation Act* of 1990. These laws and regulations establish procedures for the identification, evaluation, and protection of cultural resources. DOE's American Indian Policy is also considered.

The Native American resources section in the environmental consequences section follows the same format as the prehistoric and historic resources sections when discussing potential impacts. Impacts to Native American resources will be postulated if alternatives have the potential to affect sites important in the Native American physical universe or religion or to reduce access to sacred sites or traditional-use areas.

Paleontological Resources. Paleontological resources consist of the remains, impressions, and traces of plants or animals from a former geological age.

The paleontological resources section in the environmental consequences section follows the same format as the prehistoric, historic, and Native American resources sections in discussing potential impacts and mitigation methods. The potential loss or destruction of these resources that are scientifically important also is discussed.

4.1.8 SOCIOECONOMICS

Socioeconomic impact analysis assesses the environmental consequences of demographic and economic changes resulting from the implementation of each of the proposed alternatives. Increasing the level of activity at operational facilities 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 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.

Four sites, two commercial and two DOE facilities, have been identified as candidate sites for the proposed blending of HEU into LEU as UNH. Both commercial sites contain existing blending capabilities; therefore, no new construction would be required. Socioeconomic impacts from employment needs for the operational phase are assessed. The two commercial facilities are also evaluated as candidate sites for blending HEU into LEU as UF_6. Blending is assumed to take place in existing facilities and no new construction is required. Some additional workers are needed for the operational phase, and socioeconomic impacts are assessed. The ORR facility is also evaluated as a candidate site for blending HEU into LEU as molten metal. Socioeconomic impacts from operational employment needs are assessed in this document.

The use of either the commercial or DOE sites or both would require additional employment; therefore, potential impacts to surrounding communities are assessed. The study focuses on the potential impacts of additional workers on housing availability, health care services, education, public safety, and local transportation. Potential socioeconomic impacts are assessed for the geographic area that would be most affected, the ROI.

Changes to demographic and economic indicators of the REAs and ROIs are assessed by comparing baseline (no action) projections of the affected regions to estimates of project-induced impacts. Baseline projections for the project period are derived from population forecasts developed by Bureau of Economic Analysis.

Proposed project alternatives would require additional workers during operation phases. An analysis of the existing labor availability is performed to determine the number of workers that are needed to come from outside the region. In addition to jobs created directly by the proposed project alternatives, other job opportunities will be indirectly created within the region. These indirect jobs and income are measured by employing the most recent version of the Regional Input-Output Modeling System developed by Bureau of Economic Analysis. Population increases due to the in-migration of new workers and their families are assessed together with their effects on housing, community services, and local transportation.

Environmental Justice Assessment. The environmental justice analysis focuses on potential disproportionately high and adverse human health or environmental effects from the 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. EPA and DOE are in the process of developing implementation guidance concerning Executive Order 12898 and the approach taken in this EIS may differ somewhat from the guidance that is eventually issued and from the approach taken in other EISs. Selected demographic characteristics of region-of-influence (80 km [50 mi]) for each of the four candidate sites were generated from 1990 block level U.S. Census data. The analysis identified census tracts where minorities comprise 50 percent, or simple majority, of the total population in the census tracts, or where minorities comprise less than 50 percent but greater than 25 percent of the total population in the census tract. The analysis also identified low-income communities where 25 percent or more of the population is characterized as living in poverty (yearly income of less than $8,076 for a family of two). Impacts are assessed based on the analysis presented for each resource and issue area for each blending technology at each site. Any disproportionately high and adverse human health or environmental effects on minority and low-income populations are discussed.

4.1.9 Public and Occupational Health

The assessment of impacts to workers and the public for radiological releases from normal blending operations and facility accident conditions for each alternative is performed using the Hanford

Environmental Radiation Dosimetry Software System, Generation II (GENII) and MACCS computer codes, respectively. Impacts from facility accidents were originally estimated in the HEU Draft EIS using the GENII computer code. GENII is generally used and best suited for modeling impacts of radiological releases under normal operation of facilities because it handles a large number of radiological isotopes and accounts for the ingestion pathway. GENII was used with 50-percent meteorology (average meteorological conditions that would occur 50 percent of the time in any given period at the site) during the accident. It was assumed that the noninvolved worker is placed in the sector that yields the maximum dose calculated by GENII and is located 1,000 m (3,280 ft) away (or at the site boundary if less than 1,000 m [3,280 ft]) from the accident. Latent cancer fatalities were calculated by applying this dose to all noninvolved workers at a site. This was done to compensate for a lack of data regarding onsite worker distribution, but yields highly conservative results.

In response to public comments, DOE has revised its analyses to improve the realism in the calculation of noninvolved worker doses. Accidental releases of uranium were remodeled using the MACCS computer code with more detailed site-specific information to better estimate noninvolved worker cancer fatalities at each candidate site. MACCS is a widely used code that offers better capabilities than GENII in terms of modeling accident conditions. MACCS assumes, unlike GENII, that when an accident occurs, food production would be interdicted (no consumption of contaminated food). It uses actual (recorded onsite) meteorological conditions and statistically distributes population dose among sectors based on frequency of wind direction recorded over a 1-year period. MACCS also accounts for various site-specific protective measures such as evacuation sheltering and temporary relocation. All information required for MACCS were gathered including the worker distribution data for each site and incorporated into MACCS runs to obtain a more realistic estimate of potential worker accident consequences (see Appendix E for additional details).

Public Health Risks

The risks to the general public are determined in the following ways: 1) for present operations, doses presented in the most recent environmental or safety reports are used to calculate health risks, and 2) incremental radiological/chemical doses and respective subsequent risks for various blending operations are modeled using site-specific parameters.

The radiological and chemical effluents for the No Action Alternative are obtained from currently reported releases. For each of the other alternatives, radiological and chemical effluents are obtained from data reports specific to each blending process (further supplementary information is presented in Appendix E).

As discussed earlier, radiological impacts under normal operations are obtained using the GENII computer code. The assessment of incremental impacts to the MEI from blending alternatives at two DOE sites, Y–12 and SRS, and at one of the commercial sites, B&W, is directly performed using site-dependent factors such as meteorology and an assumed facility location on the site. Sufficient information exists for these sites for use in GENII to adequately represent ambient conditions (current conditions representing no action) and to calculate incremental increases in the MEI dose due to the proposed blending alternatives. However, for the assessment of impacts at the NFS site, a "calibration" factor (a benchmark ratio) is used to assess the incremental impacts to the MEI since all site-specific parameters required by GENII are not available. In this case, the "calibration" factor is established by dividing the no action dose reported in a recent NFS EA (NF NRC 1991a:4-34) by a corresponding GENII calculated no action dose (the GENII dose was calculated using the release terms in the EA). This benchmark ratio is used to adjust MEI doses calculated by GENII for each blending alternative.

For the calculation of incremental population doses for the two DOE sites, Y–12 and SRS, GENII is run using site-dependent factors such as meteorology, population distributions, agricultural production, and an assumed facility location. The incremental population doses for the two commercial sites, B&W and NFS, however, are calculated using a ratio obtained by dividing the dose to the population within 80 km (50 mi) by the MEI dose reported in the B&W EA (BW NRC 1995a: 73, 75) and NFS EA (NF NRC 1991a:4-34, 4-36), respectively. The incremental population dose for B&W and NFS for

each blending alternative is then calculated by multiplying this ratio by the incremental dose to the MEI.

[Text deleted.]

The resulting doses are compared with regulatory limits and, for perspective, with background radiation levels in the area of the site. These doses then are converted into the projected number of fatal cancers using a risk estimator of 500 fatal cancers per 1,000,000 person-rem derived from data presented both in a report prepared by the National Research Council's Committees on the Biological Effects of Ionizing Radiations (BEIR V) and cited in the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP Publication 60), by the International Commission on Radiological Protection. The calculated health effects from each of the blending processes then are compared to those determined for the total site; the difference of the two yields a value that corresponds to a no action result. By presenting total site impacts, a conservative assumption that any blending operation can be performed concurrently with existing operations is maintained.

Hazardous and Toxic Chemical Consequences. Public health risks from hazardous chemical releases during normal operation at the respective DOE and commercial sites are assessed by essentially the same analytical approach using conservative assumptions. Engineering design for the facilities used to process HEU and/or store HEU or LEU includes the anticipated emissions of hazardous chemicals. From the emissions data, concentrations at the site boundary are assumed to represent the maximum that any member of the public will encounter; therefore, the site boundary concentrations are derived through modeling using the Industrial Source Complex Short-Term Model (Version 2) system recommended by EPA. The noncancer risks to the MEI of the public consist of hazard quotients (HQs) that compare chemical exposure levels to the Reference Concentration values published by EPA in the Integrated Risk Information System (IRIS). The lifetime cancer risk to the MEI is calculated from doses derived from modeled exposure level, using slope factors or unit risks for individual chemicals published in IRIS or the Health Effects Summary Tables, the yearly summary of EPA's regulatory toxicity data, including IRIS information. The hazard index (HI) values (that is, sum of HQs) and cancer risks are conservative because a single point at the site boundary is chosen for the calculations. The cancer risks are conservative due to the single point concentration and the position where the exposure is assumed. The conservatism of the cancer risk calculation is also due to the assumption that the MEI is exposed to the chemical over the individual's lifetime. The HI is independent of the cancer risk. If the HI is ≤ 1.0, all non-cancer exposure values meet OSHA standards. If the lifetime cancer risk is $\leq 1 \times 10^{-6}$ (40 CFR 300.430), the incidence of cancers from hazardous toxic chemicals cannot be distinguished from the cancer risk for an individual member of the general population.

Facility Accidents. [Text deleted.] The potential for and associated consequences of reasonably foreseeable accidents are assessed for the public for each alternative using the MACCS computer code. The potential impacts from events such as process-related accidents and a severe earthquake (the evaluation basis earthquake) are evaluated in terms of potential cancer fatalities that may result for the public from bounding scenarios. [Text deleted.] The evaluation basis earthquake is a severe earthquake, postulated for the purpose of evaluating consequences of mitigation and prevention system failures, and as such, it is analogous to a beyond design basis accident.

Three measures of accident consequences are presented. "Dose" is a measure of the amount of radiation received by the body. "Latent cancer fatalities per accident" is a measure of the health consequences of an accident if it occurs. It is the number of people that would be expected to die of cancer as a result of receiving that dose (which assumes that the postulated accident occurs). "Risk (cancer fatalities per year)" is a measure that reflects possible fatalities which considers both the probability that an event will occur and the consequences of that event. The numbers of latent cancer fatalities from the bounding scenarios are evaluated to provide an overall measure of accident impacts. The risk is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities to the public or increased likelihood of cancer fatality to the MEI).

The potential impacts from accidental releases of toxic chemicals to the public from these same bounding scenarios are evaluated in terms of immediately dangerous to life or health (IDLH) concentrations (NIOSH 1990a:4-5,116-117,126-127,160-161). These concentrations represent the maximum concentration from which, in the event of respirator failure, one could escape within 30 min without a respirator and without experiencing any escape-impairing (for example, severe eye irritation) or irreversible health effects. Concentrations to the public also are compared with Threshold Limit Values (TLV) for Short-Term (15-min) Exposure Limits (STEL) and Time (8-hr) Weighted Average (TWA) concentrations to workers (ACGIH 1992b:2-5,22-23,28-29). The latter represents the time-weighted average concentration for a normal 8-hr work-day and a 40-hr work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The former represents the concentration to which workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.

Occupational Health Risks

Health risks are assessed for two types of workers. The first type is the involved worker who would be located inside a facility that is involved with the storage or disposition of HEU materials. The second type is the noninvolved worker who might be located somewhere else on the site but is not involved in the storage or disposition of HEU materials.

Radiological Impacts. Involved worker exposures are based on blending process dose measurements. The doses to noninvolved workers at each respective site are determined based on occupational dose histories; for these workers, impacts associated with each blending alternative are assumed to be negligible compared with those associated with their primary onsite activities.

The worker doses are converted into the number of projected fatal cancers using the risk estimator of 400 fatal cancers per 1,000,000 person-rem for doses less than 20 rem and dose rates less than 10 rad/hr (ICRP 1991a:70). This lower risk estimator, compared with that for members of the public, reflects the absence of children in the workforce.

Hazardous and Toxic Chemical Impacts. Since direct chemical monitoring data on worker exposure is not available for specific operations, the onsite worker is assumed to receive the maximum exposure any involved or noninvolved onsite person will receive. OSHA-regulated levels (that is, the Permissible Exposure Level) are applied to all hazardous chemicals that are released at the site. This includes both the process-specific releases as well as those that are a result of other site operations. All onsite exposures are assumed to occur at a distance of 100 m (330 ft) from a centralized point of release, which will yield a conservative concentration level for each chemical. The concentrations are derived through modeling using the Industrial Source Complex Short-Term Model (Version 2) model system recommended by EPA. The noncancer risks to the onsite worker consist of HQs that compare chemical exposure levels to the Permissible Exposure Level values established by OSHA. The HI for each alternative is the sum of all HQs for the alternative. The cancer risks to the onsite worker are calculated from doses derived from modeled exposure levels, using slope factors or unit risks for individual chemicals published in IRIS or Health Effects Summary Tables. The worker exposure is based on an 8-hour day and for 52 weeks of 40-hour duration (that is, 0.237 fractional year) and a lifetime exposure. The HI values and cancer risks are conservative because a single point at 100 m (330 ft) from a centralized source term is chosen for the calculations. The cancer risks are conservative due to the single point concentration and the position where the exposure is assumed. The cancer risks to the facility worker for each chemical are computed from the dose (converted from air concentrations) and the unit risk or slope factors to yield a probable risk. The risks are conservative because a single point at or near the maximum onsite concentration is selected for exposure of the facility worker. The conservatism of the cancer risk calculation is also due to the assumption that the worker is exposed to the chemicals over the individual's working lifetime of 40 years. Actual risks are lower than the estimated risks. As described for public health risks, this conservative approach is applied uniformly to workers at all sites. If the HI is ≤ 1.0, all non-cancer exposure values meet OSHA standards. If the

lifetime cancer risk is $\leq 1x10^{-6}$ (40 CFR 300.430), the incidence of cancers from hazardous toxic chemicals cannot be distinguished from the cancer risk for a general individual member of the workforce. It should be noted that when the OSHA standards for HIs are exceeded and/or the cancer risk exceeds $1.0x10^{-6}$ a health concern does not necessarily exist and, indeed, may not exist. The model used to calculate HI and cancer risk in this EIS only establishes a baseline for comparison of alternatives among different sites. This baseline is then used to determine the extent by which each alternative adds or subtracts from the no action HI and cancer risk for workers at each site.

Facility Accidents. [Text deleted.] The potential impacts from accidents are evaluated in terms of potential cancer fatalities that may result for noninvolved workers from bounding scenarios explained previously under Public Health Risks. The risk of cancer fatalities from these bounding scenarios is also evaluated to provide an overall measure of accident impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities in the worker population).

The calculation for the dose to the noninvolved worker population is similar to the calculation for the dose to the general population within 80 km (50 mi) (described previously), except that a site-specific worker distribution is used. No credit was taken for short-term reactions such as evacuation or relocation. However, it was assumed that workers would be shielded from inhalation of the radioactive material for approximately half the time the radioactive plume would be present at the site. The noninvolved worker's breathing rate is taken as $2.7x10^{-4}$ m^3/s (0.01 ft^3/s) during immersion in the plume. It is also assumed that for healthy workers who are exposed to radioactivity of exposure rate less than 10 rad/hr or doses less than 20 rem, there would be 400 fatal cancers per 1,000,000 person-rem of exposure. For an exposure rate greater than 10 rad/hr or doses greater than 20 rem, there would be 800 fatal cancers per 1,000,000 person-rem of exposure.

The potential impacts from accidental releases of hazardous chemicals to noninvolved workers from these same bounding scenarios are evaluated in terms of IDLH concentrations (NIOSH 1990a:4-5,116-117,126-127,160-161). These concentrations represent the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing (for example, severe eye irritation) or irreversible health effects. Concentrations also are compared with TLV for STEL and TWA concentrations to workers (ACGIH 1992b:2-5,22-23,28-29). The latter represents the time-weighted average concentration for a normal 8-hour work-day and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The former represents the concentration to which workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.

In addition to the potential impacts to noninvolved workers, there are potential impacts to workers who could be located in the facilities. Quantitative statements of these impacts cannot be made until details are developed further in site-specific safety documentation, at which time the number and location of facility workers can be estimated to support accident impact analyses. Reference is made to an analysis of related facilities (OR DOE 1994d:6-26,6-27); its results are summarized as an indication of impacts to involved workers.

4.1.10 WASTE MANAGEMENT

The waste management analysis evaluates impacts of proposed alternatives on the existing and projected waste management activities at the candidate sites against the no action alternative at that site. The impact assessment addresses the waste types and waste volumes from the various blending processes at each site and compares them with the no action alternative.

The following categories of waste are analyzed: low-level, mixed low-level, hazardous, and nonhazardous waste. Wastes generated from environmental restoration programs are considered.

The waste management baseline information is extracted from annual site environmental reports; *The Integrated Data Base: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics-Annual Report*; the Waste Management Information System; the Mixed Waste Inventory Report; site treatment plans; site annual waste generation and minimization reports; site waste management plans; facility descriptions; process operation descriptions; and planning documents. Existing environmental agreements affecting emission, effluents, and waste streams also are examined to determine the requirements for each known site. A regulatory setting is developed for each site based on current Federal, State, regional, and local regulations and agreements.

This EIS assesses the environmental impacts associated with waste management for each proposed blending process. Waste generation and effluent (post-treatment) data are based on operating data for existing blending facilities and on estimates for new blending capabilities. The impact on waste management infrastructure and practice caused by waste streams for each blending process is evaluated. For the No Action (baseline) Alternative, waste generation data from the current affected environment are used.

For the purposes of analysis in this EIS, data from DOE's Integrated Data Base Program as shown in Tables 4.1.10–1 and 4.1.10–2 were used to calculate LLW disposal land usage for commercial and DOE disposal facilities, from 1990 through 1993. To determine a usage factor to use in the waste management impact analysis, SRS was selected, since the waste disposal facilities at ORNL accept only waste generated at ORNL, and not from K–25, Y–12, or from offsite. The SRS average value was rounded down to the nearest 100 cubic meters (that is, 8,600 m^3/ha [123,000 ft^3/acre]). Except for special conditions documented in Site Treatment Plans, in compliance with the *Federal Facility Compliance Act* of 1992, and subject to NEPA analysis and FFCA, DOE sites do not normally accept waste from other sites for disposal. NTS currently accepts waste from 15 generators with 9 more pending (7 submitting applications for approval and 2 awaiting DOE approval), for disposal of selected waste forms meeting NTS Waste Acceptance Criteria. No additional waste will be shipped to NTS until the completion of the NTS Sitewide EIS (or other applicable NEPA documentation, including the Waste Management PEIS) and in accordance with decisions in the associated ROD(s). For B&W and NFS, an average value of 20,000 m^3/ha (286,000 ft^3/acre) was calculated, assuming the waste would go to a commercial facility. The value used closely approximates usage at Barnwell, which is expected to remain operational through 2005 (DOE 1995kk:112,115). However, if necessary, the commercial facility at Richland, Washington, is also an option. It must be recognized that the specific site where wastes will be disposed is not a fixed issue. For this analysis, normal practice was assumed for the process waste, in that it is assumed to be disposed of in accordance with current practice (that is, the commercial sites would ship their waste offsite to a commercial facility, and the DOE sites would dispose of their waste onsite). At ORR, the proposed Class II LLW disposal facility was assumed to be utilized, with a usage factor of 3,300 m^3/ha (47,200 ft^3/acre) (OR DOE 1995e:1).

Table 4.1.10–1. Low-Level Waste Disposal Land Usage Factors for Commercial Sites

Site	Total Cumulative Volume (m^3)	Estimated Area Utilized (ha)	Land Usage Factor (m^3/ha)
	1993		
Barnwell, SC	701,368	36.6	19,163
Beatty, NV[a]	137,455	15.7	8,755
Richland, WA	355,051	11.9	29,836
	1992		
Barnwell, SC	684,223	34.7	19,718
Beatty, NV[a]	137,455	15.7	8,755
Richland, WA	349,763	11.9	29,392
	1991		
Barnwell, SC	660,705	29.8	22,171
Beatty, NV[a]	122,880	15.7	7,827
Richland, WA	338,042	11.9	28,407
	1990		
Barnwell, SC	638,337	29.8	21,421
Beatty, NV[a]	118,341	15.7	7,538
Richland, WA	326,170	7.8	41,817
	Average		
Barnwell, SC			20,618
Beatty, NV[a]			8,219
Richland, WA			32,363

[a] Stopped accepting LLW December 31, 1992.

Source: DOE 1991h; DOE 1992f; DOE 1994c; DOE 1994d.

Table 4.1.10–2. Low-Level Waste Disposal Land Usage Factors for Department of Energy Sites

Site	Total Cumulative Volume (m^3)	Estimated Area Utilized (ha)	Land Usage Factor (m^3/ha)
	1993		
Hanford	601,610	171.8	3,502
INEL	147,084	32.3	4,554
LANL	220,700	17.4	12,684
NTS	458,435	174.2	2,632
ORNL[a]	209,300	7	29,900
SRS	665,239	67.9	9,797
	1992		
Hanford	589,506	169.8	3,472
INEL	146,300	21.2	6,901
LANL	218,000	17.2	12,674
NTS	439,700	55	7,995
ORNL[a]	208,500	7	29,786
SRS	649,700	78.2	8,308
	1991		
Hanford	582,800	167.8	3,473
INEL	145,300	21.2	6,854
LANL	215,700	17.2	12,541
NTS	419,600	55	7,629
ORNL[a]	207,400	7	29,629
SRS	636,700	78.2	8,142
	1990		
Hanford	578,990	166.8	3,471
INEL	144,000	21.2	6,792
LANL	209,900	17	12,347
NTS	408,400	No data	No data
ORNL[a]	207,200	6	34,533
SRS	612,800	72.1	8,499
	Average		
Hanford			3,480
INEL			6,275
LANL			12,562
NTS			6,085
ORNL[a]			29,772
SRS			8,687

[a] Can only accept waste generated at ORNL. Cannot accept waste from Y–12 or K–25.

Source: DOE 1991h; DOE 1992f; DOE 1994c; DOE 1994d.

4.2 NO ACTION ALTERNATIVE

To satisfy the requirements of NEPA, the No Action Alternative is presented as a baseline for comparison with the various action alternatives. Under no action, DOE would not dispose of surplus HEU. Surplus HEU is currently proposed to remain in storage primarily at DOE's Y–12 Plant and current operations at each of the proposed HEU blending sites would continue. The No Action Alternative establishes baseline characteristics necessary for the determination of environmental impacts for each of the candidate sites.

The interim storage, pending disposition (for up to 10 years) of surplus HEU at Y–12 (where most of the HEU is stored), is analyzed in the Y–12 EA. Impacts from interim storage are briefly summarized below.

Impacts of Interim Storage at the Y–12 Plant. Under the No Action Alternative, there are potential environmental impacts due to interim storage of HEU at the Y–12 Plant. The impacts to each resource during interim storage have been summarized below from the Y–12 EA, September 1994.

The Y–12 EA evaluates the continued receipt, prestorage processing, and interim storage of enriched uranium for up to 10 years in quantities that would exceed the historical maximum storage level. This EA states that eight facilities are currently used to store enriched uranium or process it for storage. These facilities would continue to be used for the interim storage of enriched uranium above the historical maximum storage level (OR DOE 1994d:3-4). No new facilities would need to be constructed to accomplish the proposed action of the Y–12 EA. Minor internal modifications would be required to provide enhanced security and additional storage capacity. Facilities and buildings within Y–12 that contain substantial quantities of enriched uranium have DOE-approved SARs, which are currently undergoing a Safety Analysis Report Update Program to meet requirements of new DOE orders.

Highly enriched uranium and LEU would be stored in vault-like cages, tube vaults, vaults, or modular storage vaults. LEU could be stored in other configurations such as drums stacked in warehouse storage areas depending upon the U-235 content of LEU. Within the storage configurations, HEU and LEU are stored in stainless or galvanized steel cylindrical containers. The criticality-safe containers are constructed to DOT specifications or are DOE-approved storage containers.

No construction or demolition of buildings is anticipated; therefore, archaeological, cultural, ecological resources, groundwater, and land use would not be affected. Wastewater discharge, domestic sewer discharge, or radionuclide discharge would not exceed applicable permit levels.

The release of contaminates into the atmosphere at the Y–12 site occurs as a result of plant operations, maintenance and waste management operations, and steam generation. Routine releases to the atmosphere would essentially be terminated when HEU is placed in storage. Therefore no additional impacts are anticipated to air quality while HEU is in interim storage.

The annual amounts of waste generated as a result of prestorage processing and storage are not expected to be higher than the 1993 quantities. This was because 1993 was the peak year for the disassembly of weapons systems at the Y–12 Plant which generated the highest rate of enriched uranium processing.

The annual doses for incident-free radiological exposure to workers and to the public were estimated to be well within the 1 rem (worker) and 10 mrem (public) maximum exposure limits. The annual collective dose from airborne releases due to Y–12 operations to all the involved workers and to the public within 80 km (50 mi) of ORR was estimated to be 12.9 person-rem and 12 person-rem, respectively. Under accident conditions, the average collective dose to the onsite worker population and the public was estimated to be highest under the solvent fire scenario, 7,100 person-rem and 100 person-rem, respectively. Potential radiological impacts as a result of the beyond design basis collapse postulated for Building 9212 was estimated to result from an extreme natural hazard (tornado or earthquake) or an airplane crash. The average collective dose to all the workers onsite at Y–12 and the public within 80 km (50 mi) was estimated to be 14,000 person-rem and 190 person-rem, respectively.

A bounding accident analysis was performed to determine the potential uranium toxicity exposures to the public (chemical risk). From the largest uranium

release postulated, the concentration to the maximally exposed individual of the public was estimated to be 20 mg U/m^3. It was stated that there would be no discernible toxic effect for a 30-minute exposure below the level of concern value of 21 mg U/m^3 for acute exposures. Nitric acid and hydrofluoric acid also present hazard potential in the event of a release. The chemical accident scenario assumed that the entire tank of nitric acid is released. From this scenario, it was estimated that the maximally exposed member of the public would receive 25 mg/m^3 in the worst case which is just below the level of concern of 26 mg/m^3. A leak of anhydrous hydrofluoric acid into the air could be more dangerous. The scenario assumed that the entire hydrofluoric acid tank is released. This scenario predicted that 88 onsite personnel would be exposed to hydrofluoric acid concentrations exceeding one-tenth of the IDLH standard. Twenty-five of these 88 persons would be exposed to concentrations of hydrofluoric acid exceeding this standard. Mitigation measures such as hydrofluoric acid detectors and remote shutoff valves were installed to alert operators of a release, isolate a leak, and minimize the amount of hydrofluoric acid discharged.

4.2.1 Land Resources

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. Existing and planned land-use activities associated with these missions would continue at each of these sites and impacts to land use from these actions would be independent of and unaffected by the proposed action. The existing landscape characteristics would remain consistent with existing and proposed land uses under the No Action Alternative.

4.2.2 Site Infrastructure

Under the No Action Alternative, the existing and reasonably foreseeable activities described in Chapter 3 for each of the candidate sites would continue. Table 4.2.2–1 summarizes the baseline site infrastructure requirements for each candidate site. The existing site infrastructure has adequate capacity to support all of these no action requirements.

4.2.3 Air Quality and Noise

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections in Chapter 3 are the existing air quality and noise conditions. The concentration of criteria and toxic/hazardous pollutants resulting from the No Action Alternative are in compliance with applicable Federal and State air quality regulations and guidelines. Table 4.2.3–1 summarizes the baseline ambient concentrations of criteria pollutants from existing sources at each candidate site.

4.2.4 Water Resources

Surface Water. Under the No Action Alternative, no additional impacts to surface water resources are anticipated beyond the effects of existing and future activities that are independent of and unaffected by

Table 4.2.2–1. Site Infrastructure Baseline Characteristics for the No Action Alternative

Site	Y–12	SRS	B&W	NFS
Land (ha, fenced)	328	80,130	212	25.5
Road (km)	42	230	<1	3
Railroad (km)	11	103	0.305	0
Electricity (MWh/yr)	420,500	659,000	64,700	21,800
Electric Peak Load (MWe)	62	130	14.3	3.5
Natural Gas (m^3/yr)	66,000,000	0	2,850,000	12,900
Diesel/oil (l/yr)	0	28,400,000	470,000	36,000
Coal (t/yr)	2,940	210,000	0	0
Steam Generation (kg/hr)	99,000	85,400	1,460	6,260
Water Usage (l/yr)	7,530,000,000	153,687,000,000	195,000,000	57,000,000

Note: MWh=megawatt hour; MWe=megawatt electric.
Source: Tables 3.3.2–2, 3.4.2–2, 3.5.2–1, and 3.6.2–1.

Table 4.2.3–1. Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at Each Candidate Site Boundary for the No Action Alternative

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	5	22	4	1.97
	1 hour	40,000[a]	11	171	13.1	2.52
Lead (Pb)	Calendar Quarter	1.5[a]	0.05	0.0004	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	3	5.7	3.5	0.62
Particulate matter (PM_{10})	Annual	50[a]	1	3	0.02	0.03
	24 hours	150[a]	2	50.6	0.16	0.21
Sulfur dioxide (SO_2)	Annual	80[a]	2	14.5	0.34	0.02
	24 hours	365[a]	32	196	2.28	0.15
	3 hours	1,300[a]	80	823	11.8	0.35
Mandated by Tennessee, South Carolina, and Virginia						
Total suspended particulates (TSP)	Annual	60[c]	1[d]	12.6	0.03	0.03[d]
	24 hours	150[c]	2	47[d, e]	0.22	0.21
Gaseous fluorides (as HF)	1 month	0.8[c]	0.2	0.09	[b, d]	0.02
	1 week	1.6[c]	0.3	0.39	[b, d]	<0.06
	24 hours	2.9[c]	<0.6	1.04	[b, d]	0.06
	12 hours	3.7[c]	<0.6	1.99	[b, d]	0.1
	8 hours	250[c]	0.6	<2.99[d]	[b, d]	0.11

[a] Federal standard.

[b] No emissions from existing processes.

[c] State standard or guideline.

[d] No State standard.

[e] Based on maximum measured SRS ambient monitored data for 1985.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations for Y–12 include other ORR operations.

Source: 40 CFR 50; DOE 1995i; NF DEC nda; SC DHEC 1992b; SR NUS 1991a; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995a; WSRC 1994e.

the proposed action. Under the No Action Alternative, because of the reduced operating requirements of existing facilities at both ORR and SRS, surface water withdrawals are expected to decrease. Wastewater from the Y–12 Plant and SRS would continue to be discharged to NPDES-permitted site streams, although the volume discharged would decrease. As a result of reduction in discharges to site streams, water quality should improve. Under the No Action Alternative, current surface water withdrawal is expected to remain unchanged at B&W. Currently, no surface water is used at NFS.

Groundwater. Under the No Action Alternative, no additional impacts to groundwater resources are anticipated beyond the effects of existing and future activities that are independent of and unaffected by the proposed action. Under the No Action Alternative, existing missions at SRS and B&W that withdraw groundwater would be expected to continue. Currently no groundwater is used at ORR and NFS. All drinking water for NFS is obtained from the city of Erwin. Water quality data obtained from wells located near ORR and SRS indicate that water quality is above or bordering drinking water standards for a number of parameters. Under the No Action Alternative, current restoration programs would continue at ORR and SRS. Minimal impacts

on groundwater quality are expected due to wastewater releases.

4.2.5 GEOLOGY AND SOILS

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections of Chapter 3 are the existing geologic and soil conditions. There would be no construction or demolition of buildings and no disturbance of the land beyond the effects of existing and future activities that are independent of the proposed action. Although it is currently proposed that Y–12 would continue to receive HEU for storage, existing facilities would be used and no new facilities would be needed for storage. Because no new construction would occur beyond the effects of existing and future activities that are independent of the proposed action, the No Action Alternative would have no impact on the geological or soil resources at the four candidate sites. Any impacts to geology and soils from current missions would be independent of and unaffected by the No Action Alternative.

4.2.6 BIOTIC RESOURCES

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections in Chapter 3 are the existing biotic conditions. There would be no construction or demolition of buildings, so there would be no loss of wildlife habitat beyond the effects of existing and future activities that are independent of the proposed action. Although it is currently proposed that Y–12 would continue to receive HEU for storage, existing facilities would be used and no new facilities would be required for storage. Because no new construction would occur, the No Action Alternative would have no impact on biotic resources, including terrestrial and aquatic resources, wetlands, and threatened and endangered species at any of the candidate sites. Any impacts to biotic resources from current missions would be independent of and unaffected by the No Action Alternative.

4.2.7 CULTURAL RESOURCES

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections in Chapter 3 are the existing cultural resources conditions. There would be no construction or demolition of buildings, so there would be no disturbance of the land beyond the effects of existing and future activities that are independent of the proposed action. Although it is currently proposed that Y–12 would continue to receive HEU for storage, existing facilities would be used and no new facilities would be required for storage. The No Action Alternative would have no impact on cultural resources, including prehistoric and historic resources, Native American resources, and paleontological resources at any of the candidate sites. The effects considered include those resulting directly from land disturbance during construction, visual intrusion on the settings or environmental context of historic structures, visual and audio intrusions on Native American sacred sites, reduced access to Native American traditional use areas, unauthorized artifact collection, and vandalism. Any impacts to cultural resources from current missions would be independent of and unaffected by the No Action Alternative.

4.2.8 SOCIOECONOMICS

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections of Chapter 3 are the existing socioeconomic conditions. Under the No Action Alternative, the worker population would not change at these sites; therefore, no environmental consequences are anticipated. The No Action Alternative assumes continuation of operations at the four candidate sites. Employment, local economy, population, housing, community services, and local transportation are the parameters used to assess the baseline characteristics. Table 4.2.8–1 summarizes the baseline conditions for these parameters for each candidate site.

4.2.9 PUBLIC AND OCCUPATIONAL HEALTH

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections of Chapter 3 are the existing normal operation and facility accident conditions.

Table 4.2.8–1. Socioeconomic Parameters Baseline Characteristics for the No Action Alternative

Site	ORR	SRS	B&W	NFS
Employment	15,273	19,208	1,846	325
Payroll (million $)	523	1,149[a]	80	13.2
Regional Economic Area				
Employment				
1995	462,900	243,800	321,400	253,800
2000	488,700	259,400	334,700	265,500
Unemployment (%)				
1994	4.9	6.7	4.9	5.9
Per capita income				
1995 ($)	18,200	17,800	18,000	16,800
2000 ($)	19,214	18,930	18,788	17,594
Region of Influence				
Population				
1995	519,300	477,600	219,900	322,600
2000	548,200	508,300	229,000	337,600
Housing units				
1995	222,000	189,400	90,500	135,700
2000	234,400	201,600	94,300	141,900
Students				
1995	83,400	88,200	34,200	52,500
2000	88,000	93,900	35,600	54,900
Teachers				
1995	5,140	5,060	2,400	2,920
2000	5,420	5,380	2,500	3,060
Police officers				
1995	792	956	358	556
2000	836	1,020	373	582
Firefighters				
1995	1,120	1,363	960	1,201
2000	1,180	1,450	1,000	1,260
Physicians				
1995	1,300	1,370	299	870
2000	1,380	1,460	312	910
Hospital occupancy (%)				
1995	73	66	70	61
2000	78	69	73	64

[a] Total payroll for 1992 is based on 1990 employee wage and 1992 total number of employees.

Source: AHA 1994a; AMA 1994a; BW 1995b:1; BW Fire 1995a; BW School 1995a; Census 1991a; Census 1991b; Census 1991c; Census 1991u; Census 1993a; Census 1993b; Census 1993c; Census 1993e; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOJ 1994a; NF Fire 1995a; NF School 1995a; NFS 1995b:2; OR Fire 1995a; OR Police 1995a; OR School 1995a; ORR 1991a:4; SR Fire 1995a; SR School 1995a; SRS 1991a:3.

Under the No Action Alternative during normal operations, both radiological and hazardous chemical releases to the environment as well as direct exposures would occur. Table 4.2.9–1 summarizes the baseline conditions for the resulting radiological doses and potential health effects to the public and workers. To put operational doses into perspective, the doses from natural background radiation also are included in Table 4.2.9–1. If normal operations at the four candidate sites were to continue, the resulting impacts would remain within the regulatory limits. The risks of adverse health effects to workers and the public would be small.

At ORR, the annual dose to the MEI of the public, including continued operation of the Y–12 interim

Table 4.2.9–1. Potential Radiological Impacts to Workers and the Public Resulting From Normal Operations Baseline Characteristics for the No Action Alternative

Receptor	ORR	SRS	B&W	NFS
Natural background radiation dose (mrem/yr)	295	298	329	340
Average worker (mrem/yr)	4	17.9	10	50
Fatal cancer risk for 20 years	3.2×10^{-5}	1.4×10^{-4}	8.0×10^{-5}	4.0×10^{-4}
Maximum worker exposure (mrem/yr)	2,000	3,000	3,300	470[a]
Maximally exposed member of public (mrem/yr)	2[b]	0.32	5.0×10^{-2}	3.3×10^{-2}
Fatal cancer risk for 20 years	2.0×10^{-5}	3.2×10^{-6}	5.0×10^{-7}	3.3×10^{-7}
Total worker dose (person-rem/yr)	68	216	18	16.3
Number of fatal cancers for 20 years	0.54	1.7	0.14	0.13
Total population dose (person-rem/yr)	28	21.5	0.35	0.2
Number of fatal cancers for 20 years	0.28	0.22	3.5×10^{-3}	2.0×10^{-3}

[a] Representative of one-half year.

[b] Representative of air and liquid media only; an additional 1 mrem/yr may be incurred due to direct exposure.

Source: BW 1995b:1; BW NRC 1991a; DOE 1993n:7; NF NRC 1991a; NFS 1995b:2; OR DOE 1994c; SRS 1995a:13; WSRC 1994d.

storage is 2.0 mrem. After 20 years of operation, the corresponding cumulative risk of fatal cancer to this individual is 2.0×10^{-5}. The annual population dose (within an 80-km [50-mi] radius of the site), including interim storage facilities at Y–12, would be 28 person-rem. After 20 years of operation, the corresponding cumulative number of fatal cancers in this population would be 0.28.

Hazardous chemical impacts to the public resulting from normal operation are presented in Table 4.2.9–2. The hazardous chemical impacts from all site operations are needed to estimate the total site impacts for the various alternatives. The noncancer adverse health effects expected and the risk of cancer due to the total chemical exposures are estimated for each site. Tables showing the toxic chemical effects and the exposure limits for each chemical are presented in Appendix E in Tables E.3.2–1 and E.3.3–1, respectively. The background chemical exposure levels are negligible for the sites analyzed because releases come primarily from site operations and not commercial industrial operations that are present in surrounding communities. The no action

Table 4.2.9–2. Potential Hazardous Chemical Impacts[a] to Workers and the Public Resulting From Normal Operations Baseline Characteristics for the No Action Alternative

Receptor	ORR	SRS	B&W	NFS
Maximally Exposed Individual				
Hazard index[b]	3.95×10^{-2}	5.16×10^{-3}	1.15×10^{-5}	9.55×10^{-2}
Cancer risk[c]	0	1.31×10^{-7}	1.68×10^{-8}	0
Onsite Worker				
Hazard index[d]	0.154	1.16	4.07×10^{-3}	7.57×10^{-3}
Cancer risk[e]	0	1.94×10^{-4}	3.94×10^{-5}	0

[a] Includes any background emissions that would be present at the site in the absence of site operations plus site emissions that exist at the present time.

[b] Hazard index for MEI=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

[c] Cancer risk for MEI=(emissions of concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[d] Hazard index for workers=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[e] Cancer risk for workers=(emissions for 8-hour) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: NFS 1995b:2; OR MMES 1995i; SRS 1995a:2; SRS 1996a:1; VA DEQ 1995a.

level of exposures is used to calculate the noncancer and cancer risks for all sites. All supporting analyses are provided in Appendix E, Tables E.3.4–1 through E.3.4–4. [Text deleted.] The HIs for the public show that the hazardous chemical concentrations are within EPA's (Reference Concentrations) regulatory limits. The HIs for the workers at SRS indicate the potential for noncancer effects. At SRS and B&W, the cancer risks for the onsite worker are 1.94×10^{-2} and 3.94×10^{-5}, respectively.

Under the No Action Alternative, it is currently proposed that HEU would continue to be stored at the Y–12 Plant and other operations would continue at SRS, B&W, NFS, and the remainder of ORR. Potential accidents and their consequences have been addressed in site safety documentation prepared for existing facilities. The Y–12 EA (DOE/EA-0929, September 1994) addresses accident consequences for the interim storage of HEU at the Y–12 Plant. The potential radiological consequences to the involved worker range up to several thousand rem (fatal); up to 2 rem (9.0×10^{-4} increased likelihood of latent cancer fatality) to the noninvolved worker; up to 14 rem (7.0×10^{-3} latent cancer fatalities) to the maximally exposed individual; and up to 190 person-rem to the surrounding population. The maximum chemical accident consequences would be from a hydrogen fluoride leak. Evacuation level concentrations would be reached for a short distance outside the site boundary under most weather conditions for such an accident; fatalities could not be ruled out under limiting conditions. Since 1989, DOE has been engaged in a program to update SARs for the Y–12 Plant, as in some cases existing SARs did not reflect current standards. That effort is ongoing. Accident probability and consequences are dependent on the accident scenarios, which vary at these sites due to the type, form, amount, and processes, and the radiological and hazardous chemicals resident at the site. Under the No Action Alternative, the risk of accidents at these sites would be unchanged.

4.2.10 WASTE MANAGEMENT

Under the No Action Alternative, current and reasonably achievable missions at ORR, SRS, B&W, and NFS would continue. Under this alternative, it is currently proposed that surplus HEU continue to be stored at the Y–12 Plant. Under the No Action Alternative, waste management practices would continue. Under the No Action Alternative, all four sites would continue to manage low-level, mixed low-level, hazardous, and nonhazardous wastes. Table 4.2.10–1 summarizes the baseline conditions for the waste types for each candidate site.

At the Y–12 Plant, solid LLW would continue to be stored until future disposal methods are determined. Mixed LLW would continue to be generated at Y–12 under the No Action Alternative during the treatment of nitrate waste from the purification/recycling of

Table 4.2.10–1. Annual Waste Generated Baseline Characteristics for the No Action Alternative

Waste Category	ORR	SRS	B&W	NFS
Low-Level				
Liquid (m^3)	2,576	0	50,005	18,900
Solid (m^3)	8,030	14,100	620	3,000
Mixed Low-Level				
Liquid (m^3)	84,210	115	0	<1
Solid (m^3)	960	18	14	<1
Hazardous				
Liquid (m^3)	32,640	Included in solid	55,115	<1
Solid (m^3)	1,434	74	0	<1
Nonhazardous				
Liquid (m^3)	1,743,000	700,000	576,160	56,700
Solid (m^3)	52,730	6,670	1,700	2,300

Source: BW 1995b:1; BW NRC 1991a; BW NRC 1995a; NF NRC 1991a; NFS 1995b:2; OR LMES 1995b; SR DOE 1994c.

uranium and in the treatment of plating shop wastes. Mixed LLW would be managed in accordance with the *ORR Site Treatment Plan*, which complies with FFCA. The Y–12 Plant's hazardous waste treatment, storage, and disposal units would continue to operate in accordance with RCRA interim status requirements pending receipt of RCRA operating permits. Nonhazardous sanitary and nonradioactive process waste liquids would be treated in conventional sewage treatment plants. The resultant solids would be disposed of with solid nonhazardous waste in a permitted landfill sized to handle projected waste volumes. Asbestos and general refuse would continue to be managed in the Y–12 Plant Sanitary Landfill. Under the No Action Alternative, this landfill would also continue to accept nonradiological medical wastes that have been rendered noninfectious.

4.3 DISCUSSION OF SITE-SPECIFIC ANNUAL IMPACTS ASSOCIATED WITH BLENDING HIGHLY ENRICHED URANIUM TO LOW-ENRICHED URANIUM

The site-specific alternatives in this section consider blending surplus HEU to a suitable assay LEU for fabrication as fuel for commercial reactors or for disposal as waste. Most of the surplus HEU, whether commercial (130 t) or off-spec (40 t) material (described in Section 2.1.1), could be blended with suitable blendstock material to produce LEU for commercial use. There are two blending processes available for this purpose: blending HEU to LEU as UNH, and blending HEU to LEU as UF_6. Currently, the commercial fuel industry receives all LEU fuel feed as UF_6; however, since UNH crystals could also be used as fuel feed, the UNH blending process is considered reasonable for reactor fuel. The environmental consequences of the two processes, blend as UNH and blend as UF_6, are presented in Sections 4.3.1 and 4.3.2.

All of the surplus HEU including commercial (130 t), off-spec (40 t), and noncommercial (30 t), could be blended with blendstock material to produce LEU for disposal as waste. There are two blending processes available for this purpose: blending as UNH and blending as metal. For the reasons explained in Section 2.2.2, UNH and metal are not acceptable waste forms for disposal; therefore, LEU in UNH and metal form would be converted to U_3O_8 prior to being discarded as waste. The environmental consequences of the two processes, blend as UNH and blend as metal, are presented in Sections 4.3.3 and 4.3.4. The analyses in Section 4.3 describe annual impacts.

The following four sections discuss the environmental consequences of blending surplus HEU to either 4-percent or 0.9-percent LEU at each of the candidate sites. All four candidate sites have the capability to blend surplus HEU to 4-percent or 0.9-percent LEU as UNH. The two commercial sites may add the capability to blend surplus HEU to 4-percent LEU as UF_6 for commercial fuel. The Y-12 site has the capability to blend surplus HEU to 0.9-percent LEU as metal. UNH and metal blending facilities at Y–12 and SRS and UNH blending facilities at NFS are currently not operating. UF_6 conversion and blending facilities do not currently exist, but might be developed at B&W and NFS by the addition of new processing equipment to existing facilities.

The SRS site currently lacks the capability to solidify UNH material at enrichment levels higher than about 1 percent. (See Section 2.2.3.3.) Nonetheless, the environmental impacts from the solidification process have been included in this analysis for SRS as for the other sites so a valid comparison can be made among them. Development of a new UNH solidification facility at SRS (or offsite locations) might be proposed in the future by DOE, by a commercial entity, or by another Federal agency to whom off-spec LEU derived from surplus HEU might be sold or transferred pursuant to the *USEC Privatization Act* (Public Law 104-134, Section 3112(e)(1)).

Except as noted in the proceeding paragraph, none of the analyzed processes would necessitate construction of new facilities, require land disturbance, or affect the VRM classification of any of the candidate sites; consequently, no impacts to land resources, geology and soils, or cultural resources are anticipated. Any future construction at B&W or NFS would be a business decision, and is not proposed by DOE or necessitated by this proposed action or alternatives. No construction of a solidification facility at SRS is proposed at this time. If any such construction at any of the sites were proposed, it could involve land disturbance and associated impacts, such as minor air emissions. Additional NEPA review would be conducted as necessary for any such new construction, if it were proposed.

[Text deleted.]

4.3.1 TECHNOLOGY AND SITE-SPECIFIC IMPACTS FOR BLENDING HIGHLY ENRICHED URANIUM TO 4-PERCENT LOW-ENRICHED URANIUM AS URANYL NITRATE HEXAHYDRATE

The process would involve dissolving both surplus HEU and uranium blendstock in nitric acid, yielding UNH for further blending and conversion to UNH crystals or to uranium oxide as UO_2 as described in Section 2.2.2.1. This process could be performed at any or all of the four facilities.

Assessment of impacts of blending HEU to 4-percent LEU as UNH are based on an annual throughput of 10 t of impure, unalloyed 50-percent assay HEU metal to pure 4-percent assay UNH crystals with appropriate blendstock. The blendstock feed material used in this alternative is assumed to be pure U_3O_8 or metal.

4.3.1.1 Site Infrastructure

Operation of facilities to blend HEU to 4-percent LEU as UNH would potentially affect site infrastructure, mainly electrical power, fuel, and water/steam supply.

Site infrastructure requirements are discussed in Section 2.2.2.1 and detailed in Table 4.3.1.1–1 for each candidate site; however, the discussion of impacts on site infrastructure is presented for all the sites collectively.

Due to the use of existing facilities and the estimated UNH blending facility utility requirements, there is no anticipated need for modifications to onsite or offsite road and rail access or right-of-way corridors for such services as electrical transmission lines, natural gas and water supply pipelines, and telecommunications. The additional annual electrical service requirement represents a small percentage increase for the DOE sites (that is, less than 1 percent of the Y–12 Plant and SRS's annual consumption) with only a few percent increase in peak demand, as shown in Table 4.3.1.1–1. For commercial facilities, this increase is slightly higher, approximately 6 percent for B&W and over 18 percent for NFS. The increase in peak load is approximately 14 percent for B&W and 57 percent for NFS. The capacity at both the DOE and commercial sites is adequate to accommodate the blending facility's electrical service requirements without implementing any major modifications or constructing new transmission or distribution facilities.

The fuel and water requirements to support the blending facility represent relatively small fractions of current annual usage or existing capability at Y–12 and SRS. Natural gas is available and in use at all sites except for SRS where oil is the major fuel source. Annual fuel oil consumption at ORR is 416,000 l (110,000 gal); none of this is used at the Y–12 Plant. Coal-fired boilers are in use at both DOE sites for the production of process steam, whereas the commercial sites utilize either natural gas or oil depending upon availability and cost. The total fuel requirements, in terms of total fuel energy equivalent for the UNH conversion and blending facility, represent an increase of 0.6, 0.2, and 12 percent of current fuel consumption at ORR, SRS, and B&W, respectively. For NFS, the blending facility represents an increase of 742 percent of current fuel consumption because the facilities are less active than normal; however, based on fuel consumption data for building and process equipment (that is, 790,000 l [209,000 gal] of fuel oil), the fuel requirements for the UNH blending facilities would be about 36 percent of NFS's installed capacity. Annual raw water requirements to support blending facility operations are insignificant compared with current usage at ORR and SRS. For B&W and NFS, this requirement represents an increase of about 9.7 percent and 33.3 percent of current usage, respectively. The available water capacity at each site is adequate to satisfy the blending facility requirements under this alternative.

As a result of the extensive site infrastructure already existing at Y–12 and SRS, minimal effects in terms of the percentage increase in site infrastructure resource usage would result from the operation of the UNH conversion and blending facilities at either site. Site infrastructure resource requirements are well within the available capacity at both the Y–12 Plant and SRS. For B&W and NFS, the infrastructure resource requirements of the blending facility represent a more significant increase over current useage; however, the existing infrastructure is capable of accommodating the blending facility requirements with no significant adverse site infrastructure-related environmental effects being incurred.

4.3.1.2 Air Quality and Noise

Operation of facilities to blend HEU to 4-percent LEU as UNH would generate criteria and toxic/hazardous pollutants. Concentrations of these pollutants resulting from this alternative were estimated for each site and are presented in Table 4.3.1.2–1. The discussion of impacts on air quality and noise are presented for all the sites collectively.

Air Quality. Air pollutant emissions associated with the operation of the UNH blending facility consist of

Table 4.3.1.1–1. Annual Changes to Site Infrastructure for Blending (10 t/yr) Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

	Access			Electrical		Fuel			Water	
Site	Area (ha)	Road (km)	Rail (km)	Energy (MWh/yr)	Peak Load (MWe)	Natural Gas (m^3/yr)	Diesel/Oil (l/yr)	Coal (t/yr)	Water (million l/yr)	Steam (kg/hr)
UNH facility	0	0	0	4,000	2	17,000	56,800	363	19	1
Y–12 baseline	328	42	11	420,500	62	66,000,000	0	2,940	7,530	99,000
Y–12 percent change	0	0	0	0.95	3.2	<0.1[a]	NA[b]	12	0.25	0.001
SRS baseline	80,130	230	103	659,000	130	0	28,400,000	210,000	153,687	85,400
SRS percent change	0	0	0	0.6	1.5	NA[c]	0.3[a]	0.17	0.012	0.001
B&W baseline	212	<1	0.305	64,700	14.3	2,850,000	470,000	0	195	1,460
B&W percent change	0	0	0	6.2	14	0.6	71.5[a]	NA[d]	9.7	0.07
NFS baseline	25.5	3	0	21,800	3.5	12,900[e]	36,000[e]	0	57	6,260
NFS percent change	0	0	0	18.4	57.1	132	933[a]	NA[d]	33.3	0.02

[a] Percent change includes required natural gas, oil, or coal energy equivalent.

[b] Natural gas is the primary fuel at Y–12, and all of the blending facility oil requirements have been converted to a natural gas energy equivalent; fuel oil (0.96 kg/l) is assumed to be 41,800 BTUs/kg or 40,128 BTUs/l and natural gas is assumed to be 35,315 BTUs/m^3 (that is, 56,800 l of fuel oil=64,515 m^3 of natural gas).

[c] Natural gas is not available at SRS and all of the blending facility process natural gas requirements would be supplied via liquid petroleum gas (LPG); these requirements have been converted to a fuel oil energy equivalent; the natural gas is assumed to be 35,315 BTUs/m^3, LPG is assumed to be 24,800 BTUs/l, and fuel oil is assumed to be 40,128 BTUs/l (that is, 17,000 m^3 of natural gas=24,200 l of LPG=14,900 l of fuel oil).

[d] Coal is not utilized at B&W-NNFD or NFS, and all of the blending facility coal derived energy requirements would be supplied via the fuel oil energy equivalent; the fuel oil energy content is assumed to be 40,128 BTUs/l, and for coal it is assumed to be 30.9 million BTUs/t, (363 t of coal=279,200 l of fuel oil).

[e] Values shown are based on current usage; typical annual consumption is estimated at approximately 790,000 l of fuel oil.

Note: NA=not applicable; MWh=megawatt hour; MWe=megawatt electric; BTU=British thermal unit.

Source: OR LMES 1995b; Tables 3.3.2–2, 3.4.2–2, 3.5.2–1, and 3.6.2–1.

criteria pollutants from the operation of boilers to produce steam and toxic/hazardous pollutants such as nitric acid used or generated in the blending process. These pollutants are controlled using liquid scrubbing prior to HEPA filtration to remove chemical vapors and particulates.

The 24-hour concentration of sulfur dioxide (SO_2) at ORR is approximately 9 percent of the standard, which is the highest percent of a standard for the criteria pollutants at ORR. The UNH blending would contribute 8 and 53 percent to the 24-hour concentration of SO_2 and total suspended particulates (TSP) at ORR, respectively. The remaining criteria pollutant concentrations would be less than 55 percent of the respective standard.

The 3-hour concentration of SO_2 at SRS is approximately 63 percent of the standard, which is the highest percent of a standard for criteria pollutants at SRS. The UNH blending process would contribute less than 1 percent to the 3-hour concentration of SO_2 at SRS. The remaining criteria pollutant concentrations would be less than 63 percent of the respective standard.

The annual concentration of nitrogen dioxide (NO_2) at B&W was calculated to be approximately 3.5 percent of the annual NAAQS for NO_2. NO_2 is considered to be a primary emission at the site. The UNH blending process would contribute less than 1 percent to the annual concentration of NO_2 at the site. The addition of the blending emissions of NO_2 to those existing at B&W would increase the percent of the annual NAAQS for NO_2 only slightly. Criteria pollutant concentrations would be expected to remain in compliance with the NAAQS and State-mandated standards.

The primary source of criteria pollutants at NFS is from space heating, which is accomplished by combustion of natural gas. The annual concentration of NO_2 at NFS is approximately 0.6 percent of the standard, which is the highest percent of a standard for criteria pollutants at NFS. Monitoring performed at NFS by TDEC indicated that the facility is in compliance with Federal and State regulations and guidelines (NF NRC 1991a:4-30). Operation of the UNH blending facilities would add less than 0.1 percent to the annual concentration of NO_2, which would not be expected to change the compliance status of NFS.

Table 4.3.1.2–1 presents the estimated concentrations of criteria pollutants from blending HEU to 4-percent LEU as UNH. Table 4.3.1.2–2 presents the total concentrations of no action criteria pollutants plus blending HEU to 4-percent LEU as UNH at each site. During operation, impacts from the UNH blending facilities with respect to the concentrations of criteria and toxic/hazardous air pollutants are expected to be within Federal and State regulations and guidelines for each site.

Noise. Operation of the UNH blending facility in an existing building at each site would result in little or no change in the contribution to noise levels at offsite receptors. Existing buildings are located at a sufficient distance from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

Noise impacts associated with increased traffic on access routes would be small considering that any of the four facilities would require a maximum of 125 employees during operation, many of whom would be employees currently working at the site (OR LMES 1995b:20).

Potential measures to minimize noise impacts on workers include providing workers in noisy environments with appropriate hearing protection devices that meet OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

4.3.1.3 Water Resources

Environmental impacts associated with the operation of UNH conversion and blending facilities would affect surface and groundwater resources. Water resource requirements and discharges provided in Section 2.2.2.1 were used to assess impacts to surface water and groundwater. The discussion of impacts are provided for each site separately.

Oak Ridge Reservation

Surface Water. Operation of UNH blending facilities would require an additional 19 million l/yr (5.0 MGY) of water, mostly for process operations and steam generation and a lesser amount for potable water. This would be less than 1 percent of the Clinch River's average flow (132 m^3/s [4,661 ft^3/s]), and the

Table 4.3.1.2–1. Estimated Concentrations of Criteria Pollutants Based Upon Blending (10 t/yr) Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	UNH Blending Alternative Concentration[a] Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	11.5	0.07	5.22	0.6
	1 hour	40,000[b]	53	0.14	16.96	0.77
Lead (Pb)	Calendar Quarter	1.5[b]	c	c	c	c
Nitrogen dioxide (NO_2)	Annual	100[b]	1.33	0.01	0.1	0.02
Particulate matter[d] (PM_{10})	Annual	50[b]	0.03	<0.01	0.02	<0.01
	24 hours	150[b]	0.37	<0.01	0.16	0.02
Sulfur dioxide (SO_2)	Annual	80[b]	2.46	0.02	0.27	0.04
	24 hours	365[b]	29.3	0.32	1.82	0.27
	3 hours	1,300[b]	161	0.71	9.41	0.64
Mandated by Tennessee, South Carolina, and Virginia						
Total suspended particulates[d] (TSP)	Annual	60[e]	6.74[f]	0.05	0.02	<0.01[f]
	24 hours	150[e]	80.16	0.88[f]	0.16	0.02
Gaseous fluorides (as HF)	1 month	0.8[e]	c	c	c, f	c
	1 week	1.6[e]	c	c	c, f	c
	24 hours	2.9[e]	c	c	c, f	c
	12 hours	3.7[e]	c	c	c, f	c
	8 hours	250[e]	c	c,f	c, f	c

[a] Model results.
[b] Federal standard.
[c] No emissions from this process.
[d] It is conservatively assumed that PM_{10} concentrations are TSP concentrations.
[e] State standard or guideline.
[f] No State standard.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: 40 CFR 50; OR LMES 1995b; SC DHEC 1992b; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995b; WSRC 1994e.

Table 4.3.1.2–2. Estimated Total Concentrations of Criteria Pollutants for No Action Plus Blending (10 t/yr) Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	No Action Plus Blending Concentration[a] Y–12 ($\mu g/m^3$)	SRS ($\mu g/m^3$)	B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	16.51	22	9.22	2.57
	1 hour	40,000[b]	64	171	30.06	3.29
Lead (Pb)	Calendar Quarter	1.5[b]	0.05	0.0004	[c]	[c]
Nitrogen dioxide (NO_2)	Annual	100[b]	4.33	5.71	3.6	0.64
Particulate matter (PM_{10})	Annual	50[b]	1.03	3	0.04	0.03
	24 hours	150[b]	2.37	50.6	0.32	0.23
Sulfur dioxide (SO_2)	Annual	80[b]	4.46	14.5	0.61	0.06
	24 hours	365[b]	61.3	196	4.1	0.42
	3 hours	1,300[b]	241	824	21.21	0.99
Mandated by Tennessee, South Carolina, and Virginia						
Total suspended particulates	Annual	60[d]	7.74[e]	12.65	0.05	0.04[e]
(TSP)	24 hours	150[d]	82.16	47.88[e]	0.38	0.23
Gaseous fluorides (as HF)	1 month	0.8[d]	0.2	0.09	[c, e]	0.02
	1 week	1.6[d]	0.3	0.39	[c, e]	<0.06
	24 hours	2.9[d]	<0.6	1.04	[c, e]	0.06
	12 hours	3.7[d]	<0.6	1.99	[c, e]	0.1
	8 hours	250[d]	0.6	<2.99[e]	[c, e]	0.11

[a] Model results.
[b] Federal standard.
[c] No emissions from no action and this process.
[d] State standard or guideline.
[e] No State standard.
[Text deleted.]
Note: Ozone, as a criteria pollutant, is not directly emitted nor monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.
Source: 40 CFR 50; DOE 1995i; NF DEC nda; OR LMES 1995b; SC DHEC 1992b; SR NUS 1991a; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995b; WSRC 1994e.

potable water usage would be within ORR's treatment capacity.

The liquid effluents from involved operations and sanitary wastewater discharges, would not contain radionuclides or hazardous chemicals. The wastewater generated from the operations would be conveyed to the Y–12 Central Pollution Control Facility or the Y–12 West End Treatment Facility for processing. The approximately 18.7 million l/yr (4.9 MGY) of additional treated wastewater would be discharged to East Fork Poplar Creek. Treated sanitary and process wastewater discharges (18.7 million l/yr [4.9 MGY]) released to East Fork Poplar Creek would not exceed 1 percent of the average flow (1.3 m^3/s [45 ft^3/s]) and therefore should not result in any downstream flow effects. Releases to the Clinch River would represent less than 1 percent of the average flow. All discharges would be monitored to comply with NPDES permit limits. The difference between the amount of water being used and the amount of water being discharged can be attributed to drift and evaporation in the cooling towers. Stormwater runoff from the main plant area would be collected in detention ponds, monitored, and, if acceptable, discharged to nearby streams. Stormwater runoff from outside the main plant area, except from those facilities that require

onsite management controls by regulations (for example, sanitary treatment plants and landfills), would be discharged to nearby streams.

The Y–12 Plant is currently involved with remediation of East Fork Poplar Creek under CERCLA because East Fork Poplar Creek was contaminated by past releases from the Y–12 Plant. Significant cleanup activities are required onsite and offsite. Future NPDES permits would be obtained after review of the current water quality and how it is affected by discharges from Y–12. In addition, discharges from the treatment plants are required to meet all permit limits; therefore, no impacts to water quality are expected.

Domestic wastewater from the Y–12 Plant, including some sinks in process areas, is discharged to the sanitary sewer for treatment under an industrial user's permit. This permit allows the Y–12 Plant to discharge wastewater to be treated at the ORR wastewater treatment facility through two main sewage lines into the ORR sanitary sewer system in accordance with effluents limitations, monitoring requirements, and other conditions set forth in the permit. Radiological and nonradiological parameters are monitored for these sewer lines.

UNH blending facilities lie outside the 100- and 500-year floodplains.

Groundwater. No groundwater would be used at Y–12 given the plentiful surface water available; therefore, no impacts on groundwater levels are expected.

Groundwater quality would not be affected by the operation of UNH blending facilities. Because there would be no direct discharge of process wastewater to ground or groundwater, and wastewater would be treated at either the Y–12 Central Pollution Control Facility or at the Y–12 West End Treatment Facility before being released to surface waters, no impacts on groundwater quality are expected. Groundwater contamination at ORR is the result of practices that have been discontinued. The Y–12 Plant has implemented a comprehensive groundwater monitoring plan to monitor groundwater flow, quality, and content by sampling groundwater monitoring wells across the facility. Water quality of the East Fork Poplar Creek would be protected by the extensive Y–12 efforts to protect water quality.

Savannah River Site

Surface Water. Surface water required for the operation of UNH blending facilities (19 million l/yr [5 MGY]) would be taken from the existing water supply system, which obtains water from the Savannah River and groundwater wells. These surface water withdrawals would represent less than 1 percent of the regulated minimum flow of the Savannah River (152 m^3/s [5,368 ft^3/s]), and would not be expected to affect downstream users. Use of the Savannah River would not be affected by consumptive use associated with the UNH blending facilities. Operation of UNH blending facilities under these conditions would not violate riparian rights (Section 3.4.4).

The major sources of liquid effluents from involved operations would be nonhazardous wastewater that would not contain radionuclides and chemicals. Fourmile Branch near F- and H-Canyons is an area of low instream flow and was determined by an SRS study to be acceptable for sanitary water discharges after treatment at the new Centralized Sanitary Wastewater Treatment Facility. The 18.7 million l/yr (4.9 MGY) would represent less than 1 percent of the minimum flow of Fourmile Branch and would not be expected to adversely impact stream hydrology. All discharges would be required to comply with NPDES permit limits. Stormwater runoff from the facility would be collected in detention ponds, monitored, and, if clean, discharged to nearby streams. Stormwater from outside the main plant area would be discharged to nearby streams.

The UNH blending would be accommodated in facilities located outside the 100-year floodplain of Fourmile Branch or Upper Three Runs Creek. Statewide information concerning 500-year floodplains at SRS is not available. However, the blending alternatives at SRS would not be likely to affect or be affected by the 500-year floodplain of either the Fourmile Branch or Upper Three Runs Creek because the F- and H-Canyons are located at an elevation of approximately 32.6 m (107 ft) and 64 m (210 ft) above these streams and at distances from these streams of 0.8 km (0.5 mi) and 1.5 km (0.94 mi), respectively. The maximum flow that has occurred on the Upper Three Runs Creek was in 1990, with a flow rate of about 58 m^3/s (2,040 ft^3/s). At that time, the creek reached an elevation of almost 30 m (98 ft) above mean sea level (SR USGS

1996a:1). The elevation of the buildings in F- and H-Canyons are located more than 62 m (203 ft) above the highest flow elevation of the Upper Three Runs Creek. The maximum flow that has occurred on the Fourmile Branch was in 1991 with a rate of approximately 5 m^3/s (186 ft^3/s), and an elevation about 6.1 m (199 ft) above mean sea level (SR USGS 1996a:1). Elevations of the buildings in F- and H-Areas are approximately 31 m (101 ft) higher than the maximum flow level than has occured.

Groundwater. Suitable groundwater from the deep aquifers at the site is abundant, and aquifer depletion is not a problem. Pumping from the deep aquifer to meet domestic, process, and other water uses has continued as needed since the early 1950s. This usage has not adversely affected water levels in the deep aquifer.

Normal operation of UNH conversion and blending facilities would not result in liquid effluent discharges to groundwater; thus, groundwater quality would not be directly affected by wastewater discharges.

SRS would continue to notify the South Carolina Water Resources Commission when groundwater pumping exceeds 379,000 l/day or 100,000 gal/day (138 million l/yr or 36.4 MGY).

Babcock & Wilcox

Surface Water. Water withdrawn from the James River for the UNH blending operation (19 million l/yr [5 MGY]) is less than 1 percent of the minimal flow rate of the river (12.7 m^3/s [448 ft^3/s]). The design capacity for withdrawal by the B&W facility is 1,193 million l/yr (315 MGY), and this additional amount would be 1.7 percent of the design capacity. To date, water withdrawn from the James River has had no adverse impact on the James River flow rate. The withdrawal rates associated with future operations are expected to be similar to or less than the historical flows; therefore, no adverse impacts to river flow are expected.

The aqueous process waste and sanitary wastewater is treated and then discharged to the James River through permitted outfalls. The additional 18.7 million l/yr (4.9 MGY) discharged to the river would represent an approximate 29-percent increase in the amount being treated (65 million l/yr [17 MGY]) and would represent less than 1 percent of the James River minimum flow rate (12.7 m^3/s [488 ft^3/s]). The difference in amounts between water usage and water discharge is attributed to drift and evaporation in the cooling towers.

Degradation of surface water quality is prevented by enforcement of release limits and monitoring programs mandated under the facility NPDES permit. Examination of the NPDES monthly reports indicates that Total Dissolved Solids (TDS) standards were violated in three instances.

The site has the potential for flooding if the James River experiences very high flows. The more vulnerable areas of the site are the wastewater treatment facility and the ponds that are at lower site elevations. A large flood for the site (10,000 m^3/s [353,000 ft^3/s]) would cover the two equalization ponds and could remove the sediment material and transport it downstream. Such a flood would not be expected to inundate the applicable UNH blending facility.

Groundwater. Potential groundwater impacts include drawdown of the water table in the vicinity of facility wells and degradation of groundwater quality due to uncontrolled leakage from the subsurface soils. B&W withdrawals of groundwater in the area of the James River are small in comparison to the capacity of the wells and groundwater system.

There are no discharges of wastewater that could result in groundwater contamination from proposed operations except for those ponds that are used to manage the flow rate of discharges into the James River. The groundwater does have low levels of TCE contamination from previous leaks that have been identified and eliminated. All but two of the underground tanks installed at the site have been removed, so the potential for accidental contamination of the groundwater is reduced. Remediation plans are being prepared for the cleanup of the TCE plume. The operation of UNH blending facilities is not expected to result directly in any impacts to the local groundwater.

Nuclear Fuel Services

Surface Water. Water required for the operation of UNH blending facilities (19 million l/yr [5 MGY]) would be taken from the existing water supply system, which obtains process water from the city of Erwin public utility system. The additional water

required would represent about 33 percent of the current usage (57 million l/yr [15 MGY]) and would not be expected to affect other users.

Aqueous process waste is piped to the wastewater treatment facility, treated, and then discharged to the Nolichucky River by a direct pipeline. The additional discharge (0.9 million l/yr [0.23 MGY]) would represent an approximate 5-percent increase in the current discharge (18.9 million l/yr [5 MGY]). Total site discharges (19.8 million l/yr [5.2 MGY]) to the Nolichucky River would be 51 percent of the current permitted capacity (38.6 million l/yr [10.2 MGY]) and less than 1 percent of the river's average flow (39 m^3/s [1,380 ft^3/s]). Sanitary wastewater (17.8 million l/yr [4.7 MGY]) would be discharged to the city of Erwin treatment system. This will increase current sanitary wastewater discharges (38 million l/yr [10 MGY]) by approximately 47 percent. Total site sanitary wastewater discharges (55.8 million l/yr [14.7 MGY]) would not exceed the current permitted capacity (75.7 million l/yr [20 MGY]). There are no plans for noncontact cooling water to be discharged to Banner Spring Branch. Discharge is required to meet all NPDES permit limitations.

The site has the potential for being flooded if the Nolichucky River experiences very high flows. Elevations of the building floors are between 500 and 510 m (1,640 and 1,670 ft). The UNH blending would be accommodated at facilities in the 300 Area, located outside the 100- and 500-year floodplains. Based on the Flood Insurance Rate Map and the flood profiles, 100- and 500-year floodplain elevations at the NFS site are determined to be 499.5 m (1,639 ft) and 500 m (1,640 ft) above mean sea level, respectively. Facilities in the 300 Area have building floor elevations of approximately 500.5 m (1,642 ft) above mean sea level, which would be above the 100- and 500-year floodplain elevations. The more vulnerable areas of the site include the HEU recovery area, which contains the Highly Enriched Scrap Building, Highly Enriched Scrap Expansion, and Di-Process Storage facilities. The rechanneling of the Nolichucky, associated with the highway construction and rerouting of Martin Creek to enter the Nolichucky farther downstream, has lowered the previously expected flood levels at the site. Warning devices and systems are in place along the river to warn the public and the plant of the chance of possible flooding. The NFS site has emergency plans in place to contact the city of Jonesborough Water Treatment Facility as well as other local, State, and national committees, and inform them when any accidental releases from the plant have occurred. During flooding or any accidental releases to the surface water, the Jonesborough Water Treatment Plant closes off the water intake valves so no contamination to the public water supply occurs. In addition, the intake valves are monitored routinely for any water contamination problems. By having flood warning systems in place and emergency action plans, the public water supply can remain well protected from any potential contamination.

Groundwater. No groundwater would be used at NFS given the plentiful city water available; therefore, no impacts on groundwater levels are expected.

Groundwater quality would not be affected by the operation of UNH blending facilities, because there would be no direct discharges of process wastewater to groundwater. Wastewater would be treated prior to discharge to the Nolichucky River.

Currently, groundwater contamination occurs in the Quaternary alluvium adjacent to NFS's settling ponds, beneath the buried holding tanks and beneath the radioactive solid waste burial ground. A pump-and-treat restoration program is in place to clean up the groundwater contamination. There is also slightly contaminated groundwater beneath the CSX Transportation right-of-way. There are no known local down-gradient wells in the Quaternary alluvium. Banner Hill Spring has remained uncontaminated from 25 years of normal operations at the NFS facility.

4.3.1.4 Biotic Resources

The operation of the UNH blending facilities at ORR, SRS, B&W, or NFS is not expected to have significant adverse impacts on biotic resources. Operation of the blending process would be accommodated within existing buildings. There would be no loss of habitat; therefore, there would be no impacts on wildlife. The increase of water intake or discharge to site streams would be minimal (less than 1 percent of stream flow rates), which would cause no impacts to aquatic resources.

Impacts to wetlands would not occur since these resources are not located in the proposed area of activities. No Federal- or State-listed threatened or endangered species would be affected.

4.3.1.5 Socioeconomics

This section describes the potential socioeconomic effects resulting from operation of facilities for the blending of HEU to 4-percent LEU as UNH at ORR, SRS, B&W, or NFS. Any upgrades/modifications required at these facilities would be accomplished by the site's existing workforce, and no new jobs would be created; however, operation of the blending facilities at any of these sites would require additional employees, creating some minor economic benefits to the region.

Operation of the UNH blending facility would require 125 employees. Some workers needed for operation are currently employed at these sites; however, to assess the maximum potential impact of this alternative, the analysis assumes that all of the candidate sites would need 125 additional employees to blend HEU to LEU as UNH. The project would also create indirect jobs within the REAs ranging from 245 at SRS to 319 at ORR (Figure 4.3.1.5–1).

Available labor in each of the regions is sufficient to fill the new jobs created directly by the project and additional jobs created indirectly; therefore, it is unlikely that there would be any in-migration to these regions. Without any project-related in-migration, there would be no additional demands for housing units, community services, or transportation. The effects on housing and community services in the ROIs would be the same as for the No Action Alternative.

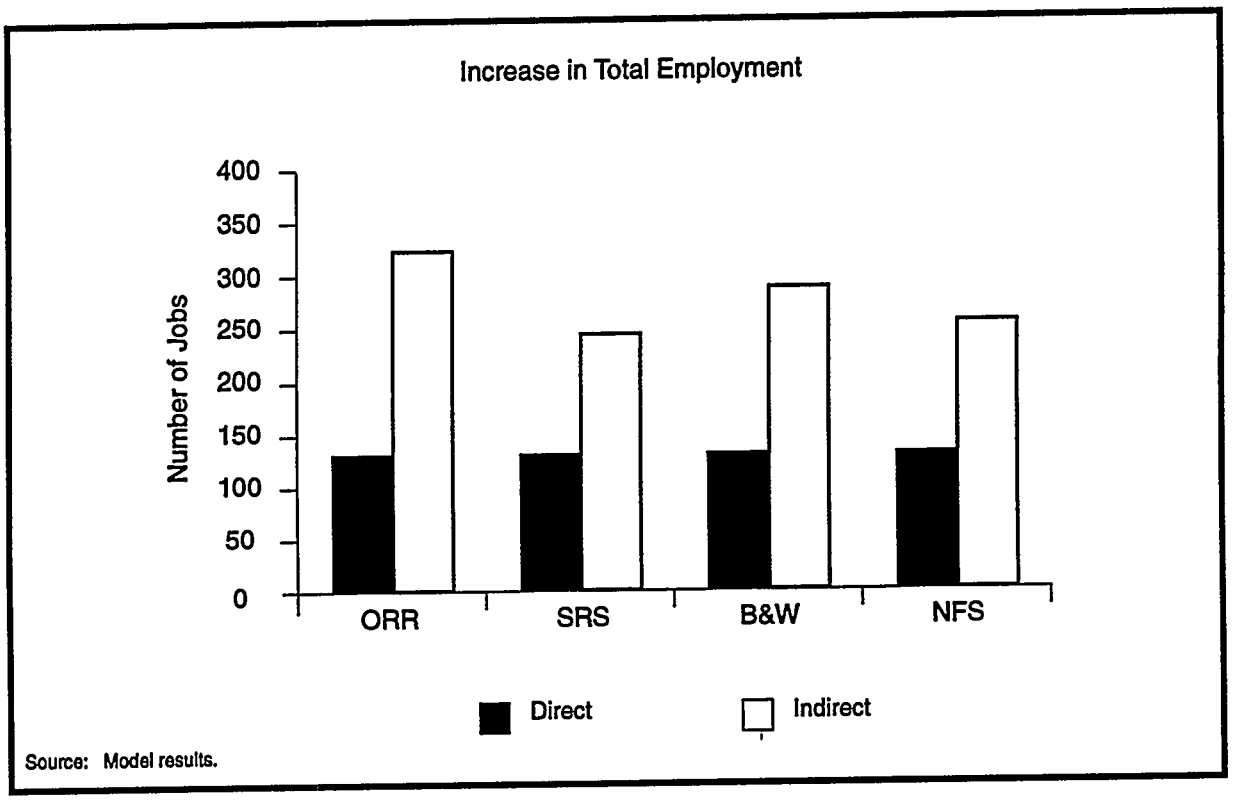


Figure 4.3.1.5–1. Increase in Total Project-Related Employment (Direct and Indirect) at Each Candidate Site Resulting From Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.

4.3.1.6 Public and Occupational Health

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or potential accidents for blending HEU to 4-percent LEU as UNH at the candidate sites. Summaries of the radiological impacts at each site to the public and to workers associated with normal operation are presented in Tables 4.3.1.6–1 and 4.3.1.6–2, respectively. Chemical impacts to these same groups are presented in Table 4.3.1.6–3, and accident impacts are presented in Table 4.3.1.6–4 through Table 4.3.1.6–7. (Further supplementary information is presented in Appendix E.)

Normal Operation

Radiological Impacts. Incremental radiological impacts to the public resulting from normal operation of UNH conversion and blending facilities at each of the sites are presented in Table 4.3.1.6–1. The impacts from total site operations, including the UNH conversion and blending facilities, are also given in the table. These impacts are provided to demonstrate compliance with applicable regulations governing total site operations. To put operational doses into perspective, comparisons are made with natural background radiation. As shown in Table 4.3.1.6–1, the doses to the MEI of the public from annual total site operations are all within radiological limits and would range from 0.052 mrem at B&W to 2 mrem at ORR. The annual population doses (within 80 km [50 mi]) would range from 0.51 person-rem at B&W to 28.2 person-rem at ORR.

Incremental and total site doses to onsite workers from normal operations are given in Table 4.3.1.6–2. The annual incremental dose to involved workers at the blending and conversion facility would be 90 mrem to the average worker and 11.3 person-rem to the entire facility workforce (DOE 1993n:7; NRC 1995b; OR LMES 1995b).

[Text deleted.] All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from blending HEU to 4-percent LEU as UNH at ORR, SRS, B&W, and NFS are presented in Table 4.3.1.6–3. The increment of potential adverse noncancer health effects and cancer risks posed by this action at the various sites are shown, followed by the total risk (that is, incremental risk plus no action contribution to risk) at each unique site.

The incremental and total site HIs for the public MEI contributed by this alternative at all sites are less than 1.0, showing that all hazardous chemicals are at concentrations below EPA's Reference Concentrations. However, at SRS the total HI for the worker is 1.16 higher than the level for no potential noncancer effects. This level is due to the no action contribution at this site. The cancer risks to the MEI at all sites are low and not significantly different from those to the nonexposed public. The cancer risks for the worker are also low except at SRS and B&W where the total cancer risks are 1.94×10^{-4} and 3.94×10^{-5}, respectively. [Text deleted.]

The incremental and total site HIs for the onsite workers contributed by this alternative at all sites are all less than 1, showing that all hazardous chemical concentrations are below OSHA's regulatory health limits (Permissible Exposure Levels), except at SRS where the total HI is 1.16. The incremental cancer risks for workers are all less than 1.0×10^{-6} (RA 1994a:477-481). The total site worker cancer risks at SRS and B&W are above the level for potential noncancer effects. The cancer risks to the MEI at all sites, and the total risk for onsite workers at Y–12 and NFS should not exhibit differences from the general public from the onset of operation. For details of calculations used to derive HIs and cancer risks, refer to Appendix E.3.

Facility Accidents

A set of potential accidents has been postulated for which there may be releases of radioactivity and hazardous chemicals that could impact involved and noninvolved onsite workers and the offsite population. A set of accident scenarios were selected to represent bounding cases. In assessing the bounding accident scenarios for the UNH blending facilities, the following parameters were evaluated: 1) material at risk; 2) energy sources (for example, fires, explosions, earthquakes, and process design-related events); 3) barriers to release; and 4) protective features of the facility.

Table 4.3.1.6–1. Potential Radiological Impacts to the Public Resulting From Normal Operation of Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Receptor	ORR		SRS		B&W		NFS	
	Incremental	Total Site[a]	Incremental	Total Site[a]	Incremental	Total Site[a]	Incremental	Total Site[a]
Maximally Exposed Individual (Public)								
Dose from atmospheric release pathway[b] (mrem/yr)	3.9×10^{-2}	1.4	2.5×10^{-3}	0.18	1.9×10^{-3}	4.8×10^{-2}	0.14	0.17
Dose from total liquid release pathway[b] (mrem/yr)	0	0.6	0	0.14	0	4.0×10^{-3}	0	9.0×10^{-4}
Dose from atmospheric and liquid release pathways combined[b] (mrem/yr)	3.9×10^{-2}	2	2.5×10^{-3}	0.32	1.9×10^{-3}	5.2×10^{-2}	0.14	0.17
Percent of natural background[c]	1.3×10^{-2}	0.68	8.4×10^{-4}	0.11	5.8×10^{-4}	1.6×10^{-2}	4.1×10^{-2}	5.0×10^{-2}
Risk of fatal cancer per year of operation[d]	2.0×10^{-8}	1.0×10^{-6}	1.3×10^{-9}	1.6×10^{-7}	9.5×10^{-10}	2.6×10^{-8}	7.0×10^{-8}	8.5×10^{-8}
Population Within 80 km								
Dose from atmospheric release pathways[e] (person-rem/yr)	0.16	26.2	0.16	20.2	1.7×10^{-2}	0.44	1.2	1.5
Dose from total liquid release pathways[e](person-rem/yr)	0	2	0	1.5	0	0.07	0	1.9×10^{-3}
Dose from atmospheric and liquid release pathways combined[e] (person-rem/yr)	0.16	28.2	0.16	21.7	1.7×10^{-2}	0.51	1.2	1.5
Percent of natural background[c]	5.2×10^{-5}	9.2×10^{-3}	7.5×10^{-5}	1.0×10^{-2}	7.0×10^{-6}	2.1×10^{-4}	2.8×10^{-4}	3.5×10^{-4}
Number of fatal cancers per year of operation[d]	8.0×10^{-5}	1.4×10^{-2}	8.0×10^{-5}	1.1×10^{-2}	8.5×10^{-6}	2.6×10^{-4}	6.0×10^{-4}	7.5×10^{-4}

[a] Includes impacts from all site operations that are expected to continue during the interim of blending process operations (reference environment).

[b] The applicable radiological limits for an individual member of the public from total site operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathway, 100 mrem/yr from all pathways combined for DOE sites: ORR and SRS and 25 mrem/yr from all pathways combined for NRC sites: B&W and NFS. Incremental radiological doses are different at each site because of site-specific characteristics such as meteorology, topography, distance to site boundary, etc.

[c] Annual natural background radiation levels: 1) ORR: the average individual receives 295 mrem; the population within 80 km receives 306,000 person-rem, 2) SRS: the average individual receives 298 mrem; the population within 80 km receives 213,000 person-rem, 3) B&W: the average individual receives 329 mrem; the population within 80 km receives 244,000 person-rem, 4) NFS: the average individual receives 340 mrem; the population within 80 km receives 429,000 person-rem.

[d] Representative of material processed at the rate of 10 t/yr.

[e] Proposed 10 CFR 834 (58 FR 16268) includes the requirement that the contractor who operates a DOE site notify DOE if the potential annual population dose exceeds 100 person-rem from all pathways combined.

Source: Appendix E.

Table 4.3.1.6–2. Potential Radiological Impacts to Workers Resulting From Normal Operation of Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Receptor	ORR	SRS	B&W	NFS
Involved Workforce[a]				
Average worker				
Dose (mrem/yr)[b]	90	90	90	90
Risk of fatal cancers per year of site operation	3.6×10^{-5}	3.6×10^{-5}	3.6×10^{-5}	3.6×10^{-5}
Total				
Dose (person-rem/yr)	11.3	11.3	11.3	11.3
Number of fatal cancers per year of site operation	4.5×10^{-3}	4.5×10^{-3}	4.5×10^{-3}	4.5×10^{-3}
Noninvolved Workforce[c]				
Average worker				
Dose (mrem/yr)[b]	4	18	10	50
Risk of fatal cancers per year of site operation	1.6×10^{-6}	7.2×10^{-6}	4.0×10^{-6}	2.0×10^{-5}
Total				
Dose (person-rem/yr)	68	216	16.7	16.3
Number of fatal cancers per year of site operation	2.7×10^{-2}	8.6×10^{-2}	6.7×10^{-3}	6.5×10^{-3}
Total Site Workforce[d]				
Dose (person-rem/yr)	79	227	28	28
Cumulative number of fatal cancers per year of site operation	3.2×10^{-2}	9.1×10^{-2}	1.1×10^{-2}	1.1×10^{-2}

[a] The in-plant (involved) worker is a worker associated with operations of the blending and conversion facilities. The estimated number of in-plant workers is 125.

[b] The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20 and 10 CFR 835).

[c] The noninvolved worker is a worker on site but not associated with operations of the blending and conversion facilities. The estimated number of noninvolved workers is 16,875 at ORR; 12,000 at SRS; 1,675 at B&W; and 325 at NFS.

[d] The total site workforce is the summation of the in-plant worker impacts and the noninvolved worker impacts. The estimated number of workers in the total site workforce is 17,000 at ORR; 12,125 at SRS; 1,800 at B&W; and 450 at NFS.

Source: BW 1995b:1; DOE 1993n:7; NFS 1995b:2; NRC 1995b; OR LMES 1995b; SRS 1995a:13.

Table 4.3.1.6–3. Potential Hazardous Chemical Impacts to the Public and Workers Resulting From the Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Receptor	Y–12		SRS		B&W		NFS	
	Incremental[a]	Total Site[b]	Incremental[a]	Total Site[b]	Incremental[a]	Total Site[b]	Incremental[a]	Total Site[b]
Maximally Exposed Individual (Public)								
Hazard index[c]	3.84×10^{-4}	3.99×10^{-2}	4.26×10^{-5}	5.20×10^{-3}	1.38×10^{-6}	1.29×10^{-5}	2.02×10^{-3}	9.75×10^{-2}
Cancer risk[d]	1.21×10^{-15}	1.21×10^{-15}	1.35×10^{-16}	1.31×10^{-7}	4.37×10^{-18}	1.68×10^{-8}	6.37×10^{-15}	6.37×10^{-15}
Onsite Worker								
Hazard index[e]	1.26×10^{-3}	0.155	1.13×10^{-3}	1.16	4.68×10^{-4}	4.54×10^{-3}	6.42×10^{-4}	8.21×10^{-3}
Cancer risk[f]	2.75×10^{-14}	2.75×10^{-14}	2.47×10^{-14}	1.94×10^{-4}	1.03×10^{-14}	3.94×10^{-5}	1.41×10^{-14}	1.41×10^{-14}

[a] Incremental=contribution only from single activity at the site.

[b] Total=no action emissions plus activity incremental.

[c] Hazard index for MEI=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

[d] Lifetime cancer risk for MEI=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Hazard index for workers=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[f] Lifetime cancer risk for workers=(emissions for 8-hour) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: OR LMES 1995b.

Table 4.3.1.6–4. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Y–12

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	11	38	320
Latent cancer fatalities per accident	4.2×10^{-3}	1.5×10^{-2}	0.13
Risk (cancer fatalities per year)	4.2×10^{-6}	1.5×10^{-6}	1.3×10^{-5}
Maximally Exposed Individual			
Dose (rem)	1.0×10^{-2}	5.1×10^{-2}	0.31
Latent cancer fatality per accident	5.2×10^{-6}	2.6×10^{-5}	1.6×10^{-4}
Risk (cancer fatality per year)	5.2×10^{-9}	2.6×10^{-9}	1.6×10^{-8}
Population Within 80 km (1,040,000 in 2010)			
Dose (person-rem)	1.5	3	44
Latent cancer fatalities per accident	7.7×10^{-4}	1.5×10^{-3}	2.2×10^{-2}
Risk (cancer fatalities per year)	7.7×10^{-7}	1.5×10^{-7}	2.2×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.1.6–5. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Savannah River Site

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3a}	10^{-4b}	10^{-4b}
Consequences			
Noninvolved Workers			
Dose (person-rem)	2.3	8.5	70
Latent cancer fatalities per accident	9.3×10^{-4}	3.4×10^{-3}	2.8×10^{-2}
Risk (cancer fatalities per year)	9.3×10^{-7}	3.4×10^{-7}	2.8×10^{-6}
Maximally Exposed Individual			
Dose (rem)	6.6×10^{-5}	3.0×10^{-4}	1.9×10^{-3}
Latent cancer fatality per accident	3.3×10^{-8}	1.5×10^{-7}	9.6×10^{-7}
Risk (cancer fatality per year)	3.3×10^{-11}	1.5×10^{-11}	9.6×10^{-11}
Population Within 80 km (710,000 in 2010)			
Dose (person-rem)	0.37	0.33	11
Latent cancer fatalities per accident	1.8×10^{-4}	1.6×10^{-4}	5.3×10^{-3}
Risk (cancer fatalities per year)	1.8×10^{-7}	1.6×10^{-8}	5.3×10^{-7}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.1.6–6. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Babcock & Wilcox

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3a}	10^{-4b}	10^{-4b}
Consequences[c]			
Noninvolved Workers			
Dose (person-rem)	24	80	760
Latent cancer fatalities per accident	9.5×10^{-3}	3.2×10^{-2}	0.3
Risk (cancer fatalities per year)	9.5×10^{-6}	3.2×10^{-6}	3.0×10^{-5}
Maximally Exposed Individual			
Dose (rem)	1.2×10^{-2}	5.6×10^{-2}	0.36
Latent cancer fatality per accident	5.9×10^{-6}	2.8×10^{-5}	1.8×10^{-4}
Risk (cancer fatality per year)	5.9×10^{-9}	2.8×10^{-9}	1.8×10^{-8}
Population Within 80 km (730,000 in 2010)			
Dose (person-rem)	0.9	1.9	26
Latent cancer fatalities per accident	4.5×10^{-4}	9.3×10^{-4}	1.3×10^{-2}
Risk (cancer fatalities per year)	4.5×10^{-7}	9.3×10^{-8}	1.3×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[c] Onsite meteorological data required for MACCS is not available. Therefore, consequences shown are based on the nearest meteorology data set, Roanoke Airport. The consequences corresponding to onsite meteorology would be approximately two to three times lower than the consequences indicated in this table. Further information is described in Appendix E.5.1.3.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.1.6–7. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Nuclear Fuel Services

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	1.6	8.7	67
Latent cancer fatalities per accident	6.6×10^{-4}	3.5×10^{-3}	2.7×10^{-2}
Risk (cancer fatalities per year)	6.6×10^{-7}	3.5×10^{-7}	2.7×10^{-6}
Maximally Exposed Individual			
Dose (rem)	2.3×10^{-3}	1.4×10^{-2}	7.8×10^{-2}
Latent cancer fatality per accident	1.2×10^{-6}	6.9×10^{-6}	3.9×10^{-5}
Risk (cancer fatality per year)	1.2×10^{-9}	6.9×10^{-10}	3.9×10^{-9}
Population Within 80 km (1,260,000 in 2010)			
Dose (person-rem)	1.3	2.2	38
Latent cancer fatalities per accident	6.4×10^{-4}	1.1×10^{-3}	1.9×10^{-2}
Risk (cancer fatalities per year)	6.4×10^{-7}	1.1×10^{-7}	1.9×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[Text deleted.]

Source: Results shown are derived from accident analyses; see Appendix E.5.

The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and an evaluation basis earthquake. With the exception of the filter fire (with continuous exhaust flow), all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake. Therefore, the evaluation basis earthquake would result in the highest atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality and other release scenarios.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and HEPA filters to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium powder and uranyl nitrate solution are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost and moderators added in the form of water from the fire system or organic solutions. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1.0×10^{19} fissions would occur prior to reaching a stable, subcritical condition and that all material releases would occur within a 2-hour period (NRC 1979b:3.34-4). The amount of radioactive material released as fission products created by the nuclear criticality would be 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium solutions, water, toxic gases, flammable gases, and toxic and reactive liquids. This is assumed to result in the release of 0.076 Ci of uranium isotopes (67 percent of the activity is U-234).

The accidents that release radioactivity and their consequences are shown in Tables 4.3.1.6–4 through 4.3.1.6–7. The consequences shown in these tables for B&W are based on meteorological data for Roanoke Airport (which is located 93 km [61 mi] west of B&W, in an area of more adverse stability), since, unlike Y–12, SRS, and NFS, onsite meteorological data required for MACCS were not available (some meteorological parameters are not monitored at B&W). Therefore, as discussed in Appendix E, Section E.5.1.3, these consequences (as shown in the table) are expected to be approximately two to three times higher than anticipated at B&W under onsite meteorological conditions.

The combined evaluation basis earthquake and earthquake-induced criticality accident release results in the highest consequences. The evaluation basis earthquake is conservatively assumed to cause both a criticality and a release of uranium material. The evaluation basis earthquake and the criticality are added together to show the range of consequences and risks at the candidate sites. If the evaluation basis earthquake were to occur, the estimated latent cancer fatalities in the general population within 80 km (50 mi) of each site would range from 5.5×10^{-3} at SRS to 2.4×10^{-2} at Y–12. For the MEI, there would be an increased likelihood of latent cancer fatality ranging from 1.1×10^{-6} at SRS to 2.1×10^{-4} at B&W. Based on the spatial distribution of noninvolved workers located on the site, the estimated number of latent cancer fatalities in the worker population ranges from 3.1×10^{-2} at SRS and NFS to 0.33 at B&W. The accident risks, reflecting both the probability of the accident occurring and the consequences, are also shown in the tables. For the general population, MEI, and noninvolved worker population, the fatal cancer risks range up to 2.4×10^{-6}, 2.1×10^{-8}, and 3.3×10^{-5} per year, respectively.

For SRS the accident analysis was performed for the H-Area. If blending were to occur in the F-Area, doses from an accidental release would be similar to an accidental release in the H-Area. The dose to the MEI would be slightly larger due to the decreased distance of 9,646 m (31,649 ft) from F-Area to the site boundary. The dose to the offsite population within 80 km (50 mi) would be slightly smaller due to F-Area being further from the offsite population than H-Area. The dose to noninvolved workers would be smaller due to the smaller workforce in the F-Area. The dose to noninvolved workers in the processing area is the dominant portion of the dose to total site noninvolved workers. The dose to noninvolved workers not in the processing area

would be a minimal effect due to the distance to other areas.

In addition to the potential impacts to noninvolved workers, there are potential impacts to involved workers, who are located in the facilities analyzed in this EIS. Potential radiological consequences to the involved worker range up to several thousand rem in the case of a criticality. The combined evaluation-basis earthquake and earthquake-induced criticality would probably result in fatal doses to the involved worker. Furthermore, fatalities to the involved workers would be expected as a result of the building collapse (from the earthquake) and the criticality (OR DOE 1994d:6-26, 6-27).

The bounding chemical release accident is a spill from nitric acid (HNO_3) and sodium hydroxide (NaOH) storage tanks caused by the evaluation basis earthquake. The release point for these accidents is the same as for radiological accidents. The seismic event is assumed to compromise the structural integrity of the curbing around the tank pits such that the two chemicals mix; they would react with sufficient heat generation to result in the airborne release of 13,000 kg (28,700 lb) of unreacted HNO_3; for sufficiently large exposures this could result in irritation to the respiratory system, eyes, skin, and pulmonary edema. If this accident were to occur, the noninvolved worker could be exposed to concentrations in excess of the IDLH level (100 ppm) at Y–12 and B&W and in excess of the TLV-STEL level (4 ppm) at NFS and SRS. The MEI of the public could be exposed to concentrations in excess of the IDLH level at Y–12 and B&W (these levels dissipate below the IDLH level at 380 and 180 m [1,250 and 590 ft] downwind, respectively), in excess of the TLV-STEL level at NFS (36 m [120 ft] downwind of the IDLH level), and at levels less than the TLV-TWA level (2 ppm) at SRS (see Section 4.1.9 for a discussion of the significance of these levels).

The SRS Interim Management of Nuclear Materials EIS (SRS IMNM EIS) also considers facility accidents that are similar to those in this EIS (SR DOE 1995e:E-25). Some of the accident scenarios involving HEU presented in the SRS IMNM EIS would have more severe consequences than the accidents postulated in the HEU EIS. Table 4.3.1.6–8 presents a comparison between the two EISs for the noninvolved worker, the maximally exposed individual, and the population within 80 km (50 mi)

Table 4.3.1.6–8. Comparison of Accident Results Between the Highly Enriched Uranium and the Savannah River Site Interim Management of Nuclear Materials Environmental Impact Statements

Accident Description	HEU EIS Evaluation Basis Earthquake Scenario	SRS IMNM EIS Severe Earthquake Scenario
Accident frequency (per year)	10^{-4}	2.0×10^{-4}
Consequence		
Noninvolved Worker		
Latent cancer fatality per accident	8.8×10^{-5}	2.2×10^{-2}
Risk (cancer fatality per year)	8.8×10^{-9}	4.4×10^{-6}
Maximally Exposed Individual		
Latent cancer fatality per accident	9.6×10^{-7}	6.3×10^{-4}
Risk (cancer fatality per year)	9.6×10^{-11}	1.3×10^{-7}
Population Within 80 km (710,000 in 2010)		
Latent cancer fatality per accident	5.3×10^{-3}	3.7
Risk (cancer fatalities per year)	5.3×10^{-7}	7.3×10^{-4}

Source: SR DOE 1995e; Table 4.3.1.6–4.

for the accident scenario resulting in the highest consequences. The consequences differ in these two documents mainly due to different meteorological assumptions used in the accident analyses. The SRS IMNM EIS assumes very conservative meteorological conditions (extreme conditions that are not likely to be exceeded 99.5 percent of the time) whereas the analyses in this EIS use average meteorological conditions (that will likely occur 50 percent of the time). The SRS IMNM EIS described the potential variability attributable to differences in meteorological assumptions as follows:

> The modeling of the various accidents postulated for the facilities associated with the different alternatives assumed

conservative (99.5 percentile) meteorological conditions (for example, direction and speed of the prevailing wind). Conservative meteorological conditions are those for which, for a given release, the concentration of radionuclides (and the resulting dose) at a fixed downwind location will not be exceeded 99.5 percent of the time. Usually, this means a highly stable-low wind speed weather condition where the wind provides only limited dilution of the material released. Use of these meteorological conditions result in consequences approximately three to four times higher for onsite workers and between 10 and 100 times higher for the offsite population than those that would occur during average (50 percentile) meteorological conditions (SR DOE 1995e: E-7).

Therefore, SRS IMNM EIS gives generally higher consequences due to the difference in material present and the conservative meteorological conditions assumed. In addition, SRS IMNM EIS used a site specific evaluation basis earthquake frequency of $2x10^{-4}$, whereas the HEU EIS used a generic accident frequency range of 10^{-3} to 10^{-5} appropriate for all four sites. Both the SRS IMNM EIS frequency of $2x10^{-4}$ and the HEU EIS frequency of 10^{-4} are within the accident frequency range. The Y–12 EA evaluated an earthquake with a $5.0x10^{-4}$ frequency also within the frequency range for the HEU EIS. These events (that is, earthquakes) are very rare. [Text deleted.] For the HEU EIS, the latent cancer fatalities following an evaluation basis earthquake are $8.8x10^{-5}$, $9.6x10^{-7}$, and $5.3x10^{-3}$ for the noninvolved worker, the MEI, and the population within 80 km (50 mi), respectively. For the SRS IMNM EIS, the latent cancer fatalities for the same earthquake are $2.2x10^{-2}$, $6.3x10^{-4}$, and 3.7. The differences between consequences for the noninvolved worker, the MEI, and the population within 80 km (50 mi) are a factor of 250, 660, and 700, respectively. This difference between the two EISs is mainly due to the assumptions employed for meteorological conditions and the source terms used in the analyses. The two analyses differ because the HEU EIS assumed a normal solution source term of 0.076 curies and the SRS IMNM EIS assumed a limiting solution source term of 1.17 curies which includes material in the facility unrelated to the blending activity. In addition to the differences between the consequences, the differences between the risks, which is the product of the consequence and the probability, are an additional factor of 2. These additional differences are due to the larger earthquake frequency that is assumed in the SRS IMNM EIS. The HEU EIS describes a spectrum of accidents for a specific material. For a wider range of accident scenarios at SRS, the SRS IMNM EIS should be consulted and the results evaluated in association with those presented in this EIS.

4.3.1.7 Waste Management

Operation of facilities required to blend surplus HEU to 4-percent LEU as UNH would affect current waste management activities at the candidate sites. There is no spent nuclear fuel, HLW, or TRU waste associated with the proposed conversion and blending. However, generation of low-level, mixed low-level, hazardous, and nonhazardous wastes would increase. This section summarizes the potential impacts on waste management activities at each candidate site resulting from blending HEU to 4-percent LEU as UNH.

As shown in Table 2.2.2.1–2, the blending process would result in generation of additional amounts of low-level, mixed low-level, hazardous, and nonhazardous wastes. Table 4.3.1.7–1 provides the estimated sitewide waste generation resulting from the blending process. At each commercial facility considered for the blending process, the generation of wastes would be evaluated for ALARA principles. Table 2.2.2.1–2 also provides the resultant waste volume after treatment (effluent) using a reasonably foreseeable treatment scheme as outlined in Figures 4.3.1.7–1 to 4.3.1.7–3.Liquid LLW from decontamination would go through a uranium recovery process first. The liquid effluent then would go to a radioactive wastewater treatment facility. The resultant sludge would be immobilized for disposal as solid LLW and the treated effluent would be discharged through a permitted outfall.

Solid LLW generated by the blending process would consist of lab wastes, decontamination solids, scrapped equipment, air sampling filters, HEPA filters, and miscellaneous contaminated solids. Solids generated from decontamination processes would go through a uranium recovery process before being packaged for disposal. All other solid LLW would be

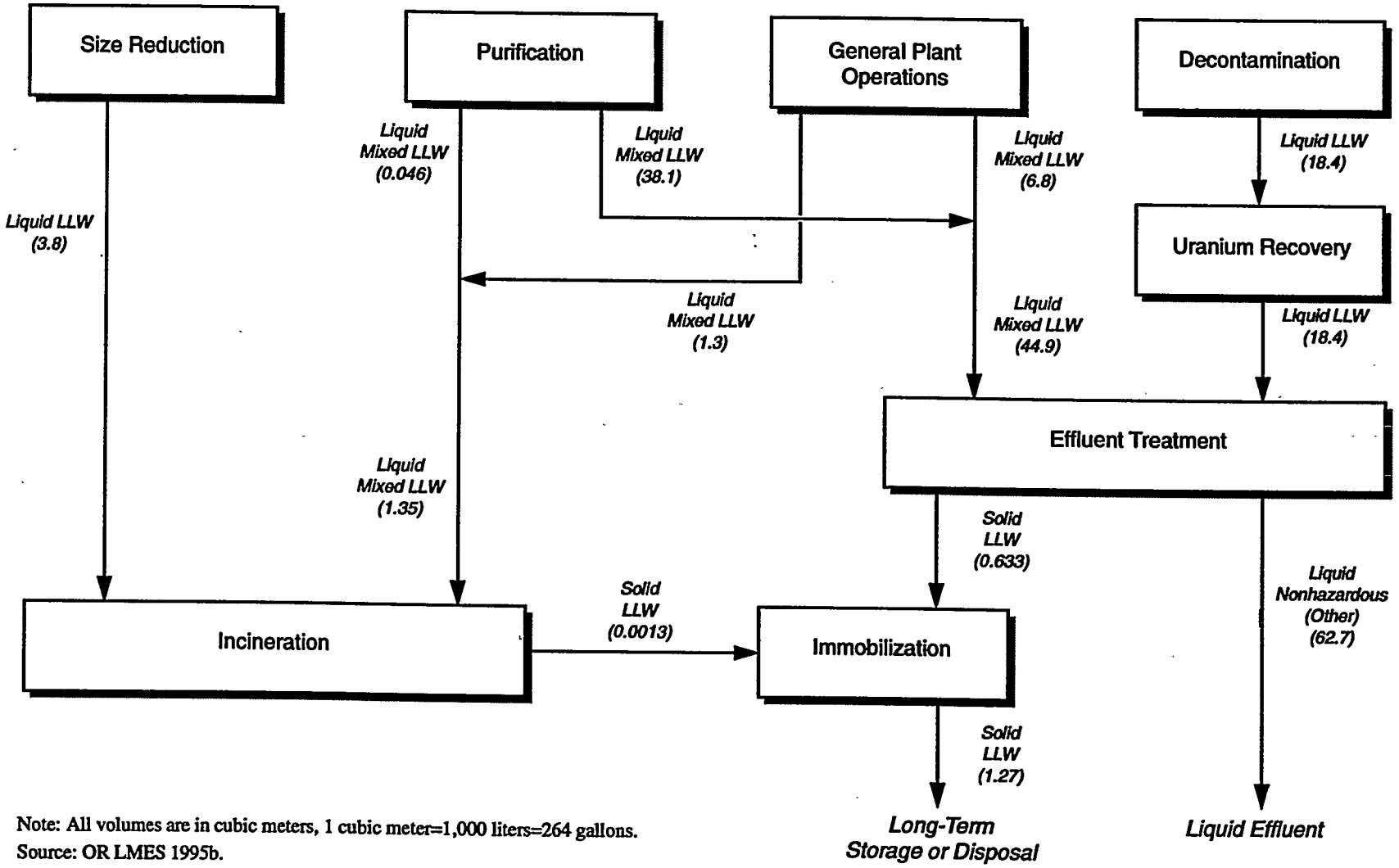
Table 4.3.1.7–1. Estimated Annual Generated Waste Volumes for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Waste Category	ORR[a]			SRS[b]			B&W			NFS		
	With UNH			With UNH			With UNH			With UNH		
	No Action (m^3)	Blending (m^3)	Increase (Percent)	No Action (m^3)	Blending (m^3)	Increase (Percent)	No Action (m^3)	Blending (m^3)	Increase (Percent)	No Action (m^3)	Blending (m^3)	Increase (Percent)
Low-Level												
Liquid	2,576	2,598	<1	0	22	>100	50,005	50,027	<1	18,900	18,922	<1
Solid	8,030	8,106	<1	14,100	14,176	<1	620	696	12	3,000	3,076	3
Mixed Low-Level												
Liquid	84,210	84,256	<1	115	161	40	0	46	New	<1	46	>100
Solid	960	960	0	18	18	0	14	14	0	<1	<1	0
Hazardous												
Liquid	32,640	32,728	<1	Included in solid	88	–	55,115	55,203	<1	<1	89	>100
Solid	1,434	1,434	0	74	74	0	0	0	0	<1	<1	0
Nonhazardous												
Liquid	1,743,000	1,761,773	1	700,000	718,773	3	576,160	594,933	3	56,700	75,473	33
Solid	52,730	53,550	2	6,670	7,490	12	1,700	2,520	48	2,300	3,120	36

[a] 1993 Generation. Wastes at ORR are managed by a centralized waste management organization and not by individual sites; therefore, generation rates represent the sum of activities at K–25, ORNL, and Y–12.

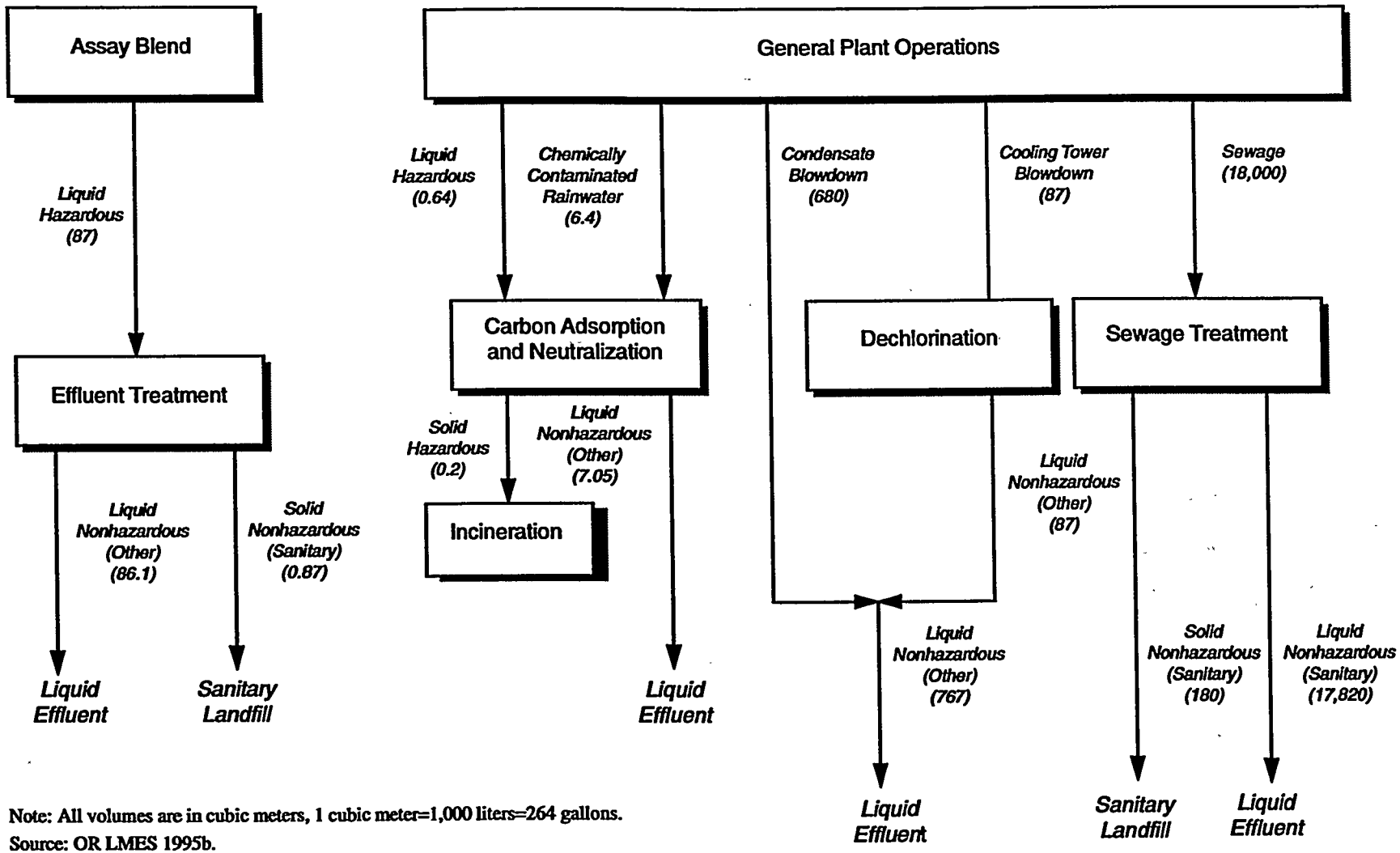
[b] 1993 Generation. Nonhazardous waste category is 1991 Generation.

Source: BW 1995b:1; BW NRC 1991a; BW NRC 1995a; NFS 1995b:2; NRC 1991a; OR LMES 1995b; Tables 3.3.10–1, 3.3.10–2, 3.3.10–3, and 3.4.10–1.



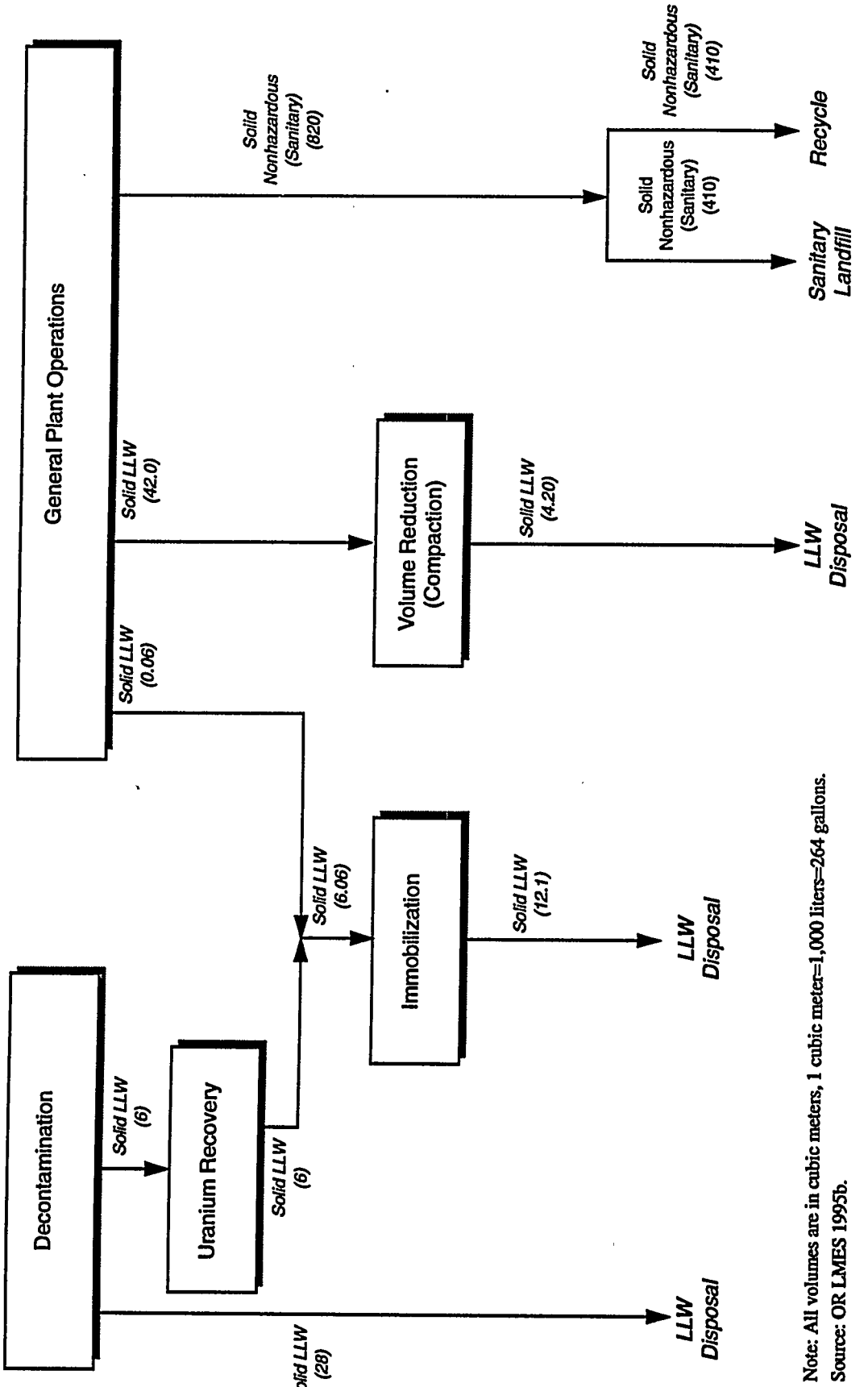
Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995b.

Figure 4.3.1.7–1. Radioactive Liquid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995b.

Figure 4.3.1.7–2. Nonradioactive Liquid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995b.

Figure 4.3.1.7–3. Solid Waste Management for Conversion and Blending 10 tyr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.

compacted and immobilized as appropriate to meet the waste acceptance criteria of an onsite or offsite LLW disposal facility. The solid LLW radiological content would include U-232, U-234, U-235, U-236, and U-238. Liquid mixed LLW consisting of spent solvents and lab waste would be incinerated, thus eliminating the hazardous constituent. The resultant ash would be immobilized and packaged for disposal as solid LLW. The sump collection wastes from general plant operations would be precipitated and filtered in a radioactive liquid waste treatment facility. The resultant sludge would be immobilized for disposal and the treated effluent would be discharged through a permitted outfall. Other solid mixed LLW would consist of contaminated gloves and wipes. After compaction, they would be packaged for storage until a sufficient volume had accumulated for treatment in an onsite or offsite RCRA-permitted facility.

Liquid hazardous waste consisting of liquid waste treatment excess/flush water and chemical spillage would be treated onsite by distillation, evaporation, neutralization, and ammonia removal. The treated effluent would be discharged through a permitted outfall. Liquid nonhazardous waste such as sewage wastewater would be treated and disposed of using current site practices and facilities. Solid nonhazardous waste would primarily consist of solid sanitary waste, trash, waste paper, scrap metal, air filters, personnel respirators, plastic bags, and gloves. Nonrecyclable portions of this waste would be disposed of in a permitted landfill per site practice.

Oak Ridge Reservation. Current waste generation rates and treatment, storage, and disposal capacities are presented for ORR in Tables 3.3.10–1 through 3.3.10–3. These tables indicate that liquid and solid LLW treatment facilities at ORR would not be greatly impacted due to this action. The liquid LLW treatment facility at ORR has the capacity to treat the increase in liquid LLW generated. Solid LLW generated at ORR would be compacted, smelted, and incinerated offsite and then stored onsite pending the completion of a proposed LLW Class II facility that is due to be operational in 2002. The amount of solid LLW generated by blending 10 t/yr of HEU that would eventually be transferred to the LLW disposal facility would be 46 m^3/yr (1,620 ft^3/yr). Assuming a usage factor of 3,300 m^3/ha (47,200 ft^3/acre) as developed in Section 4.1.10, this waste will require 0.014 ha/yr (0.034 acres/yr) in the new LLW Class II facility. The small increase in liquid mixed LLW could be handled by the onsite mixed LLW treatment facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 782 m^3 (27,600 ft^3), which would require 0.24 ha (0.59 acre) for disposal. Adequate staging capacity also is available to incorporate the amount of solid mixed LLW from the treatment of the liquid mixed LLW. The onsite hazardous waste treatment facility has the capacity to accommodate the 1-percent increase in the amount of hazardous liquid waste produced by the blending process. This action would increase liquid sanitary waste generation to approximately 1,762,000 m^3/yr (465 MGY). The onsite facilities have a capacity of 4,930,000 m^3/yr (1,300 MGY), so the increase is within the facility capacity. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated in the site's current recycling practices.

Savannah River Site. Current waste generation rates and treatment, storage, and disposal capacities are presented for SRS in Table 3.4.10–1. This table indicates that liquid and solid LLW treatment facilities at SRS would not be greatly impacted due to this action. The amount of liquid LLW generated per year by this action would be small compared to the amount of liquid LLW generated yearly at the site, and the onsite treatment facility has the capacity to accommodate the increase. There would be 46 m^3/yr (1,620 ft^3/yr) of solid LLW resulting from liquid and solid LLW treatment that would require staging and/or disposal. Assuming a usage factor of 8,600 m^3/ha (123,000 ft^3/acre) as presented in Section 4.1.10, the increase in the amount of solid LLW would require 0.005 ha/yr (0.012 acres/yr) in the onsite LLW disposal facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 782 m^3 (27,600 ft^3) which would require 0.09 ha (0.22 acre). The onsite mixed LLW treatment facility has the capacity to incorporate the increase in the amount of mixed LLW generated by the blending process. The storage capacity for mixed LLW at SRS is much greater than the yearly waste generation rate and would likely be able to handle this increase. Currently, the site incorporates liquid hazardous

waste into the solid hazardous waste treatment system. There exists at SRS the capacity to treat 2,000 m^3/yr (528,000 gal/yr) of liquid hazardous waste; therefore, the increase would not burden existing systems. A 3-percent increase in the amount of liquid nonhazardous waste would result at SRS if this action were implemented. This increase would not burden onsite facilities. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated in the site's current recycling practices.

Babcock & Wilcox. The B&W site has facilities for treating liquid LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small compared with the amount of liquid LLW generated yearly at the site. The onsite treatment facility for liquid LLW at B&W has a capacity to treat approximately 89,800 m^3/yr (23.7 MGY); therefore, B&W would be able to handle the 22 m^3/yr (5,810 gal/yr) increase in liquid LLW generated (BW NRC 1991a:13). When this process is complete, the amount of solid LLW requiring staging and eventual disposal would be 46 m^3/yr (1,620 ft^3/yr). This waste would be hauled offsite to a disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre) as developed in Section 4.1.10, this waste would require 0.002 ha/yr (0.005 acres/yr) in a disposal facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 782 m^3 (27,600 ft^3) which would require 0.039 ha (0.097 acre). The small amount of liquid mixed LLW generated would require some form of treatment. [Text deleted.] This waste can be treated in the existing LLW treatment facility at B&W. Currently, onsite treatment facilities process approximately 55,115 m^3 (14.6 million gal) of liquid hazardous waste. The increase in liquid hazardous waste generation of 88 m^3 (23,200 gal) should not burden this treatment system. The amount of liquid nonhazardous waste resulting from the blending process would increase by 3 percent over current operations. This could be accomplished in existing facilities that have a capacity of 2.5 times the combined requirement. B&W has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

Nuclear Fuel Services. The NFS site has facilities for treating LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small and the onsite treatment facility would likely have the capacity to handle an increase of approximately 22 m^3/yr (5,810 gal/yr). This action will add 46 m^3 (1,620 ft^3) of solid LLW requiring staging and eventual disposal. This waste would be shipped offsite to a disposal facility. With a usage factor of 20,000 m^3/ha (286,000 ft^3/acre) as presented in Section 4.1.10, this waste would require 0.002 ha/yr (0.005 acres/yr) in a disposal facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 782 m^3 (27,600 ft^3), which would require 0.039 ha (0.097 acre). The small amount of liquid mixed LLW generated by this process would require some form of treatment. The liquid LLW treatment system could handle the increase in mixed LLW. [Text deleted.] The amount of liquid nonhazardous waste resulting from the blending process would increase from current operations. It would be discharged to the public treatment works with the rest of the nonhazardous liquid waste. NFS has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

4.3.2 TECHNOLOGY AND SITE-SPECIFIC IMPACTS FOR BLENDING HIGHLY ENRICHED URANIUM TO 4-PERCENT LOW-ENRICHED URANIUM AS URANIUM HEXAFLUORIDE

The process analyzed in this section involves converting surplus HEU to UF_6 and blending it in the gaseous form with natural or low-enriched UF_6 to obtain the desired enrichment level. There are no DOE or commercial facilities in the United States that have the capability to convert HEU to UF_6. However, for the reasons explained in Section 2.2.1, B&W and NFS are used as representative sites for this alternative.

Assessment of impacts of blending HEU to 4-percent LEU as UF_6 are based on an annual throughput of 10 t of impure alloyed 50-percent assay HEU metal to 4-percent assay UF_6 with LEU blendstock. The blendstock feed material used in this alternative is assumed to be pure UF_6.

4.3.2.1 Site Infrastructure

Operation of facilities to blend HEU to 4-percent LEU as UF_6 would potentially affect site infrastructure, mainly electrical power, fuel, and water/steam supply. Site infrastructure requirements are discussed in Section 2.2.2.3 and detailed in Table 4.3.2.1–1 for each site; however, the discussion of impacts on site infrastructure is presented for all the sites collectively.

Due to the use of existing facilities, and the estimated utility requirements for the UF_6 blending facility, there is no anticipated need for modifications to onsite or offsite road and rail access or right-of-way access corridors for such services as electrical transmission lines, natural gas and water supply pipelines, and telecommunications.

Annual electrical service requirements would result in approximately a 38-percent increase over the current annual usage at B&W and a 115-percent increase in annual consumption for NFS (This increase at NFS is due to its current unoperational state.) Peak load is estimated to increase by approximately 14 and 57 percent at B&W and NFS, respectively. Even with this increase, the capacity at both commercial facility sites would still be adequate to accommodate the blending facility's electrical service requirements without implementing any major modifications or constructing new transmission or distribution facilities.

Due to a decrease in processing requirements, the facilities at NFS are less active than normal; therefore, increases in resource requirements from the blending facility are orders of magnitude higher than current annual consumptive fuel use. Natural gas is the primary fuel in use at B&W with a significant fraction used in steam boilers to satisfy energy requirements of current operations. Similarly, NFS uses natural gas in boilers for building and process heat production. Fuel oil is used at both sites when natural gas is unavailable or uneconomical. The fuel requirements for the UF_6 conversion and blending facility represent an increase over current usage of 16.6 percent at B&W. For NFS, the blending facility represents an increase of 1,075 percent of current fuel consumption; however, based on fuel consumption data for NFS building and process equipment (790,000 l [209,000 gal] of fuel oil), the fuel requirement for the UF_6 blending facility would be about 65 percent of NFS's installed capacity. The annual raw water requirements for operation of the blending facility would result in about a 10.3 percent increase in current usage at B&W and a 35.1 percent increase at NFS. The available water capacity at each site is adequate to satisfy the blending facility requirements under this alternative.

The infrastructure resources at B&W and NFS are capable of accommodating the blending facility requirements without incurring any significant adverse environmental effects. No major modification or upgrade to these resources is expected due to development, operation, and decommissioning of the UF_6 blending facility at either site.

4.3.2.2 Air Quality and Noise

Operation of facilities to blend HEU to 4-percent LEU as UF_6 would generate criteria and toxic/hazardous pollutants that could potentially exceed Federal and State ambient air quality standards or guidelines. Concentrations of these pollutants resulting from this alternative were estimated for each site and are presented in Table 4.3.2.2–1.

Air Quality. Air pollutant emissions associated with the operation of the UF_6 blending facility consist of criteria pollutants from the operation of boilers to produce steam and toxic/hazardous pollutants used or generated in the blending process such as nitric acid.

Table 4.3.2.1–1. Changes to Site Infrastructure for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Site	Access		Electrical		Fuel			Water	
	Road (km)	Rail (km)	Energy (MWh/yr)	Peak Load (MWe)	Natural Gas (m^3/yr)	Diesel/Oil (l/yr)	Coal (t/yr)	Water (million l/yr)	Steam (kg/hr)
UF_6 facility	0	0	25,000	2	21,200	56,800	545	20	1
B&W baseline	<1	0.305	64,700	14.3	2,850,000	470,000	0	195	1,460
B&W percent change	0	0	38.6	14	0.7	101[a]	NA[b]	10.3	0.07
NFS baseline	3	0	21,800	3.5	12,900[c]	36,000[c]	0	57	6,260
NFS percent change	0	0	115	57.1	165	1322[a]	NA[b]	35.1	0.02

[a] Percent change includes required coal energy equivalent.

[b] Coal is not utilized at B&W NNFD or NFS and all of the blending facility coal derived energy requirements would be supplied via the fuel oil energy equivalent; the fuel oil energy content is assumed to be 40,128 BTUs/l and for coal it is assumed to be 30.9 million BTUs/t (that is, 545 t of coal=419,185 l of fuel oil).

[c] Values shown are based on current usage; typical annual consumption is estimated at approximately 790,000 l of fuel oil, equivalent.

Note: NA=not applicable; MWh=megawatt hour; MWe=megawatt electric; BTU=British thermal unit.

Source: BW 1995b:1; NF NRC 1991a; NFS 1995b:2; OR LMES 1995a.

Table 4.3.2.2–1. Estimated Concentrations of Criteria Pollutants Based Upon Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	UF_6 Blending Alternative Concentration[a]	
			B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	5.43	0.62
	1 hour	40,000[b]	17.63	0.80
Lead (Pb)	Calendar Quarter	1.5[b]	[c]	[c]
Nitrogen dioxide (NO_2)	Annual	100[b]	0.14	0.03
Particulate matter[d] (PM_{10})	Annual	50[b]	0.03	<0.01
	24 hours	150[b]	0.19	0.03
Sulfur dioxide (SO_2)	Annual	80[b]	0.4	0.05
	24 hours	365[b]	2.74	0.4
	3 hours	1,300[b]	14.11	0.96
Mandated by Tennessee and Virginia				
Total suspended particulates[d] (TSP)	Annual	60[e]	0.03	< 0.01[f]
	24 hours	150[e]	0.19	0.03
Gaseous fluorides (as HF)	1 month	1.2[e]	trace[f, g]	trace[g]
	1 week	1.6[e]	trace[f, g]	trace[g]
	24 hours	2.9[e]	trace[f, g]	trace[g]
	12 hours	3.7[e]	trace[f, g]	trace[g]
	8 hours	250[e]	trace[f, g]	trace[g]

[a] Model results.

[b] Federal standard is the most restrictive standard.

[c] No emissions from this process.

[d] It is conservatively assumed that PM_{10} concentrations are TSP concentrations.

[e] State standard or guideline.

[f] No State standard.

[g] Hydrofluorination is anticipated to be a closed system with scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; OR LMES 1995a; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995b.

These pollutants are controlled using liquid scrubbing prior to HEPA filtration to remove chemical vapors and particulates.

The annual concentration of NO_2 at B&W was calculated to be approximately 3.5 percent of the annual NAAQS for NO_2. NO_2 is considered to be a primary emission at the site. The UF_6 blending facility would contribute less than 1 percent to the annual concentration of NO_2 at B&W. Criteria pollutant concentrations would be expected to remain in compliance with the NAAQS and State-mandated standards.

The primary source of criteria pollutants at NFS is from space heating, which is accomplished by combustion of natural gas. The annual concentration of NO_2 at NFS is approximately 0.6 percent of the standard, which is the highest percent of a standard for criteria pollutants at NFS. Monitoring performed at NFS by TDEC indicated that the facility is in compliance with Federal and State regulations and guidelines (NF NRC 1991a:4-30). Operation of the UF_6 blending facility would add less than 0.1 percent of the annual concentration of NO_2, which would not be expected to change the compliance status of NFS.

Table 4.3.2.2–1 presents the estimated concentrations of criteria pollutants from blending HEU to 4-percent

LEU as UF_6. Table 4.3.2.2–2 presents the total concentrations of no action criteria pollutants plus blending at each site. During operation, impacts from the UF_6 blending facility with respect to the concentrations of criteria and toxic/hazardous air pollutants are expected to be within Federal and State regulations and guidelines for each site.

Noise. Operation of the UF_6 blending facility in an existing building at each site would result in little or no change in the contribution to noise levels at offsite receptors. Existing buildings are located at a sufficient distance from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

Noise impacts associated with increased traffic on access routes would be small considering that either of the two facilities would require a maximum of 126 employees during operation (OR LMES 1995a:24), many of whom would be employees currently working at the site.

Potential measures to minimize noise impacts on workers include providing workers in noisy environments with appropriate hearing protection devices that meet OSHA standards. As required, noise

Table 4.3.2.2–2. Estimated Total Concentrations of Criteria Pollutants for No Action Plus Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	No Action Plus Blending Concentration[a]	
			B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	9.43	2.59
	1 hour	40,000[b]	30.73	3.32
Lead (Pb)	Calendar Quarter	1.5[b]	[c]	[c]
Nitrogen dioxide (NO_2)	Annual	100[b]	3.64	0.65
Particulate matter[d] (PM_{10})	Annual	50[b]	0.05	0.03
	24 hours	150[b]	0.35	0.24
Sulfur dioxide (SO_2)	Annual	80[b]	0.74	0.07
	24 hours	365[b]	5.02	0.55
	3 hours	1,300[b]	25.91	1.31
Mandated by Tennessee and Virginia				
Total suspended particulates[d] (TSP)	Annual	60[e]	0.06	0.04[f]
	24 hours	150[e]	0.41	0.24
Gaseous fluorides (as HF)	1 month	1.2[e]	trace[f, g]	0.02
	1 week	1.6[e]	trace[f, g]	<0.06
	24 hours	2.9[e]	trace[f, g]	0.06
	12 hours	3.7[e]	trace[f, g]	0.1
	8 hours	250[e]	trace[f, g]	0.11

[a] Model results.

[b] Federal standard.

[c] No emissions from no action or this process.

[d] It is conservatively assumed that PM_{10} concentrations are TSP concentrations.

[e] State standard or guideline.

[f] No State standard.

[g] Hydrofluorination is anticipated to be a closed system with scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not emitted nor monitored by the candidate sites.

Source: 40 CFR 50; NF DEC nda; OR LMES 1995a; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995b.

levels would be measured in worker areas, and a hearing protection program would be implemented.

4.3.2.3 Water Resources

Environmental impacts associated with the operation of UF_6 blending facilities would affect surface and groundwater resources. Water resource requirements and discharges provided in Section 2.2.2.3 were used in assessing impacts to surface water and groundwater. The discussion of impacts is provided for each site separately.

Babcock & Wilcox

Surface Water. Water withdrawn from the James River for the UF_6 blending operation (20 million l/yr [5.3 MGY]) would represent less than 1 percent of the minimal flow rate of the river (12.7 m^3/s [448 ft^3/s]) and approximately 1.7 percent of the design capacity of B&W (1,193 million l/yr [315 MGY]). To date, water withdrawn from the James River has had no adverse impacts on the river's flow rate. The withdrawal rates associated with future operations are expected to be similar to or less than the historical withdrawals; therefore, minimal flow impacts are expected.

The aqueous process waste and sanitary wastewater is treated and then discharged to the James River through permitted outfalls. The additional 19.1 million l/yr (5 MGY) discharged to the river would represent an approximate 29-percent increase in the amount being treated, 65 million l/yr (17 MGY), and less than 1 percent of the James River minimum flow rate (12.7 m^3/s [448 ft^3/s]). The difference in amounts between water usage and water discharge is attributed to drift and evaporation in the cooling towers.

Degradation of surface water quality is prevented by enforcement of release limits and monitoring programs mandated under the facility NPDES permit. Examination of the NPDES monthly reports indicated that TDS standards were violated in three instances.

The site has the potential for flooding if the James River experiences very high flows. The more vulnerable areas of the site are the wastewater treatment facility and the ponds that are at lower site elevations. A large flood for the site (10,000 m^3/s [353,000 ft^3/s]) would cover the two equalization ponds and could remove the sediment material and transport it downstream. Such a flood would not be expected to inundate the applicable UF_6 blending facility.

Groundwater. Potential groundwater impacts include drawdown of the water table in the vicinity of facility wells and degradation of groundwater quality due to uncontrolled leakage from the subsurface soils. B&W withdrawals of groundwater in the area of the James River are small in comparison to the capacity of the wells and groundwater system.

There are no discharges of wastewater that could result in groundwater contamination from proposed operations, except for those ponds that are used to manage the flow rate of discharges into the James River. The groundwater does have low levels of TCE contamination from previous leaks that have been identified and eliminated. All but two of the underground tanks installed at the site have been removed; therefore, the potential for accidental contamination of the groundwater is reduced. Remediation plans are being prepared for the cleanup of the TCE plume. The operation of UF_6 blending facilities is not expected to result in any direct impacts to the local groundwater.

Nuclear Fuel Services

Surface Water. Water required for the operation of UF_6 blending facilities (20 million l/yr [5.3 MGY]) would be taken from the existing water supply system, which obtains process water from the city of Erwin public utility system. The additional water required would represent about 35.1 percent of the current usage (57 million l/yr [15 MGY]) and would not be expected to affect other users.

The aqueous process waste is piped to the wastewater treatment facility, treated, and then discharged to the Nolichucky River by a direct pipeline. The additional discharge (1.3 million l/yr [0.34 MGY]) would represent an approximate 7-percent increase in the current average daily discharge (18.9 million l/yr [5 MGY]) or less than 1 percent of the average flow (39 m^3/s [1,380 ft^3/s]). The sanitary wastewater (17.8 million l/yr [4.7 MGY]) would be discharged to the city of Erwin wastewater treatment facility. This will increase current sanitary wastewater discharge (38 million l/yr [10 MGY]) by approximately 47 percent. Total site sanitary wastewater discharges (55.8 million l/yr [14.7 MGY]) would not exceed the current

permitted capacity (75.7 million l/yr [20 MGY]). There are no plans to discharge noncontact cooling water to Banner Spring Branch. Discharges are required to meet all NPDES permit limitations.

The site has the potential for being flooded if the Nolichucky River experiences very high flow. Elevations of the building floors are between 500 and 510 m (1,640 and 1,670 ft). The UF_6 conversion and blending facility would not be accommodated at facilities in the 300 Area, located inside the 100- or 500-year floodplain. [Text deleted.] Based on the Flood Insurance Rate Map and the flood profiles, 100- and 500-year floodplain elevations at the NFS site are determined to be 499.5 m (1,639 ft) and 500 m (1,640 ft) above mean sea level, respectively. Facilities in the 300 Area have building floor elevations of approximately 500.5 (1,642 ft) above mean sea level, which would be above the 100- and 500-year flood elevations. Warning devices and systems are in place along the river to warn the public and the plant of the chance of possible flooding. The NFS site has emergency plans in place to contact the city of Jonesborough Water Treatment Facility as well as other local, State, and national committees, and inform them when any accidental releases from the plant have occurred. During flooding or because of accidental releases to the surface water, the Jonesborough Water Treatment Plant closes off the water intake valves, so no contamination to the public water supply occurs. The rechanneling of the Nolichucky associated with the highway construction and the rerouting of Martin Creek to enter the Nolichucky farther downstream have lowered the previously expected flood levels at the site.

Groundwater. No groundwater would be used at NFS given the plentiful city water available. Therefore, no impacts to groundwater levels are expected.

Groundwater quality would not be affected by the operation of UF_6 blending facilities, because there would be no direct discharges of process wastewater to groundwater. Wastewater would be treated prior to discharge to the Nolichucky River.

Currently, groundwater contamination occurs in the Quaternary alluvium adjacent to the NFS's settling ponds beneath the buried holding tanks and beneath the radioactive solid waste burial ground. A pump and treat restoration program is in place to clean up groundwater contamination. There is also slightly contaminated groundwater beneath the CSX Transportation right-of-way. There are no known local down-gradient wells in the Quaternary alluvium. Banner Hill Spring has remained uncontaminated from 25 years of normal operations at the NFS facility.

4.3.2.4 Biotic Resources

The operation of the UF_6 blending facilities at B&W or NFS is not expected to have significant adverse impacts on biotic resources. Operations would be accommodated within existing buildings. There would be no loss of habitat; therefore, no impacts on wildlife are anticipated. The increase of water intake or discharges to site streams would be minimal (less than 1 percent of stream flow rates), which would cause no impacts to aquatic resources.

Impacts to wetlands would not occur, since these resources are not located in the proposed area of activities. No Federal- or State-listed threatened or endangered species would be affected.

4.3.2.5 Socioeconomics

This section describes the potential socioeconomic effects resulting from operation of facilities to blend HEU to 4-percent LEU as UF_6 at B&W or NFS. Any upgrades/modifications required at either facility would be accomplished by the site's existing workforce, and no new jobs would be created. However, operation of the blending facilities at either location would require additional employees creating some positive economic benefits to the region.

Operation of the UF_6 blending facility would require 126 employees. Some workers needed for operations are currently employed at these sites; however, to assess the maximum potential impact of this alternative, the analysis assumes that both candidate sites would need 126 additional employees to blend HEU to LEU as UF_6. The project would also create 285 and 253 indirect jobs within the B&W and NFS REAs, respectively (Figure 4.3.2.5–1). The regional unemployment rates would decrease from 4.9 to 4.8 percent at B&W and from 5.9 to 5.7 percent at NFS.

Available labor in both regions would be sufficient to fill the new jobs created directly by the project and additional indirect jobs. Therefore, it is unlikely that there would be any in-migration to the regions.

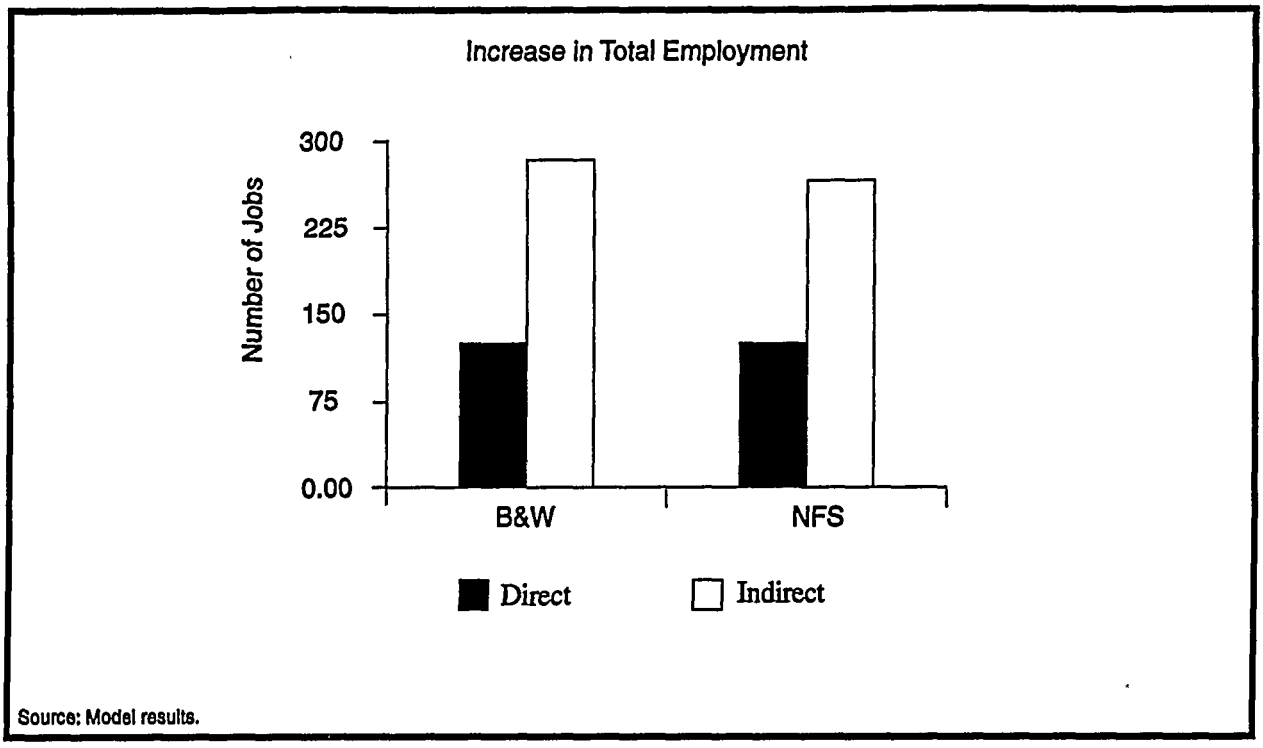


Figure 4.3.2.5–1. Increase in Total Project-Related Employment (Direct and Indirect) at Each Candidate Site Resulting From Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride.

Without any project-related in-migration, there would be no additional demands for housing units, community services, or transportation. The effects on housing and community services in the ROIs would be the same as for the No Action Alternative.

4.3.2.6 Public and Occupational Health

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or potential accidents for blending HEU to 4-percent LEU as UF_6 at the two commercial sites under consideration. Summaries of the radiological impacts to the public and workers associated with normal operation at each site are presented in Tables 4.3.2.6–1 and 4.3.2.6–2, respectively. Chemical impacts to these same groups are presented in Table 4.3.2.6–3, and accident impacts are presented in Tables 4.3.2.6–4 and 4.3.2.6–5. (Further supplementary information is presented in Appendix E.)

Normal Operation

Radiological Impacts. Incremental radiological impacts to the public resulting from normal operation of the UF_6 blending facilities at both sites are presented in Table 4.3.2.6–1.The impacts from total site operations, including the UF_6 blending facilities, are also given in the table. These impacts are provided to demonstrate compliance with applicable regulations governing total site operations. To put operational doses into perspective, comparisons are made with the doses from natural background radiation. As shown in Table 4.3.2.6–1, the doses to the MEI of the public from annual total site operations are all within radiological limits and would be 0.054 mrem at B&W and 0.28 mrem at NFS. The annual population doses within 80 km (50 mi) would be 0.52 person-rem at B&W and 2.6 person-rem at NFS.

Incremental and total site doses to onsite workers from normal operations are given in Table 4.3.2.6–2. The annual incremental dose to involved workers at the blending facility would be 115 mrem to the average worker and 14.5 person-rem to the entire facility workforce (NRC 1995b:A-9; OR LMES 1995a:24).

Table 4.3.2.6–1. Potential Radiological Impacts to the Public Resulting From Normal Operation of Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Receptor	B&W		NFS	
	Incremental	Total Site[a]	Incremental	Total Site[a]
Maximally Exposed Individual (Public)[b]				
From atmospheric release pathway (mrem/yr)[c]	3.5×10^{-3}	5.0×10^{-2}	0.25	0.28
From total liquid release pathway (mrem/yr)[c]	0	4.0×10^{-3}	0	9.0×10^{-4}
From atmospheric and liquid release pathways combined (mrem/yr)[c]	3.5×10^{-3}	5.4×10^{-2}	0.25	0.28
Percent of natural background[d]	1.1×10^{-3}	1.6×10^{-2}	7.4×10^{-2}	8.2×10^{-2}
Risk of fatal cancer per year of operation[e]	1.8×10^{-9}	2.7×10^{-8}	1.3×10^{-7}	1.4×10^{-7}
Population Within 80 km				
From atmospheric release pathways dose (person-rem/yr)	3.2×10^{-2}	0.45	2.3	2.6
From total liquid release pathways (person-rem/yr)	0	7.0×10^{-2}	0	1.9×10^{-3}
From atmospheric and liquid release pathways combined (person-rem/yr)	3.2×10^{-2}	0.52	2.3	2.6
Percent of natural background[d]	1.3×10^{-5}	2.1×10^{-4}	5.4×10^{-4}	6.1×10^{-4}
Number of fatal cancers per year of operation[e]	1.6×10^{-5}	2.6×10^{-4}	1.2×10^{-3}	1.3×10^{-3}

[a] Includes impacts from all site operations that are expected to continue during the interim of blending process operations (reference environment).

[b] The applicable radiological limits for an individual member of the public from total site operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathways, and 25 mrem/yr from all pathways combined.

[c] Incremental radiological doses are different at each site because of site-specific characteristics such as meteorology, topography, distance to site boundary, etc.

[d] Annual natural background radiation levels: 1) B&W: the average individual receives 329 mrem; the population within 80 km receives 244,000 person-rem, and 2) NFS: the average individual receives 340 mrem; the population within 80 km receives 429,000 person-rem.

[e] Representative of material processed at the rate of 10 t/yr.

Source: Appendix E.

Table 4.3.2.6–2. Potential Radiological Impacts to Workers Resulting From Normal Operation of Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Receptor	B&W	NFS
Involved Workforce[a]		
Average worker		
Dose (mrem/yr)[b]	115	115
Risk of fatal cancer per year of site operation	4.6×10^{-5}	4.6×10^{-5}
Total		
Dose (person-rem/yr)	14.5	14.5
Number of fatal cancers per year of site operation	5.8×10^{-3}	5.8×10^{-3}
Noninvolved Workforce[c]		
Average worker		
Dose (mrem/yr)[b]	10	50
Risk of fatal cancer per year of site operation	4.0×10^{-6}	2.0×10^{-5}
Total		
Dose (person-rem/yr)	16.7	16.3
Number of fatal cancers per year of site operation	6.7×10^{-3}	6.5×10^{-3}
Total Site Workforce[d]		
Dose (person-rem/yr)	31.2	30.8
Number of fatal cancers per year of site operation	1.2×10^{-2}	1.2×10^{-2}

[a] The involved worker is a worker associated with operations of the blending and conversion facilities. The estimated number of in-plant workers is 126. The average in-plant worker dose is estimated to be similar to that for UNH blending operations, with an additional 25 mrem/yr incurred from fluorination processes.

[b] The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20).

[c] The noninvolved worker is a worker onsite but not associated with operations of the blending and conversion facilities. The estimated number of noninvolved workers is 1,674 at B&W and 325 at NFS.

[d] The total site workforce is the summation of the in-plant worker impacts and the noninvolved worker impacts. The estimated number of workers in the total site workforce is 1,800 at B&W and 451 at NFS.

Source: BW 1995b:1; NFS 1995b:2; NRC 1995b; OR LMES 1995a.

[Text deleted.] All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from blending HEU to 4-percent LEU as UF_6 at B&W and NFS are presented in Table 4.3.2.6–3. The table presents the increment of potential adverse noncancer health effects and cancer risks posed by this action at the various sites, followed by the total risk (that is, incremental risk plus no action contribution to risk) at each unique site.

The incremental and site total HIs for the public MEI contributed by this alternative are all less than 1.0 at B&W and NFS, and the cancer risks to the MEI of the public are below the value of $1.0x10^{-6}$ (RA 1994a: 477-481).

The incremental and site total HIs for the onsite workers contributed by this alternative are all less than 1.0 at B&W and NFS showing that all chemicals or combinations are below OSHA Permissible Exposure Levels. The incremental lifetime cancer risks for B&W and NFS, respectively, are below the value of $1.0x10^{-6}$, but total site lifetime cancer risk exceeds this level for B&W. Since the HIs represent ratios between actual exposure levels to hazardous chemicals and their regulated levels, there is no time limit placed on the exposures. Likewise, the cancer risks to the MEI and onsite workers represent lifetime and working lifetime for the onsite individual. Therefore, the MEI and the onsite workers should not exhibit differences from the general public from the onset to the end of operations (with the exception noted). For details of the calculations used to derive the HIs and cancer risks, refer to Appendix E.3.

Facility Accidents

A set of potential accidents has been postulated for which there may be releases of radioactivity and hazardous chemicals that could impact noninvolved onsite workers and the offsite population. A set of accident scenarios was selected to represent bounding cases. In assessing the bounding accident scenarios for the conversion and blending facility, the following parameters were evaluated: 1) material at risk, 2) energy sources (for example, fires, explosions, earthquakes, and process design-related events), 3) barriers to release, and 4) protective features of the facility. The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and an evaluation basis earthquake. With the exception of the fluidized bed release and the filter fire

Table 4.3.2.6–3. Potential Hazardous Chemical Impacts to the Public and Workers at Various Sites Resulting From Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

	B&W		NFS	
Receptor	**Incremental [a]**	**Total Site[b]**	**Incremental[b]**	**Total Site[c]**
Maximally Exposed Individual (Public)				
Hazard index[c]	$1.44x10^{-6}$	$1.29x10^{-5}$	$2.10x10^{-3}$	$9.76x10^{-2}$
Cancer risk[d]	$8.44x10^{-18}$	$1.68x10^{-8}$	$1.23x10^{-14}$	$1.23x10^{-14}$
Worker Onsite				
Hazard index[e]	$5.09x10^{-4}$	$4.58x10^{-3}$	$6.98x10^{-4}$	$8.27x10^{-3}$
Cancer risk[f]	$1.98x10^{-14}$	$3.94x10^{-5}$	$2.72x10^{-14}$	$2.72x10^{-14}$

[a] Incremental=contribution only from single activity at the site.

[b] Total site includes any background emissions that would be present in the absence of site operations plus site emissions that exist at the present time.

[c] Hazard index for MEI=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

[d] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Hazard index for workers=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[f] Lifetime cancer risk for workers=(emissions for 8-hour) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: OR LMES 1995a.

(with continuous exhaust flow), all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake. Therefore, it is concluded that the evaluation basis earthquake would result in the highest atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality, UF_6, and other release scenarios.

In a fluidized bed release, it is assumed that the high-temperature filters would be removed for replacement but the filter housing would be closed without new filters inside. The inventory of one bed is swept out by the nitrogen used to fluidize the bed. The quantity of material assumed to be released is 7.5 kg (16.5 lb) of HEU.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and HEPA filters to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium powder and uranyl nitrate solution would be damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost and moderators added as water from the fire system or organic solutions. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1.0×10^{19} fissions would occur prior to reaching a stable, subcritical condition and that all material releases would occur within a 2-hour period (NRC 1979b:3.34-4). The amount of radioactive material released as fission products created by the nuclear criticality would be 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium solutions, water, toxic gases, flammable gases, and toxic and reactive liquids. This is assumed to result in the release of 0.061 Ci of uranium (76 percent of the activity is U-234).

In the UF_6 release, the evaluation basis earthquake causes equipment failures and a pressurized release of a UF_6 cylinder. Thirty percent of a cylinder containing LEU is assumed to be released into the atmosphere consistent with NRC's guidance presented in the *Nuclear Fuel Cycle Facility Accident Analysis Handbook* (NUREG-1320, May 1988). After the accident, it is estimated that there would be a release of 30 percent of the material to equalize the pressure inside and outside the cylinder. This is assumed to result in the release of 1,900 kg (4,100 lb) of 1.5-percent assay LEU as shown in Appendix E.5.2.2.

The accidents that release radioactivity and their consequences are shown in Tables 4.3.2.6–4 and 4.3.2.6–5. The consequences shown in these tables for B&W are based on meteorological data for Roanoke Airport (which is located 93 km [61 mi] west of B&W, in an area of more adverse stability), since, unlike NFS, onsite meteorological data required for MACCS were not available (some meteorological parameters are not monitored at B&W). Therefore, as discussed in Appendix E, Section E.5.1.3, these consequences (as shown in the table) are expected to be approximately two to three times higher than anticipated at B&W under onsite meteorological conditions.

The accident with the highest consequences is a UF_6 cylinder release. The evaluation basis earthquake is conservatively assumed to cause a criticality, a UF_6 cylinder release, and a release of uranium material. The evaluation basis earthquake, criticality, and UF_6 cylinder release are added together to show the range of consequences and risks at the candidate sites. If a UF_6 cylinder release were to occur, there would be an estimated 1 and 1.4 latent cancer fatalities in the general population within 80 km (50 mi) of B&W and NFS, respectively. For the MEI, there would be increased likelihood of latent cancer fatality of 1.9×10^{-2} and 3.0×10^{-3} at these two sites, respectively. Based on the spatial distribution of noninvolved workers located on the site, the estimated number of fatalities in the worker population would be 30 and 2.5 respectively. The accident risks, reflecting both the probability of the accident occurring and the consequences, are also shown in the tables. For the general population, MEI, and noninvolved worker population, the fatal cancer risks range up to 1.4×10^{-4}, 1.9×10^{-6}, and 3.0×10^{-3} per year, respectively.

In addition to the potential impacts to noninvolved workers, there are potential impacts to involved workers, who are located in the blending facilities analyzed in this EIS. Potential radiological consequences to the involved worker range to several

Table 4.3.2.6–4. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride at Babcock & Wilcox

Accident Description	Fluid Bed	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario	UF_6 Cylinder Release
Accident frequency (per year)	10^{-3}[a]	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]	10^{-4}[b]
Consequences[c]					
Noninvolved Workers					
Dose (person-rem)	990	24	80	524	54,000
Latent cancer fatalities per accident	0.4	9.5×10^{-3}	3.2×10^{-2}	0.21	30
Risk (cancer fatalities per year)	4.0×10^{-4}	9.5×10^{-6}	3.2×10^{-6}	2.1×10^{-5}	3.0×10^{-3}
Maximally Exposed Individual					
Dose (rem)	0.49	1.2×10^{-2}	5.6×10^{-2}	0.25	26
Latent cancer fatality per accident	2.4×10^{-4}	5.9×10^{-6}	2.8×10^{-5}	1.3×10^{-4}	1.9×10^{-2}
Risk (cancer fatality per year)	2.4×10^{-7}	5.9×10^{-9}	2.8×10^{-9}	1.3×10^{-8}	1.9×10^{-6}
Population Within 80 km (730,000 in 2010)					
Dose (person-rem)	38	0.9	1.9	18	1,900
Latent cancer fatalities per accident	1.9×10^{-2}	4.5×10^{-4}	9.3×10^{-4}	9.1×10^{-3}	1
Risk (cancer fatalities per year)	1.9×10^{-5}	4.5×10^{-7}	9.3×10^{-8}	9.1×10^{-7}	1.0×10^{-4}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[c] Onsite meteorological data required for MACCS is not available. Therefore, consequences shown are based on the nearest meteorology data set, Roanoke Airport. The consequences corresponding to onsite meteorology would be approximately two to three times lower than the consequences indicated in this table. Further information is described in Appendix E.5.1.3.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.2.6–5. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride at Nuclear Fuel Services

Accident Description	Fluid Bed	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario	UF_6 Cylinder Release
Accident frequency (per year)	10^{-3}[a]	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]	10^{-4}[b]
Consequences					
Noninvolved Workers					
Dose (person-rem)	68	1.6	8.7	46	5,000
Latent cancer fatalities per accident	2.7×10^{-2}	6.6×10^{-4}	3.5×10^{-3}	1.8×10^{-2}	2.5
Risk (cancer fatalities per year)	2.7×10^{-5}	6.6×10^{-7}	3.5×10^{-7}	1.8×10^{-6}	2.5×10^{-4}
Maximally Exposed Individual					
Dose (rem)	9.7×10^{-2}	2.3×10^{-2}	1.4×10^{-2}	5.4×10^{-2}	5.7
Latent cancer fatality per accident	4.8×10^{-5}	1.2×10^{-6}	6.9×10^{-6}	2.7×10^{-5}	3.0×10^{-3}
Risk (cancer fatality per year)	4.8×10^{-8}	1.2×10^{-9}	6.9×10^{-10}	2.7×10^{-9}	3.0×10^{-7}
Population Within 80 km (1,260,000 in 2010)					
Dose (person-rem)	53	1.3	2.2	26	3,000
Latent cancer fatalities per accident	2.7×10^{-2}	6.4×10^{-4}	1.1×10^{-3}	1.3×10^{-2}	1.4
Risk (cancer fatalities per year)	2.7×10^{-5}	6.4×10^{-7}	1.1×10^{-7}	1.3×10^{-6}	1.4×10^{-4}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[Text deleted.]

Source: Results shown are derived from accident analyses; see Appendix E.5.

thousand rem in the case of a criticality. The combined evaluation basis earthquake, earthquake-induced criticality, and UF_6 cylinder release would probably result in fatal doses to the involved worker. Furthermore, fatalities to the involved workers would be expected as a result of the building collapse (from the earthquake) and the criticality (OR DOE 1994d:6-26, 6-27).

The bounding chemical release accidents (caused by the evaluation basis earthquake) are a spill from HNO_3 and NaOH storage tanks, and the rupture of processing lines resulting in the emptying of the HF tank and a F_2 cylinder. The release point for these accidents is the same as for radiological accidents. The seismic event is assumed to compromise the structural integrity of the curbing around the HNO_3 and NaOH tank pits such that the two chemicals mix; they are assumed to react with sufficient heat generation to result in the airborne release of 2,600 kg (5,730 lb) of unreacted HNO_3; for sufficiently large exposures, this could result in irritation to the respiratory system, eyes, and skin and pulmonary edema. If this accident were to occur, the impact to the noninvolved worker could be exposure to concentrations in excess of the IDLH level (100 ppm) at B&W, and in excess of the TLV-STEL level (4 ppm) at NFS. The impact to the MEI of the public could be exposure to concentrations in excess of the TLV-STEL level at each site (280 and 160 m [920 and 530 ft] downwind of the IDLH level at B&W and NFS, respectively).

The HF and F_2 releases, (600 and 500 kg [1,320 and 1,100 lb], respectively), which cause similar health impacts as to HNO_3, could result in exposure to the noninvolved worker of concentrations in excess of the IDLH level (30 and 25 ppm, respectively) at B&W and in excess of the TLV-STEL level (6 and 2 ppm, respectively) at NFS. The public could be exposed to concentrations in excess of the TLV-STEL level at each site. (See Section 4.1.9 for a discussion of the significance of these levels.)

4.3.2.7 Waste Management

Operation of UF_6 blending facilities would increase waste generated at the candidate sites. There is no

Table 4.3.2.7–1. Estimated Annual Generated Waste Volumes for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

	B&W			NFS		
Waste Category	No Action (m^3)	With UF_6 Blending (m^3)	Increase (Percent)	No Action (m^3)	With UF_6 Blending (m^3)	Increase (Percent)
Low-Level						
Liquid	50,005	50,054	<1	18,900	18,949	<1
Solid	620	765	23	3,000	3,145	5
Mixed Low-Level						
Liquid	0	159	>100	<1	159	>100
Solid	14	14	0	<1	<1	0
Hazardous						
Liquid	55,115	55,121	<1	<1	6	>100
Solid	0	0	0	<1	<1	0
Nonhazardous						
Liquid	576,160	595,315	3	56,700	75,855	34
Solid	1,700	2,520	48	2,300	3,121	36

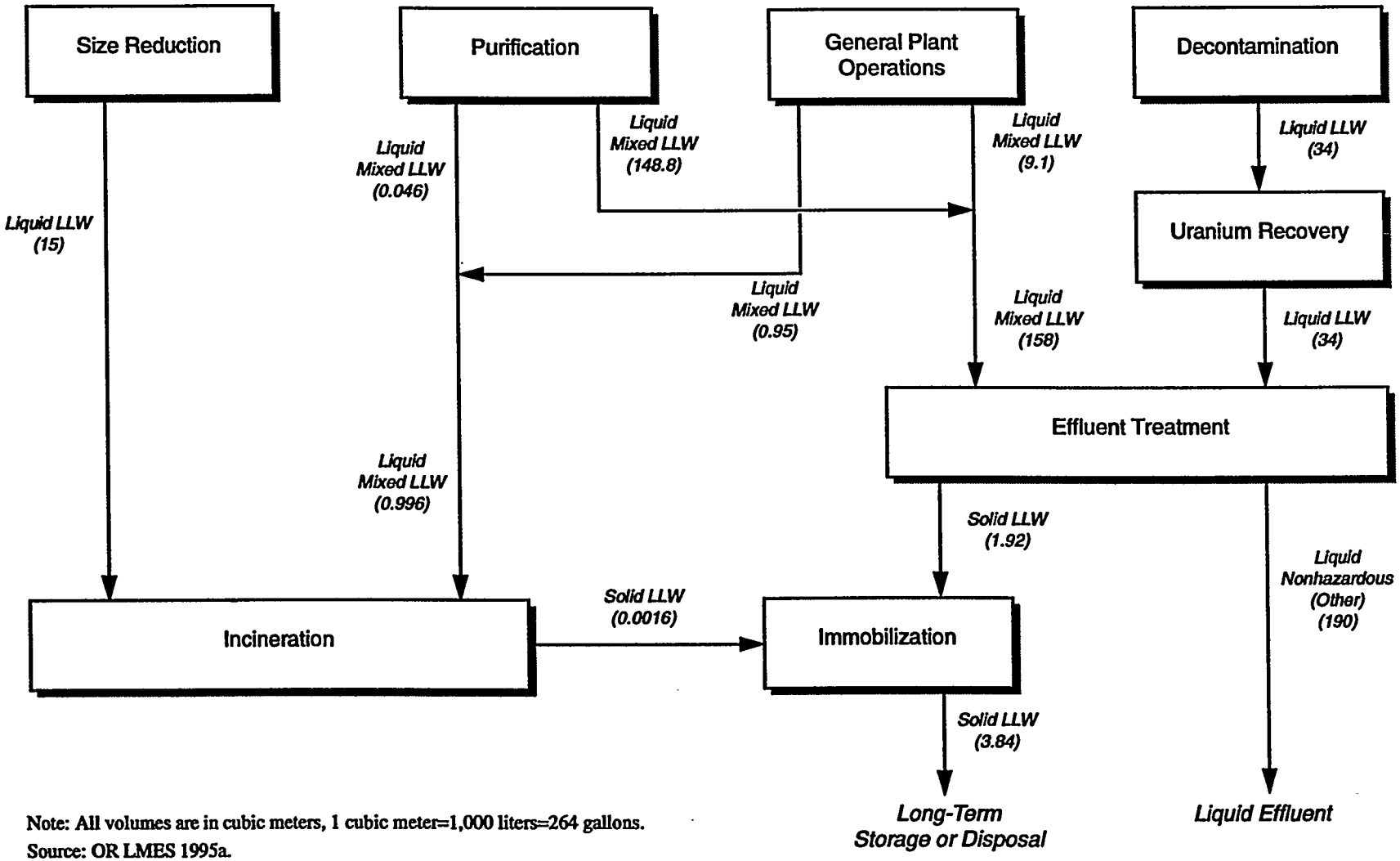
Source: BW 1995b:2; BW NRC 1991a; BW NRC 1995a; NF NRC 1991a; NFS 1995b:2.; OR LMES 1995a.

spent nuclear fuel, HLW, or TRU waste associated with the proposed action. However, generation of low-level, mixed low-level, hazardous, and nonhazardous wastes would increase. This section summarizes the impacts on treatment, storage, and disposal facilities at each potential site resulting from the UF_6 blending.

The blending process would result in the generation of low-level, mixed low-level, hazardous, and nonhazardous wastes. Table 4.3.2.7–1 provides the sitewide waste generation resulting from the blending process. At each facility considered for the blending process, the generation of wastes would be evaluated against ALARA principles. Table 2.2.2.3–2 also provides the resultant waste volume after treatment (effluent) using a proposed treatment scheme as outlined in Figures 4.3.2.7–1 to 4.3.2.7–3. Liquid LLW from decontamination would go through a uranium recovery process first. The liquid effluent then would go to a radioactive wastewater treatment facility. The resultant sludge would be immobilized for disposal as solid LLW and the treated effluent would be discharged through a permitted outfall.

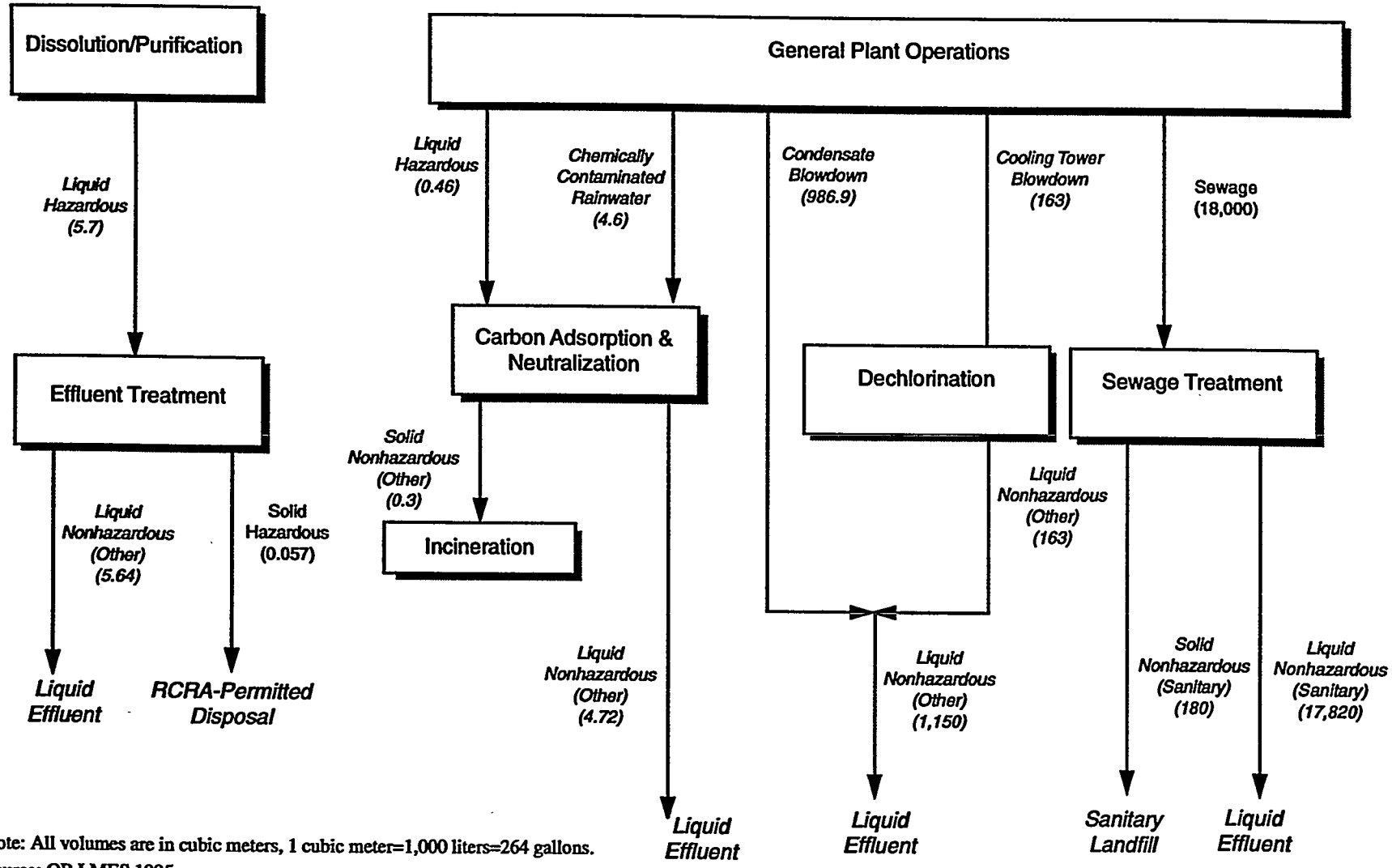
Solid LLW generated by the blending process would consist of lab wastes, decontamination solids, scrapped equipment, contaminated calcium fluoride, spent sodium fluoride, sintered-metal filter cartridges, air sampling filters, HEPA filters, and miscellaneous contaminated solids. Decontamination solids would go through a uranium recovery process before being packaged for disposal. All other solid LLW would be compacted and immobilized as appropriate to meet the waste acceptance criteria of an onsite or offsite LLW disposal facility. This solid LLW radiological content would include U-232, U-234, U-235, U-236 and U-238. Liquid mixed LLW consisting of spent solvents and lab waste would be incinerated, thus eliminating the hazardous constituent. The small amount of solid mixed LLW remaining would increase the amount to be disposed of offsite. The resultant ash would be immobilized and packaged for disposal as solid LLW. The sump collection wastes from general plant operations would be precipitated and filtered in a radioactive liquid waste treatment facility. The resultant sludge would be immobilized for disposal and the treated effluent would be discharged through a permitted outfall.

Liquid hazardous waste consisting of liquid waste treatment excess/flush water and chemical spillage would be treated onsite by distillation, evaporation, neutralization, and ammonia removal. The treated effluent would be discharged through a permitted outfall. Liquid nonhazardous waste such as sewage wastewater would be treated and disposed of using current site practices and facilities. Solid nonhazardous waste would primarily consist of solid sanitary waste, trash, waste paper, scrap metal, air



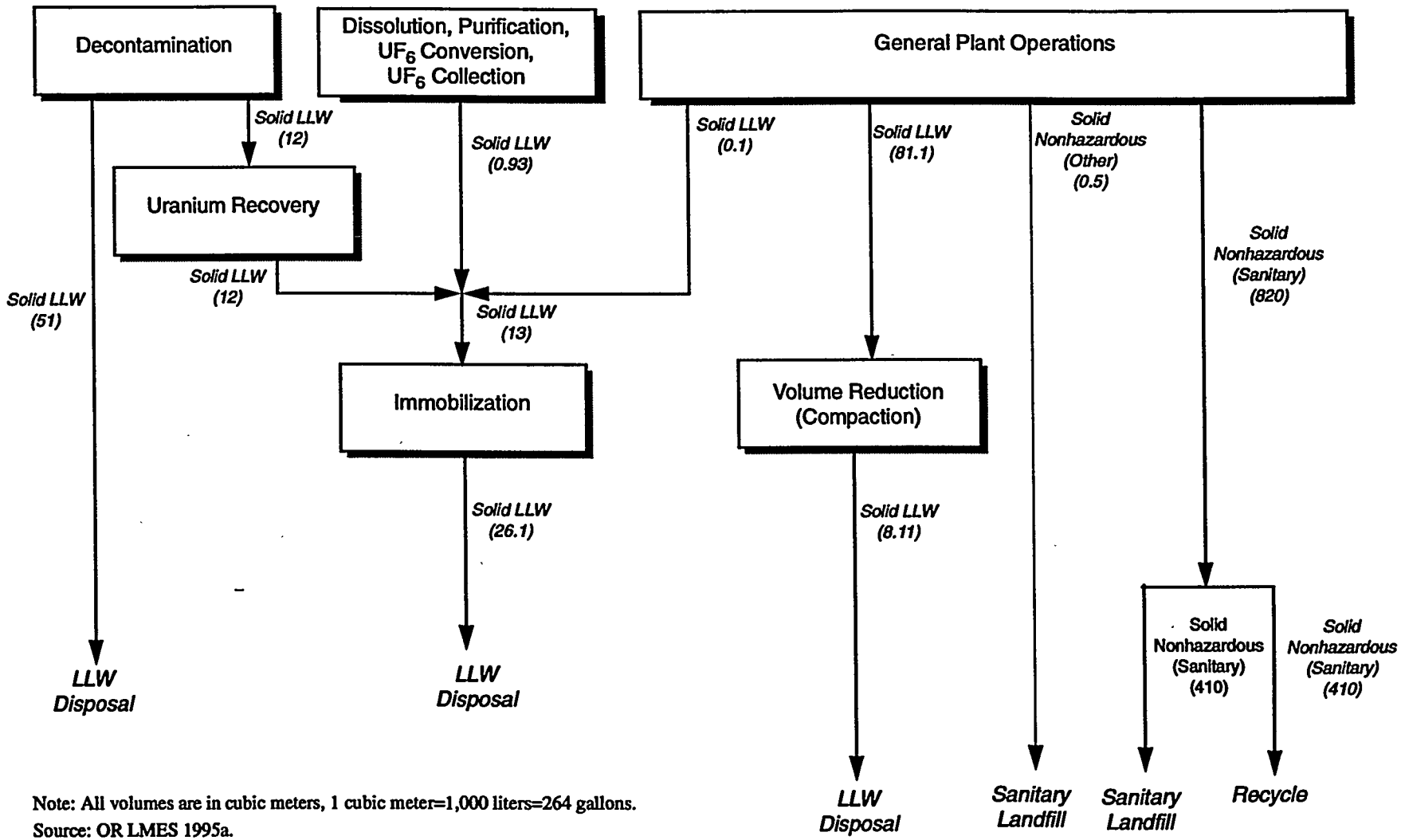
Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995a.

Figure 4.3.2.7–1. Radioactive Liquid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995a.

Figure 4.3.2.7–2. Nonradioactive Liquid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995a.

Figure 4.3.2.7–3. Solid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride.

filters, personnel respirators, plastic bags, and gloves. Nonrecyclable portions of this waste would be disposed of in a permitted landfill per site practice. Solid and liquid nonhazardous wastes would be generated from the minor building modification activities associated with this blending alternative. Wastes generated during building modification would include concrete and steel construction waste materials and sanitary solids and wastewater. Any steel construction waste would be recycled as scrap material before completing building modification. The remaining nonhazardous wastes generated would be disposed of as part of the building modification project by the contractor. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 1,510 m^3 (53,400 ft^3), which would require a total disposal area of 0.076 ha (0.19 acres).

Babcock & Wilcox. The B&W site has facilities for treating liquid LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small compared with the total amount of liquid LLW generated yearly at the site. The onsite treatment facility for liquid LLW at B&W has a capacity to treat approximately 89,800 m^3/yr (23,700,000 gal/yr); therefore, the facility would be able to handle the 159 m^3/yr (42,000 gal/yr) increase in liquid LLW generated (BW NRC 1991a:13). When this process is complete, the amount of solid LLW requiring staging and eventual disposal for processing 10 t/yr HEU would be 89 m^3/yr (3,140 ft^3/yr). This waste would be hauled offsite to a disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre), the increase in the amount of solid LLW would require 0.004 ha/yr (0.01 acres/yr) in a disposal facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 1,510 m^3 (53,400 ft^3), which would require a total disposal area of 0.076 ha (0.19 acres). The small amount of liquid mixed LLW generated would require some form of treatment. This waste can be treated in the existing LLW treatment facility at B&W. Currently, onsite treatment facilities annually process approximately 55,300 m^3 (1,930,000 gal) of liquid hazardous waste. The increase in liquid hazardous waste generation of 6 m^3/yr (1,590 gal/yr) would not burden this treatment system. The amount of liquid sanitary waste resulting from the blending process would increase by 3 percent over current operations. This could be accommodated in existing facilities, which have a capacity 2.5 times the combined requirement. B&W has current recycling practices that could incorporate the increased amount of recyclable nonhazardous waste resulting from this action.

Nuclear Fuel Services. The NFS site has facilities for treating LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small and the onsite treatment facility has the capacity to handle more than twice the combined volume, which would increase approximately 49 m^3/yr (1,730 ft^3/yr). This action will add 89 m^3/yr (3,140 ft^3/yr) of solid LLW requiring staging and eventual disposal. This waste would be shipped offsite to a disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre), the increase in the amount of solid LLW would require 0.004 ha/yr (0.01 acre/yr) in a disposal facility. After treatment, solid LLW to be disposed of as a result of processing the entire potentially commercially usable HEU (170 t) would be 1,510 m^3 (53,400 ft^3), which would require a total disposal area of 0.076 ha (0.19 acres). The small amount of liquid mixed LLW generated by this process could be accommodated in the LLW treatment facility at NFS. [Text deleted.] The liquid sanitary waste resulting from the blending process would be discharged to the public treatment works with the rest of the nonhazardous liquid waste. NFS has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

4.3.3 TECHNOLOGY AND SITE-SPECIFIC IMPACTS FOR BLENDING HIGHLY ENRICHED URANIUM TO 0.9-PERCENT LOW-ENRICHED URANIUM AS URANYL NITRATE HEXAHYDRATE

Blending surplus HEU to 0.9-percent LEU as UNH involves the same processes described in Section 4.3.1. A significantly smaller quantity of HEU (2.1 t/yr) can be blended annually in producing the 0.9-percent LEU (ratio of HEU to blendstock is 70 to 1) than 4-percent LEU (ratio of HEU to blendstock is 14 to 1). The only differences between blending to 0.9-percent and blending to 4-percent LEU are in the areas of public and occupational health, intersite transportation, and waste management. Specific differences are discussed in the appropriate sections that follow.

4.3.3.1 Site Infrastructure

As shown in Section 2.2.2.1, the annual site infrastructure resources consumed in implementing this blending process are equal to the blending of HEU to 4-percent LEU as UNH except for two resource areas: electricity and natural gas. Annual electricity requirements for blending to 0.9-percent LEU increase by 1,000 megawatt hour (MWh) and the natural gas requirements increase by 2,800 m^3. Site infrastructure resource requirements are the same as those shown in Table 4.3.1.1–1 except electricity requirements are 5,000 MWh/yr and natural gas requirements are 19,800 m^3/yr. The major difference in processing HEU to a waste product versus reactor fuel is in the elimination of the purification process requirements. The elimination of the purification process step results in no effect in the site infrastructure resources. Accordingly, the annual site infrastructure services required to implement this action, along with the associated environmental impacts, will be the same as that presented for the 4-percent LEU blending process described in Section 4.3.1.1.

4.3.3.2 Air Quality and Noise

Operation of facilities to blend HEU to 0.9-percent LEU as UNH would generate criteria and toxic/hazardous pollutants at ORR, SRS, B&W, and NFS. Annual air pollutant emissions resulting from this alternative would be equal to those associated with blending to 4-percent LEU as UNH; therefore, annual air and noise consequences of this alternative action would be the same as the consequences presented previously in Section 4.3.1.2.

4.3.3.3 Water Resources

Operational requirements and discharges for blending HEU to 0.9-percent LEU as UNH would be less than those associated with blending to 4-percent LEU; therefore, environmental consequences of this alternative action would be less than or similar to the consequences presented previously in Section 4.3.1.3.

4.3.3.4 Biotic Resources

Annual operational intake or discharges for blending HEU to 0.9-percent LEU as UNH would be equal to those associated with blending to 4-percent LEU as UNH; therefore, environmental consequences of this alternative action would be equal to the consequences presented previously in Section 4.3.1.4.

4.3.3.5 Socioeconomics

The potential socioeconomic impacts resulting from blending HEU to 0.9-percent LEU as UNH at ORR, SRS, B&W, or NFS would be equal to those associated with blending to 4-percent LEU as UNH, except would continue over a longer period of time. Upgrades to any one of these facilities would be accomplished by the site's existing workforce, and no new jobs would be created. [Text deleted.]

Operation of the proposed blending facility would require 125 employees, the same workforce requirement as for blending HEU to 4-percent LEU as UNH. The activities would generate some minor economic benefits to the affected region.

4.3.3.6 Public and Occupational Health

The radiological releases and their associated impacts resulting from potential accidents involving the HEU blending facility at any of the four sites under consideration would be similar to but not necessarily equal to those associated with blending to 4-percent LEU as UNH. This facility will blend HEU to 0.9-percent LEU in the form of UNH. Summaries of the radiological impacts to the public and workers

associated with accidents are presented in Tables 4.3.3.6–1 through 4.3.3.6–4. (Further supplementary information is presented in Appendix E.)

Normal Operation

Radiological Impacts. [Text deleted.] In comparison to annual impacts for blending to 4-percent LEU as UNH, conveyed in Section 4.3.1.6, all annual impacts would be identical both to the public and to workers when blending to 0.9-percent LEU.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from blending HEU to 0.9-percent LEU as UNH at Y–12, SRS, B&W, and NFS are equal to those presented in Table 4.3.1.6–3 for blending HEU to 4 percent because all incremental and total site HIs and cancer risks are identical.

Facility Accidents

A set of potential accidents has been postulated for which there may be releases of radioactivity and hazardous chemicals that could impact noninvolved onsite workers and the offsite population. A set of accident scenarios was selected to represent bounding cases. In assessing the bounding accident scenarios for the blending facility, the following parameters were evaluated: 1) material at risk, 2) energy sources (for example, fires, explosions, earthquakes, and process design-related events), 3) barriers to release, and 4) protective features of the facility.

Table 4.3.3.6–1. Accident Consequences and Risk of Major Accidents for Blending 2.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Y–12

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	11	38	960
Latent cancer fatalities per accident	4.2×10^{-3}	1.5×10^{-2}	0.38
Risk (cancer fatalities per year)	4.2×10^{-6}	1.5×10^{-6}	3.8×10^{-5}
Maximally Exposed Individual			
Dose (rem)	1.0×10^{-2}	5.1×10^{-2}	0.94
Latent cancer fatality per accident	5.2×10^{-6}	2.6×10^{-5}	4.7×10^{-4}
Risk (cancer fatality per year)	5.2×10^{-9}	2.6×10^{-9}	4.7×10^{-8}
Population Within 80 km (1,040,000 in 2010)			
Dose (person-rem)	1.5	3	130
Latent cancer fatalities per accident	7.7×10^{-4}	1.5×10^{-3}	6.7×10^{-2}
Risk (cancer fatalities per year)	7.7×10^{-7}	1.5×10^{-7}	6.7×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.3.6–2. Accident Consequences and Risk of Major Accidents for Blending 2.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Savannah River Site

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3a}	10^{-4b}	10^{-4b}
Consequences			
Noninvolved Workers			
Dose (person-rem)	2.3	8.5	210
Latent cancer fatalities per accident	9.3×10^{-4}	3.4×10^{-3}	8.4×10^{-2}
Risk (cancer fatalities per year)	9.3×10^{-7}	3.4×10^{-7}	8.4×10^{-6}
Maximally Exposed Individual			
Dose (rem)	6.6×10^{-5}	3.0×10^{-4}	5.8×10^{-3}
Latent cancer fatality per accident	3.3×10^{-8}	1.5×10^{-7}	2.9×10^{-6}
Risk (cancer fatality per year)	3.3×10^{-11}	1.5×10^{-11}	2.9×10^{-10}
Population Within 80 km (710,000 in 2010)			
Dose (person-rem)	0.37	0.33	32
Latent cancer fatalities per accident	1.8×10^{-4}	1.6×10^{-4}	1.6×10^{-2}
Risk (cancer fatalities per year)	1.8×10^{-7}	1.6×10^{-8}	1.6×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and an evaluation basis earthquake. With the exception of the filter fire (with continuous exhaust flow), all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake; therefore, it is concluded that the evaluation basis earthquake would result in the highest atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality and other release scenarios.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and HEPA filters to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium powder and uranyl nitrate solution are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing between storage containers is lost and moderators from the fire suppression system are added as water or as organic solutions. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1.0×10^{19} fissions occur prior to reaching a stable, subcritical condition and that all material releases occur within a 2-hour period (NRC 1979b:3.34-4). The amount of radioactive material released as fission products created by the nuclear criticality is 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium solutions, water, toxic gases, flammable gases, and toxic and reactive liquids. This is assumed to result in the release of 0.19 Ci of uranium isotopes (54 percent of the activity is U-234).

The accidents that release radioactivity and their consequences are shown in Tables 4.3.3.6–1 through 4.3.3.6–4. The consequences shown in these tables for

Table 4.3.3.6–3. Accident Consequences and Risk of Major Accidents for Blending 2.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Babcock & Wilcox

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences[c]			
Noninvolved Workers			
Dose (person-rem)	24	80	2,300
Latent cancer fatalities per accident	9.5×10^{-3}	3.2×10^{-2}	0.91
Risk (cancer fatalities per year)	9.5×10^{-6}	3.2×10^{-6}	9.1×10^{-5}
Maximally Exposed Individual			
Dose (rem)	1.2×10^{-2}	5.6×10^{-2}	1.1
Latent cancer fatality per accident	5.9×10^{-6}	2.8×10^{-5}	5.4×10^{-4}
Risk (cancer fatality per year)	5.9×10^{-9}	2.8×10^{-9}	5.4×10^{-8}
Population Within 80 km (730,000 in 2010)			
Dose (person-rem)	0.9	1.9	79
Latent cancer fatalities per accident	4.5×10^{-4}	9.3×10^{-4}	3.9×10^{-2}
Risk (cancer fatalities per year)	4.5×10^{-7}	9.3×10^{-8}	3.9×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[c] Onsite meteorological data required for MACCS is not available. Therefore, consequences are based on the nearest meteorology data set, Roanoke Airport. The consequences corresponding to onsite meteorology would be approximately two to three times lower than the consequences indicated in this table. Further information is described in Appendix E.5.1.3.

Source: Results shown are derived from accident analyses; see Appendix E.5.

B&W are based on meteorological data for Roanoke Airport (which is located 93 km [61 mi] west of B&W, in an area of more adverse stability), since, unlike Y–12, SRS, and NFS, onsite meteorological data required for MACCS were not available (some meteorological parameters are not monitored at B&W). Therefore, as discussed in Appendix E, Section E.5.1.3, these consequences (as shown in the table) are expected to be approximately two to three times higher than anticipated at B&W under onsite meteorological conditions.

The combined evaluation basis earthquake and earthquake-induced criticality accident release results in the highest consequences. If the combined evaluation basis earthquake and earthquake-induced criticality were to occur, the estimated increase in latent cancer fatalities in the general population within 80 km (50 mi) of each site would range from 1.6×10^{-2} at SRS to 6.9×10^{-2} at Y–12. For the MEI, there would be an increased likelihood of latent cancer fatality ranging from 3.0×10^{-6} at SRS to 5.7×10^{-4} at B&W. Based on the spatial distribution of noninvolved workers located on the site, the estimated number of latent cancer fatalities ranges from 8.4×10^{-2} at NFS to 0.94 at B&W. The accident risks, reflecting both the probability of the accident occurring and the consequences, also are shown in the tables. For the general population, MEI, and noninvolved worker population, the fatal cancer risks range up to 6.9×10^{-6}, 5.7×10^{-8}, and 9.4×10^{-5} per year, respectively.

For SRS the accident analysis was performed for the H-Area. If blending were to occur in the F-Area, the doses from an accidental release would be similar to an accidental release in the H-Area. The dose to the MEI would be slightly larger due to the decreased distance of 9,646 m (31,649 ft) from F-Area to the site boundary. The dose to the offsite population within 80 km (50 mi) would be slightly smaller due to F-Area being farther from the offsite population than H-Area. The dose to the noninvolved workers would be smaller

Table 4.3.3.6–4. Accident Consequences and Risk of Major Accidents for Blending 2.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Nuclear Fuel Services

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	1.6	8.7	200
Latent cancer fatalities per accident	6.6×10^{-4}	3.5×10^{-3}	8.0×10^{-2}
Risk (cancer fatalities per year)	6.6×10^{-7}	3.5×10^{-7}	8.0×10^{-6}
Maximally Exposed Individual			
Dose (rem)	2.3×10^{-3}	1.4×10^{-2}	0.23
Latent cancer fatality per accident	1.2×10^{-6}	6.9×10^{-6}	1.2×10^{-4}
Risk (cancer fatality per year)	1.2×10^{-9}	6.9×10^{-10}	1.2×10^{-8}
Population Within 80 km (1,260,000 in 2010)			
Dose (person-rem)	1.3	2.2	110
Latent cancer fatalities per accident	6.4×10^{-4}	1.1×10^{-3}	5.7×10^{-2}
Risk (cancer fatalities per year)	6.4×10^{-7}	1.1×10^{-7}	5.7×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[Text deleted.]

Source: Results shown are derived from accident analyses; see Appendix E.5.

due to the smaller workforce in the F-Area. The dose to noninvolved workers in the processing area is the dominant portion of the dose to the total site noninvolved workers. The dose to noninvolved workers not in the processing area would be a minimal effect due to the distance to the other areas.

In addition to the potential impacts to noninvolved workers, there are potential impacts to involved workers, who are located in the facilities analyzed in this EIS. Potential radiological consequences to the involved worker range up to several thousand rem in the case of a criticality. The combined evaluation-basis earthquake and earthquake-induced criticality would probably result in fatal doses to the involved worker. Furthermore, fatalities to the involved workers would be expected as a result of the building collapse (from the earthquake) and the criticality (OR DOE 1994d:6-26,6-27).

The bounding chemical release accident is a spill from HNO_3 and NaOH storage tanks caused by the evaluation basis earthquake. The release point for these accidents is the same as for radiological accidents. The seismic event is assumed to compromise the structural integrity of the curbing around the tank pits such that the two chemicals mix; they would react with sufficient heat generation to result in the airborne release of 13,000 kg (28,700 lb) of unreacted nitric acid. For sufficiently large exposures this could result in irritation to the respiratory system, eyes, skin, and pulmonary edema. If this accident were to occur, the noninvolved worker could be exposed to concentrations in excess of the IDLH level (100 ppm) at Y–12 and B&W and in excess of the TLV-STEL level (4 ppm) at NFS and SRS. The MEI of the public could be exposed to concentrations in excess of the IDLH level at Y–12 and B&W (these levels dissipate below the IDLH level 380 and 180 m [1,250 and 591 ft] downwind, respectively), in excess of the TLV-STEL level at NFS (36 m [118 ft] downwind of the IDLH level), and at levels less than the TLV-TWA level (2 ppm) at SRS. (See Section 4.1.9 for a discussion of the significance of these levels.)

The SRS IMNM EIS also considers facility accidents that are related to those in this EIS. A comparison between the accident analysis in the SRS IMNM EIS and the HEU EIS is contained in Section 4.3.1.6.

4.3.3.7 Waste Management

The process of blending HEU as uranyl nitrate to 0.9-percent LEU for disposal as waste is bounded for this analysis by the throughput capacity of process facilities at Y–12, which assumes processing 8.4 t/yr of uranium-aluminum (U/Al) alloy, at 25 percent HEU. At a dilution ratio of 70 to 1, the resulting waste product would contain 149 t of LEU at 0.9 percent U-235 in a U/Al oxide mixture, resulting in approximately 177 t waste product for disposal.

There is no spent nuclear fuel, HLW, or TRU waste associated with blending to LLW as UNH; however, generation of low-level, mixed low-level, hazardous, and nonhazardous wastes would increase. This section summarizes the potential impacts on waste management activities at each site resulting from the blending of HEU to approximately 0.9-percent LEU as UNH crystals.

The blending process would result in an increased generation of low-level, mixed low-level, hazardous, and nonhazardous wastes, which are shown in Table 2.2.2.1–2. Table 4.3.3.7–1 provides the sitewide waste generation resulting from the blending process. At each facility considered for the blending process, the generation of wastes would be analyzed against ALARA principles. Table 2.2.2.1–2 also provides the resultant waste volume after treatment (effluent) using a proposed treatment scheme as outlined in Figures 4.3.3.7–1 to 4.3.3.7–3. Liquid LLW from decontamination could go through a uranium recovery process first. The liquid effluent would then go to a radioactive wastewater treatment facility. The resultant sludge could be immobilized for disposal as solid LLW and the treated effluent would be discharged through a permitted outfall. Solid LLW generated by the blending process would consist of lab wastes, decontamination solids, scrapped equipment, air sampling filters, HEPA filters, and miscellaneous contaminated solids. Decontaminated solids could go through a uranium recovery process before being packaged for disposal. All other solid LLW could be compacted and immobilized as appropriate to meet the waste acceptance criteria of an onsite or offsite LLW disposal facility. The solid LLW radiological content would include U-232, U-234, U-235, U-236, and U-238. Liquid mixed LLW consisting of spent solvents and lab waste could be incinerated, thus eliminating the hazardous constituent. The resultant ash could be immobilized and packaged for disposal as solid LLW. The sump collection wastes from general plant operations could be precipitated and filtered in a radioactive liquid waste treatment facility. The resultant sludge could be immobilized for disposal and the treated effluent could be discharged through a permitted outfall. Other solid mixed LLW would consist of contaminated gloves and wipes. After compaction, they could be packaged for storage until a sufficient volume had accumulated for disposal in an offsite RCRA-permitted facility.

Liquid hazardous waste consisting of liquid waste treatment excess/flush water and chemical spillage would be treated onsite by distillation, evaporation, neutralization, and ammonia removal. The treated effluent would be discharged through a permitted outfall. Liquid nonhazardous waste such as sewage wastewater would be treated and disposed of using current site practices and facilities. Solid nonhazardous waste would primarily consist of solid sanitary waste, trash, waste paper, scrap metal, air filters, personnel respirators, plastic bags, and gloves. Nonrecyclable portions of this waste would be disposed of in a permitted landfill per site practice.

The wastes quantified in Table 2.2.2.1–2 result only from the process of blending 2.1 t of HEU per year to 0.9-percent LEU as UNH. The end product from this process will be an LEU waste that may be staged temporarily at SRS or ORR in existing facilities until there is sufficient quantity for cost-effective shipment to the disposal site(s). The blending process of 2.1 t of HEU will result in 177 t of LEU waste per year. Assuming a loading of a 90-kg/55-gal (0.208 m^3) drum, it can be determined that this blending process will result in approximately 409 m^3 (14,400 ft^3) of LEU "end product" waste per year. In a DOE LLW disposal facility, this waste would require from 0.05 to 0.12 ha (0.12 to 0.31 acre) of space per year, based on usage factors for DOE facilities that range from 3,300 to 8,600 m^3/ha (47,200 to 123,000 ft^3/acre), respectively.

The following discussions for each site considered for this blending process present analyses for the wastes

Table 4.3.3.7–1. Estimated Annual Generated Waste Volumes for Blending 2.1 t/yr Highly Enriched Uranium as Uranyl Nitrate to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

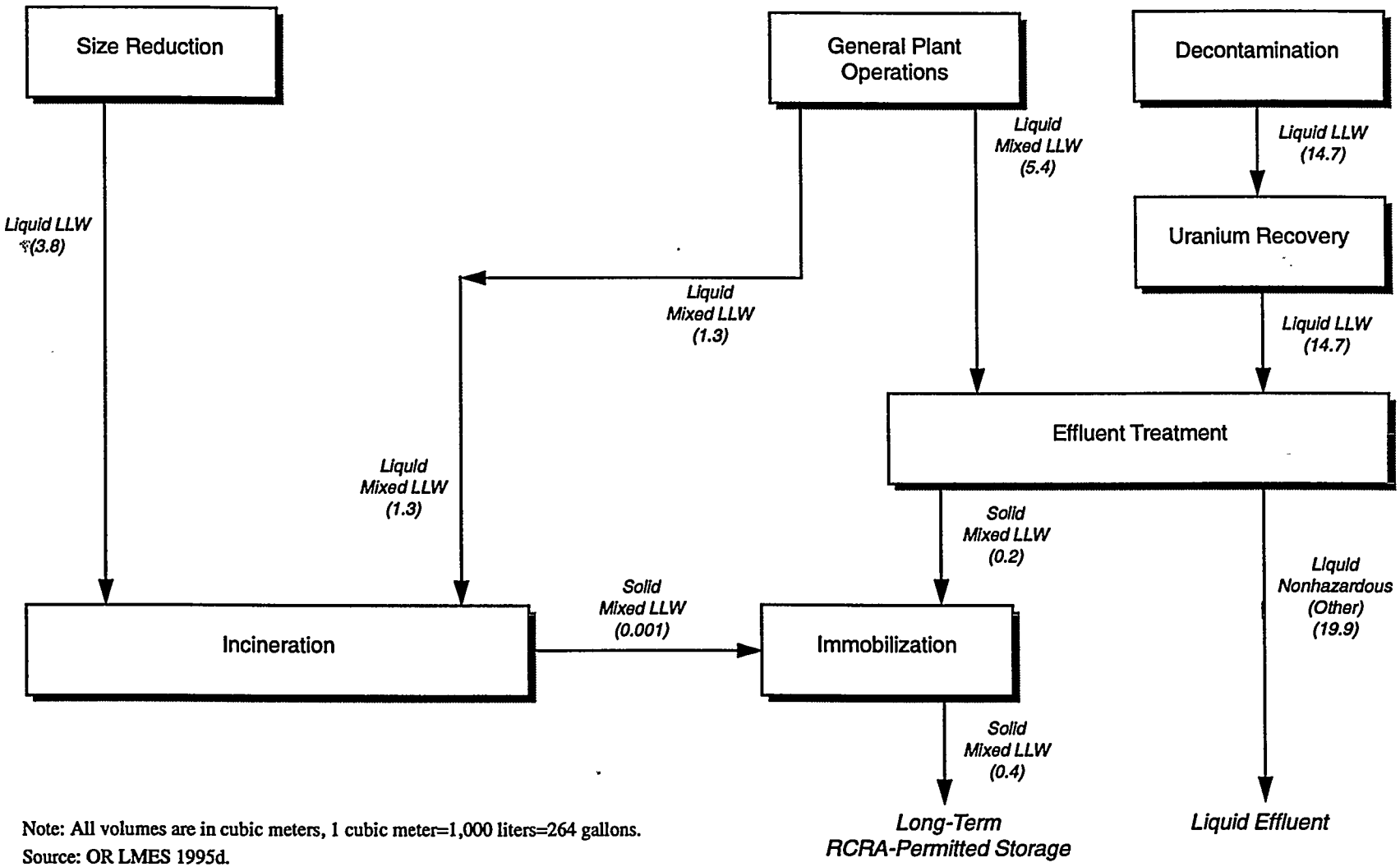
Waste Category	ORR[a] No Action (m^3)	ORR[a] With UNH Blending (m^3)	ORR[a] Increase (Percent)	SRS[b] No Action (m^3)	SRS[b] With UNH Blending (m^3)	SRS[b] Increase (Percent)	B&W No Action (m^3)	B&W With UNH Blending (m^3)	B&W Increase (Percent)	NFS No Action (m^3)	NFS With UNH Blending (m^3)	NFS Increase (Percent)
Low-Level												
Liquid	2,576	2,595	<1	0	19	>100	50,005	50,024	<1	18,900	18,919	<1
Solid	8,030	8,099	<1	14,100	14,169	<1	620	689	11	3,000	3,069	2
Mixed Low-Level												
Liquid	84,210	84,217	<1	115	122	6	0	7	>100	<1	7	>100
Solid	960	960	0	18	18	0	14	14	0	<1	<1	0
Hazardous												
Liquid	32,640	32,651	<1	Included in solid	11	NA	55,115	55,126	<1	<1	11	>100
Solid	1,434	1,434	0	74	74	0	0	0	0	<1	<1	0
Nonhazardous												
Liquid	1,743,000	1,761,763	1	700,000	718,763	3	576,160	594,893	3	56,700	75,463	33
Solid	52,730	53,550	2	6,670	7,490	12	1,700	2,520	48	2,300	3,120	36

[a] 1993 Generation. Generation rates represent sum of activities at K–25, ORNL, and Y–12.

[b] 1993 Generation. Nonhazardous waste category is 1991 Generation.

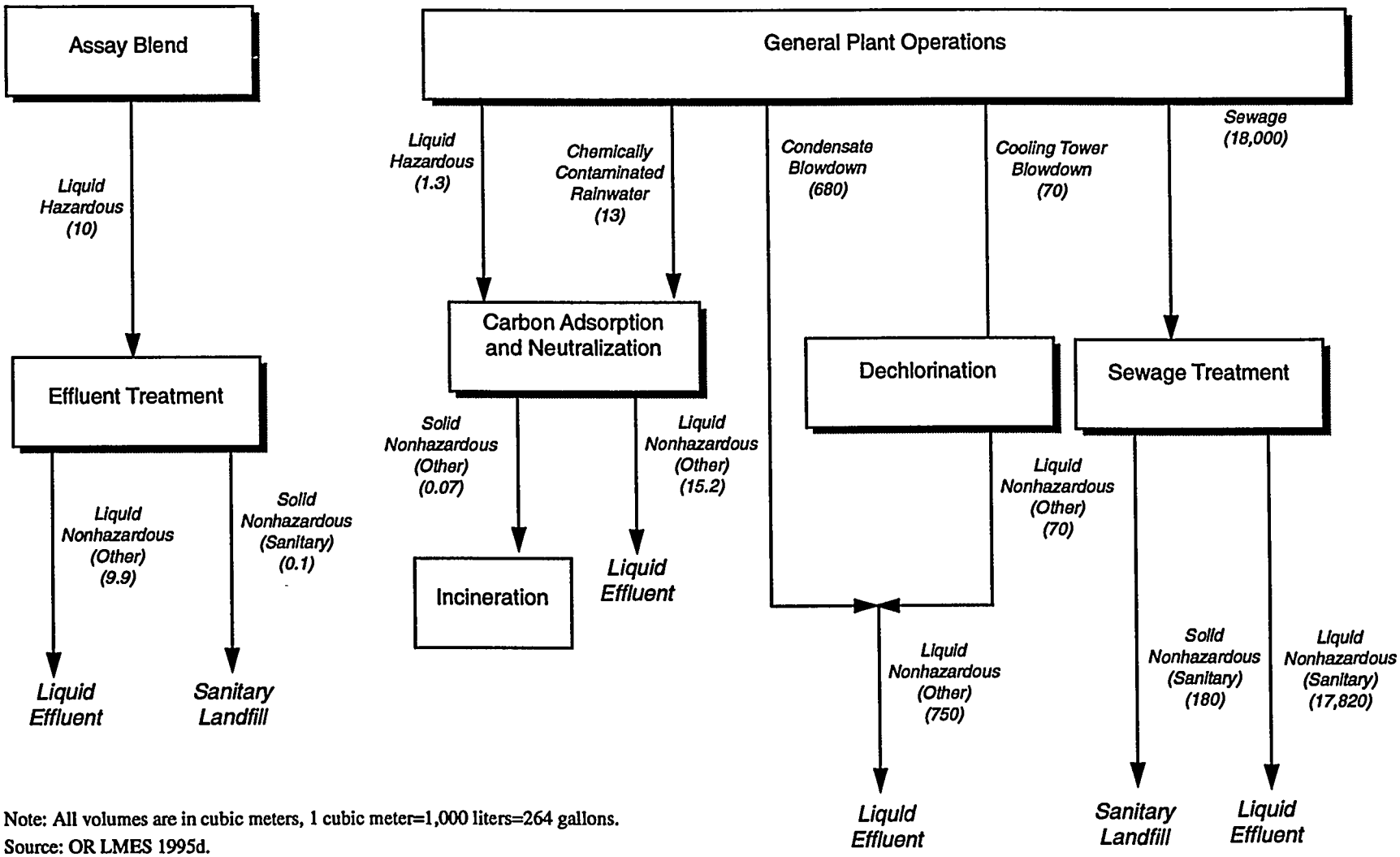
Note: NA=not applicable.

Source: BW 1995b:1; BW NRC 1991a; BW NRC 1995a; NF NRC 1991a; NFS 1995b:2; OR LMES 1995d, Tables 3.3.10–1, 3.3.10–2, 3.3.10–3, and 3.4.10–1.



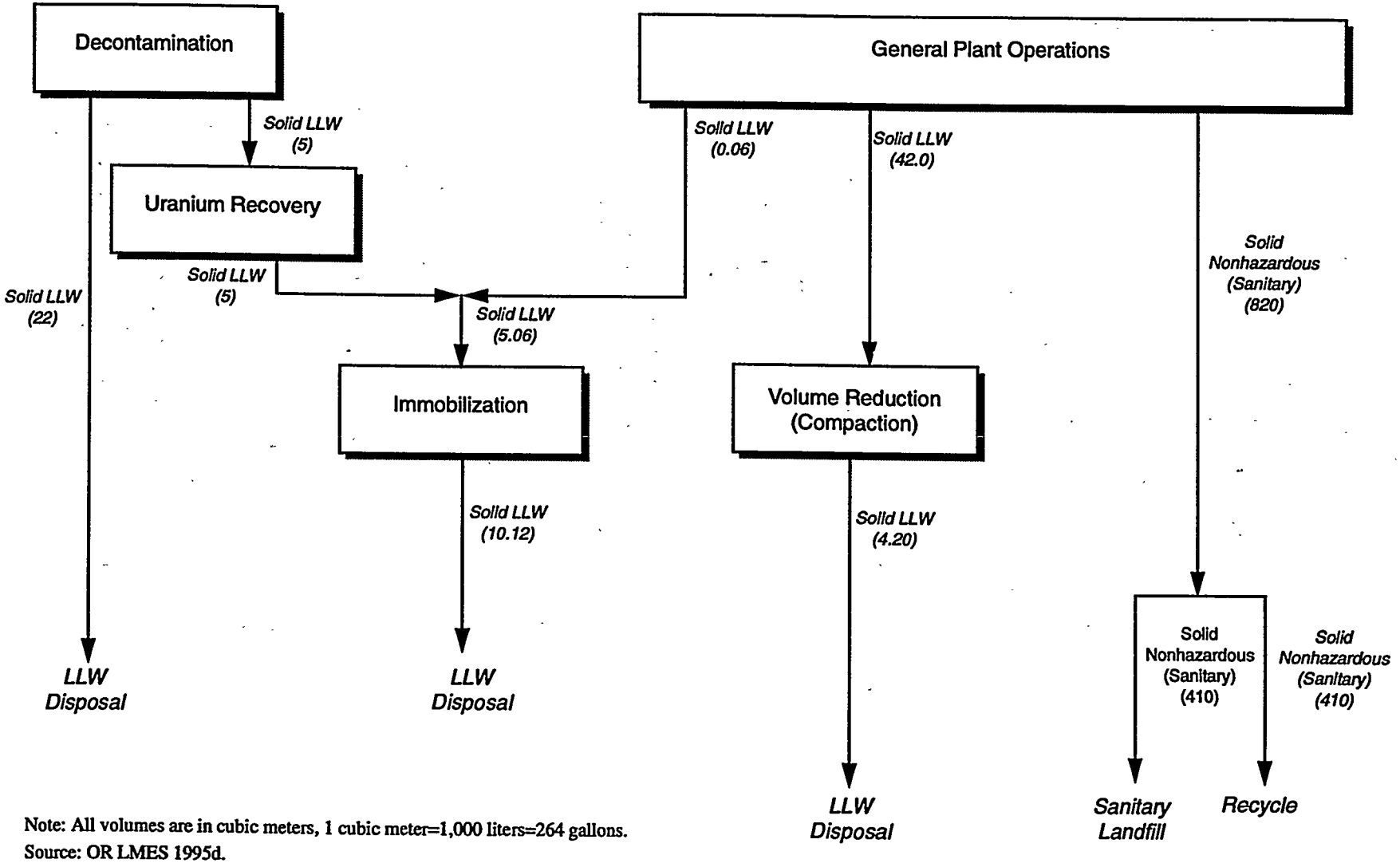
Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995d.

Figure 4.3.3.7–1. Radioactive Liquid Waste Management for Conversion and Blending 2.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995d.

Figure 4.3.3.7–2. Nonradioactive Liquid Waste Management for Conversion and Blending 2.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995d.

Figure 4.3.3.7–3. Solid Waste Management for Conversion and Blending 2.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.

generated by the blending process and not the ultimate management of the waste end product. The annual and total quantities of LEU "end product" (as LLW) for disposal and transportation related to this LLW are discussed in section 4.4 and 4.5. Depending on the alternative, the total amount of HEU that would be potentially not commercially usable could vary between 30 t (15 percent of surplus inventory) and 200 t (100 percent of surplus inventory), as stated in Chapter 2. Multiple sites and blending processes would be used under all alternatives (except no action) for blending the entire surplus inventory to LLW, as explained in Chapter 2.

Oak Ridge Reservation. Current waste generation rates and treatment, storage, and disposal capacities are presented for ORR in Tables 3.3.10–1 through 3.3.10–3. These tables indicate that liquid and solid LLW treatment facilities at ORR would not be greatly affected due to this action. The liquid LLW treatment facility at ORR has the capacity to treat the increase in liquid LLW generated. Solid LLW generated at ORR would be compacted, smelted, and incinerated offsite and then stored onsite pending the completion of a proposed LLW Class II facility that is due to be operational in 2002. The amount of solid LLW generated by this action that would eventually be transferred to the LLW disposal facility would be 36 m^3/yr (1,271 ft^3/yr). Assuming a usage factor of 3,300 m^3/ha (OR DOE 1995e:1), this waste will require 0.01 ha/yr (0.28 acres/yr) in the new LLW Class II facility. The small increase in liquid mixed LLW could be handled by the onsite mixed LLW treatment facility. Adequate staging capacity is also available to incorporate the amount of solid mixed LLW from the treatment of the liquid mixed LLW. The onsite hazardous waste treatment facility has the capacity to accommodate the less than 1-percent increase in the amount of hazardous liquid waste produced by the blending process. This action would increase the liquid sanitary waste generation to 1,762,000 m^3/yr (465 MGY). The onsite facilities have a capacity of 4,930,000 m^3/yr (1,300 MGY), so the increase is within facility capacity. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated by the site's current recycling practices.

Savannah River Site. Current waste generation rates and treatment, storage, and disposal capacities are presented for SRS in Table 3.4.10–1. These tables indicate that liquid and solid LLW treatment facilities at SRS would not be greatly impacted due to this action. The amount of liquid LLW generated per year by this action is small compared with the amount of liquid LLW generated yearly at the site, and the onsite treatment facility has the capacity to accommodate the increase. There would be 36 m^3 (1,271 ft^3) of solid LLW generated per year resulting from liquid and solid LLW treatment that would require staging and/or disposal. Assuming a usage factor of 8,600 m^3/ha, the increase in the amount of solid LLW would require 0.004 ha/yr (0.01 acre/yr) in the onsite LLW disposal facility. The onsite mixed LLW treatment facility has the capacity to incorporate the less than 1-percent increase in the amount of mixed LLW generated by the blending process. Currently, the site incorporates liquid hazardous waste into the solid hazardous waste treatment system. The capacity exists to treat 2,000 m^3/yr (528,000 gal/yr) of liquid hazardous waste at SRS; therefore, the increase of 11 m^3/yr (2,900 gal/yr) will not burden existing systems. A 3-percent increase in the amount of liquid nonhazardous waste would result at SRS if this action were implemented. This increase would not burden onsite facilities. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated by the site's current recycling practices.

Babcock & Wilcox. The B&W site has facilities for treating liquid LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small compared with the amount of liquid LLW generated yearly at the site. The onsite treatment facility for liquid LLW at B&W has a capacity to treat approximately 89,800 m^3/yr (23,700,000 gal/yr); therefore, B&W would be able to handle the increase in liquid LLW generated (BW NRC 1991a:13). When this process is complete, the amount of solid LLW requiring staging and eventual disposal would be 36 m^3/yr (1,271 ft^3/yr). This waste would be hauled offsite to a licensed disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre), this waste would require 0.002 ha/yr (0.0005 acre/yr) in a commercial

licensed disposal facility. The small amount of liquid mixed LLW generated could be accommodated in the liquid LLW treatment facility. Currently, onsite treatment facilities process approximately 55,300 m^3 (14,600,000 gal) of liquid hazardous waste per year. The increase in liquid hazardous waste generation of 11 m^3 (2,900 gal/yr) should not burden this treatment system. The amount of liquid nonhazardous waste resulting from the blending process would increase by 29 percent over current operations. This could be accommodated in existing facilities, which have a capacity of 2.5 times the combined requirement. B&W has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

Nuclear Fuel Services. The NFS site has facilities for treating LLW, hazardous waste, and process waste. The amount of liquid LLW generated per year by this action can be accommodated onsite in the LLW treatment facility that has a capacity of 38,700 m^3/yr. When this process is complete, the amount of solid LLW requiring staging and eventual disposal would be 36 m^3/yr (1,271 ft^3/yr). This waste would be shipped offsite to a licensed disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre), this waste would require 0.002 ha/yr (0.005 acre/yr) in a commercial licensed disposal facility. [Text deleted.] The amount of liquid nonhazardous waste resulting from the blending process would increase by 33 percent from current operations. The increase results in a combined effluent that is within the capacity of the POTW where it is processed. NFS has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

4.3.4 Technology and Site-Specific Impacts for Blending Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Under this process, surplus HEU metal would be melted down and mixed with molten DU to attain the appropriate enrichment level of 0.9-percent assay. The homogeneous molten mixture then would be converted to oxide form. This process would be used only for surplus HEU to be discarded as waste.

Assessment of impacts of blending HEU to 0.9-percent LEU as metal is based on an annual throughput of 3.1 t of 50-percent assay HEU (impure U/Al metal alloy) blended to approximately 264 t/yr LEU. The resultant product would be an impure U/Al metal alloy containing 0.9-percent assay uranium metal, which would be subsequently converted to oxide form prior to disposal. When oxidized, including aluminum, the total mass of the waste product would be 278 t/yr. The blendstock for this alternative would be DU, requiring a blending ratio of 70 to 1 (each metric ton of HEU would require about 70 t of blendstock). The Y–12 Plant is considered for this alternative because it is the only site where metal blending capability currently exists.

4.3.4.1 Site Infrastructure

Operation of facilities to blend HEU to 0.9-percent LEU as metal would potentially affect site infrastructure, mainly electrical power, fuel, and water/steam supply. Site infrastructure requirements are discussed in Section 2.2.2.2 and detailed in Table 4.3.4.1–1 for the Y–12 Plant. The discussion of impacts on site infrastructure is presented for all the sites collectively.

Due to the use of existing facilities at the Y–12 Plant and the estimated metal blending facility utility requirements, there is no anticipated need for modifications to onsite or offsite road and rail access or right-of-way access corridors for such services as electrical transmission lines, natural gas and water supply pipelines, and telecommunications. The existing road, rail, and other utility services at the Y–12 Plant are considered adequate to support the projected needs of the metal blending facility.

The annual electrical service requirements of the metal blending facility are 3,800 MWh with a maximum peak demand in any 1-hour period estimated at 1 MWe. This requirement is less than 1 percent of current annual consumption at the Y–12 Plant.

The fuel and water requirements to support the metal blending facility represent relatively small fractions of current annual usage or available capacity at ORR. Natural gas is available and in use at the Y–12 Plant. [Text deleted.] Annual fuel oil consumption at ORR is 416,000 l (110,000 gal); however, none of this oil is used at the Y–12 Plant. Coal fired boilers are in use for the production of process steam. The fuel requirements for the metal conversion and blending facility represent only 0.2 percent of current fuel consumption at ORR. Annual raw water requirements to support the blending facility operations represent only 0.2 percent of current usage at ORR.

As a result of the extensive site infrastructure already existing at Y–12, minimal effect, in terms of the percentage increase in site infrastructure resource usage, can be expected due to the development, operation, and decommissioning of the metal blending facility. In addition, the metal blending facility's site infrastructure resource requirements are well within the available capacity at the Y–12 Plant.

4.3.4.2 Air Quality and Noise

Operation of facilities to blend HEU to 0.9-percent LEU as metal would generate criteria and toxic/hazardous pollutants. Concentrations of pollutants resulting from this alternative were estimated for ORR and are presented in Table 4.3.4.2–1.

Air Quality. Air pollutant emissions associated with the operation of the metal blending facility consist of criteria pollutants from the operation of boilers to produce steam and toxic/hazardous pollutants such as nitric acid used or generated in the blending process. These pollutants are controlled using liquid scrubbing prior to HEPA filtration to remove chemical vapors and particulates.

The 24-hour concentration of SO_2 at ORR is approximately 9 percent of the standard, which is the highest percent of a standard for the criteria

Table 4.3.4.1–1. Additional Site Infrastructure Resources for Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

	Access		Electrical		Fuel			Water	
Site	Road (km)	Rail (km)	Energy (MWh/yr)	Peak Load (MWe)	Natural Gas (m^3/yr)	Diesel/ oil (l/yr)	Coal (t/yr)	Water (million l/yr)	Steam (kg/hr)
Metal facility	0	0	3,800	1	708	37,850	127	12	0
Y–12 baseline	42	11	421,000	62	66,600,000	0	2,940	7,530	99,300
Y–12 percent change [Text deleted.]	0	0	0.9	1.6	0.07[a]	NA[b]	4.4	0.16	0

[a] Percent change includes required natural gas or oil energy equivalent.

[b] Natural gas is the primary fuel at Y–12, and all of the blending facility oil requirements have been converted to a natural gas energy equivalent; fuel oil (0.96 kg/l) is assumed to be 41,800 BTUs/kg or 40,128 BTUs/l, and natural gas is assumed to be 35,315 BTUs/m^3 (that is, 37,850 of fuel oil=43,065 m^3 natural gas).

[Text deleted.]

Note: NA=not applicable; MWh=megawatt hour; MWe=megawatt electric; BTU=British thermal unit.

Source: OR LMES 1995c; OR MMES 1995a.

Table 4.3.4.2–1. Estimated Concentrations of Criteria Pollutants Based Upon Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Metal Blending Alternative Concentration for Y–12[a] ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	6.7
	1 hour	40,000[b]	31
Lead (Pb)	Calendar Quarter	1.5[b]	[c]
Nitrogen dioxide (NO_2)	Annual	100[b]	0.47
Particulate matter (PM_{10})	Annual	50[b]	0.02
	24 hours	150[b]	0.27
Sulfur dioxide (SO_2)	Annual	80[b]	0.86
	24 hours	365[b]	10.2
	3 hours	1,300[b]	56.2
Mandated by Tennessee			
Total suspended particulates (TSP)	Annual	60[d]	2.37[e]
	24 hours	150[d]	28.16
Gaseous fluorides (as HF)	1 month	0.8[d]	[c]
	1 week	1.6[d]	[c]
	24 hours	2.9[d]	[c]
	12 hours	3.7[d]	[c]
	8 hours	250[d]	[c]

[a] Model results.

[b] Federal standard.

[c] No emissions from this process.

[d] State standard or guideline.

[e] No State standard or guideline.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: 40 CFR 50; OR LMES 1995c; TN DEC 1994a; TN DHE 1991a.

pollutants at ORR. The metal blending would contribute 3 and 19 percent to the 24-hour concentration of SO_2 and TSP at ORR respectively. The remaining criteria pollutant concentrations would be less than 20 percent of the respective standard.

[Text deleted.]

Table 4.3.4.2–2 presents the total concentrations of no action criteria pollutants plus blending at the Y–12 site. During operation, impacts from the metal blending with respect to the concentrations of criteria and toxic/hazardous air pollutants are expected to be within Federal and State regulations and guidelines for ORR.

Noise. Operation of the metal blending facilities in an existing building at ORR would result in little or no contribution to noise levels at offsite receptors. Existing buildings are located at a sufficient distance from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

Noise impacts associated with increased traffic on access routes would be small considering that the facility would require a maximum of 72 employees during operation (OR LMES 1995c:20), many of whom would be employees currently working at the site.

Table 4.3.4.2–2. Estimated Total Concentrations of Criteria Pollutants for No Action Plus Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	No Action Plus Blending Concentration at Y–12[a] ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	11.7
	1 hour	40,000[b]	42
Lead (Pb)	Calendar Quarter	1.5[b]	0.05
Nitrogen dioxide (NO_2)	Annual	100[b]	3.47
Particulate matter (PM_{10})	Annual	50[b]	1.02
	24 hours	150[b]	2.27
Sulfur dioxide (SO_2)	Annual	80[b]	2.86
	24 hours	365[b]	42.2
	3 hours	1,300[b]	136
Mandated by Tennessee			
Total suspended particulates (TSP)	Annual	60[c]	3.37[d]
	24 hours	150[c]	30.16
Gaseous fluorides (as HF)	1 month	0.8[c]	0.2
	1 week	1.6[c]	0.3
	24 hours	2.9[c]	<0.6
	12 hours	3.7[c]	<0.6
	8 hours	250[c]	0.6

[a] Model results.

[b] Federal standard.

[c] State standard or guideline.

[d] No State standard.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: 40 CFR 50; DOE 1995i; OR LMES 1995c; TN DEC 1994a; TN DHE 1991a.

Potential measures to minimize noise impacts on workers include providing workers in noisy environments with appropriate hearing protection devices that meet OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

4.3.4.3 Water Resources

Environmental impacts associated with the operation of metal blending facilities would affect surface and groundwater resources. Water resource requirements and discharges provided in Section 2.2.2.2 were used to assess impacts to surface water and groundwater. The discussion of impacts are provided for each site separately.

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Surface Water. Operation of metal blending facilities would require an additional 12 million l/yr (3.2 MGY) of water or less than 1 percent of the Clinch River's average flow (132 m^3/s [4,647 ft^3/s]).

The wastewater generated from the operations would be conveyed to the Y–12 Central Pollution Control Facility or the Y–12 West End Treatment Facility for processing. Approximately 11.7 million l/yr (3.1 MGY) of additional treated sanitary and wastewater would be discharged to East Fork Poplar Creek, not exceeding 1 percent of the creek's average flow (1.3 m^3/s [45 ft^3/s]), and therefore these discharges should not result in any downstream flow

effects. Releases to the Clinch River would represent less than 1 percent of the average flow (132 m^3/s [4,661 ft^3/s]). All discharges would be monitored to comply with NPDES permit limits. Stormwater runoff from the main plant area would be collected in detention ponds, monitored, and if acceptable, discharged to nearby streams. Stormwater runoff from outside the main plant area, except those facilities that require onsite management controls by regulations such as sanitary treatment plants and landfills, would be discharged to nearby streams.

The Y–12 Plant is currently involved with the remediation of East Fork Poplar Creek under CERCLA because East Fork Poplar Creek was contaminated by past releases from the Y–12 Plant. Future NPDES permits would be written after review of the current water quality and how it is affected by discharges from Y–12. In addition, discharges from the treatment plants are required to meet all permit limits, therefore, no impacts to water quality are expected.

Domestic wastewater from the Y–12 Plant, including some sinks in process areas, are discharged to the sanitary sewer for treatment under an industrial user's permit. This permit allows the Y–12 Plant to discharge wastewater to be treated at the Oak Ridge Wastewater Treatment Facility through two main sewage lines into the Oak Ridge sanitary sewer system in accordance with effluents limitations, monitoring requirements, and other conditions set forth in the permit. Radiological and nonradiological parameters are monitored for these sewer lines.

The proposed area for the metal blending facility lies outside the 100- and 500-year floodplains.

Groundwater. No groundwater would be used at Y–12 given the plentiful surface water supplies; therefore, no impacts on groundwater levels are expected.

Groundwater quality would not be affected by the operation of metal blending facilities. Because there would be no direct discharge of process wastewater to groundwater, and wastewater would be treated at either the Y–12 Central Pollution Control Facility or at the Y–12 West End Treatment Facility before being released to surface waters, no impacts on groundwater quality are expected. Groundwater contamination at ORR has been the result of past practices that have since been discontinued. The Y–12 Plant implements a Comprehensive Groundwater Monitoring Plan to monitor groundwater flow, quality, and content by sampling groundwater monitoring wells across the facility. Water quality of East Fork Poplar Creek would be protected by the extensive Y–12 efforts to protect water quality.

[Text deleted.]

4.3.4.4 Biotic Resources

The operation of the metal blending facilities at the Y–12 Plant is not expected to have significant adverse impacts on biotic resources. Operations would be conducted within existing buildings. There would be no loss of habitat; therefore, no impacts on wildlife are anticipated. The increase of water intake or discharges to site streams would be minimal (less than 1 percent of stream flow rates), which would cause no impacts to aquatic resources.

Impacts to wetlands would not occur since these resources are not located in the proposed area of activities. No Federal- or State-listed threatened or endangered species would be affected.

4.3.4.5 Socioeconomics

This section describes the potential socioeconomic impacts resulting from operation of facilities for the blending of HEU to 0.9-percent LEU as metal at the Y–12 Plant at ORR. Any upgrades/modifications required at either site would be accomplished by the site's existing workforce, and no new jobs would be created; however, operation of the blending facility at either location would require additional employees, creating some minor economic benefits to the region.

Operation of the metal blending facilities would require 72 employees. Some workers needed for operation are currently employed at these sites; however, to assess the maximum potential impact of this alternative, the analysis assumes that both candidate sites would need 72 additional employees to blend HEU to LEU as metal. The project would also create 184 indirect jobs within the ORR REA (Figure 4.3.4.5–1). The regional unemployment rate would decrease from 4.9 to 4.8 percent at ORR. Earnings also would increase slightly in the region as a result of the project.

Available labor in each region is sufficient to fill the new jobs created directly by the project and additional indirect jobs; therefore, it is unlikely that there would be any in-migration to the region. Without any project-related in-migration, there would be no additional demands for housing units, community services, or transportation. The effects on housing and community services in the ROI would be the same as for the No Action Alternative.

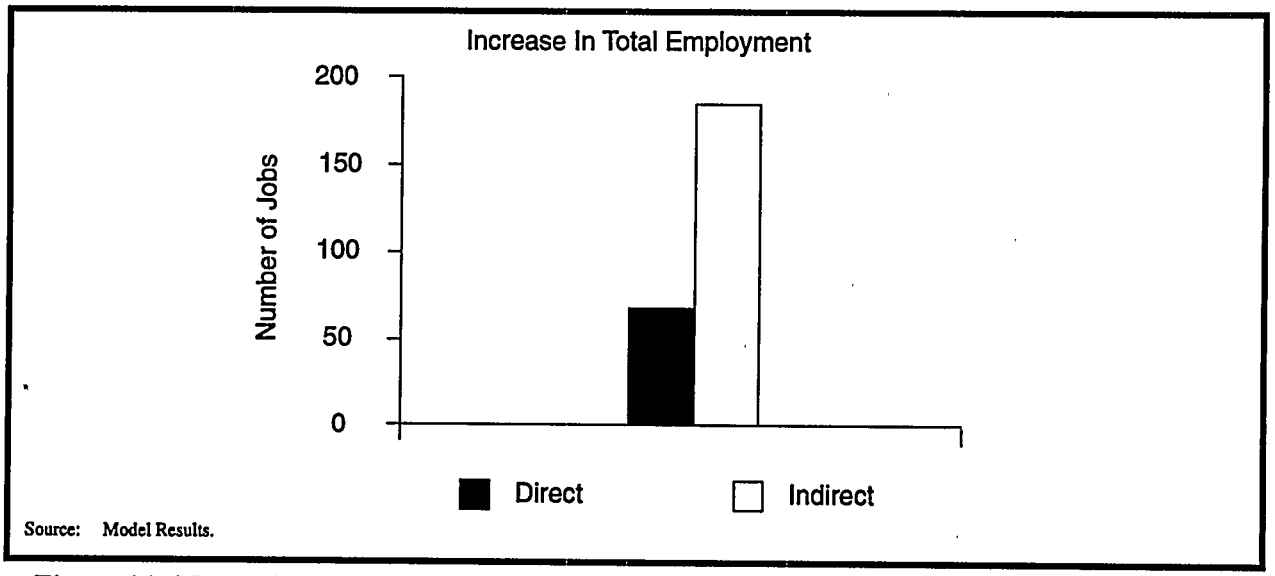


Figure 4.3.4.5–1. Increase in Total Project-Related Employment (Direct and Indirect) at Oak Ridge Reservation Resulting From Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal.

4.3.4.6 Public and Occupational Health

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either the normal operation or potential accidents for blending HEU to 0.9-percent LEU as metal at ORR. Summaries of the radiological impacts to the public and workers associated with normal operation at ORR are presented in Tables 4.3.4.6–1 and 4.3.4.6–2. Chemical impacts to these same groups are presented in Table 4.3.4.6–3, and accident impacts are presented in Table 4.3.4.6–4. (Further supplementary information is presented in Appendix E.)

Normal Operation

Radiological Impacts. Incremental radiological impacts to the public resulting from normal operation of the metal blending facilities at ORR are presented in Table 4.3.4.6–1. The impacts from total site operations, including the metal blending facilities, also are given in the table. These impacts are provided to demonstrate compliance with applicable regulations governing total site operations. To put operational doses into perspective, a comparison is made with the doses from natural background radiation. As shown in Table 4.3.4.6–1, the dose to the MEI of the public from annual total site operations is within radiological limits and would be 2.0 mrem at ORR. The annual population dose within 80 km (50 mi) would be 28.1 person-rem at ORR.

Incremental and total site doses to onsite workers from normal operations are given in Table 4.3.4.6–2. The annual incremental dose to involved workers at the blending and conversion facility would be 110 mrem to the average worker and 7.9 person-rem to the entire facility workforce (DOE 1993n:7; NRC 1995b; OR LMES 1995c).

Table 4.3.4.6–1. Potential Radiological Impacts to the Public Resulting From Normal Operation of Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Receptor	ORR	
	Incremental	Total Site[a]
Maximally Exposed Individual (Public)		
From atmospheric release pathway (mem/yr)[b]	2.6×10^{-2}	1.4
From total liquid release pathway(mrem/yr)[b]	0	0.6
From atmospheric and liquid release pathways combined (mrem/yr)[b]	2.6×10^{-2}	2
Percent of natural background[c]	8.8×10^{-3}	0.68
Risk of fatal cancer per year of site operation[d]	1.3×10^{-8}	1.0×10^{-6}
Population Within 80 km		
From atmospheric release pathways dose (person-rem/yr)[e]	0.11	26.1
From total liquid release pathways (person-rem/yr)[e]	0	2
From atmospheric and liquid release pathways combined (person-rem/yr)[e]	0.11	28.1
Percent of natural background[c]	3.6×10^{-5}	9.2×10^{-3}
Number of fatal cancers per year of site operations[d]	5.5×10^{-5}	1.4×10^{-2}

[a] Includes impacts from all site operations that are expected to continue during the interim of blending process operations (reference environment).

[b] The applicable radiological limits for an individual member of the public from total site operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathway, and 100 mrem/yr from all pathways combined. [Text deleted.]

[c] Annual natural background radiation levels at ORR: the average individual receives 295 mrem; and the population within 80 km receives 306,000 person-rem.

[d] Representative of material processed at the rate of 3.1 t/yr.

[e] Proposed 10 CFR 834 (58 FR 16268) includes the requirement that the contractor who operates a DOE site notify DOE if the potential annual population dose exceeds 100 person-rem from all pathways combined.

Source: Appendix E.

Table 4.3.4.6–2. Potential Radiological Impacts to Workers Resulting From Normal Operation of Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Receptor	ORR
Involved Workforce[a]	
Average Worker	
Dose (mrem/yr)[b]	110
Risk of fatal cancer per year of site operation	4.4×10^{-5}
Total	
Dose (person-rem/yr)	7.9
Number of fatal cancers per year of site operation	3.2×10^{-3}
Noninvolved Workforce[c]	
Average worker	
Dose (mrem/yr)[b]	4
Risk of fatal cancers per year of site operation	1.6×10^{-6}
Total	
Dose (person-rem/yr)	68
Number of fatal cancers per year of site operation	2.7×10^{-2}
Total Site Workforce[d]	
Dose (person-rem/yr)	76
Number of fatal cancers per year of site operation	3.0×10^{-2}

[a] The in-plant (involved) worker is a worker associated with operations of the blending and conversion facilities. The estimated number of in-plant workers is 72.

[b] The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 835).

[c] The noninvolved worker is a worker on site but not associated with operations of the blending and conversion facilities. The estimated number of noninvolved workers is 16,928 at ORR.

[d] The total site workforce is the summation of the in-plant worker impacts and the noninvolved worker impacts. The estimated number of workers in the total site workforce is 17,000 at ORR.

Source: DOE 1993n:7; NRC 1995b; OR LMES 1995c.

[Text deleted.]. All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from blending HEU to 0.9-percent LEU as metal at Y–12 are presented in Table 4.3.4.6–3. The increment of potential adverse noncancer health effects and cancer risks posed by this action at the various sites is shown, followed by the total risk (that is, incremental risk plus no action contribution to risk) at each unique site. There are no cancer risks for those sites where there are no known carcinogens among the hazardous chemicals released, and therefore the slope factor is 0 for all chemicals.

The incremental and site total HIs for the public MEI contributed by this alternative are all less than 1.0 at Y–12 showing that all hazardous chemical concentrations are below EPAs concentrations (Reference Concentrations). The cancer risks to the MEI of the public are below the value of 1.0×10^{-6} (40 CFR 300.430).

The incremental and total site HIs for the onsite workers contributed by this alternative are less than 1.0 at Y–12. [Text deleted.] The incremental and total cancer risks to the workers at Y–12 are below the value of 1.0×10^{-6}.

Facility Accidents

A set of potential accidents have been postulated for which there may be releases of radioactivity that could impact noninvolved onsite workers and the offsite population. A set of accident scenarios was selected to represent bounding cases. In assessing the bounding accident scenarios for the conversion and blending facility, the following parameters were evaluated: 1) material at risk, 2) energy sources (fires, explosions,

Table 4.3.4.6–3. Potential Hazardous Chemical Impacts to the Public and Workers Resulting From Blending 3.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal at Y–12

Receptor	Incremental[a]	Total Site[b]
Maximally Exposed Individual (Public)		
Hazard index[c]	2.24×10^{-4}	3.97×10^{-2}
Cancer risk[d]	9.25×10^{-16}	9.25×10^{-16}
Worker Onsite		
Hazard index[e]	8.82×10^{-4}	0.155
Cancer risk[f]	2.40×10^{-14}	2.40×10^{-14}

[a] Incremental=contribution only from single activity at the site.

[b] Total=total site includes any background emissions that would be present in the absence of site operations plus site emissions that exist at the present time.

[c] Hazard index for MEI=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

[d] Lifetime cancer risk for MEI=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Hazard index for workers=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[f] Lifetime cancer risk for workers=(emissions for 8-hour) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: OR LMES 1995c.

earthquakes, and process design-related events), 3) barriers to release, and 4) protective features of the facility.

No toxic chemicals were identified among the materials at risk. The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process related accidents, and an evaluation basis earthquake. With the exception of the filter fire (with continuous exhaust flow) all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake; therefore, it is concluded that the evaluation basis earthquake would result in the worst-case atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality and other release scenarios.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and HEPA filters to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium metal are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost and moderators added as water from the fire system. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1.0×10^{19} fissions occur prior to reaching a stable, subcritical condition and that all material releases occur within a 2-hour period (NRC 1979b: 3.34-4). The amount of radioactive material released as fission products created by the nuclear criticality is 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium mixtures, water, and reactive liquids. This is assumed to result in the release of 2.1 millicurie (mCi) of uranium isotopes (48 percent of the activity is U-232 and 33 percent of the activity is U-234).

The accidents that release radioactivity and their consequences are presented in Table 4.3.4.6–4. The accident with the highest consequences is a criticality. If it were to occur (in conjunction with the evaluation basis earthquake), there would be an estimated 2.5×10^{-3} latent cancer fatalities in the general population within 80 km (50 mi) of Y–12. For the MEI, there would be an increased likelihood of latent cancer fatality of 3.3×10^{-5} at ORR. Based on the spatial distribution of noninvolved workers located at

ORR, the estimated number of latent cancer fatalities in the worker population is 2.1×10^{-2}. The accident risks, reflecting both the probability of the accident occurring and the consequences, also are shown in the tables. For the general population, MEI, and noninvolved worker population, the fatal cancer risks are 2.5×10^{-7}, 3.3×10^{-9}, and 2.1×10^{-6} per year, respectively. In addition to the potential impacts to noninvolved workers, there are potential impacts to involved workers, who are located in the facilities analyzed in this EIS. Potential radiological consequences to the involved worker range to several thousand rem in the case of a criticality. The combined evaluation-basis earthquake and earthquake-induced criticality would probably result in fatal doses to the involved worker. Furthermore, fatalities to the involved workers would be expected as a result of the building collapse (from the earthquake) and the criticality (OR DOE 1994d:6-26, 6-27). [Text deleted.]

[Table deleted.]

4.3.4.7 Waste Management

Operation of facilities required to blend surplus HEU to 0.9-percent LEU as metal would affect current waste management practices at ORR. There is no spent nuclear fuel, HLW, or TRU waste associated with the blending; however, generation of low-level, mixed low-level, hazardous, and nonhazardous wastes would increase. This section summarizes the impacts on treatment, storage, and disposal facilities at ORR resulting from blending HEU to 0.9-percent LEU as metal.

The blending process would result in the generation of low-level, mixed low-level, and nonhazardous wastes (as presented in Table 2.2.2.2–2). Table 4.3.4.7–1 presents the increased sitewide waste generation resulting from the blending process. [Text deleted.] Table 2.2.2.2–2 also provides the resultant waste volume after treatment (effluent) using a proposed treatment scheme as outlined in Figures

Table 4.3.4.6–4. Accident Consequences and Risk of Major Accidents for Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal at Y–12

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3a}	10^{-4b}	10^{-4b}
Consequences			
Noninvolved Workers			
Dose (person-rem)	11	38	14
Latent cancer fatalities per accident	4.2×10^{-3}	1.5×10^{-2}	5.6×10^{-3}
Risk (cancer fatalities per year)	4.2×10^{-6}	1.5×10^{-6}	5.6×10^{-7}
Maximally Exposed Individual			
Dose (rem)	1.0×10^{-2}	5.1×10^{-2}	1.4×10^{-2}
Latent cancer fatality per accident	5.2×10^{-6}	2.6×10^{-5}	6.8×10^{-6}
Risk (cancer fatality per year)	5.2×10^{-9}	2.6×10^{-9}	6.8×10^{-10}
Population Within 80 km (1,040,000 in 2010)			
Dose (person-rem)	1.5	3	1.9
Latent cancer fatalities per accident	7.7×10^{-4}	1.5×10^{-3}	9.7×10^{-4}
Risk (cancer fatalities per year)	7.7×10^{-7}	1.5×10^{-7}	9.7×10^{-8}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

4.3.4.7–1 through 4.3.4.7–3. Liquid LLW from decontamination could go through a uranium recovery process first. The liquid effluent then would go to a radioactive wastewater treatment facility. The resultant sludge would be immobilized for disposal as solid LLW, and the treated effluent would be discharged through a permitted outfall. The sump collection wastes from general plant operations would be precipitated and filtered in a radioactive liquid waste treatment facility. The resultant sludge would be immobilized for disposal, and the treated effluent would be discharged through a permitted outfall. Solid LLW generated by the blending process would consist of lab wastes, decontamination solids, graphite, slag, brick and insulation, oil filters, air sampling filters, HEPA filters, and miscellaneous contaminated solids. Decontamination solids could go through a uranium recovery process before being packaged for disposal. All other solid LLW could be compacted and immobilized as appropriate to meet the waste acceptance criteria of an onsite or offsite LLW disposal facility. The solid LLW radiological content would include U-232, U-234, U-235, U-236, and U-238. Liquid include mixed LLW consisting of spent solvents and lab waste could be incinerated, thus eliminating the hazardous constituent. The resultant ash could be immobilized and packaged for disposal as solid LLW. Other solid mixed LLW would consist of contaminated gloves and wipes. After compaction, they would be packaged for storage until sufficient volume had accumulated for disposal in an offsite RCRA-permitted facility.

Liquid nonhazardous waste such as sewage wastewater would be treated and disposed of using current site practices and facilities. Solid nonhazardous waste would primarily consist of solid sanitary waste, trash, waste paper, scrap metal, air filters, personnel respirators, plastic bags, and gloves. Nonrecyclable portions of this waste would be disposed of in a permitted landfill per site practice.

The wastes quantified in Table 4.3.4.7–1 result only from the process of blending 12.52 t/yr of impure U/Al metal alloy that contains 3.1 t of HEU to 0.9-percent LEU as metal. The end product from this process will be an LEU waste that may be staged temporarily at ORR in existing facilities until there is sufficient quantity for cost-effective shipment to the disposal site(s). The blending process of 3.1 t of HEU will result in approximately 260 t/yr of LEU waste (OR LMES 1995c:1). Using a loading of 90-kg (55-gal) drum, it can be determined that this blending process will result in approximately 610 m^3/yr (21,500 ft^3/yr) of LEU waste. In a DOE LLW disposal facility, this waste would require from 0.07 to 0.18 ha/yr (0.18 to 0.46 acres/yr) of space, based on usage factors for DOE facilities that range from 3,300 to

Table 4.3.4.7–1. Estimated Annual Waste Volumes Generated for Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal at Oak Ridge Reservation

Waste Category	No Action (m^3)	With Metal Blending (m^3)	Increase (Percent)
Low-Level			
Liquid	2,576	2,856	11
Solid	8,030	8,575	7
Mixed Low-Level			
Liquid	84,210	84,219	<1
Solid	960	960	0
Hazardous			
Liquid	32,640	32,641	<1
Solid	1,434	1,434	0
Nonhazardous			
Liquid	1,743,000	1,754,664	<1
Solid	52,730	53,200	1

Source: OR LMES 1995c;Tables 3.3.10–1, 3.3.10–2, and 3.3.10–3.

8,600 m^3/ha (47,200 to 123,000 ft^3/acre), respectively. The annual and total quantities of the LEU "end product" (as LLW) for disposal and transportation of the LLW to a representative disposal site are discussed in Sections 4.4 and 4.5. The following discussion of ORR for this blending alternative present analyses for the wastes generated by the blending process and not the ultimate management of the LEU waste end-product.

Depending on the alternative, the total amount of HEU that potentially would be blended to LEU as waste could vary between 30 t (15 percent of surplus inventory) and 200 t (100 percent of surplus inventory) as stated in Chapter 2. Multiple sites would be used for all alternatives (except no action) necessary to blend the surplus inventory to LLW, as explained in Chapter 2.

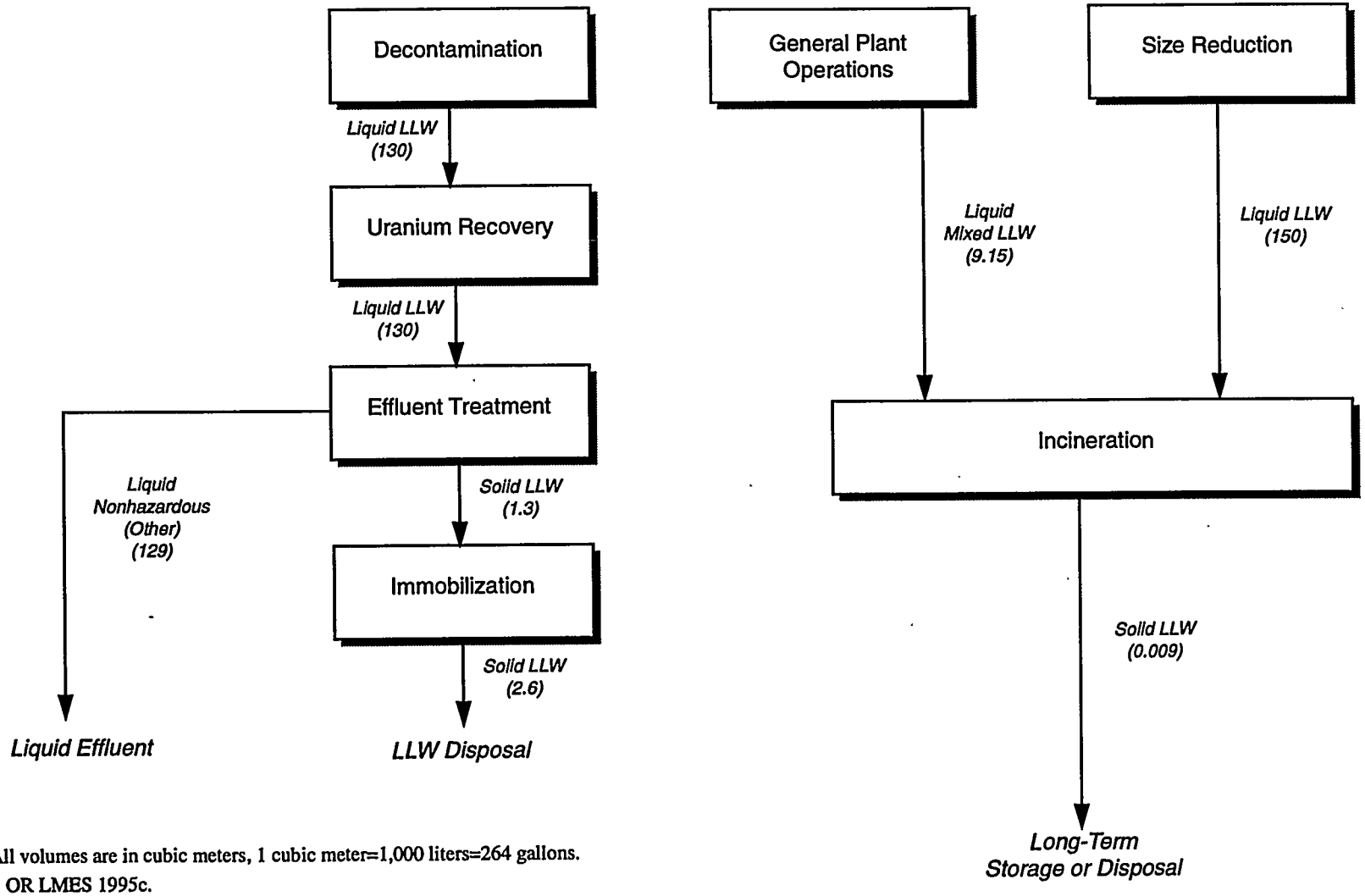
Oak Ridge Reservation. Current waste generation rates and treatment, storage, and disposal capacities are presented for ORR in Tables 3.3.10–1 through 3.3.10–3. Liquid and solid LLW treatment facilities at ORR would not be greatly impacted due to this action. The liquid LLW treatment facility at ORR has the capacity to treat the 11-percent increase in liquid LLW generated. Solid LLW generated at ORR would be compacted, smelted, and incinerated offsite and then stored onsite pending the completion of a proposed LLW Class II facility that is due to be operational in 2002. The amount of solid LLW generated by this action that will eventually be transferred to the LLW disposal facility would be 364 m^3/yr (12,850 ft^3/yr). Assuming a usage factor of 3,300 m^3/ha (47,200 ft^3/acre) (OR DOE 1995e:1), this waste will require 0.11 ha/yr (0.27 acre/yr) in the new LLW Class II facility. The small increase in liquid mixed LLW could be handled by the onsite mixed LLW treatment facility. This action would increase liquid sanitary waste generation to 1,755,000 m^3/yr (464 MGY). The onsite facility has a capacity of 4,930,000 m^3/yr (1,300 MGY) so the increase is within the facility capacity. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated in the site's current recycling practices.

[Text deleted.]

4.3.5 Conversion of the Blendstock From Uranium Hexafluoride to Uranium Oxide at General Electric Wilmington

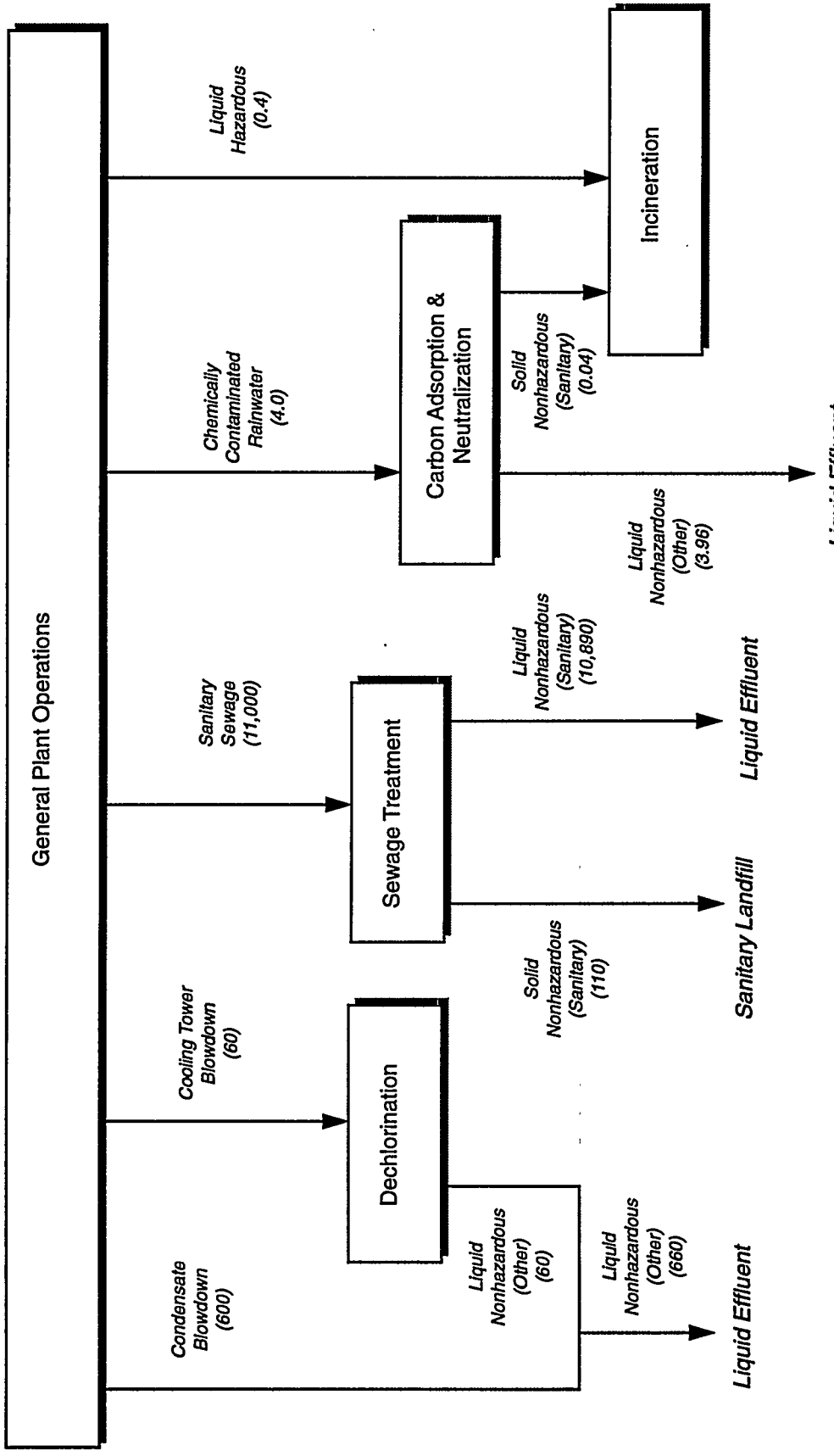
The General Electric (GE) Nuclear Fuel Plant at Wilmington, North Carolina operates under NRC License SNM-1097, Docket Number 70-1113. The most recent NEPA document addressing its operations is the *Environmental Impact Appraisal for Renewal of Special Nuclear Material License No. SNM-1097* (NUREG-1078, June 1984). This section discusses the potential impacts associated with the conversion of the UF_6 blendstock to uranium oxide blendstock at GE Wilmington. The conversion of UF_6 to uranium oxide is a process that GE Wilmington has performed for over 25 years and currently performs under its NRC license. This license permits GE Wilmington to process up to 50 t of U-235 contained in uranium to a maximum, nominal enrichment of 6-percent U-235 in the form of UF_6, UO_2, U_3O_8, and other intermediate forms characteristic of LEU fuel fabrication activities (GE 1995b:I-1.3). GE Wilmington is authorized in their most recent license application to convert UF_6 to uranium oxide by the ammonium diuranate process, the GE UF_6 to UO_2 conversion process, and a dry conversion process (GE 1995b:I-1.6).

Operation of the GE Wilmington plant has had no adverse effects on land use in the past, and there are no plans to expand the facility. Therefore, no additional impacts to land resources, pre-historic and historic sites, Native American resources, floodplains, or wetlands will result from this action. Any future construction at GE Wilmington would be a business decision, and is not proposed or necessitated by the proposed action or alternatives. For blending HEU to 4-percent LEU, up to 207 t of NU blendstock in a UF_6 form could be shipped to GE Wilmington representing approximately 17 percent of the average yearly quantity of UF_6 converted at GE Wilmington. For blending HEU to 0.9-percent LEU, up to 219 t of DU blendstock in a UF_6 form could be shipped to GE Wilmington, representing approximately 18 percent of the average yearly quantity of UF_6 converted at GE Wilmington. These values assume that all blendstock for the UNH blending process would be UF_6 and therefore represent maximum values. A more likely scenario is that only small portion of the blendstock would be UF_6 and therefore the amount of material



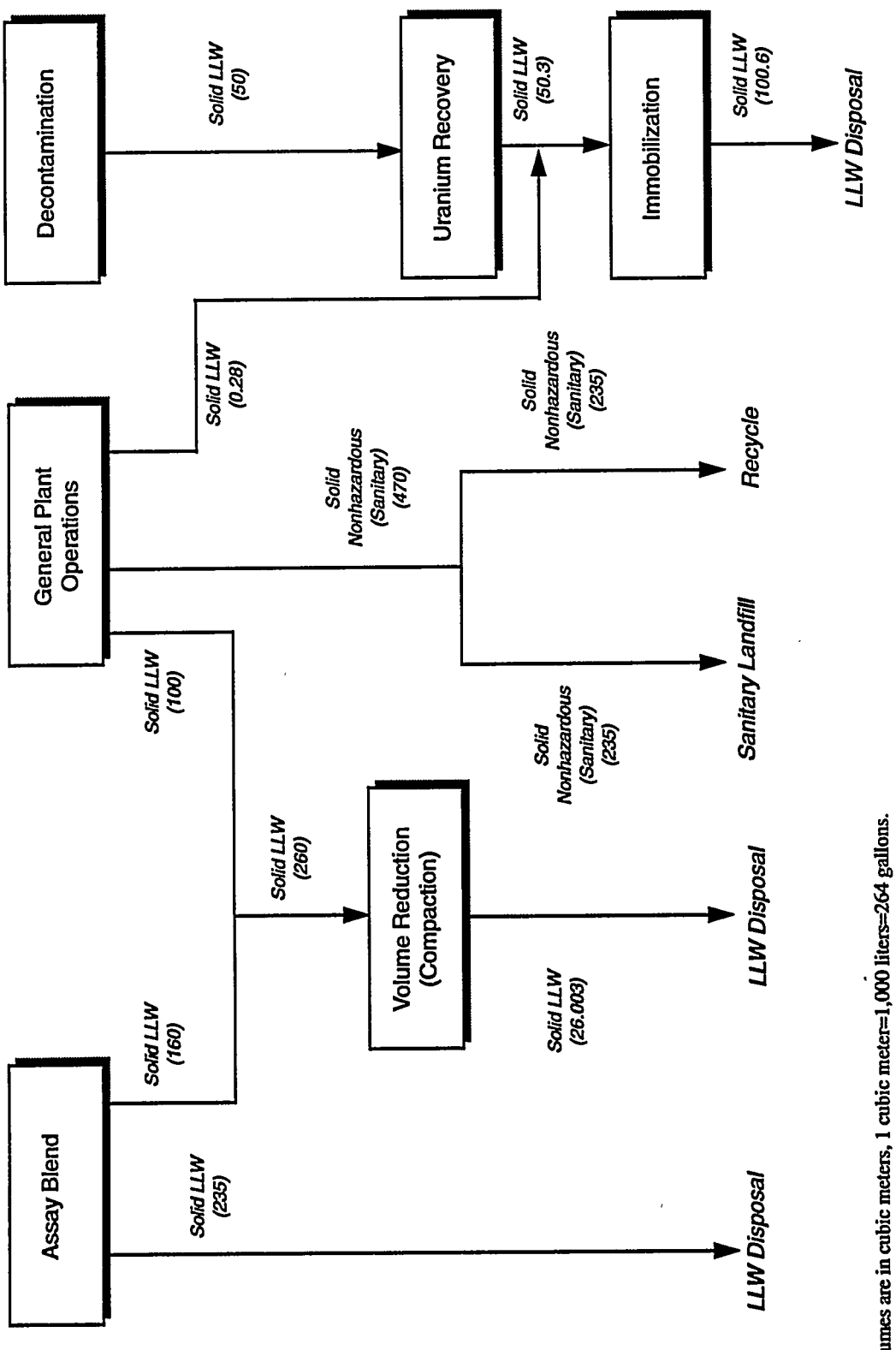
Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995c.

Figure 4.3.4.7–1. Radioactive Liquid Waste Management for Conversion and Blending 3.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995c.

Figure 4.3.4.7–2. Liquid Nonradioactive Waste Management for Conversion and Blending 3.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995c.

Figure 4.3.4.7-3. Solid Waste Management for Conversion and Blending 3.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal.

that GE Wilmington would process would be much less.

Operation of facilities to blend HEU to 4-percent or 0.9-percent LEU as UNH would potentially affect site infrastructure—mainly electric power, fuel, and water/steam supply. As a result of the site infrastructure already existing at GE Wilmington, minimal effects in terms of the percentage increase in site infrastructure resource usage would result from the operation of the UF_6 conversion facility. Normal operation of GE Wilmington's fuel fabrication facility is not expected to have a significant effect on nonradiological air quality parameters. The North Carolina Department of Natural Resources and Community Development has reviewed GE's process discharges and issued permits to operate air pollution control equipment for the different release points. Operation of the UF_6 conversion facility in an existing building would result in little or no change in the contribution to noise levels at offsite receptors (GE NRC 1984a:60). Direct effects on surface waters are controlled by requirements of the NPDES permit and NRC license. GE's liquid effluent during the 1978 to 1982 period met the applicable limits for radiological and nonradiological constituents at the point of release. Because these discharge limits are low, and because the waste stream is very small compared to the average flow of the Northeast Cape Fear River, significant impacts to the river are not expected (GE NRC 1984a:61-62). Continued operation of the GE plant would have no significant impacts on terrestrial vegetation or wildlife other than the continued use of potential habitat by industrial facilities. Because no new construction on underdeveloped areas is planned, there is no additional loss of habitat. No threatened or endangered species are known to frequent the area, and none should be affected by continued plant operation (GE NRC 1984a:62).

No upgrades or modifications of this facility would be required by the proposed action or alternatives. Any future consideration would be a business decision and is not necessitated by this proposed action or alternatives. In the event upgrades or modifications are undertaken, they would be performed by the existing site workforce, and no new jobs would be created. Because the operation is consistent with current operation, no additional employees are assumed to be needed to convert LEU from UF_6 to U_3O_8. During normal operations at GE Wilmington, the dose to the MEI is estimated to be 0.13 mrem/yr. This dose is about 14 percent of the EPA standard. Therefore, normal operation of the GE plant has resulted in maximum annual doses to the nearest resident that are well below the limits outlined in 40 CFR 190. The 1980 population within a 80-km (50-mi) radius of the plant is almost 370,000 people. During normal operations at GE Wilmington, the cumulative dose to the surrounding population within 80 km (50 mi) of the site is approximately 0.15 person-rem/yr. The natural background dose rate is 82 mrem/yr along the North Carolina coastal plain, which results in a population dose within 80 km (50 mi) around GE of 30,000 person-rem. The total body dose of 0.15 person-rem is negligible compared to the background dose (GE NRC 1984a:62-65). GE Wilmington would dispose of the solid low-level waste offsite. The State of North Carolina is a member of the Southeast Compact, which utilizes an NRC/State of South Carolina-licensed burial facility operated by Chem Nuclear Systems, Inc., in Barnwell, South Carolina. GE Wilmington would utilize this facility to dispose of this waste (GE 1995b:I-1.8–I-1.9).

4.4 INTERSITE TRANSPORTATION

For this EIS, intersite transportation is the transport of radioactive materials between sites in truckload shipments by DOE safe secure trailer (SST) or commercial conveyance. The SSTs are vehicles designed specifically for the safety and security of the cargo. These radioactive materials receive continual surveillance and accountability by DOE's Transportation Safeguards Division at Albuquerque, New Mexico. Shipments by SSTs are accompanied by armed guards and are monitored by a tracking system. Using a computer code, the health risks were calculated for transportation between sites of various forms of surplus HEU, NU or DU blendstock, LEU for commercial use, and LEU for waste disposal (as LLW) as defined for each alternative. Quantities of materials, distance between sites, material forms, handling procedures, transportation modes, types of packaging, and other shipment criteria are identified for each alternative and used for the transportation analyses. Results obtained (health risk impacts) are presented in terms of potential radiological and nonradiological impacts to transport crew members and the public under accident and accident-free scenarios.

4.4.1 METHODOLOGY

This section presents the methodology used in this EIS to determine the potential risks from intersite transportation. A comparison of potential transportation impacts for the alternatives considered and the cumulative annual impacts also are presented. Impacts are presented for the No Action Alternative and for all the blending alternatives.

Under the No Action Alternative, surplus HEU would remain in storage at the Y–12 Plant and would not be blended to LEU; thus, there would be no transportation risk.

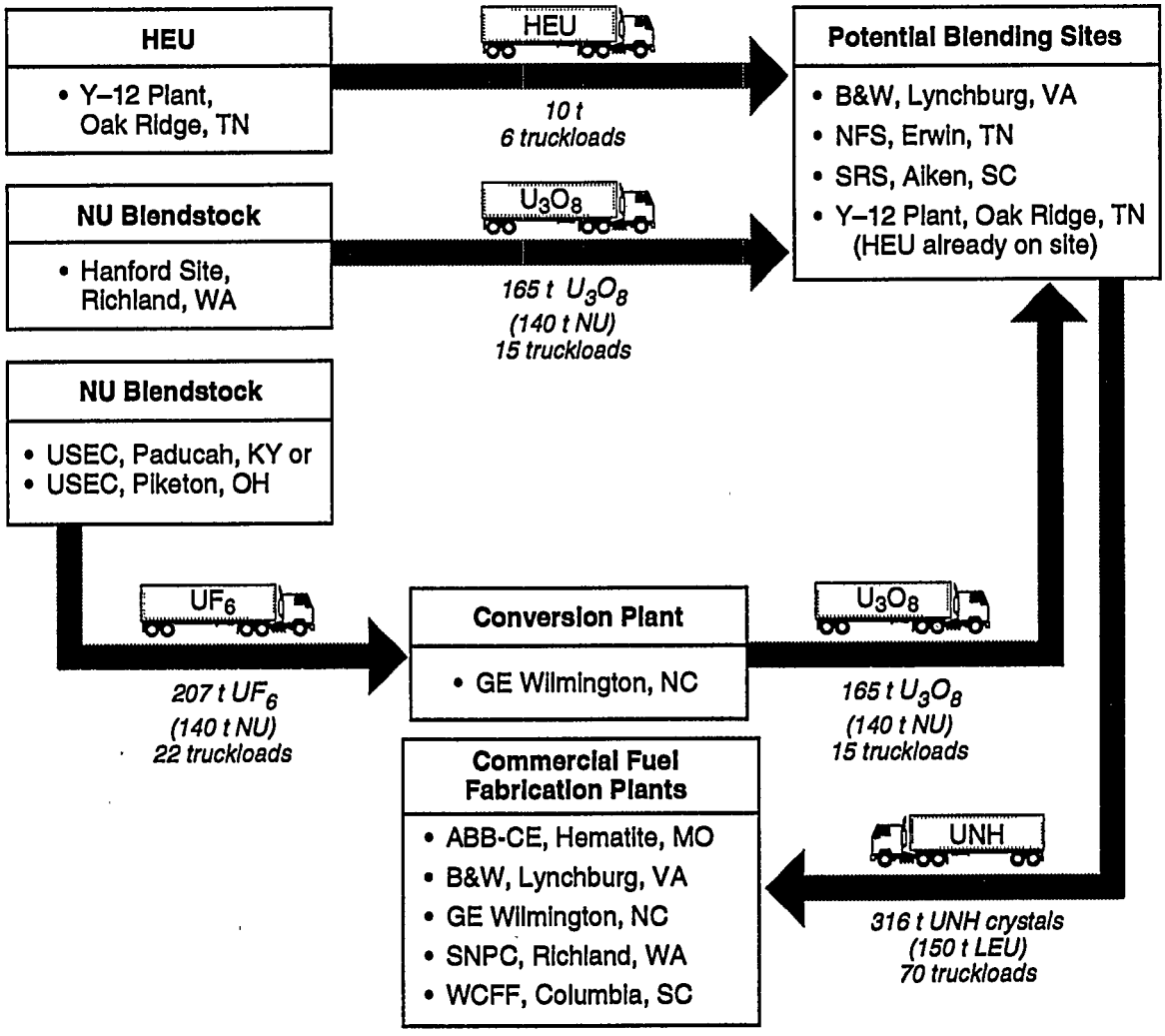
Under alternatives associated with blending HEU to LEU for commercial use, surplus HEU would be transported by DOE-owned SSTs from the Y–12 Plant to one or more of the three candidate blending sites: SRS, B&W, or NFS. There would be no SST transportation risk at ORR since both surplus HEU and the blending facilities are located at the Y–12 Plant.

For blending HEU to 4-percent LEU as UNH (crystals), HEU would be transported in SSTs from the Y–12 Plant to SRS, B&W, or NFS.[1] The NU blendstock material in either oxide or UF_6 form would be transported from its sources to these blending sites (or to a conversion plant first in the case of NU in UF_6 form). The blended LEU product then would be shipped to a fuel fabrication plant as UNH (crystals) for use in commercial reactor fuel. An overview of the transportation modes associated with blending HEU to LEU as UNH (crystals) is presented in Figure 4.4.1–1.

For blending HEU to 4-percent LEU as UF_6, HEU would be transported in SSTs from the Y–12 Plant to B&W or NFS. The NU blendstock material in UF_6 form could be transported from its sources to these blending sites (in this case NU in UF_6 form does not need conversion to oxide because blending would occur in UF_6 form). The blended LEU product then would be shipped to a fuel fabrication plant as UF_6 for use in commercial reactor fuel. An overview of the transportation modes associated with blending HEU to LEU as UF_6 is presented in Figure 4.4.1–2.

For the blending processes, NU or DU blendstock would be required. NU blendstock (in oxide or UF_6

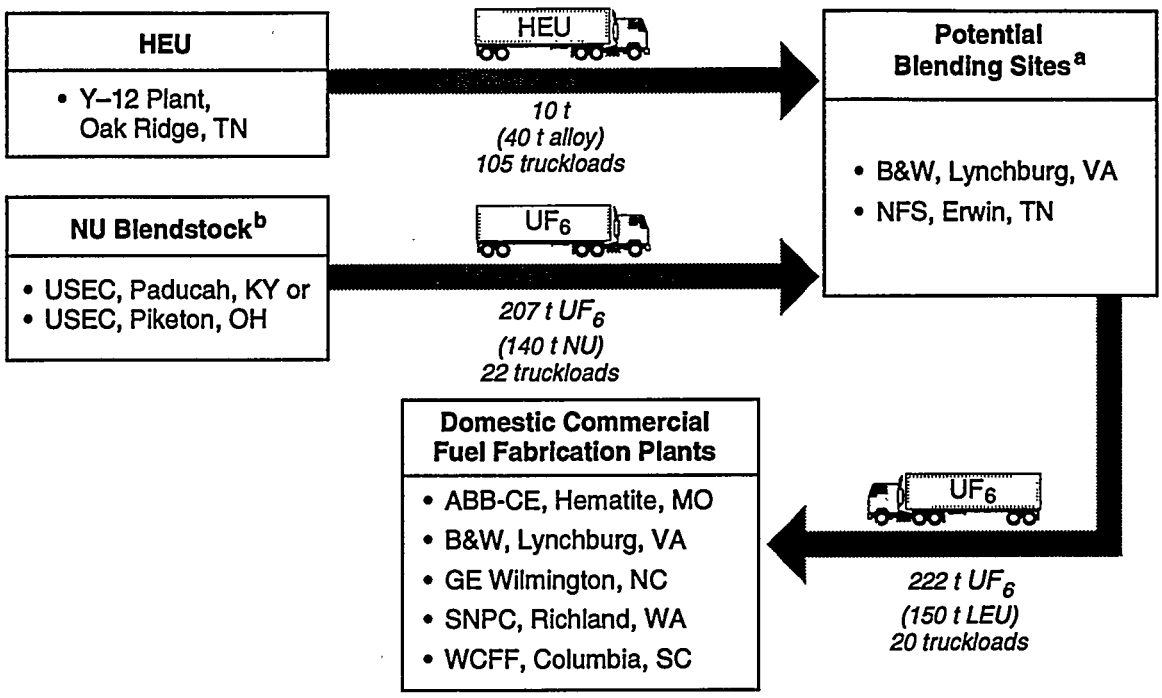
[1] The approximately 20 t of HEU solutions at SRS could be blended to approximately 617 t of 4-percent UNH solution. The UNH solution could be transported from SRS using NRC-certified liquid cargo tank trailers (for example, DOE-specification MC-312, NRC Certificate of Compliance Number 509) or other DOT-approved Type A fissile packaging to one of several offsite facilities that could perform the solidification of the material. SRS is close to existing commercial fuel fabrication facilities in both South Carolina and North Carolina that could perform the solidification. The South Carolina facility (97 km [61 mi] from SRS) is assumed as a representative solidification site for the purpose of analysis only (it is not proposed at this time). This project (transportation for solidification of 617 t of LEU solution) would require about 350 truckloads of 16,800 kg (37,040 lb) of UNH solution (includes 1.8 t uranium per truckload). The impact from nonradiological would be about 3.7×10^{-3} fatalities for the entire project. The risk from radiological accidents is estimated to be 3.9×10^{-5} fatalities for the entire project. The impacts from normal (accident-free) transportation, including handling and air pollution would be about 1.9×10^{-2} fatalities. The combined impact for the total campaign would be about 2.3×10^{-2} fatalities. The location of such offsite solidification and the extent of any transportation may depend in part on future proposals concerning the off-spec material as SRS and/or construction of a UNH solidification facility. Additional NEPA review would be conducted, as appropriate.



Note: ABB-CE=Asea Brown-Boveri Combustion Engineering; SNPC=Siemens Nuclear Power Corporation; WCFF=Westinghouse Columbia Fuel Facility.
Source: Derived from OR LMES 1995b.

2640/HEU

Figure 4.4.1–1. Annual Transportation for the Production of Uranyl Nitrate Hexahydrate Crystals From 10 t/yr Highly Enriched Uranium for Commercial Use.



[a] For this EIS, the new UF_6 site is assumed to be located at B&W or NFS.

[b] Transportation risk calculations are based on existing availability of blendstock. LEU (1.5-percent assay) could be used in lieu of NU; the cumulative risk would be similar.

Note: ABB-CE=Asea Brown-Boveri Combustion Engineering; B&W=Babcock & Wilcox; GE=General Electric; HEU=highly enriched uranium; LEU=low-enriched uranium; NFS=Nuclear Fuel Services; SNPC=Siemens Nuclear Power Corporation; UF_6=uranium hexafluoride; USEC=United States Enrichment Corporation; WCFF=Westinghouse Columbia Fuel Facility.

Source: Derived from OR LMES 1995a.

2548/HEU

Figure 4.4.1–2. Annual Transportation for the Production of Uranium Hexafluoride From 10 t/yr Highly Enriched Uranium for Commercial Use.

form) could be provided from several Government or commercial sources and transported directly to the blending site. For this EIS, DOE's Hanford Site in Washington is used as a representative source for NU (in oxide form) because its location is farthest from the potential blending sites. DU blendstock (in metal form) would be obtained from the Fernald Environmental Management Project in Fernald, Ohio (Fernald), the Y–12 Plant, or SRS. Fernald is used as a representative site for assessing the transportation of DU (metal) blendstock. NU blendstock (in UF_6 form) would be provided by representative sources from the USEC Paducah Gaseous Diffusion Plant at Paducah, Kentucky (USEC Paducah), or the USEC Portsmouth Gaseous Diffusion Plant at Piketon, Ohio (USEC Piketon). The NU blendstock (as UF_6) may need to be transported to a site where it would be converted to uranium oxide as U_3O_8. The GE Nuclear Fuel Plant at Wilmington, North Carolina, is used as a representative conversion site for this analysis. The U_3O_8 then would be shipped to the selected blending site (Y–12, SRS, B&W, or NFS) for the UNH blending process. For blending HEU to LEU as UF_6, the UF_6 blendstock would not need to be converted to U_3O_8 and would be transported directly from USEC Paducah or USEC Piketon to the UF_6 blending site, B&W or NFS.

When HEU is blended down to 4-percent LEU for commercial use, it would require transportation, either as UNH crystals or UF_6, to one of five potential domestic fuel fabrication plants: Asea Brown-Boveri Combustion Engineering at Hematite, Missouri (ABB-CE); B&W; GE Wilmington; Siemens Nuclear Power Corporation at Richland, Washington; and Westinghouse Columbia Fuel Facility at Columbia, South Carolina.

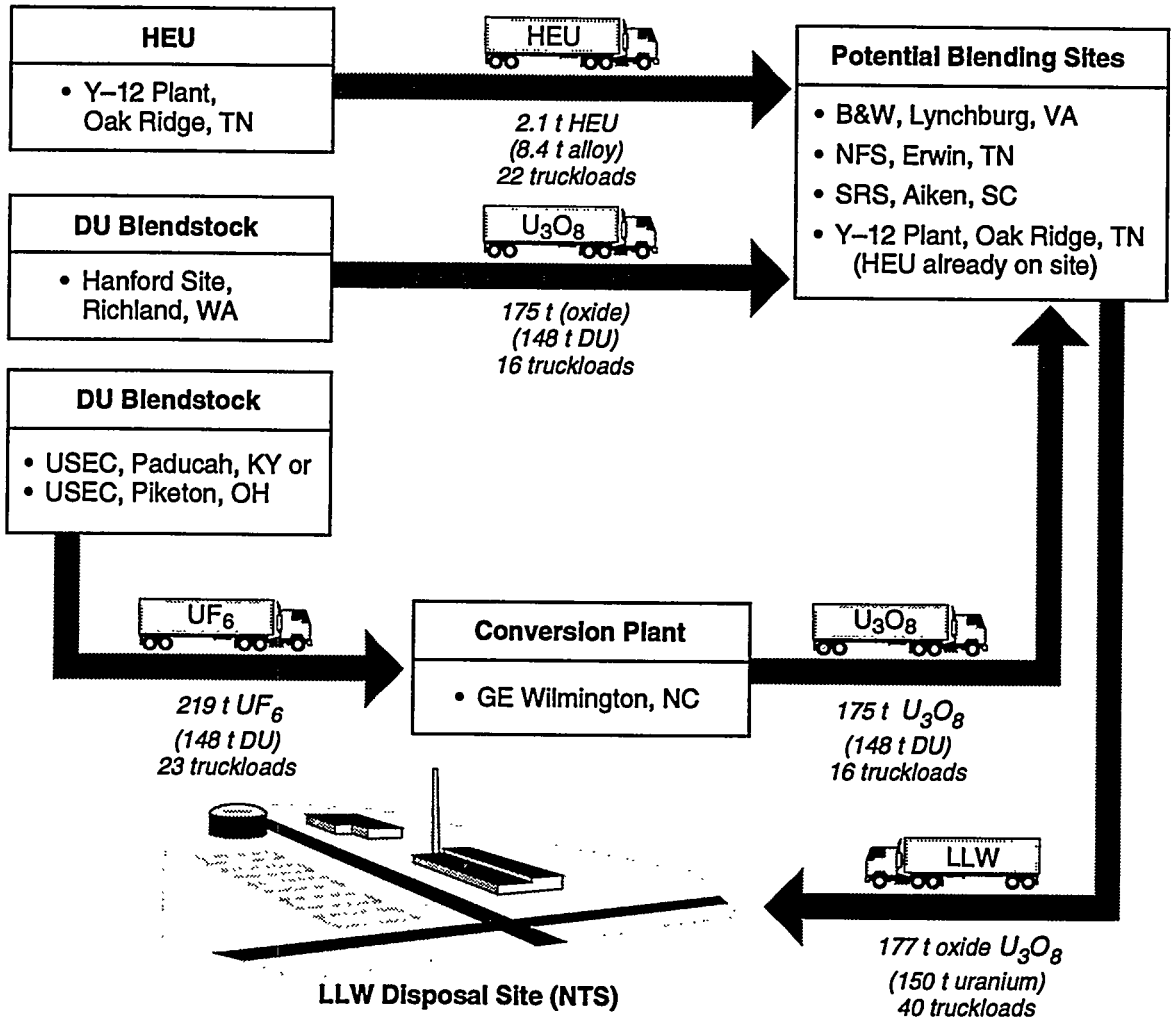
Under alternatives associated with blending HEU to LEU for disposal as waste, surplus HEU would be transported to SRS, B&W, and NFS. Blending at Y–12 would not require offsite transportation of surplus HEU.

For blending HEU to 0.9-percent LEU as UNH, the transportation modes would be similar to the UNH blending alternative explained above except for the destination of the LEU product. In this alternative, the blended LEU product would be converted to oxide form and shipped to an LLW disposal site. For the analyses in this EIS, the transportation route from blending sites to NTS was used as a representative route. NTS is one of only two DOE LLW sites accepting offsite DOE waste. NTS has accepted similar waste forms for disposal in the past. Non-DOE sites take only a limited amount of DOE waste. Use of NTS as a representative route for transportation risk analyses does not imply that this site necessarily would be the LLW disposal site; other DOE sites—and although less likely non-DOE sites—in lieu of or in combination with NTS could be the disposal site(s). An overview of the transportation modes associated with blending HEU to 0.9-percent LEU as UNH (converted to oxide form prior to transportation for disposal as waste) is presented in Figure 4.4.1–3.

Blending HEU to 0.9-percent LEU as metal would be performed at the Y–12 Plant. As in the UNH alternative, no off-site transportation would be required for metal blending at the Y–12 Plant. The DU blendstock (metal) would be shipped from Fernald, which is used as the representative route for the analyses in this EIS. The resulting LEU product would be converted to oxide form and transported to an LLW disposal site, which is NTS for the purposes of the analyses in this EIS. An overview of the transportation modes associated with blending HEU to 0.9-percent LEU as metal (converted to oxide form prior to transportation for disposal as waste) is presented in Figure 4.4.1–4.

Actual and projected inventories of HEU, NU, and DU materials were used for the transportation risk analysis. The additional annual projected quantities of LLW generated from the project are estimated. It is assumed that HEU would be stabilized and packaged for shipment at the originating site (Y–12 Plant) to meet DOT, NRC, and DOE requirements.

Unit risk factors were developed for each form of material to estimate the potential risk of transporting truckload shipments by SST or commercial conveyance over intersite routes. These factors were used, in conjunction with distance and the number of shipments, to estimate potential radiological and nonradiological impacts to transport crew members and the public. The unit risk factors were determined by using average rural, suburban, and urban populations along each route; an average container or truckload of material; and the risk per kilometer for each of the material forms.

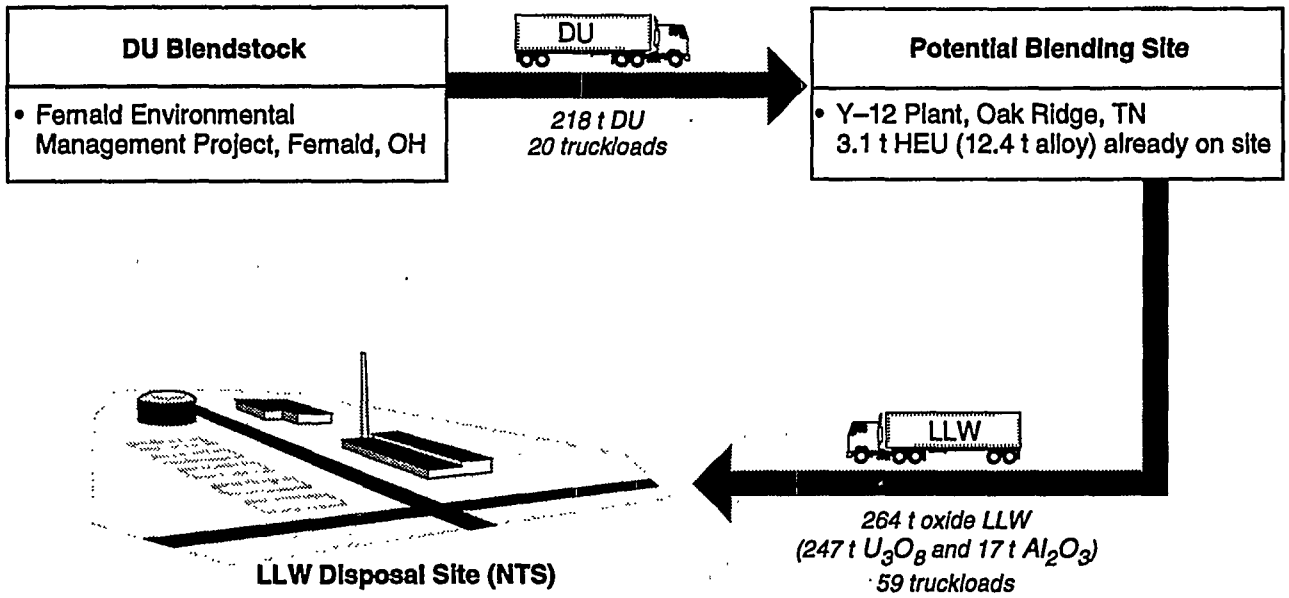


Note: NTS=Nevada Test Site

Source: Derived from OR LMES 1995d.

2547/HEU

Figure 4.4.1–3. Annual Transportation for the Production of Low-Enriched Uranium (Oxide) as Waste for Disposal From 2.1 t/yr Highly Enriched Uranium Under the Uranyl Nitrate Hexahydrate Alternative.



Note: NTS=Nevada Test Site; Al_2O_3= aluminum oxide.
Source: Derived from OR LMES 1995c.

2549/HEU

Figure 4.4.1–4. Annual Transportation for the Production of Low-Enriched Uranium (Oxide) as Waste for Disposal From 3.1 t/yr Highly Enriched Uranium Under the Metal Alternative.

The health risks were analyzed using the RADTRAN Version 4 computer code in conjunction with the projected inventories of material forms (nuclide composition) and the most direct routing between sites for each alternative. The potential annual health risk impacts were tabulated and presented for both accident and accident-free scenarios. Appendix G presents a summary of the RADTRAN transportation risk analysis methodology.

4.4.2 AFFECTED ENVIRONMENT

Included in the evaluation are the vehicle loading, transport, and unloading of 200 t of surplus HEU. The HEU would be placed in DOT-specification packaging and transported in a maximum of 105 truckloads per year. In addition, the risks of loading, transporting by commercial truck, and unloading the blendstock materials (oxide, metal, and UF_6), the UNH and UF_6 reactor fuel feed material, and the LEU LLW (oxide) are assessed. To produce reactor fuel feed material, the blendstock material would consist of a maximum of 165 t/yr of U_3O_8 (140 t NU) or a maximum of 207 t/yr of less than 3-percent NU blendstock in the UF_6 form (140 t NU) to be shipped from USEC Paducah or USEC Piketon to either the blending site or conversion plant, depending on the blending process. For the UNH reactor fuel feed material alternative, approximately 165 t/yr of U_3O_8 could be shipped from GE Wilmington to the blending plant. To produce LLW using UNH blending, approximately 175 t/yr of U_3O_8 (148 t DU) or approximately 219 t/yr of depleted UF_6 (148 t DU) converted to U_3O_8 would be required, depending on the blending process. To produce LLW using metal blending, approximately 218 t/yr of DU metal would be required. The blending process would produce approximately:

- 316 t/yr of UNH (crystals) reactor fuel feed material, including 150 t (90 kg per container, 3,511 containers, 70 shipments)
- 222 t/yr of UF_6 reactor fuel feed material, including 150 t LEU (2,275 kg per container, 20 shipments)
- 177 t/yr of U_3O_8 (oxide) LLW from UNH blending, including 150 t of uranium (90 kg per container, 40 shipments)
- 264 t/yr of LLW (oxide) from metal blending, including 247 t U_3O_8 and 17 t aluminum oxide (Al_2O_3) (90 kg per container, 59 shipments)

All of the health risks from transporting these materials are calculated on an annual basis.

Although DOE has experienced traffic accidents related to the intersite transport of radioactive materials, there has never been a traffic accident involving a release of radioactive material causing injury or death during transportation.[2] Risk impacts were determined using standard analysis criteria and accepted computer models.

The Department of Energy's unclassified radioactive and other hazardous materials are transported by commercial carrier (truck, rail, or air). Special nuclear materials, such as HEU, are transported by DOE-owned and -operated SSTs.

4.4.2.1 Site Transportation Interfaces for Hazardous Materials

The existing transportation modes that serve each of the four candidate blending sites and the links to those modes for the intersite transport of hazardous materials are summarized in Table 4.4.2.1–1. Although hazardous materials could be transported by rail, truck, air, and barge modes, the materials in this EIS would be transported only by truck. HEU would be transported exclusively by SST. Radioactive blendstock, LEU fuel feed material, and LLW would be transported by certified commercial truck carriers. There would be no rail, barge, or air

[2] DOE's hazardous material (radioactive and nonradioactive) shipments are small compared to the large shipment volume from non-DOE hazardous material transport activities. DOT estimates that approximately 3.6 billion t/yr of regulated hazardous materials are transported and that approximately 500,000 movements of hazardous materials occur each day (Public Law 101-615, Section 2[1]). There are approximately 2 million annual shipments of radioactive materials involving about 2.8 million packages, which represents about 2 percent of the annual hazardous materials shipments. Most radioactive shipments involve small or moderate quantities of material in relatively small packages. In comparison, the DOE Nuclear Weapons Complex ships about 6,200 radioactive packages (commercial and classified) annually among its sites. DOE's annual shipments of radioactive packages represent less than 0.3 percent of all radioactive shipments in the United States.

Table 4.4.2.1–1. Transportation Modes and Comparison Ratings for the Candidate Sites

Site	Onsite Railroad Service	Nearest Interstate Highway (km)	Distance to Airport for Cargo Shipments (km)	Barge Service	Possible Weather Delays[a]	Overall Level of Transport Service
ORR	Yes	6	61	Yes	Minimal	Good
SRS	Yes	48	32	Yes	Minimal	Good
B&W	Yes	108	18	No	Minimal	Good
NFS	No	2	66	No	Minimal	Good

[a] DOE Transportation Safeguards System shipments.

Source: BW 1995b:1;DOE 1991j; NFS 1995b:2.

shipments; thus, there would be zero impacts from transportation by these modes.

In the *Nuclear Weapons Complex Reconfiguration Site Evaluation Panel Report* (October 1991), two sites (ORR and SRS) were given a comparative rating based on the strengths and weaknesses of their transportation services (DOE 1991j:7). For consistency, the rating methodology and evaluation procedures established by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel also were applied to the B&W and NFS sites.

4.4.2.2 Packaging

Approved packaging refers to a container and all accompanying components or materials necessary to perform its containment function. Packages used by DOE for hazardous materials shipments are either certified to meet specific performance requirements or built to specifications described in the DOT hazardous materials regulations. For relatively low-level radioactive materials, DOT-specification, Type A packagings are used. These packagings are designed to retain their contents under normal transportation conditions. More sensitive radioactive materials shipments, including HEU and UF_6, require the use of highly sophisticated Type B packaging, which is designed to prevent the release of contents under all credible transportation accident conditions.

For this assessment, a stainless steel model 6M, Type B packaging, which resembles a 55-gal drum, would be used for HEU shipments in SSTs from the Y–12 Plant to the blending site. A more detailed description of the 6M packaging is given in Appendix G. DOT-specification, Type B packaging would also be used for transporting NU (as UF_6) blendstock and UF_6 fuel feed material by commercial conveyance. Historically, the use of Type B packaging has demonstrated that an accidental release of radioactive material is unlikely. Type A packaging would be used for transporting NU (as U_3O_8), DU (as U_3O_8 and metal), U_3O_8 blendstock, UNH (crystals) fuel feed material, and LLW (oxide).

4.4.2.3 Safe Secure Transport

Nuclear materials, which include HEU, require special measures to ensure physical security and protection from radiation during transportation. DOE's Transportation Safeguards Division, located at Albuquerque, New Mexico, has the responsibility to provide for the transport of these materials. The Transportation Safeguards Division was established in 1975 and has accumulated over 112 million km (70 million mi) of over-the-road experience with no accidents causing a fatality or release of radioactive material. DOE's transportation vehicle, the SST is a specially designed part of an 18-wheel tractor-trailer truck that incorporates various deterrents to prevent unauthorized removal of the cargo. The SST is designed to protect the cargo, in the event of an accident, through superior structural characteristics and a highly reliable cargo tie down system similar to that used in aircraft. The thermal characteristics of the SST allow the trailer to be totally engulfed in a fire without incurring damage to the cargo. The tractor-trailers and their escort vehicles are equipped with communications, electronic, radiological monitoring, and other equipment, which further enhance en route safety and security.

Armed nuclear materials couriers, who are Federal officers, accompany each shipment containing special nuclear material. These couriers are trained in tractor-trailer driving, electronic and communication systems operation, and are authorized by the *Atomic Energy Act* to carry firearms and make arrests in the performance of their duties. They drive the tractor-trailers, escort vehicles, and operate the communications and other convoy equipment. The couriers must meet periodic qualification requirements for firearms, physical fitness, and driving proficiency. They also must pass an annual medical examination and are subject to random drug and alcohol testing.

The Department of Energy makes every effort to ensure that its convoys travel at safe speeds and do not travel during inclement weather. Should the convoys encounter adverse weather, provisions exist for them to seek secure shelter at previously identified facilities. A liaison program provides State and local law enforcement officers information on what actions to take to assist one of these vehicles should it be involved in an accident. A DOE control center maintains an emergency contact directory of Federal, State, and local response organizations located throughout the contiguous United States.

4.4.3 Environmental Consequences

4.4.3.1 No Action

Under no action, surplus HEU would remain in storage at the Y–12 Plant; therefore, there would be no transportation or transportation risk.

4.4.3.2 Surplus Highly Enriched Uranium Disposition Alternatives

This section describes the health effects from the intersite transportation of surplus HEU, LEU, and LLW based on the results of RADTRAN analyses. Impacts are presented for each disposition alternative: blend to 4-percent LEU as UNH (crystals) or as UF_6 reactor fuel feed material or blend to 0.9-percent (oxide) LLW.

Transport of Highly Enriched Uranium from the Y–12 Plant to Babcock & Wilcox, Nuclear Fuel Services, and Savannah River Site

The shipments of HEU would consist of an average of approximately 10 t/yr of HEU as metal and metal alloys, oxides, compounds, and nitrates. The maximum amount of HEU to be shipped would not exceed 10 t/yr to any one site; therefore, this rate was used for transportation risk calculations. HEU would be shipped in cans (similar in size and shape to a coffee can); the cans would be placed in a Type 2R inner container (a containment barrier); and the Type 2R inner container then would be placed in a 6M, Type B (DOT specification), stainless steel packaging, which resembles a 55-gal drum. Up to three cans could be placed in a 6M packaging. A maximum of 20 t/yr could be shipped to multiple sites; however, no more than 5,000 packages would be shipped per year to any one blending site. Figure 4.4.3.2–1 shows a representative 6M packaging array for HEU considered in this assessment.

Eight 6M packages could be placed in a cargo restraint transporter (CRT), which is a method of palletizing the cargo and constraining it during transport. A diagram of a typical CRT, loaded with 6M packages, is shown in Figure 4.4.3.2–2. Each SST carries up to six CRTs. The 6M package testing is described in Appendix G.

Onsite Transportation Impacts at the Y–12 Plant. Highly enriched uranium that would be blended at the Y–12 Plant would be transported between facilities by means of Blue Goose vehicles (trucks for onsite transport of HEU). There has never been a Blue Goose accident that resulted in the release of radioactive material. The Y–12 EA includes information on a postulated bounding criticality accident. This criticality could result in yields of 1.0×10^{19} fissions (spike and total). Radiation exposure would vary from greater than 600 rem at the site of the accident to 50 rem at 36.6 m (120 ft). This would produce acute radiation sickness within a radius of up to 36.6 m (120 ft) with a probable fatality rate of less than 5 percent. At distances less than 15.2 m (50 ft), the fatality rate would be 100 percent (OR DOE 1994d:6-55).

For HEU that would be blended at sites other than the Y–12 Plant, HEU would be removed from storage,

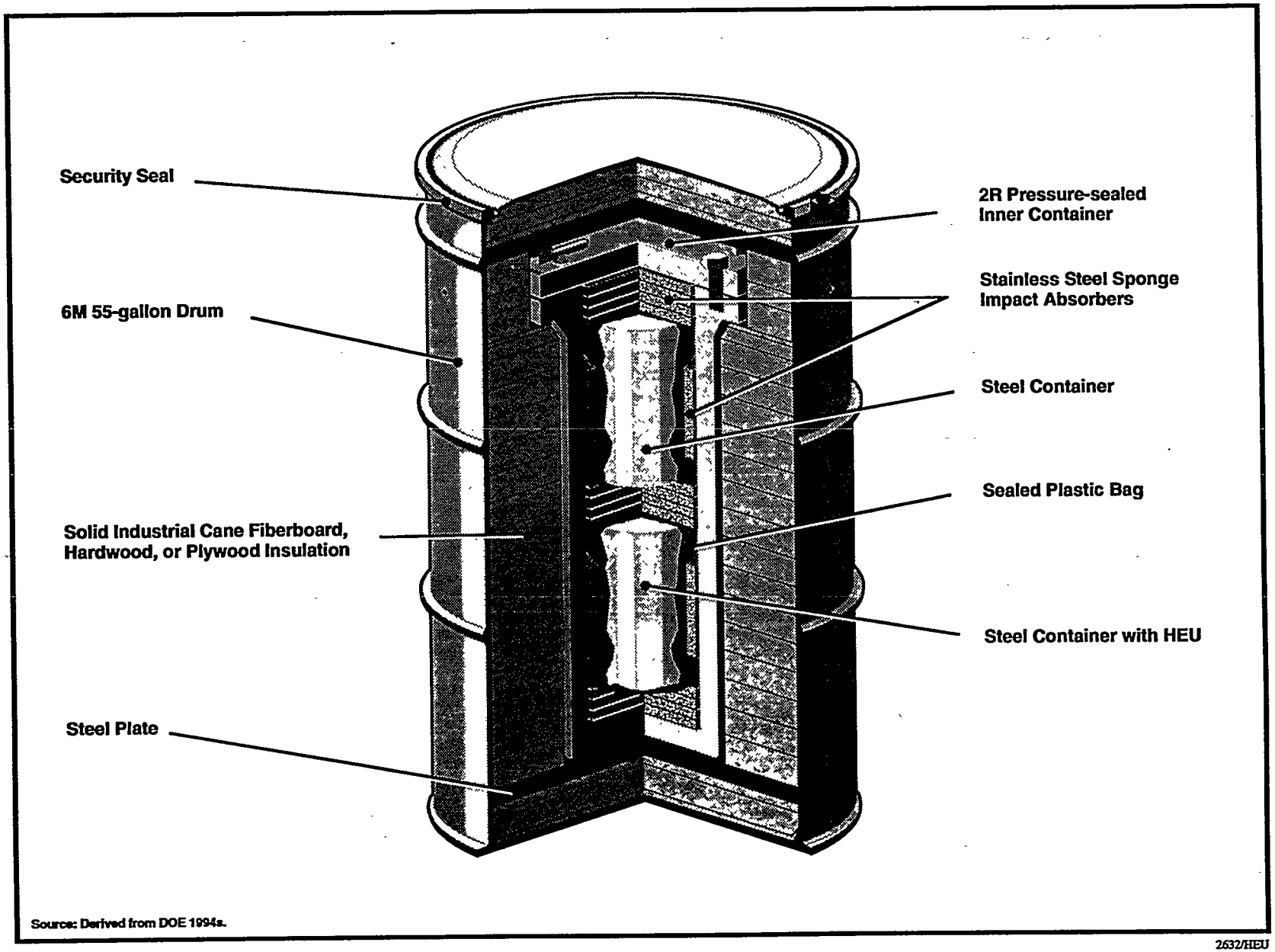


Figure 4.4.3.2–1. A Representative 6M Packaging Array.

loaded onto SSTs at the storage facility, and transported away from the Y–12 Plant. There would be no other onsite transportation. Onsite risks would be limited to loading operations. Onsite over-the-road risks are included in the analysis of the SST transportation to the blending plant.

The potential health risks associated with the loading of SSTs at the Y–12 Plant are based on the following criteria:

- There would be an average of 10 t/yr of HEU material to be transported to blending facilities for 5 years, or 50 t of HEU total, in the initial campaign. Following this initial campaign, the remaining 150 t of surplus HEU inventory would continue to be transported at the same postulated rate of 10 t/yr (for a total of 200 t over a 40-year period, depending on the alternative). All subsequent shipments of additional surplus HEU that may be generated by the Nuclear Weapons Complex are calculated against this same criterion of 10 t/yr.

- Up to six CRTs would be loaded into each SST.

- HEU would be transferred directly from storage into the SSTs within the Y–12 Plant's protected area.

- It would take about 8 hours to prepare and stage HEU for each SST load. This includes preparation of documentation, radiation surveys, and actual loading. Most of the transportation-related radiation exposure would occur during the 15 minutes it would take for two cargo handlers to load each CRT into an SST. The complete transfer of all CRTs into 105 SSTs would take about 840 hrs/yr, collectively.

- The SSTs would mount flush with the storage facility shipping dock for ease of loading.

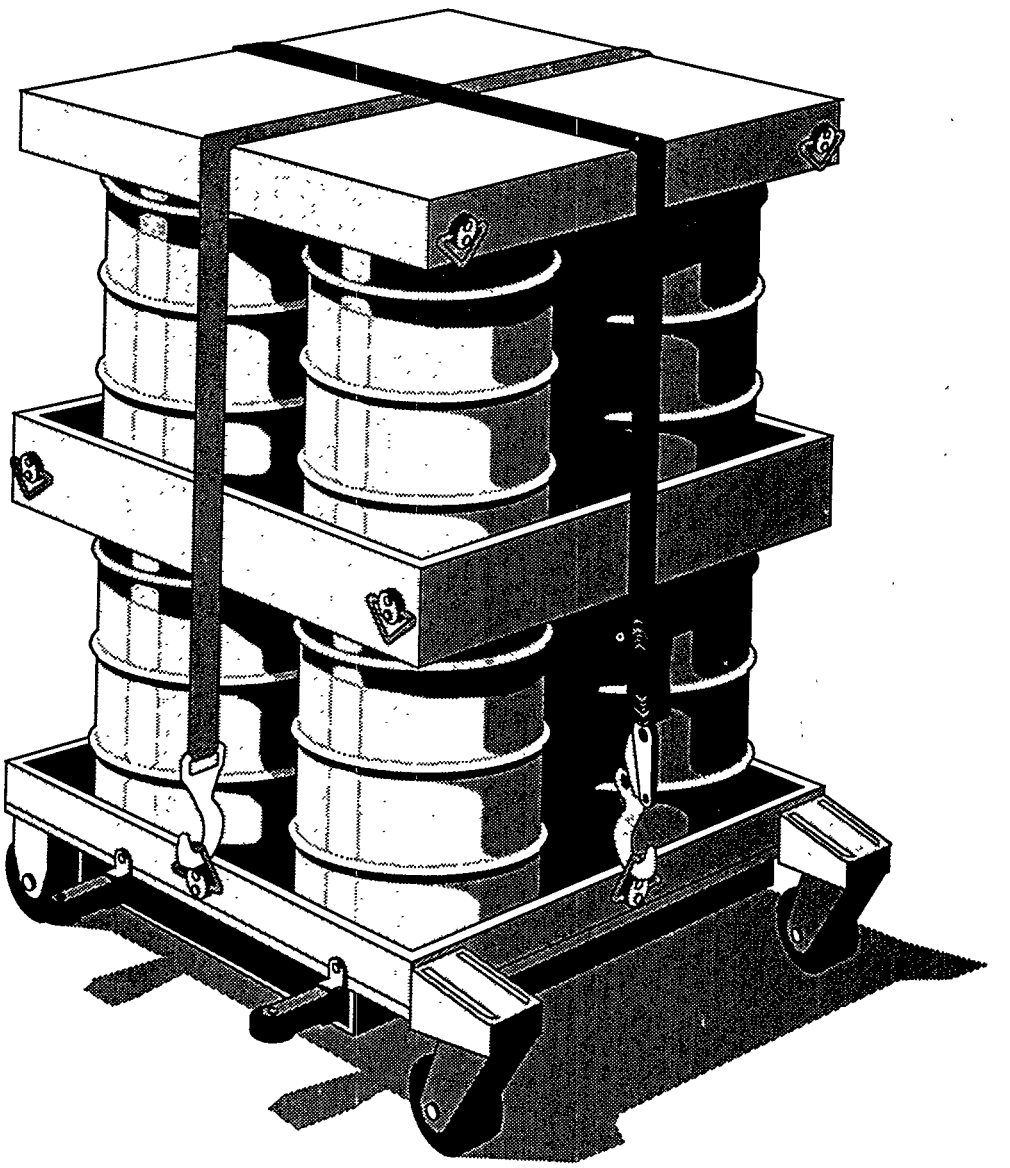
- Only fork lifts would be utilized to move the material from storage, place it in the CRTs, and load the SSTs for shipment.

- There would be only two cargo handlers. Thirty-five other workers would be within 50 m (164 ft) of the loading site. This includes 10 people involved in the loading of the SSTs (warehouse, health physics, and nuclear material control and accountability personnel). The other workers are not subdivided into Government or civilian personnel.

The Y–12 Plant has no record of a transportation-related accident or incident involving special nuclear materials (ORR 1995a:10). Because of the low speeds involved in transferring HEU from the storage facility to the SSTs and the rigid design standards for Type B packagings to withstand an accident (for example, a fork lift puncture), it is extremely unlikely that a Type B package would be breached. It is extremely unlikely that a package could be damaged so severely that both the inner and outer containers would fail, that some fraction of the contents would be dispersed, and that a worker or citizen fatality would occur as a result of an accident during the transfer of HEU.

Accident-free radiological exposures to cargo handlers, other workers, and the public while transferring HEU from the storage facility to an SST are summarized in Table 4.4.3.2–1. The exposed groups of workers are the two cargo handlers and 35 other workers within a 50-m (164-ft) radius. Because the loading would occur onsite in a secured area away from the general public, there would be no exposure to the public under accident-free conditions.

The highest dose to an average individual would be received by a cargo handler and is estimated to be a total of 0.03 rem over the duration of the loading activity. The collective dose to the two cargo handlers is estimated to be 0.06 person-rem. Using the worker dose-to-risk conversion factor of 4×10^{-4} cancer fatalities per person-rem multiplied by the collective dose, 2.4×10^{-5} latent cancer fatalities are estimated. This means there is a probability of 2.4×10^{-5} or about 1 chance in 42,000 that any excess cancer fatalities would occur among the workers as a result of accident-free exposure during HEU transfer activities.



Source: Derived from SNL 1988b.

2631/HBU

Figure 4.4.3.2–2. A Typical Cargo Restraint Transporter Configured with 6M Containers.

The risk of fatalities resulting from additional air pollution caused by the operation of equipment is too small to measure.

Impacts From Transportation of Surplus Highly Enriched Uranium From the Y–12 Plant to Savannah River Site, Babcock & Wilcox, and Nuclear Fuel Services. HEU material would be transported to the blending sites by DOE-owned and -operated SSTs. Typical SST transport routes were selected for the analysis. The exact routes, when determined, would be classified for security and theft/diversion purposes. The routes selected for analyses maximize the use of interstate highways, as established by INTERSTAT (a computer routing code). Rural, suburban, and urban population data were used to define the properties and characteristics along the routes. Credit was not given for the special shielding provided by the SST walls, which provide additional protection and decrease radiation exposure.

The RADTRAN computer code, developed by SNL, was used to determine radiological risks. Release fractions are characterized in RADTRAN in terms of eight accident severity categories, which are determined by a combination of crush force and 982 °C (1,800 °F) or hotter fire durations. For this analysis, the release fraction was assumed to be zero for accident Categories I through VII. The release fractions for Category VIII accidents were conservatively estimated to be 0.1 for the strictly controlled SST shipments of HEU and 1.0 for the transport of other radioactive materials. The Category VIII accident is one with crush forces of $2.2x10^6$ newtons ($2.2x10^{11}$ dynes) or greater, a 982 °C (1,800 °F) fire duration of 1.5 hrs or more, or a combination of force and fire of similar destructive capability. The physical states (characteristics that would affect the fractions that are airborne, inhaled, and deposited in the lungs) and the chemical forms were estimated. The methodology for conducting the transportation risk analysis is described in greater detail in Appendix G.

Annual radiological risks from the transportation of surplus HEU from the Y–12 Plant to the blending sites are shown in Appendix G, Table G.1–5. The maximum impact would be to the public, and the highest collective dose to the public is estimated to be 3.7 person-rem, resulting in $1.9x10^{-3}$ fatal cancers from transportation to B&W for the UF_6 blending alternative.

Nonradiological risks of highway transportation (those risks that are caused by added air pollution or by highway accidents not involving a radiological release) are summarized in Appendix G, Table G.1-5. The risk of fatalities resulting from additional air pollution caused by the operation of trucks was estimated on the basis of $1.0x10^{-7}$ fatalities per km of travel in urban zones (SNL 1982a:11). Accident fatalities incurred by the crew and public were estimated on the basis of fatality rates per kilometer of travel in rural, suburban, and urban zones. These rates are as follows: 1) for occupational risks per km, $1.5x10^{-8}$ rural, $3.7x10^{-9}$ suburban, and $2.1x10^{-9}$ urban; and 2) for public risks per km, $5.3x10^{-8}$ rural, $1.3x10^{-8}$ suburban, and $7.5x10^{-9}$ urban (SNL 1986a:167). The nonradiological risks are greater than those from radiological effects; however, they are no greater than similar nonradiological risks experienced by the vehicle population as a whole.

A summary of potential radiological and nonradiological annual health impacts from the

Table 4.4.3.2–1. Accident-Free Radiological Exposure From Transferring Materials per Shipment Between the Storage Site and a Truck

Types of Population[a]	Population Size	Dose	Latent Cancer Fatality
Cargo Handlers			
Collective population	2	$6.0x10^{-2}$ person-rem	$2.4x10^{-5}$
Average individual dose	1	$3.0x10^{-2}$ rem	$1.2x10^{-5}$
Other Workers			
Collective population	35	$4.0x10^{-3}$ person-rem	$1.6x10^{-6}$
Average individual dose	1	$1.2x10^{-4}$ rem	$4.6x10^{-8}$

[a] Under normal (accident-free) conditions, the public does not receive a measurable dose.

Source: RADTRAN model results.

transportation of HEU from the Y–12 Plant to the blending sites is shown in Table 4.4.3.2–2. The risk due to handling (loading and unloading) is higher than the relative contribution from transportation risk, which is comparable at each site. This handling risk is added to the transportation risk in the analysis of determining health impacts. The highest impact is estimated to be 1.3×10^{-2} potential fatalities from transporting HEU to B&W under the UF_6 blending alternative for commercial reactor fuel feed material. Additional information is included in Appendix G.

Table 4.4.3.2–2. Annual Health Impacts From Transportation of Highly Enriched Uranium (93-Percent U-235[a]) From Y–12 to Blending Sites

Blending Site	Total Health Effect[b]
UNH Blending for Commercial Reactor Fuel (10 t/yr HEU)	
B&W	7.4×10^{-4}
NFS	5.1×10^{-4}
SRS	7.2×10^{-4}
Y–12[c]	3.1×10^{-4}
UNH Blending for LLW Disposal (2.1 t/yr HEU)	
B&W	2.7×10^{-3}
NFS	1.9×10^{-3}
SRS	2.6×10^{-3}
Y–12[c]	1.1×10^{-3}
UF_6 Blending for Commercial Reactor Fuel (10 t/yr HEU)	
B&W	1.3×10^{-2}
NFS	8.9×10^{-3}
Metal Blending for LLW Disposal (3.1 t/yr HEU)	
[Text deleted.]	
Y–12[c]	1.7×10^{-3}

[a] A bounding value per Appendix G.

[b] Fatalities.

[c] Only handling risk.

Source: RADTRAN model results.

Impacts From Transportation of Surplus Highly Enriched Uranium From United States Enrichment Corporation Piketon (Portsmouth Gaseous Diffusion Plant) to Blending Sites. Approximately 10 t of HEU at USEC Piketon could be transported directly to the blending sites rather than being placed in interim storage first at the Y–12 Plant. Table 4.4.3.2–3 summarizes the potential radiological and nonradiological annual health impacts from the transport of HEU from USEC Piketon for each alternative. The annual amount of HEU to be transported would remain unchanged; 10 t for blending to 4-percent LEU as commercial reactor fuel, 2.1 t for blending to 0.9-percent LEU as UNH for disposal as LLW, and 3.1 t for blending to 0.9-percent LEU as metal for disposal as waste. Handling risk is also included in annual health impacts presented in Table 4.4.3.2–3. The incremental change as compared to the transport of an equivalent amount of HEU from the Y–12 Plant to the same sites (that is, the difference in risk from that shown in Table 4.4.3.2–2) becomes insignificant when included in the cumulative total health impact from transporting all materials under each blending alternative for the campaign of the proposed action. The basic impact assessment for intersite transportation uses the Y–12 Plant as the representative source of surplus HEU in the analysis since most of DOE's surplus HEU would be located at Y–12. If surplus HEU located at USEC Piketon is shipped from any of these sites, the impacts can be calculated from Table 4.4.3.2–3. The inventory in this scenario would only last 1 to 7 years.

Onsite Transportation Impacts at Blending Sites. The B&W site, NFS, and the Y–12 Plant have never experienced a transportation-related accident involving special nuclear materials. SRS has experienced two leaks resulting in some contamination (BW 1995b:1; NFS 1995b:2; ORR 1995a:10; SRS 1995a:5). The health effects of unloading the trucks and placing the HEU into interim storage at the blending site are presented in Table 4.4.3.2–1.

Upon arrival at the blending site, HEU would be immediately unloaded from the SSTs and placed in the interim storage facility. Onsite road risks from the site gate to the unloading dock are included in the line haul transport assessment from the Y–12 Plant to the blending site. There would be no other onsite transportation at any blending facility. A radiological accident is unlikely to occur during the unloading of SSTs and the transfer of materials to an interim storage facility for the same reasons presented for transferring the materials at the Y–12 Plant. It is extremely unlikely that a Type B container would be accidentally breached and the contents dispersed;

Table 4.4.3.2–3. Annual Health Impacts from Transportation of Highly Enriched Uranium (93-Percent U-235[a]) From United States Enrichment Corporation Piketon to Blending Sites

Blending Site	Total Health Effect[b]
UNH Blending for Commercial Reactor Fuel (10 t/yr HEU)	
B&W	1.04×10^{-3}
NFS	1.09×10^{-3}
SRS	1.30×10^{-3}
Y–12	9.42×10^{-4}
UNH Blending for LLW Disposal (2.1 t/yr HEU)	
B&W	3.81×10^{-3}
NFS	3.99×10^{-3}
SRS	4.75×10^{-3}
Y–12	3.45×10^{-3}
UF_6 Blending for Commercial Reactor Fuel (10 t/yr HEU)	
B&W	1.82×10^{-2}
NFS	1.90×10^{-2}
Metal Blending for LLW Disposal (3.1 t/yr HEU)	
Y–12	5.17×10^{-3}

[a] A bounding value per Appendix G.
[b] Fatalities.
Source: RADTRAN model results.

therefore, the probability of an accident-induced radiological exposure or fatality during the transfer of the HEU from SSTs to storage at the blending site is negligible.

Accident-free radiological exposures to cargo handlers, other workers, and the public while transferring HEU from the SSTs to the blending site interim storage facility are summarized in Table 4.4.3.2–1. The exposed workers would be the two cargo handlers and 35 other workers (for example, guards) within a 50-m (164-ft) radius. Because the unloading would occur onsite in a secured area away from the general public, there would be no exposure to the public under accident-free conditions.

The highest dose to an average individual would be received by a cargo handler and is estimated to be 0.03 rem. The collective dose to two cargo handlers is estimated to be 0.06 person-rem; 2.4×10^{-5} latent cancer fatalities are estimated.

Transport of Blendstock Materials

The blending of uranium by the UNH process for commercial use (4-percent U-235 enrichment) could require the transport of 165 t/yr of NU blendstock (as U_3O_8) from Hanford (a representative site) to the blending sites, or 207 t of UF_6 from either USEC Paducah or USEC Piketon to GE Wilmington for conversion to U_3O_8. UNH blending for waste disposal (0.9-percent U-235 enrichment) would require 175 t/yr of DU as oxide, which is also assumed to be shipped from the representative site at Hanford, or 219 t/yr of depleted UF_6 from USEC Paducah or USEC Piketon to GE Wilmington for conversion to U_3O_8 and then shipment of 175 t/yr of U_3O_8 to the blending sites. For blending HEU to LLW under the metal alternative, 218 t/yr of DU as metal would be required from Fernald and shipped to the blending site. The estimated impacts from accident-free radiological exposure from transferring blending materials from storage to a truck are summarized in Table 4.4.3.2–1.

Transport of Natural Uranium Blendstock From Hanford to the Blending Site. NU blendstock (oxide) would be of 0.71-percent enrichment and shipped as a solid. A maximum of 165 t/yr of U_3O_8 (140 t NU) would be transported in DOT-specification metal box packages by commercial carrier. A typical Type A metal box packaging is shown in Figure 4.4.3.2–3. The annual radiological and nonradiological impacts from transporting NU blendstock are presented in Appendix G, Table G.1–6. The highest total impact is 1.1×10^{-2} fatalities (from Hanford to SRS). Potential impacts from loading trucks at origin and unloading trucks at the blending site are shown in Table 4.4.3.2–1.

Transport of Natural Uranium or Depleted Uranium as Uranium Hexafluoride Blendstock From Either United States Enrichment Corporation Paducah or United States Enrichment Corporation Piketon to Wilmington. The UF_6 blendstock would be of less than 3-percent enrichment and would be shipped as a solid. A maximum of 207 t/yr of UF_6 (140 t NU) would be required for blending to fuel feed material or 219 t/yr

of UF_6 (148 t DU) for blending to LLW. The material would be placed in a specification UF_6 cylinder (inner packaging), which then would be placed in an approved Type B protective overpack (outer packaging for added protection) for shipment by commercial carrier. Up to 23 cylinders, each containing 9 t of material, would be required per year. It is estimated that up to 23 truckloads per year (one cylinder per truckload) would be needed to transport the material. The IAEA assessed and approved the adequacy of UF_6 transport regulations as pertaining to radiological and chemical hazards. This material has been successfully transported throughout the world via ship, rail, and truck without loss of life or property due to a radiological or chemical release. The annual radiological and nonradiological impacts from transportation of UF_6 from USEC Paducah or USEC Piketon to GE Wilmington, B&W, or NFS are presented in Appendix G, Table G.1–6. The overall annual risk of transporting UF_6 is estimated to be small. Figure 4.4.3.2–4 presents an illustration of a commercial truck loaded with 9 t, Type B overpack that is typically used for the transport of UF_6 material.

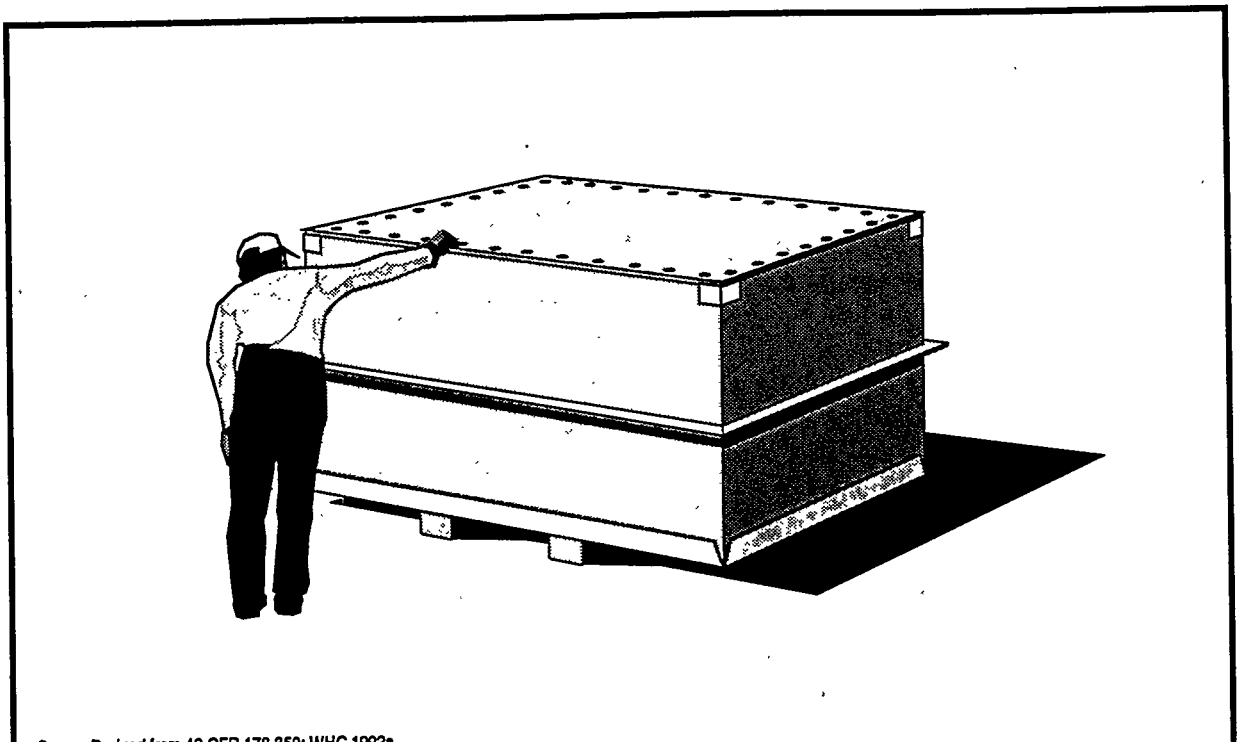
Transport of Triuranic-Octaoxide From General Electric Wilmington to the Blending Sites. At GE Wilmington, the UF_6 would be converted into U_3O_8, which would be shipped to B&W, NFS, SRS, or the Y–12 Plant. A maximum of 165 t of U_3O_8 (140 t of uranium) per year would be transported in a maximum of 75 DOT-specification, Type A metal box packages for blending as UNH (4-percent U-235) fuel feed material. Each package would contain about 2,200 kg (4,850 lb) of uranium, depending upon the material assay. The material would be transported by an estimated 15 commercial flatbed truckloads per year to the selected blending site. For UNH of 0.9-percent U-235, approximately 175 t of U_3O_8 would be transported by an estimated 16 commercial shipments. The radiological and nonradiological impacts for the transport of U_3O_8 from GE Wilmington to the potential blending plants are presented in Appendix G, Table G.1–6. The annual risk of transporting U_3O_8 is estimated to be small. The estimated radiological impacts from transferring UF_6 and U_3O_8 between storage facilities and trucks at both origins and destinations are shown in Table 4.4.3.2–1.

Transport of Natural Uranium as Uranium Hexafluoride Blendstock From Either United States Enrichment Corporation Paducah or United States Enrichment Corporation Piketon to a Uranium Hexafluoride Blending Site. For the UF_6 blending alternative, UF_6 blendstock would be transported from either USEC Paducah or USEC Piketon directly to a UF_6 blending site, located at either B&W or NFS. The UF_6 alternative would not require the conversion of UF_6 blendstock into U_3O_8 at GE Wilmington (as required for the UNH option) before being transported to the blending site. For this option, 207 t/yr of UF_6 (140 t NU) would be transported.

Both the UF_6 and U_3O_8 are low-enriched materials that are routinely shipped in DOT/NRC-approved shipping containers by commercial truck. There are no unusual shipping criteria (as are required for special nuclear materials) other than meeting standards established by DOT and presented in 49 CFR and supplemented by State, local, and DOE regulations. These standards require the shipper to comply with selecting the proper, authorized packaging for the material; preparing hazardous materials shipping papers; properly certifying what is being shipped; properly marking, labeling, loading, blocking, and bracing the material; and meeting safety requirements.

The potential health effects from transporting UF_6 from USEC Paducah or USEC Piketon to B&W or NFS are presented in Appendix G, Table G.1–6. The highest impact is estimated to be 4.2×10^{-3} fatalities for the transport of UF_6 blendstock material from USEC Paducah to B&W. Potential impacts from unloading the trucks at the blending site and placing the material in interim storage are presented in Table 4.4.3.2–1.

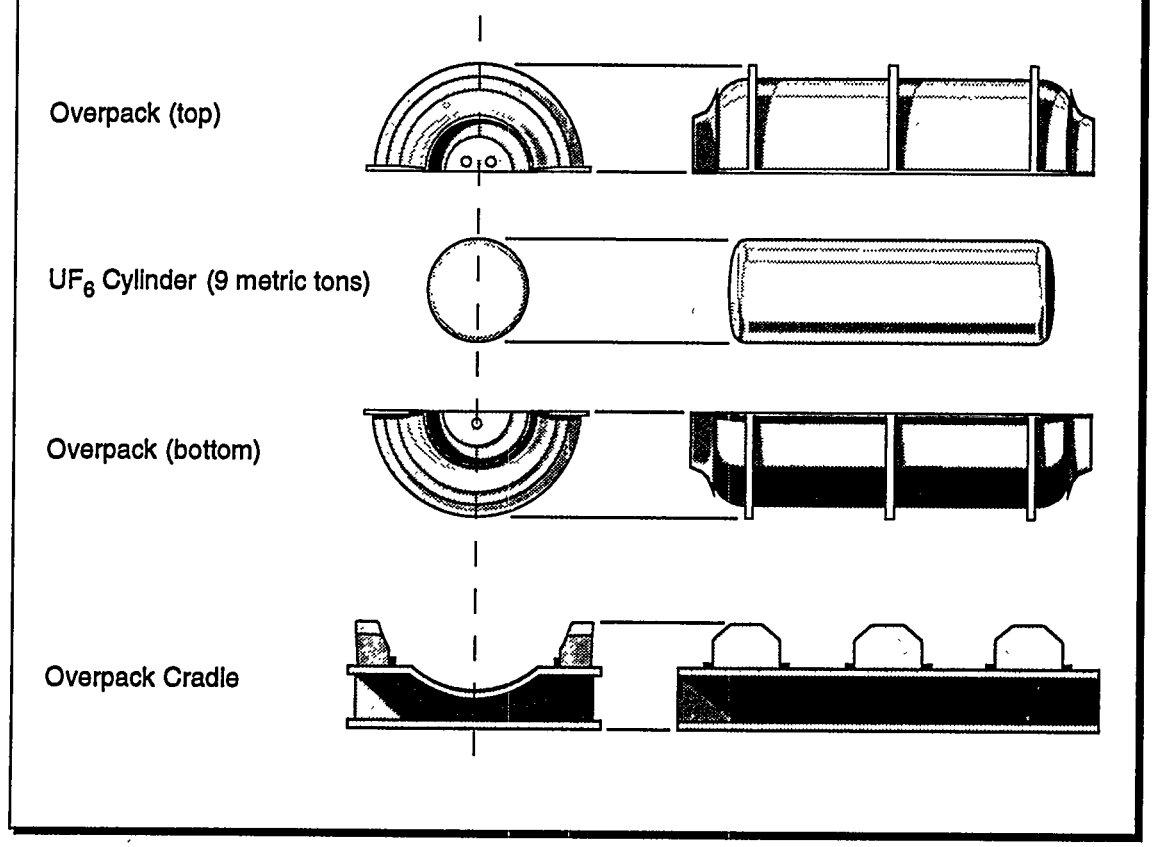
Transport of Depleted Uranium (Metal) From Fernald to the Y–12 Plant. Under the metal alternative, to blend HEU to LLW (oxide) for disposal, 218 t/yr of DU (metal) blendstock material would be required to be transported from Fernald directly to the blending site at the Y–12 Plant. DU would be shipped in DOT-specification shipping containers by commercial truck. As is required of all shippers and carriers of hazardous materials, the handling and transportation procedures for this material must comply with Federal, State, and local

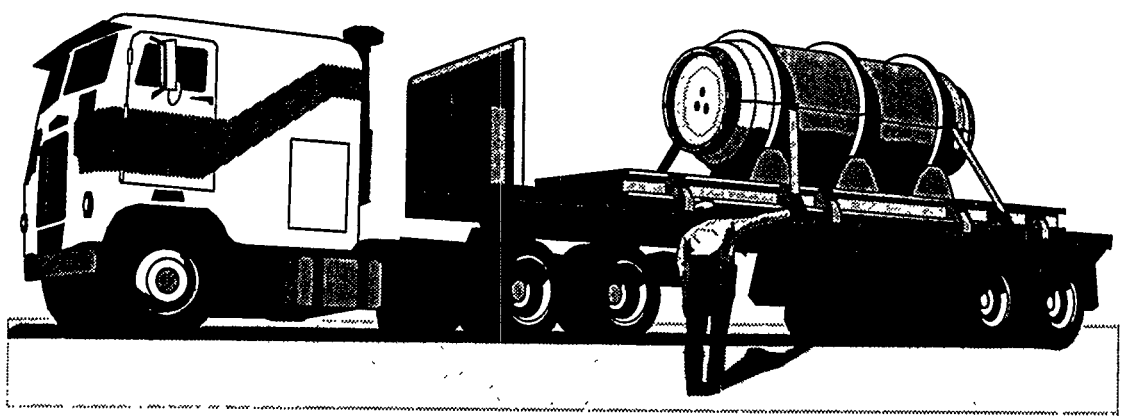


Souce: Derived from 49 CFR 178.350; WHC 1992a.

2766/HEU

Figure 4.4.3.2–3. A Typical Department of Transportation-Specification 7A, Type A Metal Box Packaging for the Transport of Most Blendstock Materials.





Source: Derived from Battelle 1977a.

2767/HEU

Figure 4.4.3.2–4. Uranium Hexafluoride Cylinder with Two-Part Nuclear Regulatory Commission-Certified Type B Overpack (9 metric tons).

regulatory standards. The impacts from transporting DU (metal) from Fernald to the blending sites are presented in Appendix G, Table G.1–6. This annual risk of transporting DU (metal) is estimated to be $2.3x10^{-3}$ fatalities. The potential impacts from loading trucks at origin and unloading trucks at destination are presented in Table 4.4.3.2–1.

Transportation of Low-Enriched Uranium From Fernald to Blending Sites. Approximately 191 t of LEU (1.25-percent enrichment), located at Fernald, could be used in lieu of NU only for the alternative to blend HEU to UNH crystals for use as commercial fuel. The LEU blendstock (in oxide U_3O_8 or UO_3 form) would be transported in 48 truckloads (80 t LEU, 1 t U-235) per year from Fernald to any of the four blending sites (SRS, the Y–12 Plant, B&W, and NFS). The highest risk from transporting LEU would be $8.44x10^{-3}$ fatalities per year (Fernald to SRS), compared to $1.10x10^{-2}$ fatalities per year form transporting NU (Hanford to SRS). NU was used for the transportation analysis in general because: (1) it is the material most likely to be used for blending, and (2) the 191 t of LEU at Fernald would not fulfill the total blendstock requirement for the life of the project (it would suffice for less than 3 years). As shown in Table 4.4.3.2–4, the blendstock risk is bounded by the transport of NU form Hanford to the blending sites. The total annual health impact from transporting NU blend stock from Hanford versus transporting LEU from Fernald is summarized in Table 4.4.3.2–4.

Transport of Uranyl Nitrate Crystals, Low-Level Waste (Oxide) from Blending Sites to a Fuel Fabrication Plant or Waste Disposal Facility. There are three probable products from the blending process: UNH reactor fuel feed material that is 4-percent enrichment in U-235, UF_6 fuel feed material that is 4-percent enrichment in U-235, or LLW (oxide) that is 0.9-percent enrichment.

The UNH (crystals) or UF_6 reactor fuel feed materials (4-percent enrichment) and LLW (0.9-percent enrichment) would be transferred from storage and loaded onto trucks at the blending site. The estimated impacts of these loading activities, on a per-shipment basis, are presented in Table 4.4.3.2–1.

The UNH crystals are the product of the UNH fuel feed material blending process. Once HEU is blended into a material containing 4-percent enriched UNH in hydrated form (crystals), the material would be shipped in NRC-certified, Type A fissile packaging via commercial carrier to a fuel fabrication plant. Approximately 14 t of blendstock are required for each metric ton of HEU; thus, 10 t/yr of HEU and 165 t/yr of U_3O_8 would be required to produce the maximum output of 316 t of UNH crystals (150 t/yr LEU) fuel feed material. It is estimated that 70 truckloads per year would be required to transport the UNH crystals to a fuel fabrication plant. The risk of transporting this material is presented in Appendix G, Table G.1–7.

Table 4.4.3.2–4. Comparison of Annual Health Impact From Transporting Natural Uranium From Hanford and Fernald to Blending Sites

Blending Site	Total Health Effect[a] Hanford NU (0.71 percent)	Fernald LEU (1.25 percent)
B&W	$1.10x10^{-2}$	$8.02x10^{-3}$
NFS	$1.00x10^{-2}$	$6.78x10^{-3}$
Y–12	$9.70x10^{-3}$	$5.57x10^{-3}$
SRS	$1.10x10^{-2}$	$8.44x10^{-3}$

[a] Fatalities.

Source: RADTRAN model results.

Under the UF_6 alternative, 222 t of UF_6 (150 t LEU) fuel feed material of 4-percent enrichment would be transported to a fuel fabrication plant per year. This material would be placed in a DOT-specification UF_6 cylinder (inner packaging), which is then placed in an NRC-certified, Type B packaging (overpack) for shipment by commercial carrier. Approximately 98 cylinders, each containing approximately 2.3 t, would be required per year. It is estimated that 20 truckloads would be needed per year to transport UF_6 to a fuel fabrication plant.

The UNH or UF_6 reactor fuel feed materials would be transported by commercial truck in compliance with DOT (49 CFR 171-180) and other regulatory requirements that govern the movement of hazardous materials. The UNH would be transported in NRC-certified, Type A fissile packaging (for example, BU-7 which has a Certificate of Compliance Number 9019).

Four sites (the Y–12 Plant, SRS, B&W, and NFS) would be capable of blending HEU to 0.9-percent LLW for disposal.

To blend down HEU to LLW (0.9-percent enrichment), approximately 70 t of blendstock are required for each metric ton of HEU. Based on the blending site's assumed blending rates and associated output, it is estimated that 40 truckloads per year would be required to transport the LLW (oxide) obtained from UNH blending to a waste disposal facility.

Metal forms would be blended down to 0.9-percent enrichment and further converted to oxide form for waste disposal only. This LLW (oxide) "end product" material would be placed in DOT-specification, Type A packages and transported by commercial truck to a waste disposal site (NTS is used for risk calculations). Approximately 59 truckloads would be required to transport 264 t of LLW per year.

The risks of transporting UNH of 4-percent or 0.9-percent enrichment, UF_6 of 4-percent enrichment, or metal LLW of 0.9-percent enrichment are small. The potential transportation health risks for these types of shipments are summarized in Appendix G, Table G.1–7.

4.4.3.3 Cumulative Summary of Transportation Environmental Impacts

The high and low range of cumulative radiological and nonradiological annual health impacts from transporting radioactive materials for alternatives in this EIS are presented in Table 4.4.3.3–1. Additional information is included in Appendix G, Table G.1–8.

The maximum potential impacts, by alternative, are summarized as follows:

- The maximum annual transportation health impacts from blending HEU to LEU as UNH (4-percent enrichment) fuel feed material would be 0.061, or approximately one excess fatality in 16 years. This option requires the transportation of HEU from the Y–12 Plant to SRS, NU blendstock from Hanford to SRS, and the transportation of fuel feed material (UNH crystals) from SRS to the fuel fabrication plant at the Siemens Nuclear Power Corporation site.

- The maximum annual transportation health impacts from blending HEU to LEU as UF_6 (4-percent enrichment) fuel feed material would be 0.031, or approximately one excess fatality in 32 years. This option requires the transportation of HEU from the Y–12 Plant to B&W, UF_6 blendstock from USEC Paducah to B&W, and the transport of UF_6 fuel feed material from B&W to the Siemens Nuclear Power Corporation Site.

- The maximum annual transportation impacts from blending HEU under the UNH alternative to LLW (0.9-percent enrichment) for disposal would be 0.038, or approximately one excess fatality in 26 years. This option requires the transport of HEU from the Y–12 Plant to B&W, DU blendstock from Hanford to B&W, and the transport of LLW from B&W to NTS for disposal.

- The annual transportation health impacts from blending HEU metal (0.9-percent enrichment) to LLW at the Y–12 Plant would be 0.035, or approximately one excess fatality in 29 years. This option requires blending of HEU to LLW at the Y–12 Plant, the transportation of DU (metal) blendstock from Fernald to the Y–12 Plant, and the transport of LLW from the Y–12 Plant to NTS for disposal.

The lowest transportation risk alternative would be to produce UNH fuel feed material of 4-percent enrichment at B&W. This would require the transport of HEU from the Y–12 Plant to B&W, the transport of UF_6 blendstock material from USEC Paducah to GE Wilmington, and the transport of U_3O_8 from GE Wilmington to B&W. This risk would be 0.012, or one excess fatality in 83 years; however the risk differences between all other alternatives and sites are not significant.

Table 4.4.3.3–1. Summary of High and Low Transportation Risk for Each Blending Alternative (per year)

HEU Origin	Blending Material Origin	Conversion Site	Blending Site	Fuel Fabrication or LLW Site	Total Health Risk[a]
Fuel Feed Material as Uranyl Nitrate Crystals (10 t/yr)					
Y–12 Plant	Hanford	–	SRS	SNPC	6.1×10^{-2}, [b]
Y–12 Plant	Paducah	GE	B&W	B&W	1.2×10^{-2}
Uranyl Nitrate LLW as Oxide (2.1 t/yr)					
Y–12 Plant	Hanford	–	B&W	NTS	3.8×10^{-2}
Y–12 Plant	Paducah	GE	Y–12	NTS	3.0×10^{-2}
Fuel Feed Material as UF_6 (10 t/yr)					
Y–12 Plant	Paducah	–	B&W	SNPC	3.1×10^{-2}
Y–12 Plant	Paducah	–	NFS	WCFF	1.5×10^{-2}
Metal LLW as Oxide (3.1 t/yr)					
[Text deleted.]					
Y–12 Plant	Fernald	–	Y–12	NTS	3.5×10^{-2}

[a] Estimated fatalities per year.

[b] Highest risk for all transportation options.

Source: RADTRAN model results.

4.5 TOTAL CAMPAIGN IMPACTS

This section describes the impacts of the various alternatives evaluated for disposing HEU at the four candidate sites. The annual operational impacts of each of the blending technologies or the resources of the candidate sites are fully described in Sections 4.3 and 4.4. In this section, the combined impacts of each alternative for disposing the 200 t of surplus HEU inventory, which may involve multiple technologies, sites, and end products, are summarized and shown in Table 2.4–1.

For each alternative analyzed other than the No Action Alternative, there are two potential processes for blending to commercial fuel (UNH and UF_6) and two potential processes for blending to waste (UNH and metal). The impacts and, in the case of blending to waste, the processing rate of the respective processes differ. In other words, the magnitude of expected impacts and the time required to complete disposition actions depend on the process selected.

The analyses in Sections 4.3 and 4.4 for the four candidate sites are based on one rate for each process so that a valid comparison can be made between the site-specific impacts. While it is recognized that some of the sites may be able to process material at a higher rate, a comparison between the impacts at the maximum rate for each site could be misleading. For example, if one site is processing material at 10 t/yr to 4-percent UNH and a second site is processing material at 40 t/yr to 4-percent UNH, then the impacts from the analysis for the second site may be greater based on the increased production rather than the site. It is also assumed that each site can process the material at the blending rates analyzed, although at some sites this may preclude other blending not associated with this proposed action.

Material could be blended to waste at the two DOE sites using UNH or Y–12 using metal blending. Similarly, material could be blended to commercial fuel feed at the two commercial sites using either UNH or UF_6 blending. To provide conservatism in the site-specific analyses below, where there is such a choice of applicable processes at a site (that is, only for blending to waste at the DOE sites and blending to commercial fuel feed at the commercial sites), the value given for each resource area is based on whichever process produces the greatest impact.

For blending to waste at DOE sites, the UNH process would produce the greatest impact in all resource areas except four. The metal process would produce the greatest impacts for liquid LLW generated, solid LLW generated, solid LLW after treatment, and transportation; therefore, the analyses below conservatively use the metal impacts for these four resource areas and the UNH impacts for all other resource areas.

For blending to commercial fuel feed at the commercial sites, the UF_6 process would produce the greatest impacts in all resource areas except three. The UNH process would produce the greatest impacts for liquid hazardous waste generated, solid nonhazardous waste after treatment, and transportation. The analyses below conservatively use the UNH impacts for these three resource areas, and the UF_6 impacts for all other resource areas.

The results indicate that all four sites have the capacity to process material with minimal impacts to the workers, the public, or the environment. For the two DOE sites, the generation of waste based on an increased usage of utilities represents small increases—less than 5 percent over current operations. For the two commercial sites, the generation of waste based on an increased usage of utilities represents increases of over 20 percent, but both facilities have adequate capacities to accommodate the increases since neither site is currently operating at full capacity. The NFS site would require a large increase in water usage (35.1 percent) and fuel requirements (933 percent). This is because NFS is currently processing material at a reduced rate; therefore, use of the these utilities (water and fuel) is currently very low. Because the quantity of water and fuel used in the past for similar operations was also used for the proposed action and in the analyses in this EIS, it is anticipated that the increase in these requirements can easily be accommodated at NFS.

For most resource areas, the impacts from a given blending process would not vary from site to site. Three exceptions to this are the radiological dose to the MEI, the dose to the public, and the total health risk during transportation. The first two exceptions are due to the MEI and the population within 80 km (50 mi) being at different distances from the blending facility for each site. The last exception is due to the

different transportation distances between various affected sites and the different distributions of populations along the shipping routes where HEU originates, blendstock originates, fuel fabrication is performed, and waste disposal is carried out. This section analyzes and compares the incremental impact over the life of the campaign for blending 200 t for each alternative. These analyses are based on the maximum impact for each resource at each site (that is, the maximum electricity needed for either UNH or UF_6 blending to fuel or UNH or metal blending to waste). The impacts will vary for different scenarios depending on the sites and processes selected.

As noted in Chapter 1, several blending technologies and facilities are likely to be used for different portions of the surplus inventory, and the decisions regarding those technologies and facilities are likely to be made in part by USEC, other private entities as marketing agents for DOE, or DOE. Thus, specific decisions concerning the locations where surplus HEU disposition actions will be implemented will be multi-dimensional and will likely involve multiple decisionmakers The impacts of both the Russian and U.S.-origin surplus HEU on the domestic producers will be limited by provisions of the *USEC Privatization Act* enacted in April 1996. Under provisions of the act, the quantity of surplus HEU that can be transferred to commercial end users will be constrained to a level that would not adversely affect the domestic market. Hence, because the quantity of U.S. material is relatively small and the *USEC Privatization Act* prevents unrestricted transfer of the material to end users, the incremental impacts of the proposed action on the domestic nuclear fuel industry would be small. The alternatives as described are not intended to represent exclusive choices among which DOE (or other decisionmakers) must choose, but rather to provide a range of reasonable alternatives.

4.5.1 NO ACTION

Under the No Action Alternative, DOE will continue to store surplus HEU (primarily at DOE's Y–12 Plant). As stated in Section 1.4.2, storage of surplus HEU is analyzed for a period up to 10 years in the Y–12 EA. Storage of weapons-usable fissile materials beyond the 10-year period (2005), including surplus HEU up to the point of disposition, is being addressed in the Storage and Disposition PEIS. Current operations as described in Section 2.2.3 at each of the potential HEU blending sites (Y–12, SRS, B&W, and NFS) would continue. The impacts from this No Action Alternative are described in Section 4.2.

4.5.2 NO COMMERCIAL USE

Under this second alternative, DOE would blend the entire stockpile of surplus HEU (200 t) to LEU and dispose of it as waste. This would include surplus HEU with or without commercial value. The blending of all surplus HEU would be performed at all four sites. Although this alternative would not recover any of the economic value of HEU for the Government or provide peaceful beneficial use of the material, it would meet nonproliferation objectives and is included to provide a comprehensive evaluation of a full range of alternatives in the HEU EIS.

Surplus HEU could be blended to waste either as UNH or metal at a rate of up to 2.1 t/yr or 3.1 t/yr, respectively. All the blending sites have UNH blending capabilities. Only ORR is considered as a blending site for metal blending because SRS, B&W and NFS neither have nor plan to build metal blending facilities. Utilizing the metal process, the time required to blend all 200 t would be more than 64 years. Utilizing the UNH process at only one of the commercial sites, the time required to blend all of the 200 t would be more than 95 years. No combination of fewer than three sites could complete the task in less than 30 years. For this alternative, all four sites would be used to blend 50 t each. If all four sites were to process material, it would take 23.8 years to finish converting all 200 t of HEU to LEU as waste.

The blending of surplus HEU to waste would not be initiated before an LLW disposal facility was identified to accept the LLW. Surplus HEU would remain in interim storage at DOE's Y–12 Plant, or at another storage facility pursuant to the Storage and Disposition PEIS, pending identification of the LLW disposal facility.

For the DOE sites, blending to waste (that is, blending 100 t at DOE sites with each site blending 50 t HEU) would take 23.8 years if the UNH process is used, and 16.1 years if the metal process is used. For the commercial sites, blending to waste (that is,

blending 100 t at the commercial sites with each commercial site blending 50 t HEU) would take 23.8 years using the UNH process. (Therefore, if all four sites were to process the material, it would take 23.8 years to convert all of the 200 t of surplus HEU to LEU as waste.) The total or maximum incremental impacts for each resource under this alternative are presented in Table 2.4–1 under Alternative 2.

[Tables deleted.]

4.5.3 LIMITED COMMERCIAL USE (25/75 FUEL/WASTE RATIO)

Under this third alternative, 50 t of the surplus HEU would be blended to commercial fuel while the remaining 75 percent (150 t) would be disposed of as waste. First, the title to 50 t of surplus HEU (with 7,000 t NU as UF_6) would be transferred to USEC. USEC (or the successor private corporation) then would select blending sites for blending 50 t of surplus HEU to LEU for use in commercial fuel. The remaining quantity would be blended into waste. [Text deleted.]

The third alternative would blend the 50 t of HEU at the commercial sites, each blending 25 t of material. [Text deleted.] The two DOE sites would not blend any commercial HEU material. The remaining 150 t of HEU material would be blended into waste using all four blending sites. Each DOE and commercial site would receive 37.5 t of material for blending. [Text deleted.] The total or maximum incremental impacts for each resource under this alternative are presented in Table 2.4–1 under Alternative 3.

[Tables deleted.]

4.5.4 SUBSTANTIAL COMMERCIAL USE (65/35 FUEL/WASTE RATIO)

Under this fourth alternative, all of the commercial material (130 t) would be blended to commercial fuel, and all of the off-spec (40 t) and non-commercial material (30 t) would be blended to waste. Thirty-five percent of the HEU would be blended and disposed of as waste while the remainder would be blended for commercial use. First, the title to 50 t of surplus HEU (with 7,000 t NU as UF_6) would be transferred to USEC. USEC (or the successor private corporation) would then select sites for blending 50 t of surplus HEU to LEU for use in commercial fuel. The remaining quantity of commercially usable HEU (80 t) would be blended at any or all of the four sites to LEU for fabrication into commercial reactor fuel. The remaining 70 t of surplus HEU would be blended to waste.

All three alternative blending processes could be used for this purpose: blending as UNH and/or UF_6 for 4-percent commercial fuel feed, and blending as UNH and/or as metal for 0.9-percent waste feed. Surplus HEU could be blended to commercial fuel as either UNH or UF_6 at a rate of 10 t/yr. Surplus HEU could be blended to waste as either UNH or as metal at a rate of up to 2.1 t/yr or 3.1 t/yr, respectively. All the blending sites have UNH blending capability. Only B&W and NFS are considered as blending sites for UF_6. Only ORR is considered as a blending site for metal blending.

Four variations of this alternative would use combinations of different sites. These particular different combinations of sites are representative only. DOE, USEC, or another private entity might choose others, depending on programmatic, commercial, or other considerations.

4.5.4.1 Substantial Commercial Use at Department of Energy Sites (65/35 Fuel/Waste Ratio)

The first variation of the fourth alternative would blend all of the HEU at the two DOE sites, with the HEU split equally between them. ORR and SRS would each blend 65 t of HEU to LEU for commercial fuel and 35 t of HEU to LEU for disposal as waste. Utilizing the DOE sites only, blending to both commercial fuel and waste would take 23.2 years if the UNH process were used for blending the 35 t to waste, and 17.7 years if the metal process were used for blending the 35 t to waste. The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4–1 under Alternative 4, Variation a.

4.5.4.2 Substantial Commercial Use at Commercial Sites (65/35 Fuel/Waste Ratio)

The second variation of the fourth alternative would blend all of the HEU at the two commercial sites,

with the HEU split equally between them. B&W and NFS would each blend 65 t of HEU to LEU for commercial fuel and 35 t of HEU to LEU for disposal as waste. Utilizing the commercial sites only, blending to both commercial fuel and waste would take 23.2 years whether the UNH or UF_6 process were used for blending. The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4–1 under Alternative 4, Variation b.

[Tables deleted.]

4.5.4.3 Substantial Commercial Use at All Four Sites (65/35 Fuel/Waste Ratio)

The third variation of the fourth alternative would blend all of the surplus HEU at all four sites, with the HEU split equally among them. ORR, SRS, B&W, and NFS would each blend 32.5 t of HEU to LEU for commercial fuel and 17.5 t of HEU to LEU for disposal as waste. [Text deleted.] The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4–1 under Alternative 4, Variation c.

4.5.4.4 Substantial Commercial Use at a Single Site (65/35 Fuel/Waste Ratio)

The fourth variation of the fourth alternative would blend all of the surplus HEU at only one site. ORR, SRS, B&W, or NFS would blend 130 t of HEU to LEU for commercial fuel, and 70 t of HEU to LEU for disposal as waste. [Text deleted.] The fourth variation is each site blending twice the amount of material as in the first and second variations of this alternative. The incremental impacts for each resource for either of the DOE sites are the same as either the total or the maximum impacts presented in Table 2.4–1 under Alternative 4, Variation a. The incremental impacts for each resource for either of the commercial sites are the same as either the total or the maximum impacts presented in Table 2.4–1 under Alternative 4, Variation b. The only exception is the normal operations dose and risk to the MEI of the public. The doses to the MEI for Y–12, SRS, B&W, and NFS are 1.81, 0.116, 0.109, and 7.92 mrem, respectively. The risks of cancer fatalities per campaign are 9.06×10^{-7}, 5.80×10^{-8}, 5.46×10^{-8}, and 3.96×10^{-6}, respectively. The doses to the population within 80 km (50 mi) are 7.41, 7.41, 0.982, and 69.9 person-rem, respectively. The risks of cancer facilities per campaign are 3.7×10^{-3}, 3.7×10^{-3}, 4.9×10^{-4}, and 3.5×10^{-2}, respectively.

[Tables deleted.]

4.5.5 Maximum Commercial Use (85/15 Fuel/Waste Ratio)

Under this fifth alternative, all of the commercial (170 t) and off-spec material would be blended to fuel. This alternative assumes that only 15 percent of the surplus HEU would be blended to LLW and disposed of as waste (30 t). This increases the amount of material that can be used for commercial use to 85 percent. First, the title to 50 t of surplus HEU (with 7,000 t NU as UF_6) would be transferred to USEC. USEC (or the successor private corporation) would then select commercial sites for blending 50 t of surplus HEU to LEU for use in commercial fuel. For the remaining quantity of potentially commercially usable HEU (120 t), DOE or USEC (or the successor private corporation) could have it blended at any or all of the four sites. The LEU product, following blending, then would be sold in the market for use in commercial reactor fuel. The remaining 30 t of surplus HEU would be blended to waste. The same processes and site variations of the fourth alternative also apply to the fifth alternative.

4.5.5.1 Maximum Commercial Use at Department of Energy Sites (85/15 Fuel/Waste Ratio)

The first variation of the fifth alternative would blend all of the surplus HEU at the two DOE sites, with the HEU split equally between them. ORR and SRS would each blend 85 t of HEU to LEU for commercial fuel and 15 t of HEU to LEU for disposal as waste. [Text deleted.] The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4–1 under Alternative 5, Variation a.

[Tables deleted.]

4.5.5.2 Maximum Commercial Use at Commercial Sites (85/15 Fuel/Waste Ratio)

The second variation of the fifth alternative would blend all of the surplus HEU at the two commercial sites, with the HEU split equally between them. B&W and NFS would each blend 85 t of HEU to LEU for commercial fuel and 15 t of HEU to LEU for disposal as waste. [Text deleted.] The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4–1 under Alternative 5, Variation b.

[Tables deleted.]

4.5.5.3 Maximum Commercial Use at All Four Sites (85/15 Fuel/Waste Ratio)

The third variation of the fifth alternative would blend all of the surplus HEU at all four sites, with the HEU split equally among them. ORR, SRS, B&W, and NFS would each blend 42.5 t of HEU to LEU for commercial fuel feed and 7.5 t of HEU to LEU for disposal as waste. [Text deleted.] The maximum or total incremental impacts for each resource under this variation are presented in Table 2.4–1 under Alternative 5, Variation c.

[Tables deleted.]

4.5.5.4 Maximum Commercial Use at a Single Site (85/15 Fuel/Waste Ratio)

The fourth variation of the fifth alternative would blend all of the surplus HEU at only one site. ORR, SRS, B&W, or NFS would blend 170 t of HEU to LEU for commercial fuel, and 30 t of HEU to LEU for disposal as waste. [Text deleted.] The fourth variation is each site blending twice the amount of material as in the first and second variations of this alternative. The incremental impacts for each resource for either of the DOE sites are the same as either the total or the maximum impacts as presented in Table 2.4–1 under Alternative 5, Variation a. The incremental impacts for each resource for either of the commercial sites are the same as either the total or the maximum impacts as presented in Table 2.4–1 under Alternative 5, Variation b. The only exception is the normal operations dose and risk to the MEI of the public. The doses to the MEI for Y–12, SRS, B&W, and NFS are 1.22, 0.078, 0.0864, and 6.24 mrem, respectively. The risks of cancer fatalities per campaign are 6.08×10^{-7}, 3.9×10^{-8}, 4.32×10^{-8}, and 3.12×10^{-6}, respectively. The doses to the population within 80 km (50 mi) are 5.01, 5.01, 0.787, and 56.3 person-rem, respectively. The risks of cancer fatalities per campaign are 2.5×10^{-3}, 2.5×10^{-3}, 3.9×10^{-4}, and 2.8×10^{-2}, respectively.

4.5.6 Summary of Alternatives Analysis

The analysis of the impacts of alternatives above is based on four particular points on the fuel/waste spectrum: 0-, 25-, 65-, and 85-percent fuel. The reader could readily calculate a reasonable estimate of the impacts of other points on the fuel/waste spectrum by interpolating the results as presented. For example, the impacts of a 75/25 fuel/waste ratio for a given set of sites would be between those presented for alternatives 4 (65/35) and 5 (85/15) for the same sites.

The impacts for particular sites could also be approximated for different site combinations than those that are analyzed above. To determine the impacts of blending a different quantity of material at a particular site than is analyzed above, the assumed quantity can be divided by the appropriate process rate (10 t/yr for blending to fuel as UF_6 or UNH, 3.1 t/yr for blending to waste as metal, and 2.1 t/yr for blending to waste as UNH) to yield the time period necessary to blend that quantity at that rate. Multiplying the resultant time period by the annual impact figures for resource areas that are additive (site infrastructure, water, radiological exposure, waste management, and transportation yields the total impacts for that quantity and site). For the remaining resources (air quality, socioeconomics, and chemical exposure) adding annual impacts does not provide a meaningful measure. For those resources, the best measure of total campaign impacts would be the maximum of any applicable annual impact.

The analyses in this section are based on annual blending rates which depend in part on DOE's ability to supply HEU to one or more sites at the process blending rates. If DOE is unable to supply material to multiple sites at the blending rates analyzed (for example, 10 t/yr for blending to fuel feed as UNH),

the impacts in a given year (as described in Sections 4.3 and 4.4) would be reduced accordingly. However, since the impacts in this section are based upon blending the entire 200 t, the total campaign impacts would be similar to those described in the previous tables, only spread over a longer time period.

Calculating the impacts that would result from the use of different process rates is less precise, as the relationships between process rates and impacts are in some cases not linear. For example, doubling the process rate for a particular process and facility would probably approximately double the air emissions, water usage, and waste generation, but it would not necessarily double the required workforce. Nonetheless, as the expected impacts from all alternatives are small during normal operations, a reasonable approximation of the impacts from different process rates could be obtained by assuming linear relationships.

The analysis supports several preliminary conclusions. For most resource areas, the impacts decrease as the portion of material blended for commercial use increases. This conclusion is based on the analysis of impacts from blending operations and transportation of materials only. It does not include the impacts from the endpoints: use of commercial nuclear fuel in reactors[3] (and of the licensing process for nuclear plants, existing or anticipated environmental documents for sites for disposal of the LLW (such as the anticipated sitewide management of the resulting spent fuel) or disposal of LLW. Those impacts are or will be assessed as part EIS for NTS, and the anticipated EIS concerning a repository for commercial spent fuel). Since the use of LEU derived from HEU in reactors supplants the use of LEU from mined uranium, the preferred alternative involves no incremental use of nuclear fuel (or spent fuel to be managed) than that which would otherwise occur. In contrast, the LLW to be disposed of from HEU that is blended to waste does represent an incremental quantity of LLW that would not need to be disposed of in the absence of this proposed action. This distinction, together with the avoided environmental impacts from uranium mining, milling, and enrichment (Section 4.7), further enhances the preferability of maximizing commercial use of surplus HEU.

The analyses show some differences between the impacts of the different blending processes. For example, for blending to waste, metal blending generates considerably more process LLW than does UNH blending.

[3] An indirect impact of the preferred alternative would be the generation of spent fuel under alternatives 3, 4, and 5, which would need to be managed and disposed of in a repository such as the Yucca Mountain Site (Yucca site is currently being characterized; preparation of an EIS has been postponed until further notice, due to lack of funding). Since the nuclear fuel derived from HEU would replace nuclear fuel that would have been created from newly mined uranium without this proposed action, there would be no additional spent fuel generated. No spent fuel would be generated for the alternatives 1 (no action) and 2 (blend all surplus HEU to waste).

4.6 CUMULATIVE IMPACTS

4.6.1 DESCRIPTION OF CUMULATIVE IMPACTS

Impacts from blending surplus HEU to LEU (assessed in Chapter 4) would be cumulative when added to impacts from existing and planned activities at each of the candidate sites evaluated in this EIS. This type of an assessment is important because significant cumulative impacts can result from several smaller actions that by themselves do not have significant impacts.

A cumulative impact is defined as the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal), private industry, or individuals 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). This section discusses potential impacts from other facilities, operations, and activities that, in combination with potential impacts from the disposition of surplus HEU proposal, may contribute to cumulative impacts.

The cumulative impacts assessment considered a wide-ranging view of the Department's programs, environmental management, and other outside interactions. Numerous NEPA documents recently completed for proposed actions at candidate sites were used to determine site-specific impacts contributed from each action. If NEPA documents were in draft form, alternatives that posed the highest potential for environmental impacts were identified and used for cumulative impact assessment. However, if a decision has been made for the proposed action (that is, ROD is published), then the impacts associated with the alternative selected were used. NEPA documents currently being prepared also were listed and qualitatively discussed as to how impacts anticipated from the respective proposed actions would contribute to the cumulative impacts at each site.

The following documents and the associated proposed actions were considered in assessing the cumulative impacts at the candidate sites:

Oak Ridge Reservation

- *EA for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y–12 Plant Oak Ridge, Tennessee,* DOE/EA-0929, October 1995 (FONSI published 60 FR 54089)

[Text deleted.]

- *Waste Management PEIS for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste,* DOE/EIS-0200-D (draft issued, August 1995)
- *Storage and Disposition of Weapons-Usable Fissile Materials PEIS,* DOE/EIS-0229-D (draft issued, February 1996)
- *PEIS for Stockpile Stewardship and Management,* DOE/EIS-0236 (draft issued, February 1996)
- *Medical Isotope Production Project: Molybdenum-99 and Related Isotopes EIS,* DOE/EIS-0249F (final issued, April 1996)

Savannah River Site

- *Interim Management of Nuclear Materials EIS,* DOE/EIS-0220, October 1995 (ROD published 60 FR 65300)
- *PEIS for Tritium Supply and Recycling* DOE/EIS-0161, October 1995 (ROD published)
- *F-Canyon Plutonium Solutions EIS,* DOE/EIS-0219, December 1994 (ROD published)
- *Supplemental EIS Defense Waste Processing Facility (DWPF),* DOE/EIS-0082-S, November 1994 (ROD published)
- *EIS on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign*

Research Spent Nuclear Fuel, DOE/EIS-0218F (final issued, February 1996)

- *DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management Programs EIS,* DOE/EIS-0203-F, April 1995 (ROD published)
- *Savannah River Site Waste Management EIS,* DOE/EIS-0217F, July 1995 (ROD published)
- *Waste Management PEIS for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste,* DOE/EIS-0200-D (draft issued, August 1995)
- *Storage and Disposition of Weapons-Usable Fissile Materials PEIS,* DOE/EA-0229-D (draft issued, February 1996)
- *PEIS for Stockpile Stewardship and Management,* DOE/EIS-0236 (draft issued, February 1996)

Babcock & Wilcox

[Text deleted.]

- *Disposition of Highly Enriched Uranium Obtained from the Republic of Kazakhstan EA,* DOE/EA-1063, May 1995 (FONSI published)

Blending of Kazakhstan HEU is part of B&W's current licensed operations.

Nuclear Fuel Services

No activities are planned at this site other than current licensed operations.

[Text deleted.]

4.6.2 Site-Specific Cumulative Impacts

The following sections discuss the cumulative impacts identified for site infrastructure, air quality and noise, water resources, socioeconomics, public and occupational health, and waste management. The discussions include the highest potential incremental impact from the blending alternatives evaluated in this EIS for each site. Because no new facility is assumed and neither land disturbance nor wastewater discharges constituting more than 1 percent of the stream flow would occur as a result of the implementation of the proposed action, the alternatives analyzed would not contribute to cumulative impacts at any of the potential blending sites for land resources, biotic resources, geology and soil resources, or cultural resources.

4.6.2.1 Site Infrastructure

The site infrastructure impacts resulting from the proposed action for disposition of surplus HEU would contribute to cumulative impacts when added to impacts resulting from existing and planned activities. This section discusses how impacts associated with the surplus HEU disposition proposed action affect each site cumulatively when combined with the No Action baseline and other proposed actions.

Oak Ridge Reservation. [Text deleted.] The ORR is proposed as an alternative site for actions associated with the Storage and Disposition PEIS and the five documents identified in Section 4.6.1. It is under consideration as a regional treatment and disposal site for LLW and mixed LLW in the Waste Management PEIS. In addition, environmental restoration activities at ORR are expected to continue for 30 years and therefore would coincide with the operation of the proposed surplus HEU blending facilities as well as the other applicable program activities described above. Impacts considered in the Y–12 EA are included in the No Action Alternative of this EIS.

The ORR was considered as a site for a centralized storage facility in the *DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS*; however, in the RODs associated with this EIS, DOE decided to regionalize by fuel type the management of its spent fuel at three locations: the Hanford Site, INEL, and SRS. Therefore, the packaging and shipment of materials is the only activity that will result at ORR from this action and the impacts are minimal. [Text deleted.]

Table 4.6.2.1–1 provides a listing of the site infrastructure related impacts associated with those applicable NEPA actions for which published data are available. [Text deleted.] The cumulative impact of implementing the proposed blending facilities in conjunction with other proposed activities is expected to have little or no impact on the onsite road and rail network. Electrical power requirements for the proposed activities are well within the site and regional power pool capacity or availability. [Text deleted.] Although fuel consumption during operation of blending facilities would increase over current usage, the additional natural gas, oil, and coal requirements for the proposed actions can be satisfied through normal contractual means and would not be limiting.

Savannah River Site. The SRS is a candidate site for the 10 documents identified in Section 4.6.1. This includes the location of an accelerator in the *PEIS for Tritium Supply and Recycling* and the location of a centralized storage facility in the *DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS.* [Text deleted.]

Highly enriched uranium material proposed for blending for the purpose of stabilization in the SRS IMNM EIS is the same material proposed for blending for the purpose of disposition in this EIS. SRS is proposed as an alternative site for actions associated with the Storage and Disposition PEIS and for the stockpile management functions in the *Draft PEIS for Stockpile Stewardship and Management.* It is also under consideration as a regional treatment and disposal site for LLW and mixed LLW in the Waste Management PEIS. In addition, environmental restoration activities at SRS are expected to continue for 30 years and therefore would coincide with the operation of the proposed surplus HEU and blending facilities as well as the other applicable program activities described above.

Table 4.6.2.1–1. Site Infrastructure Cumulative Impacts at Oak Ridge Reservation

Category	No Action[a]	Waste Management	Storage and Disposition[b]		Stockpile Stewardship and Management[c]	Medical Isotopes Facility	HEU[d]	Total
			Storage	Disposition				
[Text deleted.]								
Energy (MWh/yr)	726,000	776,200	68,000	69,000	94,000	500	5,000	1,738,700
Peak Load (MWe)	110	[e]	11	15	14	[e]	2	152
Natural Gas (m^3/yr)	95,000,000	[e]	949	10,426,000	4,000,000	[e]	19,800	109,446,750
Diesel/oil (l/yr)	416,000	[e]	49,000	208,059,750	213,000	[e]	56,800	208,794,550
Coal (t/yr)	16,300	[e]	6,600	0	800	[e]	363	24,063
Water (million l/yr)	14,210	814	370	60,560	550	120	19	76,643
[Text deleted.]								

[a] Includes actions from the Y–12 EA.

[b] Storage data is based on the maximum applicable alternative operational requirement. Pu disposition data is based on the summation of the applicable alternatives maximum operational requirements.

[c] Data presented is the maximum change in site requirements due to No Action or downsizing secondary and case fabrication.

[d] Data represents the maximum value for the blending options at Y–12.

[e] Data not reported.

Note: MWe=megawatt electric.

Source: DOE 1995cc; DOE 1995dd; DOE 1996a; DOE 1996b; DOE 1996h; OR DOE 1994d; OR MMES 1995i.

Table 4.6.2.1–2 provides a listing of the site infrastructure related impacts associated with existing and other proposed actions at SRS. The cumulative impact of implementing the proposed blending facilities in conjunction with other proposed activities is expected to have little or no impact on the onsite road and rail network. The cumulative electrical power requirements for the proposed activities would be limiting. This results primarily from consideration of the accelerator production of tritium alternative of the Tritium Supply and Recycling program. Cumulative fuel consumption and water/steam supply requirements for all the proposed actions are readily available in the area and can be satisfied through normal contractual means.

Babcock & Wilcox. There are no proposed actions at B&W in the reasonably foreseeable future other than the blending of HEU received from Kazakhstan, which is currently being implemented. [Text deleted.] This action is part of B&W's current licensed operation, and because of this small quantity of HEU (approximately 600 kg [1,320 lb]), the blending operation is anticipated to be completed prior to the proposed action associated with this EIS.

Nuclear Fuel Services. No future activities are currently proposed for NFS other than existing licensed operations. Therefore, cumulative impacts at NFS would be similar to impacts analyzed for each alternative in this EIS.

4.6.2.2 Air Quality and Noise

Cumulative impacts to air quality constitute emission sources at each facility including no action and planned or proposed emissions. Only the cumulative impacts for criteria pollutants are presented since there are no anticipated toxic/nonradiological hazardous air pollutant releases from the surplus HEU disposition proposal. Cumulative radiological air emission impacts are considered in the public and occupational health section (Section 4.6.2.5). Concentrations of criteria pollutants are calculated from these emissions using site-specific meteorology, dispersion characteristics, terrain, and stack parameters. These criteria pollutant concentrations then are compared to Federal and state regulations and guidelines to determine compliance.

Each of the candidate sites, ORR, SRS, B&W, and NFS, is currently in compliance with Federal as well as state regulations and guidelines. Air emissions from the planned or proposed activities plus the no action emissions would increase concentrations of criteria pollutants. The cumulative impacts are presented in Tables 4.6.2.2–1 through 4.6.2.2–4 for each candidate site, respectively. The resulting concentrations from cumulative impacts would be in compliance with Federal and state regulations at each candidate site.

Oak Ridge Reservation. Cumulative impacts to air quality at ORR include impacts from no action emissions, HEU blending activities and the five documents listed in Section 4.6.1. Incremental increases in air pollutants result from each of these proposed activities and contribute to the cumulative impacts at the site. Estimated cumulative concentrations of criteria pollutants at ORR are presented in Table 4.6.2.2–1. The baseline includes impacts from the Y–12 EA and FONSI. [Text deleted.]

Savannah River Site. Cumulative impacts with respect to air quality at SRS include impacts from no action emissions, HEU blending activities and the 10 documents listed in Section 4.6.1. [Text deleted.] The resulting cumulative concentrations of criteria pollutants at SRS are shown in Table 4.6.2.2–2.

Babcock & Wilcox. Cumulative impacts to air quality at B&W include impacts from no action emissions of pollutants and HEU to LEU conversion and blending. Table 4.6.2.2–3 presents cumulative impacts for B&W.

Nuclear Fuel Services. Cumulative impacts to air quality at NFS include emissions of pollutants from no action and HEU to LEU conversion and blending. Table 4.6.2.2–4 presents cumulative impacts for NFS.

Cumulative noise impacts include contributions from existing and planned facilities plus proposed facilities at each of the candidate sites. Noise impacts may result both from onsite noise sources and from offsite sources such as traffic. Noise impacts on individuals from this alternative are expected to be small, resulting in little or no increase in noise levels at offsite areas. Little or no increase in cumulative noise impacts to individuals offsite is expected to occur.

Table 4.6.2.1–2. Site Infrastructure Cumulative Impacts at Savannah River Site

Category	No Action	SRS Consolidated Actions[a]	Tritium Supply and Recycle[b]	Foreign Research Reactor Spent Nuclear Fuel	Waste Management	Storage and Disposition[c]		Stockpile Stewardship and Management	HEU[d]	Total
						Storage	Disposition			
[Text deleted.]										
Energy (MWh/yr)	659,000	963,400	4,534,000	1,500	120,000	76,000	69,000	9,700	5,000	6,437,600
Peak Load (MWe)	130	[d]	666	[e]	[e]	13	15	1.6	2	828
Natural Gas (m^3/yr)	0	0	0	[e]	[e]	0	10,426,000[f]	0	19,800[g]	10,445,800
Diesel/oil (l/yr)	28,400,000	4,070,000	9,180,000	[e]	[e]	49,000	208,059,750	28,400	56,800	249,843,950
Coal (t/yr)	210,000	2,580	221,400	[e]	[e]	4,990	0	1,090	363	440,423
Water (million l/yr)	153,687	6,430	4,595	1.9	325	60,560	459	46	19	226,114
[Text deleted.]										

[a] Includes actions from Interim Management of Nuclear Material; F-Canyon Plutonium Solutions; Defense Waste Processing Facility; and Programmatic INEL Spent Nuclear Fuel; SRS Waste Management EIS data not reported.

[b] An Accelerator Production of Tritium is to be constructed at SRS.

[c] Storage data is based on the maximum applicable alternative operational requirement. Pu disposition data is based on the summation of the applicable alternatives maximum operational requirements.

[d] Data represents the maximum value for the blending options at SRS.

[e] Data not reported.

[f] Natural gas is not available at SRS; therefore, diesel/oil gas (approximately 14.8 million l) would be substituted for a natural gas requirement of 10.4 million m^3/year.

[g] Natural gas is not available at SRS; therefore, diesel/oil gas (approximately 28,200 l) would be substituted for a natural gas requirement of 19,800 m^3/year.

Note: MWe=megawatt electric.

Source: DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1995dd; DOE 1996a; DOE 1996b; DOE 1996g; SR DOE 1994a; SR DOE 1994b; SR DOE 1995b; SR DOE 1995c; SR DOE 1995e; SRS 1993a:3.

Table 4.6.2.2–1. Estimated Cumulative Concentrations of Criteria Pollutants at Oak Ridge Reservation

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Cumulative Concentration			
			No Action ($\mu g/m^3$)	Other Onsite Activities[a] ($\mu g/m^3$)	HEU ($\mu g/m^3$)	Total ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	5	9.7	11.5	26.2
	1 hour	40,000[b]	11	29.5	53	93.5
Lead (Pb)	Calendar Quarter	1.5[b]	0.05	[c]	[d]	0.05
Nitrogen dioxide (NO_2)	Annual	100[b]	3	0.9	1.33	5.23
Particulate matter (PM_{10})	Annual	50[b]	1	9.6	0.03	10.63
	24 hours	150[b]	2	27.6	0.37	29.97
Sulfur dioxide (SO_2)	Annual	80[b]	2	43.7	2.46	48.16
	24 hours	365[b]	32	20.2	29.3	81.5
	3 hours	1,300[b]	80	718	161	959
Mandated by Tennessee						
Total suspended particulates (TSP)	24 hours	150[e]	2	27.6	80.16	109.76
Gaseous fluorides (as HF)	1 month	1.2[e]	0.2	[c]	[d]	0.2
	1 week	1.6[e]	0.3	[c]	[d]	0.3
	24 hours	2.9[e]	<0.6	[c]	[d]	<0.6
	12 hours	3.7[e]	<0.6	[c]	[d]	<0.6
	8 hours	250[e]	0.6	[c]	[d]	0.6

[a] Other onsite activities including the Y–12 EA, Waste Management, Storage and Disposition, Stockpile Stewardship and Management, and Medical Isotope Production EIS.

[b] Federal standard.

[c] Data not available.

[d] No emissions from the proposed HEU blending activities.

[e] State standard or guideline.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; DOE 1995i; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996h; OR LMES 1995b; OR LMES 1995d; TN DEC 1994a; TN DHE 1991a.

Table 4.6.2.2–2. Estimated Cumulative Concentrations of Criteria Pollutants at Savannah River Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Cumulative Concentration			
			No Action ($\mu g/m^3$)	Other Onsite Activities[a] ($\mu g/m^3$)	HEU ($\mu g/m^3$)	Total ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	22	383	0.07	405.07
	1 hour	40,000[b]	171	1708	0.14	11879.14
Lead (Pb)	Calendar Quarter	1.5[b]	0.0004	[c]	[d]	0.0004
Nitrogen dioxide (NO_2)	Annual	100[b]	5.7	21	0.01	26.71
Particulate matter (PM_{10})	Annual	50[b]	3	0.2	<0.01	3.21
	24 hours	150[b]	50.6	8.5	<0.01	59.11
Sulfur dioxide (SO_2)	Annual	80[b]	14.5	2.2	0.02	59.11
	24 hours	365[b]	196	53.3	0.32	249.62
	3 hours	1,300[b]	823	335	0.71	1158.71
Mandated by South Carolina						
Total suspended particulates (TSP)	Annual	75[e]	12.6	0.2	0.05	12.85
Gaseous fluorides (as HF)	1 month	0.8[e]	0.09	[c]	[d]	0.09
	1 week	1.6[e]	0.39	[c]	[d]	0.39
	24 hours	2.9[e]	1.04	[c]	[d]	1.04
	12 hours	3.7[e]	1.99	[c]	[d]	1.99

[a] Other onsite activities including the Interim Management of Nuclear Materials, Tritium Supply and Recycling, F-Canyon Plutonium Solutions, Defense Waste Processing Facility, Foreign Research Spent Nuclear Fuel, INEL Spent Nuclear Fuel Management, SRS Waste Management, Waste Management, Storage and Disposition, and Stockpile Stewardship and Management.

[b] Federal standard.

[c] Data not available.

[d] No emissions from the HEU blending activities.

[e] State standard or guideline.

Note: Ozone, as a criteria pollutant, is not directly emitted nor monitored by the candidate sites.

Source: 40 CFR 50; DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996g; OR LMES 1995b; OR LMES 1995d; SC DHEC 1992b; SR DOE 1994a; SR DOE 1994b; SR DOE 1995b.

Table 4.6.2.2–3. Estimated Cumulative Concentrations of Criteria Pollutants at Babcock & Wilcox

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Cumulative Concentration		
			No Action ($\mu g/m^3$)	HEU ($\mu g/m^3$)	Total ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	4	5.43	9.43
	1 hour	40,000[a]	13.1	17.63	30.73
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[c]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	3.5	0.14	3.64
Particulate matter (PM_{10})	Annual	50[a]	0.02	0.03	0.05
	24 hours	150[a]	0.16	0.19	0.35
Sulfur dioxide (SO_2)	Annual	80[a]	0.34	0.4	0.74
	24 hours	365[a]	2.28	2.74	5.02
	3 hours	1,300[a]	11.8	14.11	25.91
Mandated by Virginia					
Total suspended particulates (TSP)	Annual	60[d]	0.03	0.03	0.06
	24 hours	150[d]	0.22	0.19	0.41

[a] Federal standard.

[b] Data not available.

[c] No emissions from the proposed HEU blending activities.

[d] State standard or guideline.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; DOE 1995u; OR LMES 1995b; VA APCB 1993a; VA DEQ 1995a; VA DEQ 1995b.

Table 4.6.2.2–4. Estimated Cumulative Concentrations of Criteria Pollutants at Nuclear Fuel Services

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	Cumulative Concentration		
			No Action ($\mu g/m^3$)	HEU ($\mu g/m^3$)	Total ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[a]	1.97	0.62	2.59
	1 hour	40,000[a]	2.52	0.80	3.32
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[c]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	0.62	0.03	0.65
Particulate matter (PM_{10})	Annual	50[a]	0.03	<0.01	0.04
	24 hours	150[a]	0.21	0.03	0.24
Sulfur dioxide (SO_2)	Annual	80[a]	0.02	0.05	0.07
	24 hours	365[a]	0.15	0.40	0.55
	3 hours	1,300[a]	0.35	0.96	1.31
Mandated by Tennessee					
Total suspended particulates (TSP)	24 hours	150[d]	0.21	0.03	0.24
Gaseous fluorides (as HF)	1 month	1.2[d]	0.02	trace[e]	0.02
	1 week	1.6[d]	<0.06	trace[e]	<0.06
	24 hours	2.9[d]	0.06	trace[e]	0.06
	12 hours	3.7[d]	0.10	trace[e]	0.10
	8 hours	250[d]	0.11	trace[e]	0.11

[a] Federal standard.

[b] Data not available.

[c] No emissions from the proposed HEU blending activities.

[d] State standard or guideline.

[e] Hydrofluorination is anticipated to be a closed system with a scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; NF NRC 1991a; OR LMES 1995b; TN DEC 1994a; TN DEC nda; TN DHE 1991a.

4.6.2.3 Water Resources

Implementation of decisions associated with the HEU disposition proposed action would contribute minimal water resource impacts at each site. The potential effect of these actions on cumulative impacts for each site is discussed below.

Oak Ridge Reservation. The operation of a UNH blending facility alternative would have the greatest impact on water resources at ORR, among other blending alternatives evaluated in this EIS. Other operations and new facilities planned that could add cumulative impacts to water resources are those associated with the five other DOE programs identified in Section 4.6.1 and current DOE operations. [Text deleted.]

Table 4.6.2.3–1 summarizes the estimated cumulative water usage from the Clinch River. Water requirements during the operation of all the proposed projects would be obtained from the Clinch River. Total cumulative water requirements for the site (76,643 million l/yr [20,247 MGY]) would be 1.8 percent of the Clinch River's average flow (132 m^3/s [4,661 ft^3/s]). The proposed UNH blending facility would account for approximately 0.03 percent of the cumulative water usage.

Among the alternatives evaluated in this EIS, the operation of a UNH blending facility alternative would have the greatest impact on water quality at ORR. Table 4.6.2.3–2 summarizes the estimated cumulative water discharge to the Clinch River via Bear Creek, McCoy Branch, Rogers Quarry, and East Fork Poplar Creek. [Text deleted.]Total estimated cumulative wastewater discharge (13,141 million/yr [3,472 MGY]) would be discharged to East Fork Popular Creek and Clinch River. The proposed UNH blending facility would account for 0.1 percent of the total estimated cumulative wastewater discharge.

If all the wastewater were to be discharged to East Fork Popular Creek, the total cumulative amount (13,141 million l/yr [3,472 MGY]) would represent approximately 32 percent of the average flow (1.3 m^3/s [45 ft^3/s]). All wastewater effluent from treatment facilities would be released on a continuous basis, without causing impacts to the creek or to downstream users. Unlike wastewater effluent from treatment facilities, cooling system

Table 4.6.2.3–1. Cumulative Annual Water Usage at Oak Ridge Reservation[a, b]

Program	Water Requirement (million l/yr)
No Action	14,210[c]
[Text deleted.]	
Waste Management	814.5[b]
Storage and Disposition	60,930[b, d]
Stockpile Stewardship and Management	550
Proposed Medical Isotope Production	120[b]
HEU	19[b]
Total annual cumulative water usage	76,644

[a] Includes both groundwater and surface water usage.
[b] Data represents the maximum value for the comparative alternative scenario.
[c] Y–12 EA included in current ORR water usage.
[d] Includes 370 million l/yr for the storage alternative and 60,560 million l/yr for the disposition alternative.
[Text deleted.]
Source: DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996h; OR LMES 1995b; OR MMES 1995i.

Table 4.6.2.3–2. Cumulative Annual Wastewater Discharge at Oak Ridge Reservation

Program	Nonhazardous Sanitary and Industrial (million l/yr)
No Action	1,858[a, b]
[Text deleted.]	
Waste Management	101.9[c]
Storage and Disposition	11,162[c, d]
Stockpile Stewardship and Management	0[e]
Proposed Medical Isotope Production	f
HEU	18.7[c]
Total annual cumulative treated wastewater discharged	13,141

[a] Includes nonhazardous sanitary and nonhazardous wastewater discharges from ORR activities.
[b] Y–12 EA, no number was reported.
[c] Based on the highest treated volumes from the alternative scenario.
[Text deleted.]
[d] Includes wastewater from the storage alternative 185 million l/yr and 10,977 million l/yr for the disposition alternative.
[e] Would not releasing additional wastewater.
[f] No number was reported.
Source: DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996h; OR LMES 1995b; OR MMES 1995i.

blowdown activities associated with the Storage and Disposition Program would discharge greater quantities over a shorter period of time. These discharges would cause scouring of streambeds, erosion of stream channels, increased turbidity, and potential flooding of areas.

All the wastewater discharged to the sub-drainage basins on the ORR flows directly to the Clinch River. The total cumulative wastewater discharge (13,141 million l/yr [3,472 MGY]) would represent approximately 0.3 percent of the average flow of the river (132 m^3/s [4,647 ft^3/s]) and would therefore have no adverse effect on flow or downstream users. All discharges would be monitored to comply with NPDES permit limits.

Existing ORR treatment facilities could accommodate all the new cumulative process and wastewater streams. The expected total cumulative wastewater discharge to the tributaries, 13,141 million l/yr (3,472 MGY), would continue to meet NPDES limits and reporting requirements. DOE is currently involved with the remediation of East Fork Poplar Creek under CERCLA, because the creek was contaminated by past releases from the Y–12 Plant. Significant clean-up activities are required on- and off-site.

Savannah River Site. Among the alternatives evaluated in this EIS, the operation of a UNH blending facility would have the greatest impact on water resources at SRS. Table 4.6.2.3–3 summarizes the estimated cumulative water usage from the Savannah River and groundwater. Water requirements during operation of all the proposed projects would be obtained from existing or new well fields at SRS and from the Savannah River. Total cumulative water requirements for the site (226,115 million l/yr [59,733 MGY]) would be a 47-percent increase over current usage. Of the 226,115 million l/yr (59,733 MGY), approximately 200,000 million l/yr (52,840 MGY) would be supplied by surface water. This amount is 2.3 percent of the Savannah River's average flow and 3.5 percent of the river's minimum flow. After treatment, most of the water withdrawn is returned to the Savannah River through its onsite tributaries and would not affect downstream users. The remaining water requirements would be withdrawn from groundwater sources. Suitable groundwater from the deep aquifers at the site is abundant and aquifer depletion is not a problem. Pumping from the deep aquifer to meet domestic, process and other water uses has continued since the early 1950s. This usage has not adversely affected water levels in the deep aquifer. The proposed UNH blending facility would account for 0.008 percent of the total cumulative water usage.

Table 4.6.2.3–3. Cumulative Annual Water Usage at Savannah River Site

Program	Water Requirement (million l/yr)[a]
No Action	153,687
Interim Management of Nuclear Materials	5,100[b]
Tritium Supply and Recycling	4,595[c]
F-Canyon Plutonium Solutions	1,190[b]
Defense Waste Processing Facility	91.2[b]
Foreign Research Spent Nuclear Fuel	1.9[b]
Programmatic INEL Spent Nuclear Fuel Management	49[b]
Waste Management	325[b, d]
Storage and Disposition	61,010[b, d, e]
Stockpile Stewardship and Management	46[b, d]
HEU	19[b]
Total annual cumulative water usage	226,114

[a] Includes both groundwater and surface water usage.
[b] Based on comparative alternative scenario.
[Text deleted.]
[c] An accelerated production of tritium facility is to be constructed at SRS.
[d] Based on preliminary data.
[e] Includes 450 million l/yr for the storage alternative and 60,560 million l/yr for the disposition alternative.
Source: DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996g; OR LMES 1995b; SR DOE 1994a; SR DOE 1994b; SR DOE 1995e; SRS 1995a:2.

Among the alternatives evaluated in this EIS, the operation of a UNH blending facility would have the greatest effect on wastewater discharge to the Savannah River. Table 4.6.2.3–4 summarizes the estimated treated wastewater discharge to the Savannah River. Total cumulative wastewater discharge (13,087 million l/yr [3,457 MGY]) would be 0.15 percent of the average Savannah River flow.

[Text deleted.]

The proposed UNH blending facility would account for 0.14 percent of total estimated cumulative waste water discharge to the Savannah River and

Table 4.6.2.3–4. Cumulative Annual Wastewater Discharge at Savannah River Site

Program	Nonhazardous Sanitary and Industrial (million l/yr)
No Action	731.6[a]
Interim Management of Nuclear Materials	0[b]
Tritium Supply and Recycling	908[c]
F-Canyon Plutonium Solutions	[a]
Defense Waste Processing Facility	52.6[d]
Foreign Research Spent Nuclear Fuel	1.9[d]
Programmatic INEL Spent Nuclear Fuel Management	49[d]
Waste Management	83[d, e]
Storage and Disposition	11,196.6[e, f]
Stockpile Stewardship and Management	46[d, e]
HEU	18.7[d]
Total annual wastewater discharges to the Savannah River	13,087

[a] Currently discharged from the Centralized Sanitary Wastewater Treatment Plant (730 million l/yr) and the F- and H-Area effluent treatment facility (1.6 million l/yr).

[b] No number reported.

[c] An accelerated production of tritium facility is to be constructed at SRS.

[d] Based on the highest treated volumes from the alternative scenarios.

[e] Based on preliminary data.

[f] Includes 219.6 million l/yr for the storage alternative and 10,977 million l/yr for the disposition alternative.

Source: DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996g; OR LMES 1995b; SR DOE 1994a; SR DOE 1994b; SR DOE 1995e; SRS 1995a:2.

2.2 percent of the wastewater treated at the Centralized Sanitary Waste Water Treatment Plant.

Existing SRS treatment facilities could accommodate all the new cumulative process and wastewater streams if a new facility is built for tritium supply and recycle operations as planned. The expected total cumulative wastewater discharge to the tributaries, 13,087 million l/yr (3,457 MGY), would continue to meet NPDES limits and reporting requirements

Downstream (approximately 130 river miles or 210 km), the Beaufort-Jasper Water Authority in South Carolina withdraws approximately 7,200 million l/yr (1,900 MGY) to a population of about 51,000 persons. By the year 2000, Beaufort-Jasper plans to supply water to 177,000 persons. The Cherokee Hill Water Treatment Plant (130 river miles or 210 km) downstream withdraws about 4,200 million l/yr (1,110 MGY) and plans to supply a domestic equivalent of 200,000 persons in the future.

Babcock & Wilcox. No future activities are currently proposed for B&W that would add cumulatively to the site's water usage or affect water quality. Therefore the cumulative impacts for water resources would be similar to the impacts analyzed for each alternative in this EIS.

[Text deleted.]

[Table deleted.]

Nuclear Fuel Services. No future activities are currently proposed for NFS that would add cumulatively to the site's water usage or affect water quality. Therefore, the cumulative impacts for water resources would be similar to the impacts analyzed for each alternative in this EIS.

[Table deleted.]

4.6.2.4 Socioeconomics

Implementation of decisions associated with the surplus HEU disposition proposed action would contribute minimal socioeconomic impacts on the regions. The potential effect of these actions on cumulative impacts for each site is discussed below.

Oak Ridge Reservation. The cumulative impacts resulting from HEU blending facilities at ORR on the regional economy, population, housing, community services, and local transportation would be minor (see Appendix F). A maximum of 125 direct jobs and

319 indirect jobs in the local economy would be created for this proposed action. In addition to the existing conditions, and the HEU blending program, there are five other DOE documents identified in Section 4.6.1 included in the cumulative analysis. [Text deleted.]

If all of the alternatives were located at this site, the maximum possible total of 9,000 peak construction jobs and 5,000 operations jobs would be created. This would generate a total of approximately 13,000 indirect jobs on the local economy. This is approximately 3 percent of the civilian labor force for the ORR REA.

These increases would generally be beneficial to the economy, providing new jobs and increased revenues in the ROI. However, in-migrating workers would be required to fill a portion of the new jobs created, which would require an increase in housing units and community services. Additionally, new road construction may be needed to handle traffic increases in the ROI.

The temporary nature of construction-related jobs coupled with the differences in peak employment years between the various alternatives would lessen any impacts associated with the construction phase. Operation-related jobs would have a more permanent impact on the region. Phasing in the operation employment and training for each program would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

Savannah River Site. The cumulative impacts resulting from the proposed HEU blending facilities at SRS on the regional economy, population, housing, community services, and local transportation would be minor (see Appendix F). A maximum of 125 direct jobs and 245 indirect jobs in the local economy would be created. In addition to the existing conditions and the HEU blending program, there are 10 other DOE documents identified in Section 4.6.1 included in the cumulative analysis. Programs being considered for SRS include the Storage and Disposition of Weapons-Usable Fissile Materials which would generate a maximum of 8,900 peak year construction-related jobs and 6,300 operation-related jobs and Stockpile Stewardship and Management which would create about 280 peak year construction-related and 810 operation-related jobs. The SRS IMNM EIS indicates that it is unlikely that new jobs would be created at SRS to support this program. The Tritium Supply and Recycling mission would generate approximately 1,400 peak year construction-related and 630 operation-related jobs. The *SRS Defense Waste Processing Facility Supplemental EIS* estimates this program would create a maximum of 270 peak year construction-related jobs but there would be no new operation-related jobs. Also, the *Programmatic Spent Nuclear Fuel Management and INEL Restoration and the Waste Management Program EIS* estimates this mission would generate a maximum of 2,700 peak year construction-related jobs but there would be no new operations-related jobs.

If all of the proposed alternatives were simultaneously sited at SRS, approximately 14,000 peak year construction-related and less than 8,000 operation-related jobs would be created. This would generate about 16,000 new indirect jobs during full operation in the local region which would lead to about an 8 percent increase in the civilian labor force in the SRS REA. These increases would generally be beneficial to the economy, providing new jobs and increased revenues in the ROI. However, in-migrating workers would be required to fill a portion of the new jobs created which would require an increase in housing units and community services. Additionally, new road construction may be needed to handle traffic increases in the ROI.

The temporary nature of construction-related jobs coupled with the differences in peak employment years between the various alternatives would lessen any impacts associated with the construction phase. Operation-related jobs would have a more permanent impact on the region. Phasing in the operation employment and training for each program would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

Babcock & Wilcox. The cumulative impacts resulting from the proposed HEU blending facilities at B&W on the regional economy, population, housing, community services, and local transportation would be minor. The maximum number of direct jobs created by the HEU program

should not exceed 126 at the site and another 285 indirect jobs in the regional economy. The other programs currently being considered for B&W, the disposition of Kazakhstan HEU, would be absorbed by the current workforce. [Text deleted.] The impact of this small number of jobs generated by the HEU program would be a slight improvement in the regional economy, the housing market would not be burdened, but road congestion may worsen due to increased traffic. A summary of the socioeconomic impacts of operating an HEU blending facility at B&W are presented in Appendix F of this document.

Nuclear Fuel Services. No future activities are currently being proposed for NFS other than existing licensed operations. Therefore, cumulative impacts at NFS would be similar to the impacts analyzed for each alternative in this EIS.

4.6.2.5 Public and Occupational Health

The cumulative radiological doses and resulting health effects are summarized in Table 4.6.2.5–1 for each of the four sites being assessed in this EIS. [Text deleted.]In regard to the presented cumulative impact results, it should be noted that SRS could exceed the proposed population dose reporting limit (58 FR 16268) of 100 person-rem/yr if certain activities (as shown in Table 4.6.2.5–1) are in an operational mode during the years in which blending processes are to be in effect. Furthermore, it should also be noted that the total cumulative SRS site dose to the MEI would not exceed the 100 mrem/yr limit; however, the 10 mrem/yr limit due to airborne releases (*Clean Air Act*) could be exceeded if key potential activities at the site were operational at the same time as the blending processes. However, the 100 person-rem/yr is only a proposed notification requirement. No mitigation measures would be required at this point. With the exception of no action, the values presented in this table are projected estimates and do not reflect actual doses and resulting health effects. This potential limit exceedance however, conservatively assumes that the MEI would have to be located at several different receptor points simultaneously, therefore representing an upper-bounding scenario. The cumulative chemical exposure risk and resulting health effects are summarized in Table 4.6.2.5–2 for each of the four sites being addressed in this EIS.

4.6.2.6 Waste Management

Implementation of decisions associated with surplus HEU disposition proposed actions would impact waste management activities at each of the candidate sites. The following sections discuss how waste management activities would be affected cumulatively at each site.

Oak Ridge Reservation. ORR is a candidate site for HEU blending and in five documents identified in Section 4.6.1. The largest impact results if ORR is selected as a regional disposal site under one of the Regionalized Alternatives in the Waste Management PEIS. The next largest impact is expected from the Collocation Storage option in the Storage and Disposition PEIS. As illustrated in Table 4.6.2.6–1, it is expected that surplus HEU blending alternatives would have consistently smaller impacts than other foreseeable activities. Thus, the impact of blending HEU to LEU is small compared to the cumulative impacts of other potential actions at ORR.

Savannah River Site. The SRS is a candidate site for HEU blending and in 10 documents identified in Section 4.6.1. The largest impact on radioactive waste management would result if SRS is selected for a regional treatment and disposal facility for LLW and mixed LLW as a result of the ROD from the Waste Management PEIS. The next largest radioactive waste management impact would occur if the ROD selects the preferred actions recommended in the *Interim Management of Nuclear Materials EIS*. The largest impact on nonhazardous liquid waste management would occur as a result of the ROD from the *PEIS for Tritium Supply and Recycling* and/or if SRS were selected as a reactor site for plutonium disposition in the ROD resulting from the Storage and Disposition PEIS. The largest impact on hazardous waste management would result if SRS was selected for a mixed oxide fuel fabrication mission in the ROD from the Storage and Disposition PEIS.

As illustrated in Table 4.6.2.6–2 it is expected that the surplus HEU blending alternatives would have consistently smaller impacts than other foreseeable activities; thus, the overall impact of blending HEU to LEU would not contribute significantly to cumulative impacts at SRS.

Table 4.6.2.5–1. Estimated Average Annual Cumulative Radiological Doses and Resulting Health Effects to Offsite Population and Facility Workers

Program	Maximally Exposed Individual		Total Population Within 80 km[a]		Workers	
	Total Dose[b] (rem)	Fatal Cancer Risk[c]	Total Dose[d] (person-rem)	Number of Fatal Cancers[c]	Total Dose[e] (person-rem)	Number of Fatal Cancers[c]
Oak Ridge Reservation						
No Action	$3.0x10^{-3}$	$1.5x10^{-6}$	28	$1.4x10^{-2}$	68	$2.7x10^{-2}$
Y–12 Interim Storage	$1.3x10^{-3}$	$6.5x10^{-7}$	12	$6.0x10^{-3}$	12.9	$5.2x10^{-3}$
Waste Management	$5.8x10^{-4}$	$2.9x10^{-7}$	19	$9.4x10^{-3}$	0.45	$1.8x10^{-4}$
Storage and Disposition	$4.6x10^{-8}$	$2.3x10^{-11}$	$8.2x10^{-4}$	$4.1x10^{-7}$	24	$9.6x10^{-3}$
Stockpile Stewardship and Management[f]	$2.0x10^{-4}$	$1.0x10^{-7}$	0.6	$3.0x10^{-4}$	-1.8	$-7.2x10^{-4}$
Proposed Medical Isotope Production	$3.1x10^{-4}$	$1.6x10^{-7}$	15	$7.5x10^{-3}$	25	$1.0x10^{-2}$
HEU	$3.9x10^{-5}$	$2.0x10^{-8}$	0.16	$8.0x10^{-5}$	11.3	$4.5x10^{-3}$
[Text deleted.]						
Savannah River Site						
No Action	$3.2x10^{-4}$	$1.6x10^{-7}$	21.5	$1.1x10^{-2}$	216	$8.6x10^{-2}$
Interim Management of Nuclear Materials	$2.8x10^{-3}$	$1.4x10^{-6}$	110	$5.5x10^{-2}$	140	$5.6x10^{-2}$
Tritium Supply and Recycling	$2.5x10^{-3}$	$1.2x10^{-6}$	210	0.11	42	$1.7x10^{-2}$
F-Canyon Plutonium Solutions	$8.9x10^{-6}$	$4.5x10^{-9}$	0.38	$1.9x10^{-4}$	131	$5.2x10^{-2}$
Defense Waste Processing Facility	$1.0x10^{-6}$	$5.0x10^{-10}$	$7.0x10^{-2}$	$3.5x10^{-5}$	118	$4.7x10^{-2}$
Foreign Reactor Spent Fuel	$1.8x10^{-7}$	$9.0x10^{-11}$	$8.6x10^{-3}$	$4.3x10^{-6}$	32	$1.3x10^{-2}$
INEL Spent Nuclear Fuel	$5.0x10^{-4}$	$2.5x10^{-7}$	18.4	$9.2x10^{-3}$	76	$3.4x10^{-2}$
Waste Management[g]	$3.3x10^{-5}$	$1.7x10^{-8}$	1.5	$7.4x10^{-4}$	81	$3.2x10^{-2}$
Storage and Disposition	$1.4x10^{-8}$	$7.0x10^{-12}$	$7.8x10^{-4}$	$3.9x10^{-7}$	24	$9.6x10^{-3}$
Stockpile Stewardship and Management	$1.0x10^{-8}$	$5.0x10^{-12}$	$5.9x10^{-4}$	$3.0x10^{-7}$	156	$6.2x10^{-2}$
Vogtle Nuclear Plant[h]	$1.7x10^{-4}$	$8.5x10^{-8}$	$5.7x10^{-2}$	$2.9x10^{-5}$	NA	NA
HEU	$2.5x10^{-6}$	$1.3x10^{-9}$	0.16	$8.0x10^{-5}$	11.3	$4.5x10^{-3}$
[Text deleted.]						

Table 4.6.2.5–1. Estimated Average Annual Cumulative Radiological Doses and Resulting Health Effects to Offsite Population and Facility Workers—Continued

Program	Maximally Exposed Individual		Total Population Within 80 km[a]		Workers	
	Total Dose[b] (rem)	Fatal Cancer Risk[c]	Total Dose[d] (person-rem)	Number of Fatal Cancers[c]	Total Dose[e] (person-rem)	Number of Fatal Cancers[c]
Babcock & Wilcox[i]						
No Action[j]	5.0×10^{-5}	2.5×10^{-8}	0.35	1.8×10^{-4}	18	7.2×10^{-3}
HEU	3.5×10^{-6}	1.8×10^{-9}	3.2×10^{-2}	1.6×10^{-5}	14.5	5.8×10^{-3}
[Text deleted.]						
Nuclear Fuel Services						
No Action	3.3×10^{-5}	1.7×10^{-8}	0.2	1.0×10^{-4}	16.3	6.5×10^{-3}
HEU	2.5×10^{-4}	1.3×10^{-7}	2.3	1.2×10^{-3}	14.5	5.8×10^{-3}
[Text deleted.]						

[a] Collective dose to the 80-km population surrounding each given site.

[b] The applicable limits for an individual member of the public from total site (DOE and commercial) operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathway, 100 mrem/yr from all pathways combined for DOE sites, and 25 mrem/yr from all pathways combined for commercial sites.

[c] Annual incidence of excess fatal cancers.

[d] Proposed 10 CFR 834 (58 FR 16268) includes the requirement that the contractor who operates a DOE site notify DOE if the potential annual population dose exceeds 100 person-rem from all pathways combined.

[Text deleted.]

[e] Dose presented is for the total workforce.

[f] The negative values for worker dose and fatal cancer would be due to the proposed reduction in program operations.

[g] Data presented within the SRS Waste Management EIS.

[h] The Vogtle Nuclear Plant is not located within the confines of the SRS boundary.

[i] Included impacts from B&W Commercial Fuel Operations.

[j] Includes impacts of Kazakhstan EA.

Note: NA=not applicable. Program totals are not presented because resulting summations would not accurately convey a "true" aggregate of potential site activities. This is due to different modeling techniques and parameters being employed in the respective impact evaluations.

Source: BW NRC 1991a; DOE 1993n:7; DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996g; DOE 1996h; NF NRC 1991a; NRC 1995b; OR DOE 1994c; OR DOE 1994d; SR DOE 1994a; SR DOE 1994b; SR DOE 1994e; SR DOE 1995b; SR DOE 1995e; WSRC 1994d.

Table 4.6.2.5–2. Cumulative Chemical Exposure Risk and Resulting Health Effects at Each of the Alternative Sites

Program	Maximally Exposed Individual		Onsite Worker	
	Hazard Index[a]	Cancer Risk[b]	Hazard Index[c]	Cancer Risk[d]
Oak Ridge Reservation				
No Action	3.95×10^{-2}	0	0.154	0
HEU	3.84×10^{-4}	1.21×10^{-15}	1.26×10^{-3}	2.75×10^{-14}
Total	3.99×10^{-2}	1.21×10^{-15}	0.155	2.75×10^{-14}
Savannah River Site				
No Action	5.16×10^{-3}	1.31×10^{-7}	1.16	1.94×10^{-4}
Tritium Supply and Recycling	4.10×10^{-3}	0	0.71	0
Interim Management of Nuclear Material	2.81×10^{-3}	0	1.04×10^{-3}	0
INEL Spent Nuclear Fuel	3.00×10^{-3}	0	1.00×10^{-3}	0
Defense Waste Processing Facility	1.00×10^{-3}	1.00×10^{-8}	3.00×10^{-3}	1.00×10^{-10}
HEU	4.26×10^{-5}	1.35×10^{-15}	1.13×10^{-3}	2.47×10^{-14}
Total	1.61×10^{-2}	1.41×10^{-7}	1.88	1.94×10^{-4}
Babcock & Wilcox				
No Action	1.15×10^{-5}	1.68×10^{-8}	4.07×10^{-3}	3.94×10^{-5}
HEU	1.54×10^{-6}	2.74×10^{-16}	5.70×10^{-4}	6.42×10^{-13}
Total	1.29×10^{-5}	1.68×10^{-8}	4.64×10^{-3}	3.94×10^{-5}
Nuclear Fuel Services				
No Action	9.55×10^{-2}	0	7.57×10^{-3}	0
HEU	2.10×10^{-3}	1.23×10^{-14}	7.81×10^{-4}	3.24×10^{-14}
Total	9.77×10^{-2}	1.23×10^{-14}	8.35×10^{-3}	3.24×10^{-14}

[a] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

[b] Lifetime cancer risk=(Emission concentrations) x (0.286 [converts concentrations to doses]) x (slope factor)

[c] Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[d] Lifetime cancer risk=(Emissions for 8 hr) x ((0.286 [converts concentrations to doses]) x (0.237 [Fraction of year exposed]) x (0.571 [Fraction of lifetime working]) x (slope factor)

Source: NFS 1995b:2; OR MMES 1995i; SRS 1995a:2; SRS 1996a:1; VA DEQ 1995a.

Table 4.6.2.6–1. Waste Management Cumulative Impacts at Oak Ridge Reservation, Annual Generated Volumes

Waste Category	No Action[a] (m^3)	Waste Management (m^3)	Storage and Disposition[b] (m^3)	Stockpile Stewardship and Management[c] (m^3)	Medical Isotopes (m^3)	HEU[d] (m^3)	Total (m^3)
Low-Level							
Liquid	2,576	0	17	0	Included in solid	280	2,873
Solid	8,030	16,219[e]	1,300	0	63	545	26,157
Mixed Low-Level							
Liquid	84,210	0	0	0	0	50	84,260
Solid	960	3,543[f]	67	0	0	0	4,570
Hazardous							
Liquid	32,640	Included in solid	2	0	0	90	32,732
Solid	1,434	1,124[g]	2	0	0	0	2,560
Nonhazardous							
Liquid	1,743,000	64,842	171,830	0	0	19,000	1,583,672
Solid	52,730	Not analyzed	870	0	0	820	54,420

[a] Includes actions from the Y–12 EA/FONSI.

[b] Consolidation of Pu storage collocated with HEU storage.

[c] No Action.

[d] Largest generated volumes from the two blending options.

[e] Regionalization alternative in which ORR treats and disposes of wastes from onsite and from Ames, ANL-E, Bettis, BNL, FEMP, Fermi, KAPL, KCP, Mound, PGDP, PORTS, PPPL, RMI, and WVDP.

[f] Regionalization alternative in which ORR treats and disposes of wastes from onsite and from Ames, ANL-E, BCL, Bettis, BNL, FEMP, KAPL, KCP, Mound, PGDP, PORTS NAV, PORTS, PPPL, RMI, WVDP, and U of MO.

[g] Regionalization alternative in which ORR treats and disposes of wastes from onsite and from ANL-E, Fermi, KCP and SRS.

Source: 60 FR 55249; DOE 1995cc; DOE 1995dd; DOE1996a; DOE 1996b; DOE 1996h; Table 4.2.10-1.

Table 4.6.2.6–2. Waste Management Cumulative Impacts at Savannah River Site, Annual Generated Volumes

Waste Category	1993 Generation (m^3)	SRS Consolidated Actions[a] (m^3)	Interim Management of Nuclear Materials (m^3)	Tritium Supply and Recycling (m^3)	Waste Management (m^3)	Storage and Disposition[b] (m^3)	Stockpile Stewardship and Management[c] (m^3)	HEU (m^3)	Total[d] (m^3)
Low-Level									
Liquid	0	0	No data	0	0	18,949	80	22	19,051
Solid	14,100	57,900	21,000	416	26,835[e]	2,468	88	76	122,467
Mixed Low-Level									
Liquid	115	Included in solid	No data	0	0	0	0	46	161
Solid	18	2,203	190	5	340[f]	235	0	0	2,986
Hazardous									
Liquid	Included in solid	Included in solid	0	0	Included in solid	45	1	88	134
Solid	74	Included in mixed	Included in mixed	2	151[g]	191	0	0	416
Nonhazardous									
Liquid	700,000	Not analyzed	No data	925,076	35,417	23,983,500	46,200	18,773	24,783,890
Solid	6,670	Not analyzed	No data	917	0	15,069	2,900	820	25,459

[a] Includes preferred alternatives or RODs from Defense Waste Processing Facility Supplemental EIS, Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS, Proposed Nonproliferation Policy on Foreign Research Reactor Spent Fuel EIS, Stabilization of F-Canyon Plutonium Solutions EIS, and SRS Waste Management EIS.

[b] Pit Conversion, Pu Conversion, MOX Fuel, and Reactor Alternatives.

[c] Pit Fabrication Alternative.

[d] Does not include Tritium Supply and Recycling Program because the evolutionary reactor for Storage and Disposition would also fulfill the tritium supply and recycling function.

[e] Regionalization alternative in which SRS disposes of wastes from onsite and from Ames, ANL-E, Bettis, BNL, FEMP, Fermi, KAPL, KCP, Mound, ORR, PGDP, Pinellas, PMGDP, PPPL, RMI and WVDP.

[f] Regionalization alternative in which SRS treats and disposes of wastes from onsite and from Bettis, Charleston, Mound, Norfolk, Pinellas, U of MO, and WVDP.

[g] Decentralized alternative in which SRS treats and disposes of onsite generated wastes.

Source: 60 FR 63878; 60 FR 65300;DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1995dd; DOE 1996a; DOE 1996b; DOE 1996g; SR DOE 1994a; SR DOE 1994b; SR DOE 1995b; SR DOE 1995c; SR DOE 1995e.

Babcock & Wilcox. There are no proposed actions at B&W in the reasonably foreseeable future for which an EIS is currently being prepared. [Text deleted.]. The operation of the proposed action, the blending of HEU received from Kazakhstan, is currently being implemented. This action is assumed to be part of B&W's current licensed operation and because of the small quantity of this HEU (approximately 600 kg [1,320 lb]), the blending operation is anticipated to be completed prior to the proposed action associated with this EIS.

Nuclear Fuel Services. No future activities are currently proposed for NFS other than existing licensed operations; therefore, cumulative impacts at NFS would be similar to the impacts analyzed for each alternative in this EIS.

4.7 AVOIDED ENVIRONMENTAL IMPACTS OF BLENDING SURPLUS HIGHLY ENRICHED URANIUM TO LOW-ENRICHED URANIUM FOR NUCLEAR POWER PLANTS

In blending surplus HEU to LEU for commercial nuclear power reactor use, part of the current nuclear fuel cycle in commercial nuclear power plants can be replaced. The nuclear fuel cycle for commercial nuclear power plants normally begins with mining uranium ore and ends with the disposal of the final radioactive wastes or the reprocessing of spent nuclear fuels. The typical light water reactor fuel cycle without spent fuel reprocessing in the United States is illustrated in Table 4.7–1. The blending of surplus HEU to commercial reactor fuel will replace the fuel cycle steps from uranium ore mining through uranium enrichment.

In the light water reactor uranium fuel cycle process, the most significant contributions to the adverse impact on human health and the environment are the uranium mining, uranium milling, and uranium conversion (from U_3O_8 to UF_6). The other nuclear fuel cycle processes (for example, enrichment plants and fuel fabrication plants) have considerably lower radioactive emissions than mining, milling, and conversion. A summary of the radiological atmospheric emissions of radioactive materials from these processes is shown in Table 4.7–2. The radionuclides released from the liquid effluent are considerably less than the atmospheric emission and are not included in this table.

Table 4.7–1. Comparison of Current Fuel Cycle and Highly Enriched Uranium Blending Fuel Cycle

Step	Current Fuel Cycle	HEU Blending Fuel Cycle
1	Uranium mining	NA
2	Uranium milling	NA
3	Uranium conversion	NA
4	Uranium enrichment	Blending HEU to LEU
5	Uranium preparation and uranium fuel element fabrication	Uranium preparation and uranium fuel element fabrication
6	Nuclear power plants fueling—burning in the reactor	Nuclear power plants fueling—burning in the reactor
7	Spent fuel storage	Spent fuel storage

Note: NA=not applicable.

Typical uranium concentration for fresh light water reactor fuel is about 4-percent U-235. The average reactor core (1,000 megawatt electric [MWe]) inventory is about 90 t and about one-third of the core will be replaced by fresh fuel elements each time the reactor is refueled. Therefore, approximately 30 t of LEU fuel is required for a light water reactor refueling annually.

Based on the assumptions described in Section 2.2.2, the blending rate for surplus HEU (with U-235 enrichment of 50 percent) at each candidate blending site would be 10 t/yr. This blending rate will subsequently produce 150 t/yr of uranium fuel with 4-percent enrichment. This amount of uranium fuel can be used to refuel about five currently operating light water reactors.

4.7.1 AVOIDED HUMAN HEALTH IMPACTS

By replacing the current uranium fuel cycle with the process of blending the surplus HEU to LEU fuel, the processes from uranium mining through uranium enrichment in the current fuel cycle are eliminated. As a result, adverse impacts to human health and the environment in the uranium fuel cycle process are significantly reduced. Although the HEU blending process would potentially create other impacts to the workers and the public, the magnitude of these impacts would be much smaller than those of the uranium mining, milling, conversion, and enrichment processes. Tables 4.7.1–1 and 4.7.1–2 compare the potential radiological impacts to the public and involved workers, respectively, between the current fuel cycle process and the proposed alternatives of blending surplus HEU to LEU for commercial nuclear fuel.

For the general public within 80 km (50 mi), the expected latent cancer fatalities per year of operation would be 0.051 for the current uranium fuel cycle process and 8.5×10^{-6} (blending HEU to LEU as UNH at B&W) to 1.2×10^{-3} (blending HEU to LEU as UF_6 at NFS) for the proposed blending process. The avoided latent cancer fatalities for the public then

Table 4.7–2. Comparison of Radionuclide Atmospheric Emissions Between Current Fuel Cycle and Highly Enriched Uranium Blending Fuel Cycle[a]

Source	Principle Radionuclide	Emission Rate (Ci/yr)		
		Current Fuel Cycle[b]	Blending HEU to LEU as UNH	Blending HEU to LEU as UF_6
Uranium mines	Rn-222	3,000	NA	NA
Uranium mills and mill tailing	Pb-210	$3.1x10^{-2}$	NA	NA
	Po-210	$3.1x10^{-2}$	NA	NA
	Rn-222	1,900	NA	NA
	Ra-226	$3.1x10^{-2}$	NA	NA
	Th-230	$3.5x10^{-2}$	NA	NA
	U-234	$6.1x10^{-2}$	NA	NA
	U-238	$4.9x10^{-2}$	NA	NA
Uranium conversion	Rn-222	0.59	NA	NA
	Ra-226	$4.3x10^{-6}$	NA	NA
	Pa-234m	$5.3x10^{-3}$	NA	NA
	Th-230	$5.9x10^{-5}$	NA	NA
	Th-234	$5.3x10^{-3}$	NA	NA
	U-234	$5.3x10^{-3}$	NA	NA
	U-235	$1.3x10^{-4}$	NA	NA
	U-238	$5.3x10^{-3}$	NA	NA
Uranium enrichment	Tc-99	$4.3x10^{-3}$	NA	NA
	U-234	$1.2x10^{-2}$	NA	NA
	U-235	$2.9x10^{-3}$	NA	NA
	U-236	$2.3x10^{-5}$	NA	NA
	U-238	$1.3x10^{-2}$	NA	NA
Blending HEU to LEU[c]	U-235	NA	$6.9x10^{-5}$	$1.1x10^{-4}$
	U-238	NA	$3.2x10^{-4}$	$6.2x10^{-4}$

[a] The emissions are based on the assumption that four large LWRs (about 5,000 MWe) are needed for the HEU disposition (10 t/yr).

[b] The radionuclide emissions given in EPA 1979a are for the model facilities. The emissions are adjusted according to the 5,000 MWe power output (TTI 1996c; TTI 1996d).

[c] OR LMES 1995a, OR LMES 1995b.

Note: NA=not applicable.

Source: EPA 1979a; OR LMES 1995a; OR LMES 1995b.

would be 0.051/yr due to the substitution of blending surplus HEU to LEU for commercial fuel.

For the involved workers, the expected latent cancer fatalities per year of operation would be 1.7 for the current uranium fuel cycle process and $3.2x10^{-3}$ (blending HEU to LEU as metal at Y–12) to $5.8x10^{-3}$ (blending HEU to LEU as UF_6 at B&W or NFS) for the proposed blending process. For the involved workers there would be 1.7 latent cancer fatalities avoided due to the substitution of blending surplus HEU to LEU for commercial fuel.

The total avoided latent cancer fatalities for the general public and the involved workers for each alternative are presented in Table 4.7.1–3. The total avoided latent cancer fatalities due to the substitution of blending surplus HEU to LEU for commercial fuel

Table 4.7.1–1. Comparison of Potential Radiological Human Health Impact to the General Public within 80 km (50 mi)

Fuel Cycle Process	Current Fuel Cycle[a]	Blending HEU to 4% LEU as UF_6		Blending HEU to 4% LEU as UNH			
		B&W[b]	NFS[b]	ORR[c]	SRS[c]	B&W[c]	NFS[c]
Uranium mining (LCF/yr)	$3.0x10^{-2}$	NA	NA	NA	NA	NA	NA
Uranium milling (LCF/yr)	$2.0x10^{-2}$	NA	NA	NA	NA	NA	NA
Uranium conversion (LCF/yr)	$1.2x10^{-3}$	NA	NA	NA	NA	NA	NA
HEU blending (LCF/yr)	NA	$1.6x10^{-5}$	$1.2x10^{-3}$	$8.0x10^{-5}$	$8.0x10^{-5}$	$8.5x10^{-6}$	$6.0x10^{-4}$
Total (LCF/yr)	$5.1x10^{-2}$	$1.6x10^{-5}$	$1.2x10^{-3}$	$8.0x10^{-5}$	$8.0x10^{-5}$	$8.5x10^{-6}$	$6.0x10^{-4}$

[a] The latent cancer fatalities for the current fuel cycle are derived for the model facilities and are adjusted for 5,000 MWe light water reactors and for consistency with risk estimators used in this EIS (TTI 1996c; TTI 1996d).

[b] Table 4.3.2.6–1.

[c] Table 4.3.1.6–1.

Note: LCF=latent cancer fatality; NA=not applicable.

Source: EPA 1979a.

Table 4.7.1–2. Comparison of Potential Radiological Human Health Impact to the Involved Workers

Fuel Cycle Process	Current Fuel Cycle[a]	Blending HEU to 4% LEU as UF_6		Blending HEU to 4% LEU as UNH			
		B&W[b]	NFS[b]	ORR[c]	SRS[c]	B&W[c]	NFS[c]
Uranium mining (LCF/yr)	0.94	NA	NA	NA	NA	NA	NA
Uranium milling (LCF/yr)	0.74	NA	NA	NA	NA	NA	NA
Uranium conversion (LCF/yr)	$4.6x10^{-3}$	NA	NA	NA	NA	NA	NA
HEU blending (LCF/yr)	NA	$5.8x10^{-3}$	$5.8x10^{-3}$	$4.5x10^{-3}$	$4.5x10^{-3}$	$4.5x10^{-3}$	$4.5x10^{-3}$
Total (LCF/yr)	1.7	$5.8x10^{-3}$	$5.8x10^{-3}$	$4.5x10^{-3}$	$4.5x10^{-3}$	$4.5x10^{-3}$	$4.5x10^{-3}$

[a] The latent cancer fatalities for the current fuel cycle are derived for 1,000 MWe light water reactors and are adjusted for 5,000 MWe light water reactors and for consistency with risk estimators used in this EIS (TTI 1996c; TTI 1996d).

[b] Table 4.3.2.6–2.

[c] Table 4.3.1.6–2.

Note: LCF=latent cancer fatality; NA=not applicable.

Source: NRC 1987d.

Table 4.7.1–3. Comparison of Cumulative Potential Radiological Human Health Impact

Alternatives	Current Fuel Cycle (Latent Cancer Fatalities)			Blending HEU to LEU[a] (Latent Cancer Fatalities)			Avoided Latent Cancer Fatalities
	Public	Workers	Total	Public	Workers	Total	
Limited Commercial Use—Two Commercial Sites[b]	0.26	8.5	8.8	7.3×10^{-3}	7.0×10^{-2}	7.7×10^{-2}	8.7
Substantial Commercial Use—DOE Sites Only[c]	0.66	22	23	2.6×10^{-3}	0.14	0.14	23
Substantial Commercial Use—Commercial Sites Only[c]	0.66	22	23	1.9×10^{-2}	0.19	0.21	23
Substantial Commercial Use—All Four Sites[d]	0.66	22	23	2.2×10^{-2}	0.33	0.35	22
Substantial Commercial Use—Single Site[e]	0.66	22	23	1.9×10^{-2}	9.3×10^{-2}	0.11	23
Maximum Commercial Use—DOE Sites Only[f]	0.87	29	30	3.4×10^{-3}	0.19	0.19	30
Maximum Commercial Use—Commercial Sites Only[f]	0.87	29	30	2.6×10^{-2}	0.24	0.27	30
Maximum Commercial Use—All Four Sites[g]	0.87	29	30	2.9×10^{-2}	0.43	0.46	29
Maximum Commercial Use—Single Site[h]	0.87	29	30	2.5×10^{-2}	0.12	0.15	30

[a] Because analyses for less than 10 t/yr HEU processing rate for commercial use is directly analyzed in this EIS, latent cancer fatalities obtained from Section 4.3 were used for lower processing rates in the case of multiple sites being used to process 8 t each year (anticipated amount of surplus HEU that DOE can be made available for commercial use annually as indicated in Table 2.1.2–1). Because lower processing rates would produce less human health impacts, using impacts from the Section 4.3 rate would yield conservative results.

[b] Twenty-five percent of the 200 t HEU (that is, 50 t) would be blended to LEU for commercial fuel for this alternative. B&W and NFS would each process 25 t of HEU. Therefore, it would take 6 years to blend the HEU to LEU at the processing rate of 4 t/yr.

[c] Sixty-five percent of the 200 t HEU (that is, 130 t) would be blended to LEU for commercial fuel for this alternative. Y–12 and SRS (or B&W and NFS) would each process 65 t of HEU. Therefore, it would take 16 years to blend the HEU to LEU at the processing rate of 4 t/yr.

[d] Sixty-five percent of the 200 t HEU (that is, 130 t) would be blended to LEU for commercial fuel for this alternative. All four sites would process 32.5 t of HEU. Therefore, it would take 16 years to blend the HEU to LEU at the processing rate of 2 t/yr.

[e] Sixty-five percent of the 200 t HEU (that is, 130 t) would be blended to LEU for commercial fuel for this alternative. Therefore, it would take 16 years to blend the HEU to LEU at the processing rate of 8 t/yr.

[f] Eighty-five percent of the 200 t HEU (that is, 170 t) would be blended to LEU for commercial fuel for this alternative. Y–12 and SRS (or B&W and NFS) would each process 85 t of HEU. Therefore, it would take 21 years to blend the HEU to LEU at the processing rate of 4 t/yr.

[g] Eighty-five percent of the 200 t HEU (that is, 170 t) would be blended to LEU for commercial fuel for this alternative. All four sites would process 42.5 t of HEU. Therefore, it would take 21 years to blend the HEU to LEU at the processing rate of 2 t/yr.

[h] Eighty-five percent of the 200 t HEU (that is, 170 t) would be blended to LEU for commercial fuel for this alternative. Therefore, it would take 21 years to blend the HEU to LEU at the processing rate of 8 t/yr.

Source: TTI 1996c; TTI 1996d.

could range from 8.7 (Limited Commercial Use Alternative) to 30 (Maximum Commercial Use Alternative).

4.7.2 AVOIDED AIR QUALITY IMPACTS

The ambient air quality can be affected by emissions of chemical pollutants from the current fuel cycle process and the proposed HEU blending facilities. The chemical pollutants from the current fuel cycle originate from the uranium mining, milling, conversion and enrichment processes. The pollutant emissions are also from the fossil-fuel power plants, that supply electric power for the current uranium fuel cycle, mainly for uranium enrichment. By blending surplus HEU to LEU as fuel, the uranium fuel enrichment process would be eliminated, thereby eliminating the need for fossil-fuel power plants to produce electric power. Table 4.7.2–1 compares pollutant air emissions between the proposed HEU blending process and a typical fossil-fuel power plant that supplies electric power for the current uranium fuel cycle. The comparison shows that chemical pollutant emissions from the current fuel cycle are much higher than the potential emissions from the proposed HEU blending process.

4.7.3 AVOIDED WASTE GENERATION

The volumes of wastes would also be significantly reduced if part of the current fuel cycle were to be replaced by the HEU blending process. The total volume of waste generated from blending HEU to 4-percent LEU for commercial fuel would be approximately 430 m^3/yr (15,200 ft^3/yr) as LLW and as mixed LLW. Based on historical practice in the United States, on the other hand, the volume of wastes that would be generated by uranium mining, milling, and extraction would be approximately 880,000 m^3/yr (31,077 ft^3/yr) (DOE 1995kk:145-146,154). Using LEU fuel derived from surplus HEU would eliminate additional waste streams that would be generated during conversion (from U_3O_8 to UF_6) and enrichment. While data relating conversion and enrichment rates with waste volumes are not available, the combined volume of wastes (mixed LLW) produced at the Portsmouth Diffusion Plant (a major uranium enrichment facility) in 1992 was reported as 4,500 t of mixed LLW, and projections from 1994 to 1998 were 169 t/yr for the combined waste generation from the Paducah and Portsmouth uranium enrichment plants (DOE 1993c:16.1-3; DOE 1993g:23.4-1).

Table 4.7.2–1. Comparison of Potential Emission Rates of Pollutants Between Highly Enriched Uranium Blending and Current Fuel Cycle

Pollutant	Current Fuel Cycle[a] (kg/yr)	Blending HEU to LWR Fuel: To UNH[b] (kg/yr)	Blending HEU to LWR Fuel: To UF_6[c] (kg/yr)
Carbon monoxide (CO)	150,000	2,160	2,258
Nitrogen dioxide (NO_2)[d]	6,000,000	7,300	1,433
Ozone (O_3)	NA	215	200
Particulate matter (PM_{10})	5,700,000	170	203
Sulfur dioxide (SO_2)[e]	22,000,000	13,500	2,934
Total suspended particulates (TSP)	NA	37,000	203

[a] Emissions from the supporting coal power plant are derived from the NRC regulation (10 CFR 51, Table S–3). The original numbers in the NRC document are for 1,000 MWe LWR. The numbers shown in the table are adjusted for 5,000 MWe LWRs.

[b] Maximum emissions are presented in the blending process. The maximum emissions occur in blending HEU to LEU as UNH at Y–12 and SRS (Table C.2–1).

[c] Maximum emissions are presented in the blending process. The maximum emissions occur in blending HEU to LEU as UF_6 at B&W and NFS (Table C.2–4).

[d] Original source (10 CFR 51) reported as NO_x.

[e] Original source (10 CFR 51) reported as SO_x.

Note: NA=not available.

4.7.4 OTHER ENVIRONMENTAL IMPACTS

In addition to the environmental impact discussed above, other positive environmental impacts will occur by blending HEU to LEU for use as commercial fuel in nuclear power plants. None of the analyzed processes would necessitate construction of new facilities, require land disturbance, or affect the VRM classification of any of the candidate sites; consequently, no impacts to land resources, geology and soils, or cultural resources are anticipated. Any future construction at B&W or NFS would be a business decision, and is not proposed by DOE or necessitated by this proposed action or alternatives. No construction of a solidification facility at SRS is proposed at this time. If any such construction at any of the sites were proposed, it could involve land disturbance and associated impacts, such as minor air emissions. Additional NEPA review would be conducted as necessary for any such new construction, if it were proposed. The following positive impacts can be qualitatively stated:

- Nuclear Proliferation. By blending the HEU to LEU as nuclear fuel, the surplus HEU would be "burned" in the reactors. This would reduce the risk of theft or diversion and subsequent consequences such as nuclear accidents.
- Land Resources. No additional land needs to be disturbed for mining operations.
- Site Infrastructure. No additional facility needs to be constructed. No additional energy resources need to be consumed.
- Water Resources. [Text deleted.] No major impact to water quality would occur since no surface runoff or leaching (mine drainage) from mining and mill tailings would occur.
- Geology and Soils. No new facilities would be constructed, therefore, limited exposure to the soil profile and soil erosion would occur as a result of wind and water action.
- Transportation. No additional onsite or offsite transportation is required to move ore from the mine to the mill, to move refined ore from the mill to the conversion facility, or move converted uranium from the conversion facility to the enrichment plant.

4.8 IMPACTS ON URANIUM MINING AND NUCLEAR FUEL CYCLE INDUSTRIES

4.8.1 BACKGROUND

The impacts of surplus HEU disposition on the uranium mining and nuclear fuel cycle sectors[4] will depend in large part on the degree to which supply and demand in the nuclear fuel market are balanced during the period of delivery to the market. Because the surplus HEU from Russia and the United States will increase the supply of nuclear feed material (LEU), there is potential for adverse impacts on domestic markets. This section examines changes in supply due to the purchase of Russian surplus HEU and this proposed action, and analyzes potential impacts on each of the affected sectors. An overview of the nuclear fuel cycle industry, including recent price and employment trends, is also presented.

Uranium Mining and Milling—From 1947 through 1970, the U.S. Government, through the Atomic Energy Commission, instituted a program to obtain uranium for nuclear weapons production. The commercial nuclear fuel cycle market evolved out of this program, and the uranium market gradually changed from one in which the Government was the sole purchaser to one which was almost entirely commercial. Early in the procurement program, the Atomic Energy Commission provided incentives for uranium ore exploration and production and agreed to buy all the uranium ore at a set price. The incentives were such that, by the 1960s, the Atomic Energy Commission had largely satisfied its needs, and the procurement program was phased out. This program coincided with the development and growth of the private sector nuclear energy industry. In 1964, the *Private Ownership of Special Nuclear Materials Act* (Public Law 88-489) allowed private ownership of nuclear fuels. Privatization spurred exploration efforts and construction of mills so that in a few years available production capability exceeded uranium oxide (as U_3O_8) requirements of the infant nuclear energy industry. Prices fell and the industry underwent a period of contraction.

After the rapid increase in oil prices in 1973 and 1974, the pace of new orders for nuclear power plants throughout the world accelerated. Fears of future uranium shortages led to a sharp increase of uranium oxide prices between 1975 and 1976. The rapid increase in uranium prices stimulated new exploration and additional production. Once again the market became unbalanced, with an excess of quantity supplied over quantity demanded. As a result, the price of uranium declined throughout the 1980s and early 1990s. Contributing to the price decline was the entry of the former Soviet Union into the market with its low-cost uranium oxide, and the further discovery of large, low-cost uranium ore deposits in Canada, Australia, and Africa.

The market (spot) price of uranium oxide reached a low of $18.39/kg ($8.34/lb) in 1992, but has recently begun to increase. In 1994, the spot price rose to $21.52/kg ($9.76/lb); by the summer of 1995, it had risen above $24.25/kg ($11.00/lb) and reached $26.90/kg ($12.20/lb) by the end of 1995. Recent (1995) forecasts predicted that the spot price would increase by about 2 percent annually through 2005 (EIA 1995a:32). However, the uranium oxide market is currently in a state of flux. In fact, it was recently reported that in the first two months of 1996, uranium oxide spot market prices have increased 18 percent to about $33/kg ($15/lb) (WSJ 1996a:C1). The current fluctuation in the spot price could be due to commercial inventory drawdowns occurring at a faster pace than was estimated last year. This would lead to a higher demand in the near future and sharp price increases if there is a perceived near-term shortage.

In 1993, the United States was the tenth largest uranium-producing country in the world, behind Canada, Nigeria, Kazakhstan, Russia, Uzbekistan, Australia, France, Namibia, and South Africa. As seen in Figure 4.8.1–1, U.S. production had been in sharp decline over the past 15 years, until 1995 when production rose sharply. During that period, domestic production declined from a high of 20 million kg (44 million lb) in 1980 to a low of 1.4 million kg (3.1 million lb) in 1993 (EIA 1995a:25). In 1994, U.S. output supplied only about 2 percent of the world's uranium requirements of 75 million kg (165 million lb). Responding to more favorable market conditions, U.S. firms have increased production. Domestic production of uranium oxide for the year 1995 was 2.8 million kg (6.1 million lb),

[4] The cycle consists of: mining (including conventional mining, *in situ* leaching, and recovery as a byproduct of phosphate production), milling, conversion (from uranium concentrate to UF_6), uranium enrichment, fuel fabrication, energy generation, and disposal of spent fuel.

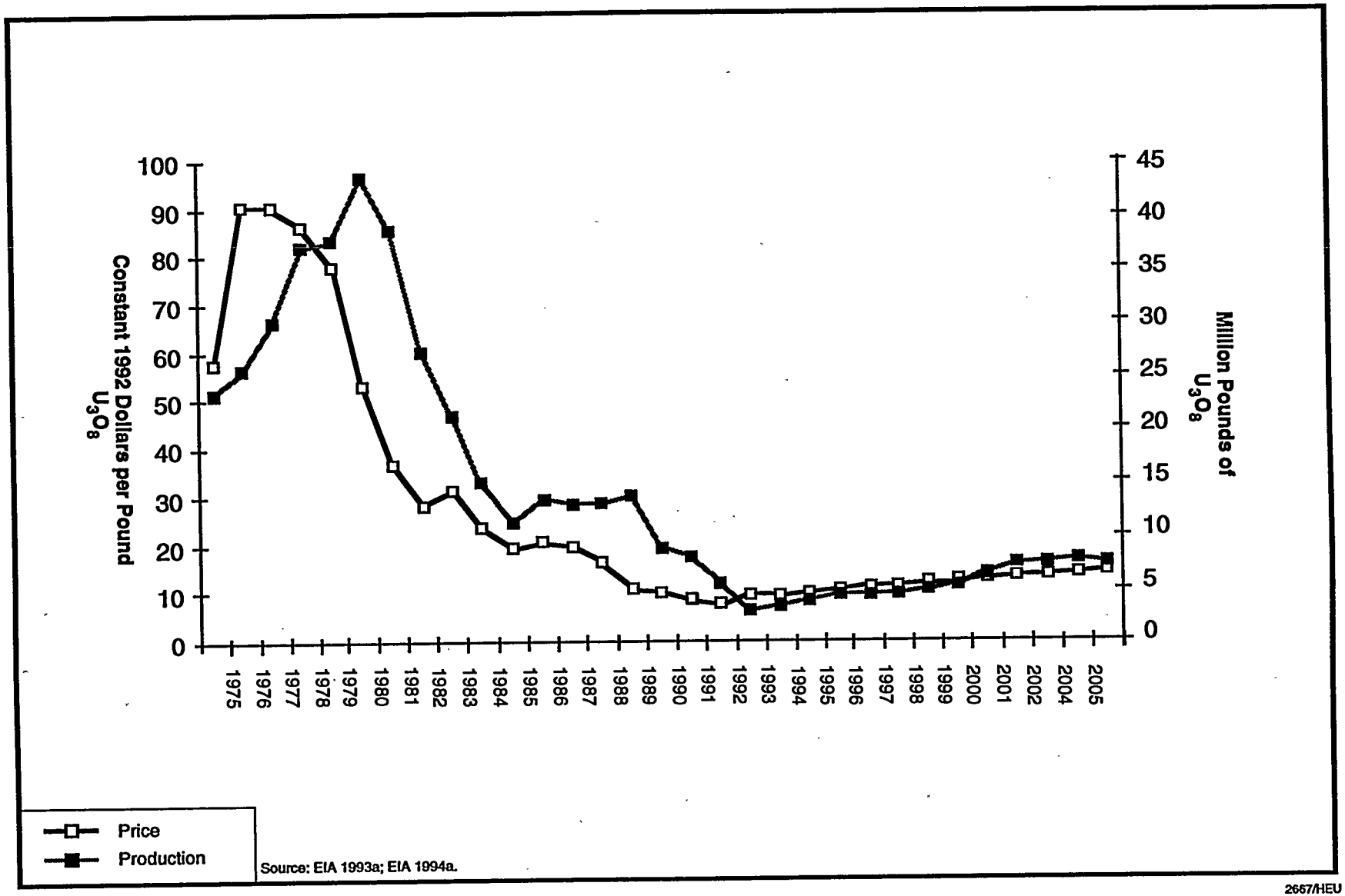


Figure 4.8.1–1. Comparison of Historic and Estimated Spot Price With U.S. Uranium Production, 1975-2005.

nearly 80 percent more than the amount produced in 1994 and higher than forceasted value shown in Figures 4.8.1–1 and 4.8.1–2. Much of this increase was the result of the reopening of a mill and the addition of an in situ leaching plant.

Additional sources of uranium oxide are inventories held by utilities, uranium producers, brokers, and governments. At the end of 1994, commercially owned inventories totaled approximately 39 million kg (86 million lb) of uranium oxide equivalent, compared to 48 million kg (106 million lb) at the end of 1993. DOE projections indicate that commercial inventories over the next 10 years will fall below a level adequate to meet 2 years of forward reactor requirements[5] (EIA1995a:31). Projections indicate a continuing decline each year between now and 2005 before stabilizing at a level equivalent to annual domestic reactor requirements. Commercial inventories, which totaled 34.9 million kg (76.9 million lb) in 1995, are projected to decrease to 20.5 million kg (45.2 million lb) in 2005. It should be noted that Government inventories at the end of 1994 totaled 33.7 million kg (74.3 million lb) of uranium oxide equivalent (EIA 1995a:27).

The 1995 uranium oxide requirement of U.S. nuclear power plants was about 20.6 million kg (45.4 million lb), while domestic production was 2.8 million kg (6.1 million lb) (EIA 1995a:32). The balance of 17.8 million kg (39.3 million lb) was made up from imports and inventory drawdowns of both uranium oxide and LEU. The United States, which was a net exporter in 1980, is projected to import almost 80 percent of its commercial needs throughout this decade. However, as noted above, recent price increases have stimulated production, which is projected to increase to 4 million kg (8.9 million lb) by the year 2005. Net imports are projected to rise from the current level of 15.2 million kg (33.5 million lb) to 17 million kg (37.4 million lb) in 2003 and decrease to 14.7 million kg (32.3 million lb) by 2005. Commercial inventories are projected to decrease from 34.9 million kg (76.9 million lb) in 1995 to 20.5 million kg (45.2 million lb) in 2005 (EIA 1995a:32).

Historically, U.S. uranium oxide production has been sensitive to changes in the current spot price. In addition, employment in this sector has been sensitive to production levels. These relationships are shown in Figures 4.8.1–1 and 4.8.1–2, which give historical relationships and projections of production, future spot prices, and employment, based on 1995 Energy Information Administration estimates.

As shown in Figures 4.8.1–1 and 4.8.1–2, immense reductions in uranium oxide production and employment have already taken place due to lower prices. Employment in 1994 was 452 person-years for mining, milling, and processing; however, there were 528 additional person-years for reclamation activities that are not related to production (EIA 1995b:20). Increases in uranium industry employment in the future are only possible if production increases above the levels shown. The forecast shown in Figure 4.8.1–1 predicts spot price increases from $21.52/kg ($9.76/lb) in 1994 to $31.22/kg ($14.16/lb) in 2005, and production increases from 1.5 million kg (3.3 million lb) to 4 million kg (8.9 million lb) of uranium oxide during the same period. Employment increases are projected to increase from 452 person-years in 1994 to 1,187 person-years in 2005. Using this as a basis, each $1 change in price would result in approximately a 0.55 million-kg (1.2 million-lb) change in production, and each 0.55 million-kg (1.2 million-lb) change in production would result in approximately a 160 person-year change in employment.

Uranium Conversion—Uranium conversion in the nuclear fuel cycle refers to the conversion of uranium oxide to UF_6. ConverDyn, a subsidiary of Allied Signal, Inc., is one of the five largest commercial converters in the world. The plant, located in Metropolis, Illinois, employs about 380 workers and is the last remaining conversion facility in the United States. The facility provides UF_6 to nuclear utilities in the United States, Asia, and Europe. With a production capacity of 12,700 metric tons of uranium (MTU)/yr as UF_6,[6] the facility is capable of supplying about 19 percent of the world's conversion services.

The UF_6 market, like the market for uranium oxide, was depressed throughout the 1980s and early 1990s.

[5] Amount of uranium required to ensure uninterrupted operation of nuclear power plants.

[6] In this discussion of conversion, UF_6 quantities are expressed as MTU contained in the product.

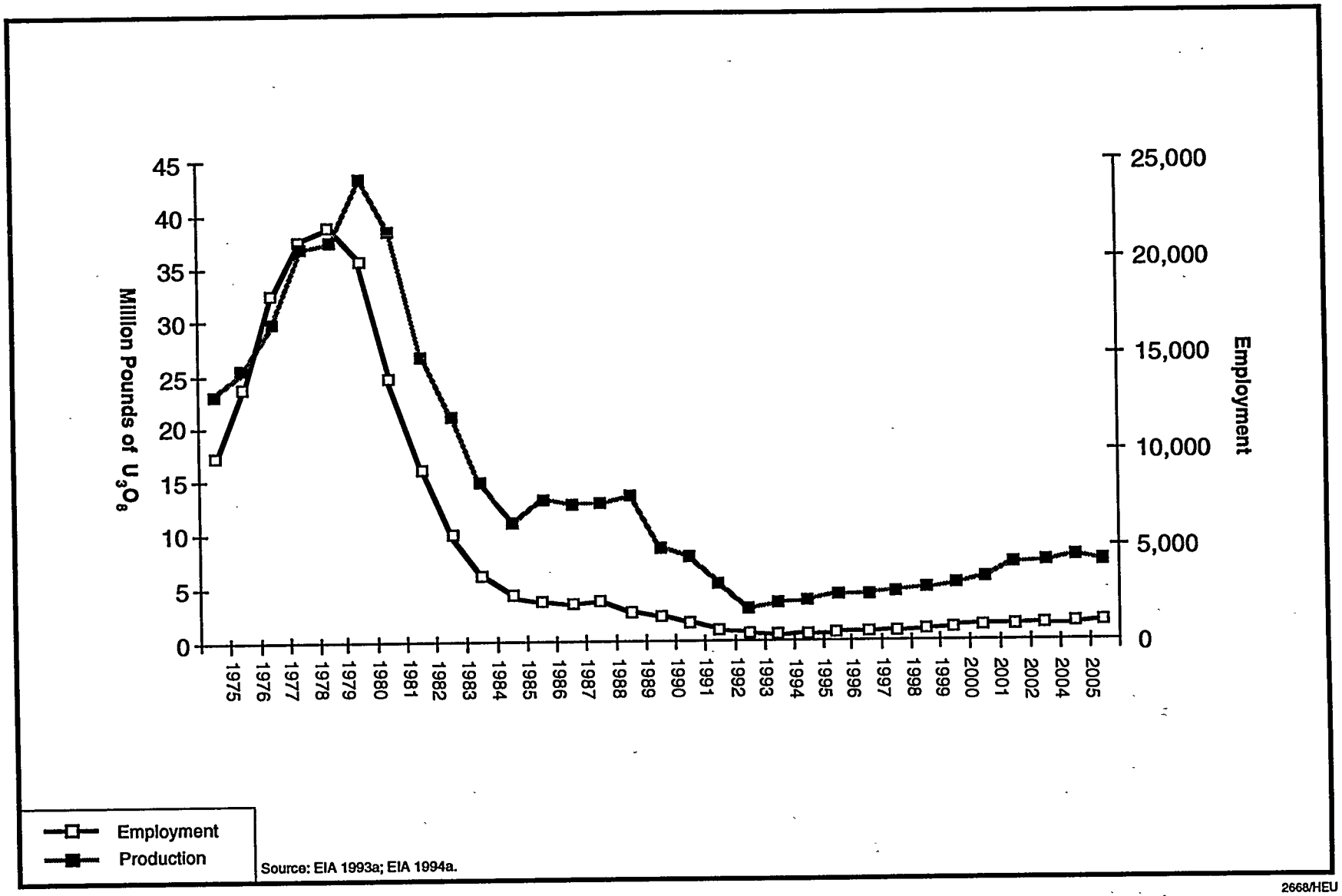


Figure 4.8.1–2. Comparison of Historic and Estimated U.S. Uranium Production With Employment, 1975-2005.

This led to shutdowns and a decrease in production. For example, a second U.S. facility, owned by Sequoyah Fuels and located in Oklahoma, was closed at the end of 1992. However, with the decrease in capacity and the recent increase in demand, the price of conversion services has increased over 70 percent since 1992. Projected increases in utility demands should permit a more stable market for the only remaining U.S. conversion facility. All of the commercial conversion facilities world-wide are operating at almost full capacity and are expected to operate at or above 90-percent capacity for the foreseeable future.

Uranium Enrichment—The enrichment levels of UF_6 from the conversion plant are increased at an enrichment plant to meet a utility's specified level of 3- to 5-percent U-235. USEC, one of the four major enrichers in the world uranium market and the only enricher in the United States, operates the Paducah Gaseous Diffusion Plant and the Portsmouth Gaseous Diffusion Plant in Kentucky and Ohio, respectively. Before 1993, when USEC assumed responsibility from DOE for the enrichment operations, DOE was the largest supplier of enrichment services in the world. The U.S. market position, however, has steadily eroded since the mid-1970s as foreign competitors have entered the market. By 1995, the two U.S. plants represented only 39 percent of worldwide installed enrichment capacity.

Fuel fabricators convert the enriched UF_6 to uranium oxide pellets. Most countries with large civil nuclear power programs have their own fuel fabrication facilities. Together, five U.S. companies represent 35 percent of the world's fabrication capacity. The five domestic commercial fuel fabrication plants are listed in Figure 2.1.1–1. The proposed action is not expected to have any impact on the fuel fabrication sector.

USEC Privatization Act—As noted in Section 1.3, the *USEC Privatization Act* was signed into law in April 1996 (see Appendix J). The Act specifically authorizes the transfer of up to 50 t of HEU and up to 7,000 t of NU from DOE stockpiles to USEC, and specifies numerical restrictions on the delivery of that material for commercial end use in the United States (Public Law 104-134, Section 3112(c)). The Act also authorizes additional sales from DOE's stockpiles of uranium, including LEU derived from HEU. Such additional sales may not be made unless: 1) the material is declared surplus; 2) the Secretary of Energy determines that the sale will not have an adverse material impact[7] on the domestic uranium mining, conversion, or enrichment industry, taking into account the sales of uranium under the Russian HEU Agreement and the Suspension Agreement; and 3) the price paid is not less than the fair market value of the material (Public Law 104-134, Section 3112(d)). The discussion that follows assesses the likely impacts of the U.S. HEU disposition program in light of the statutory "adverse material impact" standard, also taking into account the material entering the market from the Russian HEU Agreement and the Suspension Agreement.

4.8.2 Economic Consequences of Russian Highly Enriched Uranium

As a result of a formal agreement with Russia signed in February 1993, the United States, through an executive agent, will purchase 15,260 t of LEU[8] (or 22,550 t of UF_6), derived from blending 500 t of HEU from nuclear weapons materials inventories. All blending services are being performed in Russia, and delivery of LEU will take place over a 20-year period that began in 1995. The most recent schedule calls for deliveries of LEU to USEC in HEU equivalence of 6 t in 1995, 12 t in 1996, 10 t/yr from 1997 through 1999, and approximately 30 t/yr from 2000 to 2015. Importing that quantity of material into the domestic market, even over a 20-year period, would have some adverse impact on the domestic uranium mining and nuclear fuel cycle industries. Because the Russian LEU will be in a form ready for fuel fabrication, the demand for domestic uranium feed, and for conversion and enrichment services would likely be reduced. The transfer of Russian LEU to the U.S. would not affect the fuel fabrication sector.

[7] The *USEC Privatization Act* does not define the term "adverse material impact." For purposes of this analysis only, DOE assumes that it means long-term market impacts on price, or long-term impacts on employment levels or plant closures, not brought about by other activities. The analysis and discussion in this section is based on Public Law 104-134 as it appeared in the Congressional Record on April 25, 1996 (Internet version). This discussion is not, and should not be, construed to be an official interpretation of Public Law 104-134 by DOE for any other purpose.

[8] One ton of Russian HEU would generate about 30.5 t of LEU containing 3- to 5-percent U-235.

Under Section 3112(b) of the *USEC Privatization Act,* Russian LEU delivered to the U.S. executive agent (currently USEC) on or after January 1, 1997 may not be transferred to domestic end users at a rate exceeding the schedule shown in Table 4.8.2-1.

By limiting the quantity of Russian material that can be delivered for consumption by commercial end users in the United States, Section 3112 of the *USEC Privatization Act* would help to protect the domestic market from oversupply of uranium feed material.[9]

Table 4.8.2.–1. Annual Maximum Deliveries of Uranium Oxide to End Users

Year	Uranium Oxide Million Pounds Equivalent (million kg)
1996	0 (0)
1997	0 (0)
1998	2 (0.9)
1999	4 (1.8)
2000	6 (2.7)
2001	8 (3.6)
2002	10 (4.5)
2003	12 (5.4)
2004	14 (6.4)
2005	16 (7.3)
2006	17 (7.7)
2007	18 (8.2)
2008	19 (8.6)
2009 and each year thereafter	20 (9.1)

Source: Public Law 104-134, Section 3112(b)5.

The legislation does not limit the ability to export this material for use in nuclear reactors outside the United States, or to use this material for overfeeding[10] of the enrichment plants. The *USEC Privatization Act* also permits this material to be used in matched sales pursuant to the Uranium Anti-dumping Suspension Agreements.[11]

In addition, Russian LEU derived from approximately 18 t of HEU (6.3 million kg [14 million lb] U_3O_8 equivalent) is being delivered to the United States in 1995 and 1996. That material can be sold in 1996 as part of matched sales; sold at any time either for overfeeding in the United States or for end use outside the United States; or sold in 2001 for delivery to end users beginning in 2002, in quantities not to exceed 1.4 million kg (3 million lb) U_3O_8 equivalent per year (Public Law 103-134, Section 3112 (b)(2)). For purposes of this analysis only, it is assumed that 6 t would be sold in 1996 as part of matched sales, and 12 t would be delivered beginning in 2002, subject to the limitations just noted.[12]

Uranium Mining and Milling Sector Impacts—The economic impacts of the Russian LEU were analyzed in USEC's and DOE's *Environmental Assessment for the Purchase of Russian Low Enriched Uranium Derived from the Dismantlement of Nuclear Weapons in the Countries of the Former Soviet Union* (USEC/EA-94001, DOE/EA-0837, January 1994). However, the analysis in that EA was based on the assumption that the Russian LEU would be transferred to end users during the same year the material is delivered to the United States (that is, 10 t delivery to USEC in 1997 would add 10 t of nuclear fuel to the domestic market in the same year). Because the *USEC Privatization Act* restricts entry of the Russian LEU into the domestic market (with the exceptions noted in the preceding paragraph), adverse impacts to the uranium mining and milling sector would be reduced

[9] The sale of the conversion component is not restricted (Section 3112 (b)(8)).

[10] Overfeeding involves increasing the rate at which uranium feed is used in the enrichment process, with a corresponding reduction in the energy consumed for separative work.

[11] The Uranium Anti-dumping Suspension Agreements arose from charges by U.S. uranium producers and the Oil, Chemical, and Atomic Workers International Union (which represents some U.S. enrichment plant workers) that Russia and other member states of the former Soviet Union were dumping uranium into the United States. In October 1992, the U.S. Department of Commerce suspended its investigation of those charges based on an agreement between the U.S. petitioners and the former Soviet states to restrict the volume of imports into the United States. In March 1994, the Russian Suspension Agreement was amended to include the matched sales concept, which links Russian imports with sales of newly produced U.S. uranium. Matched sales must also fall within yearly quotas set in the Russian Suspension Agreement, as amended. Pursuant to the *USEC Privatization Act*, this feed material may be used in matched sales under the Suspension Agreement. Such matched sales are not subject to the numerical limits on deliveries to end users as specified in the schedule in Table 4.8.2–1.

[12] Such transactions are not proposed at this time. If such transactions are proposed, the details and impacts may differ from those analyzed, and DOE will conduct appropriate NEPA review.

from those projected in the USEC EA. For example, the USEC EA assumed that the Russian LEU would displace about 3.6 million kg (8 million lb) of uranium annually in the U.S. market during the first 5 years of delivery.[13] This quantity represents approximately 19 percent of domestic utility requirements. However, because of the legislation, the quantity transferred to end users during the same 5-year period (1995 through 1999) may not exceed 2.7 million kg (6 million lb) uranium oxide equivalent for the entire period.[14] This total compares to 17.4 million kg (38.4 million lb) that could be displaced over that period without the *USEC Privatization Act's* restrictions. This is an 85-percent reduction from the original USEC estimate.

The largest economic impact would be to foreign producers, who, before the Russian Agreement, were expected to supply up to 80 percent of the uranium oxide used by U.S. utilities during the delivery period. If the displaced uranium were prorated between domestic and foreign producers (based on current production and procurement patterns), domestic uranium producers would experience about a 4-percent reduction in delivery orders.

Under the agreement with Russia, during the period 2000 to 2015, annual deliveries from Russia to USEC would triple to 30 t of HEU that would be converted to LEU, the equivalent of 10.9 million kg (24 million lb) of uranium oxide. However, the *USEC Privatization Act* allows the delivery, for consumption by commercial end users in the United States, of only 2.7 million kg (6 million lb) uranium oxide equivalent in the year 2000. As indicated in Table 4.8.2.–1, the quantity increases each year, reaching 8.6 million kg (19 million lb) in 2008. In 2009 and each year thereafter, up to 9 million kg (20 million lb) uranium oxide equivalent could be delivered to end users. Displacement of domestic uranium oxide could range from about 30 percent per year on average during the period 2000 to 2009, to 50 percent in 2009 and thereafter.[15]

The reduction in feed requirements could adversely affect the economic prospects of domestic uranium producers, particularly beginning in 2005 when the Russian LEU could begin to displace more than 7.2 million kg (16 million lb) of uranium oxide annually and up to 9.1 million kg (20 million lb) in 2009 and each year thereafter. For example, the future expansion of domestic production capacity through the reopening of mining and milling facilities could be postponed or canceled in that period because supply requirements could be met with the Russian LEU. If Russian deliveries were at their maximum in 2009 and thereafter (9.1 million kg [20 million lb] U_3O_8), some domestic producers could be substantially impacted.

Both USEC and DOE estimated in the EA for purchase of Russian HEU that these adverse impacts to domestic uranium producers could be significantly diminished if USEC (or a successor private corporation) maintains its current uranium feed requirements while producing less LEU (USEC 1994a:6-28. Under this scenario, USEC would continue to receive uranium feed from utilities as provided in existing contracts, but would produce less LEU product, because USEC would already possess the Russian LEU. To prevent the buildup of uranium feed inventories, which would further depress the market price for uranium, USEC could overfeed the gaseous diffusion plants. By overfeeding, USEC would use greater amounts of uranium feed per ton of LEU produced. In this way, the gaseous diffusion plants would maintain demand for uranium even though the ability to supply LEU would be increased due to the availability of Russian LEU. Although overfeeding represents a less efficient use of the uranium feed, this cost would be somewhat offset by reduced electricity requirements. One potential disadvantage of overfeeding is that the concentration of U-234 per gram of U-235 in the LEU would increase, and during the latter years (when Russian deliveries would increase) ASTM specifications could be exceeded if USEC overfed all of the excess uranium feed. Nonetheless, by overfeeding the gaseous diffusion plants, USEC might be able to diminish the losses to the uranium production sector. It also should be noted, however, that the ability of USEC to overfeed its gaseous

[13]Based on an average of 10 t of HEU converted to LEU.

[14]Based on a total of 7.5 t of HEU converted to LEU.

[15]This estimate assumes that the majority of domestic utility demand for uranium feed will continue to be supplied by foreign producers. Displacement estimates also assume that 12 t of the 18 t of Russian material delivered to the United States during 1995 and 1996 are transferred to domestic users beginning in 2002.

diffusion plants would depend on the prevailing market conditions over the delivery period.[16]

Impacts on the Uranium Conversion Sector—As discussed earlier, commercial uranium conversion facilities were operating at about 90 percent capacity in 1995, and are expected to operate at almost full capacity for the foreseeable future. The improved market conditions are a result of a strengthening in world demand for conversion products and a reduction in conversion capacity. The addition of the Russian HEU converted to LEU into the commercial market could lead to some market surplus, but not likely until after 2005 when deliveries of Russian material to domestic users begins to exceed 7.3 million kg (16 million lb) U_3O_8 equivalent of HEU (6,000 MTU UF_6) per year. The *USEC Privatization Act,* by limiting the annual delivery of the Russian material to end users, mitigates economic impacts on the conversion sector. For example, because the *USEC Privatization Act* limits domestic end user deliveries to 9.1 million kg (20 million lb) per year of HEU beginning in 2009, displacement of U.S. production could total 7,500 MTU as UF_6 per year, compared to 9,000 MTU as UF_6 per year if 30 t of HEU per year could be delivered to end users.

Impacts on the Uranium Enrichment Sector—The Russian LEU would also reduce the demand for enrichment services at the gaseous diffusion plants because the Russian material would be directly processed for fuel production. Delivery of the Russian LEU to end users would peak in 2009, when approximately 4.8 million Separative Work Units,[17,18] (SWUs) of enrichment services could be displaced. Based on USEC estimates that demand for enrichment services could average about 12 million SWUs per year over the delivery period, the Russian LEU could decrease domestic annual gaseous diffusion plant production to 7.25 million SWUs. If USEC overfed the gaseous diffusion plants, production would fall to about 5 million SWUs, because less of the U-235 material would be removed from the NU feed. USEC has estimated that utility orders in excess of 7 million SWUs from the gaseous diffusion plants would be required to continue operating both enrichment plants. The *USEC Privatization Act* restricts the delivery of the Russian material to end users such that annual demand would still be sufficient to operate both plants unless USEC employed overfeeding. However, the impacts of the Russian feed material on the domestic market for enrichment services would be for a longer period, but less severe, under provisions of the *USEC Privatization Act*, because it would take an additional 13 years to eliminate the entire inventory of Russian material.

4.8.3 Economic Consequences of the Proposed Action

The proposed action would introduce into the global uranium market additional quantities of LEU derived from surplus HEU. As stated in Section 1.3, this EIS addresses disposition of a nominal 200 t of HEU, consisting of 175 t declared surplus to date, plus 25 t of HEU (not yet identified) that may be declared surplus in the future. Of the 175 t presently declared surplus, about 72 t are in forms that are not expected to be available or suitable for commercial use in the next 10 to 15 years. Of the remaining 103 t, 13 t have already been transferred to USEC (pursuant to the *Energy Policy Act* of 1992) and 50 t are proposed to be transferred to USEC over the next 6 years (pursuant to the *USEC Privatization Act*). The rate of commercialization of that material would be limited by DOE's ability to make material available, industrial infrastructure, market conditions, and legislative requirements.[19] The *USEC Privatization Act* contains three requirements for any sales by DOE of its uranium stockpile; one requirement is that the Secretary of Energy determine that the sale not have an adverse material impact on the domestic uranium mining, conversion, and enrichment industries. DOE

[16]The current market conditions (1996) of rising uranium prices and stagnant electricity prices would render this scenario impractical in the short term. The analysis in this EIS is not based on the assumption that adverse impacts on the uranium mining and milling sector would be mitigated by overfeeding. Rather, the limitations in the *USEC Privatization Act* are expected to better serve the objective.

[17]A Separative Work Unit is a measure of the separation work achieved in a uranium enrichment plant after separating uranium of a given U-235 content into two components, one having a higher percentage of U-235 than the other component.

[18]USEC estimated that SWU demand from the gaseous diffusion plant would decrease to 6.3 million SWUs during the period when Russian imports would total 30 t/yr. However, under the *USEC Privatization Act*, no more than 25 t of HEU would be transferred to end users.

[19]DOE may propose to sell additional remaining inventories of NU and surplus LEU in the future. These decisions will be addressed by future NEPA reviews, as appropriate.

will conduct an analysis of the potential impact prior to any proposed sale, as required by the Act.

Impacts on the Mining and Milling Sector—The Department of Energy estimates that an average of about 10 t of surplus HEU would be blended down to LEU for commercial use each year starting in 1998.[20] Blending down 10 t of HEU to 4-percent enrichment could displace demand for approximately 3.9 million pounds of uranium oxide annually. For the 103 t of HEU that may be commercialized, this would be the equivalent of just over 40 million pounds of uranium oxide. This is only about 10 percent of the uranium oxide equivalent displaced by the Russian HEU. Furthermore, DOE surplus HEU (uranium oxide equivalent) represents only about 4 percent of projected U.S. utility requirements or 1.5 percent of non-U.S. requirements (1996 through 2016). Nonetheless, the U.S. material would likely result in some small additional adverse impacts to the uranium mining and milling industries. However, these impacts would be small compared to any impacts already caused by the Russian HEU.

Domestic uranium producers, who supply less than 20 percent of the U.S. utility requirements, would incur smaller market losses than would foreign producers. Based on current market shares, the U.S. HEU could displace approximately 353,806 kg (780,000 lb) of domestically produced uranium oxide and reduce sector employment by approximately 100 person-years. This quantity represents less than 10 percent of the domestic market share per year for uranium oxide during the period 1998 to 2002. Transfers of the U.S.-origin HEU would likely diminish after 2002, and by the year 2009, the impacts of the U.S.-origin HEU would be inconsequential as the inventory would be almost fully depleted and transfers to end users would be minimal. As discussed in the previous section, displacement of domestic production by Russian HEU could average up to 30 percent during the period 2000 to 2009, and over 50 percent thereafter. Hence, marginal impacts of the U.S. material on the uranium mining and milling sector would occur primarily at the beginning of the delivery period, when transfers of the Russian material to end users would be severely restricted and when the market is projected to be relatively robust. One factor, however, that may diminish the impact of both the Russian- and U.S.-origin HEU on the uranium market is that large domestic and foreign inventories of uranium are being depleted and worldwide uranium production is now only one-half of world-wide demand. Demand for uranium oxide will likely increase as the remaining stocks continue to decrease. Utilities may increase their purchases beyond what would be required to meet reactor needs in order to replenish inventories.

Impacts on the Uranium Conversion Sector—The U.S. surplus HEU may have some impact on the uranium conversion market, particularly in the later years of delivery when together, the Russian and U.S. HEU could create a surplus of supply. The U.S. surplus HEU could displace up to 1,500 MTU of conversion services.[21] The cumulative impact in the year 2001, when delivery to the domestic market of the Russian LEU reaches 10 t, could be displacement of up to 4,500 MTU as UF_6. If delivery to the domestic market of the Russian material reaches 9.1 million kg (20 million lb) beginning 2009, up to 8,250 MTU as UF_6 could be displaced. In the short term, impacts on the UF_6 conversion are likely to be small. The market has improved and prices have risen to reflect increases in demand. As stated earlier, conversion facilities are expected to operate at almost full capacity in the foreseeable future. The major impact in the longer term would be from the Russian HEU, which represents a much larger share of the additional supply. Because DOE would not release the final 40 t of surplus HEU that might be commercialized unless favorable market conditions prevail, any incremental impact to the conversion industry from the U.S. HEU should be minimal.

Impacts on the Uranium Enrichment Sector—The U.S.-origin surplus HEU would further decrease the market for enrichment services provided by the Paducah and Portsmouth gaseous diffusion plants. As noted by commentors to the HEU Draft EIS, if surplus HEU is commercialized at a rate of 10 t/yr, up to 800,000 SWU per year would be displaced.[22]

[20]If DOE is able to make available only 8 t/yr after 2002, and market conditions are favorable, the transfer of the entire 103 t would be completed in 2009.

[21]Based on the conversion factor of 2.61 pounds of U_3O_8 to 1 kg of UF_6.

[22]A total of 640,000 SWU would be displaced if 8 t/yr of surplus HEU is made available to end users.

The cumulative effect of the Russian and U.S. surplus HEU could peak in the year 2007, when up to 5.1 million SWUs could be displaced. In the year 2007, domestic production could fall to 6.9 million SWUs, a level at which, according to the USEC EA, one plant could meet all of the projected demand. Production would increase above 7 million SWUs again in 2008, when the current inventory of 103 t of expected commercial U.S.-origin surplus HEU would be almost fully commercialized (only 5 t of U.S.-origin surplus HEU would remain at the beginning of 2009). If DOE were to transfer only 8 t of HEU annually after 2002, the gaseous diffusion plant production would fall below 7 million SWUs for 2 years (2008 and 2009).

The decision to maintain operation of one or two enrichment plants would be made by USEC or its successor. However, the *USEC Privatization Act* prohibits the sale of DOE material unless the Secretary of Energy determines that such sale will not have adverse material impacts on the domestic nuclear fuel cycle industry, taking into account sales under the Russian HEU Agreement and the Suspension Agreement. Accordingly, delivery of the U.S. material to end users might be extended over a slightly longer period to ensure that the enrichment plants are not adversely affected.

4.8.4 SUMMARY

The transfer of U.S.-origin HEU to commercial end users is not expected to have an adverse material impact on the nuclear fuel cycle industries. Although some impacts to each of the industry sectors (uranium mining and milling, uranium conversion, and uranium enrichment) would result from the proposed action, these impacts are likely to be minor and temporary. There are several factors that will ameliorate potential adverse economic impacts to these sectors.

- The *USEC Privatization Act* limits the delivery of both U.S. and Russian HEU to end users so as to avoid adverse material impacts on domestic production.
- Transfer of the U.S. HEU to end users would peak when Russian transfers are still small, thus limiting the cumulative impacts.
- Short term demand for uranium products (oxide, UF_6, and LEU) is currently strong, with producers in each of the affected sectors operating at highest capacities.

The cumulative impacts from the U.S.-origin HEU and the Russian HEU would vary over the period of delivery. During the period 1995 to 2000, impacts to the nuclear fuel cycle industries would be minimal because of the limitations on deliveries to end users pursuant to the *USEC Privatization Act*. The largest cumulative impacts to these industries would occur during the period 2000 to 2009, during which deliveries of U.S.-origin HEU to end users would peak under the Preferred Alternative, and delivery allowances of Russian HEU would also increase on a yearly basis. During this period, the surplus U.S. and Russian HEU could displace up to 40 percent of the domestic uranium oxide production. However, most of the displacement would be due to the Russian HEU.[23]

The impacts on the conversion and enrichment sectors would appear to be smaller than for the uranium mining and milling sector. World demand for conversion services is projected to be strong during this period, and as stated earlier, all commercial plants are expected to be operating at almost full capacity in the foreseeable future. The enrichment sector would also suffer some displacement of its services. However, the loss of some market in the short term is not expected to result in significant employment impacts. After the year 2009, the U.S.-origin HEU would be almost fully commercialized, and any impacts to domestic nuclear fuel cycle industries would be solely attributable to the Russian HEU.

[23] Also contributing to cumulative impacts would be the 7,000 t of NU that is proposed to be transferred to USEC along with 50 t of HEU. The marginal impact of this material on the uranium mining and conversion sectors is expected to be modest, as the rate of its delivery to end users is limited by the *USEC Privatization Act* (Section 3112 (c)(2)), and it is expected to be commercialized in the early years before Russian shipments increase to substantial levels. The NU would not impact the enrichment sector, as it would still need to be enriched.

4.9 IMPACTS OF TRANSFERRING NATURAL URANIUM TO UNITED STATES ENRICHMENT CORPORATION

The proposal to transfer title to 50 t of HEU to USEC includes within it the transfer of title to 7,000 t of NU now owned by DOE. This material is in the form of UF_6 and is part of a larger quantity of UF_6 that is in storage at DOE's Portsmouth and Paducah Gaseous Diffusion Plants, which are currently being leased to USEC for uranium enrichment operations. The NU was originally purchased by DOE to be enriched for use in nuclear weapons but is no longer needed for that purpose.

The most likely disposition of the 7,000 t of NU is eventual use as feedstock for enrichment to nuclear power plant fuel, the usual business of the enrichment plants. If it is so used, and follows the typical path of NU that is enriched for commercial use, it would probably be enriched to about 2 percent U-235 at the Paducah Plant, then transported to the Portsmouth Plant for additional enrichment to an appropriate commercial material, generally about 4 percent. From there the enriched UF_6 would be transported to a commercial fuel fabrication plant for conversion and fabrication of nuclear fuel.

Transportation of much larger quantities of identical material to, from, and between DOE's two enrichment plants occurs on a continuing basis as part of the normal operation of those facilities. All shipments are made in conformance with DOE O 460.1, *Packaging and Transportation Safety* and O 460.2, *Departmental Materials Transportation and Packaging Management,* Department of Transportation regulation 49 CFR Subchapter C, and the IAEA Safety Series No. 6. All UF_6 shipping containers are required to meet American National Standards Institute N14.1-1972 specifications. The material would be placed in a specification UF_6 cylinder (inner packaging), which would then be placed in a 21-PF, Type B, protective overpack (outer packaging is for added protection) for shipment by commercial carrier (see Section 4.4.3.2 for a more detailed discussion of impacts of transportation of UF_6 blendstock material).

The ongoing normal operations of the enrichment plants, including transportation of materials, are covered by existing NEPA documents[23], which, as applicable, are incorporated herein by reference. Potential environmental impacts from the operation of the Portsmouth Gaseous Diffusion Plant include the following:

- Damage to the terrestrial ecology caused by drift salts from the cooling towers within the vicinity of 300 m (1,000 ft);
- Detectable vegetation damage or excessive deposition of trace contaminants (for example, zinc) within an area of 1 km (0.6 mi) from the cooling towers;
- Increasing fogging and icing up to 70 hr/yr up to 0.63 km (1 mi) from the plant;
- Liquid discharges that increase the chemical concentrations in the Scioto River to levels above ambient. This includes residual chlorine, uranium, aluminum, sulfates, and total nitrogen; and
- The total population within 80 km (50 mi) may receive a total dose of 0.32 person rem/yr from plant releases to the atmosphere. The maximum exposed individual dose is 0.25 mrem/yr.

The shipment of 7,000 t of NU (0.71 percent enrichment) in the UF_6 form from Paducah to Portsmouth has been evaluated for this EIS. This analysis is based on 9,540 kg (21,000 lb) of material per package and 734 packages for the entire 7,000 t. The total health risk as described in Section 4.4.1 would be 0.129 fatalities for the entire 7,000 t. If the material is enriched to 2 percent LEU before transporting from Paducah to Portsmouth, the 7,000 t of NU would be reduced to 2,490 t of LEU. The total health risk would be 0.0458 fatalities for the 2,490 t. These impacts include the loading and unloading of trucks and the return of empty vehicles to the origin.

[23]Energy Research and Development Administration (ERDA), *Final Environmental Statement, Portsmouth Gaseous Diffusion Plant Expansion, Piketon, OH,* ERDA-1549, Washington, DC, 1977; ERDA, *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site, Piketon, OH,* ERDA-1555, Washington, DC, 1977; DOE, *Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site, Paducah, KY,* DOE/EA-0155, Washington, DC, 1982.

4.10 ENVIRONMENTAL JUSTICE IN MINORITY AND LOW-INCOME POPULATIONS

[Text deleted.]

Pursuant to Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations,* DOE and other Federal agencies identify and address appropriate disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. DOE is in the process of finalizing its Environmental Justice Strategy. [Text deleted.] Because the Department is still in the process of developing guidance, the approach taken in this analysis may differ somewhat from whatever guidance is eventually issued.

Previous sections of Chapter 3 describe the employment and income, population, housing, and community services surrounding each candidate site. Impacts to these socioeconomic issue areas from implementation of the proposed alternatives at these sites are discussed in Chapter 4. Selected demographic characteristics of the socioeconomic ROI for each of the four candidate sites are presented in Tables 4.10–1 through 4.10–4. [Text deleted.] Demographic characteristics for the 80-km (50-mi) surrounding public and occupational health ROI for each of the four candidate sites, are presented in Figures 4.10–1 to 4.10–8.

Any disproportionately high and adverse human health or environmental effects on minority populations and low income populations that could result from the alternatives being considered are assessed for an 80-km (50-mi) area surrounding each of the candidate sites. These are consistent with those used in the public and occupational health and safety analysis. Other considerations were given to biological, water, soil, and cultural resources. The shaded areas in Figures 4.10–1, 4.10–3, 4.10–5, and 4.10–7 show Census tracts where racial or ethnic minorities comprise 50 percent or more (simple majority) of the total population in the Census tract, or where minorities comprise less than 50 percent, but greater than 25 percent, of the total population in the Census tract. Figures 4.10–2, 4.10–4, 4.10–6, and 4.10–8 show low-income communities generally defined as those where 25 percent or more of the population is characterized as living in poverty (income of less than $8,076 for a family of two). [Text deleted.]

Any impacts to surrounding communities would most likely result from toxic/hazardous air pollutants and radiological emissions. Sections 4.3.1.6, 4.3.2.6, 4.3.3.6, and 4.3.4.6, which describe public and occupational health impacts from normal operations and accidents, show that air emissions and releases are within regulatory limits during normal operations. The analysis also shows that cumulative effects of continuous accident free operation over time would result in low levels of exposure to workers and the public. The public health impact analysis conducted for all alternatives estimates that the maximum additional cancer fatalities from operational activities would occur at ORR from either the blending of HEU to LEU as UNH for commercial fuel or the blending of HEU to LEU as metal. Under all blending alternatives, the maximum radiation dose to the public is 2.0 mrem annually, and the fatal cancer risk is 2.0×10^{-5} for 20 years for normal operations. For postulated accidents, the maximum latent cancer fatality per campaign for the alternatives to the MEI ranges from 5.7×10^{-4} to 1.9×10^{-2}; the total campaign risk (cancer fatality probability for the total campaign) ranges from 1.4×10^{-6} to 1.7×10^{-5}. The maximum latent cancer fatalities from accidents per campaign for the alternatives in the population within 80 km (50 mi) ranges from 6.9×10^{-2} to 1.4; the total campaign risk ranges from 1.6×10^{-4} to 1.2×10^{-3}. The probability of the severe accidents is about 10^{-4} per year and ranges from about 10^{-3} to 10^{-5}. Given the low probability of these accidents, there would not be any disproportionate risk of significant high and adverse impacts to particular populations, including low-income and minority populations, from accidents. Except SRS, the analysis of the demographics data presented in Figures 4.10–1 through 4.10–8, Tables 4.10–1 through 4.10–4, and for the communities surrounding the four candidate sites indicates that even if there were any health impacts to these communities, these impacts would not appear to disproportionately affect minority or low-income populations.

Table 4.10–1. Selected Demographic Characteristics for Oak Ridge Reservation Region of Influence

Characteristic/Area	Anderson County	Knox County	Loudon County	Roane County	Total Region of Influence	(percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	64,320	300,040	30,700	45,274	440,334	91.3
Hispanic	381	2,067	83	212	2,743	0.6
Non-Hispanic, American Indian	236	775	52	95	1,158	0.2
Non-Hispanic, Black	2,753	29,483	400	1,456	34,092	7.1
Non-Hispanic, Asian/Pacific Islander	537	3,263	49	186	4,035	0.8
Non-Hispanic, Other	23	121	3	4	151	0
Total 1990 Population	68,250	335,749	31,287	47,227	482,513	
[Text deleted.]						
1989 Low-Income						
Persons Below Poverty						
Number	9,664	45,608	4,192	7,467	66,931	
Percent[a]	18.4	14.1	13.6	16	14.8	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population: inmates of institutions, Armed Forces members, and individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

Table 4.10–2. Selected Demographic Characteristics for Savannah River Site Region of Influence

Characteristic/Area	South Carolina				Georgia		Total Region of Influence	
	Aiken County	Allendale County	Bamberg County	Barnwell County	Columbia County	Richmond County		(percent)
Persons by Race/Ethnicity								
Non-Hispanic, White	90,130	3,598	6,428	11,421	56,141	103,009	270,727	63.6
Hispanic	867	161	75	146	962	3,707	5,918	1.4
Non-Hispanic, American Indian	213	11	22	31	150	491	918	0.2
Non-Hispanic, Black	29,176	7,939	10,356	8,677	7,239	79,221	142,608	33.5
Non-Hispanic, Asian/Pacific Islander	528	7	20	17	1,518	3,186	5,276	1.2
Non-Hispanic, Other	26	6	1	1	21	105	160	0
Total 1990 Population	120,940	11,722	16,902	20,293	66,031	189,719	425,607	
[Text deleted.]								
1989 Low-Income								
Persons Below Poverty								
Number	16,671	3,837	4,547	4,367	4,255	32,590	66,267	
Percent[a]	14	35.8	28.2	21.8	6.6	18.2	16.2	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population: inmates of institutions, Armed Forces members, and individuals under 15 years of age.

May not total 100 percent due to rounding.

Census 1993s; Census 1994o.

Table 4.10–3. Selected Demographic Characteristics for the Babcock & Wilcox Region of Influence

Characteristic/Area	Amherst County	Appomattox County	Bedford County	Bedford City	Campbell County	Lynchburg	Total Region of Influence	(percent)
Persons by Race/Ethnicity								
Non-Hispanic, White	22,507	9,402	41,698	4,635	40,371	47,595	166,208	80.6
Hispanic	211	27	230	56	166	432	1,122	0.5
Non-Hispanic, American Indian	80	33	68	–	56	85	322	0.2
Non-Hispanic, Black	5,752	2,819	3,605	1,328	6,861	17,465	37,830	18.3
Non-Hispanic, Asian/Pacific Islander	28	14	47	54	110	441	694	0.3
Non-Hispanic, Other	–	3	8	–	8	31	50	0
Total 1990 Population	28,578	12,298	45,656	6,073	47,572	66,049	206,226	
[Text deleted.]								
1989 Low-Income								
Persons Below Poverty								
Number	2,594	1,501	3,162	927	4,763	9,889	22,836	
Percent[a]	9.8	12.4	7	16.4	10.1	16.4	11.6	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population: inmates of institutions, Armed Forces members, and individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

Table 4.10–4. Selected Demographic Characteristics for the Nuclear Fuel Services Region of Influence

Characteristic/Area	Carter County	Sullivan County	Unicoi County	Washington County	Total Region of Influence	(percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	50,618	139,850	16,434	88,198	295,100	97.1
Hispanic,	199	362	99	519	1,179	0.4
Non-Hispanic, American Indian	142	508	–	175	825	0.3
Non-Hispanic, Black	437	2,364	2	3,085	5,888	1.9
Non-Hispanic, Asian/Pacific Islander	95	500	14	323	932	0.3
Non-Hispanic, Other	14	12	–	15	41	0
Total 1990 Population	51,505	143,596	16,549	92,315	303,965	
[Text deleted.]						
1989 Low-Income						
Persons Below Poverty						
Number	9,027	19,133	2,787	13,656	44,603	
Percent[a]	18	13.5	17.1	15.6	15.1	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population: inmates of institutions, Armed Forces members, and individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

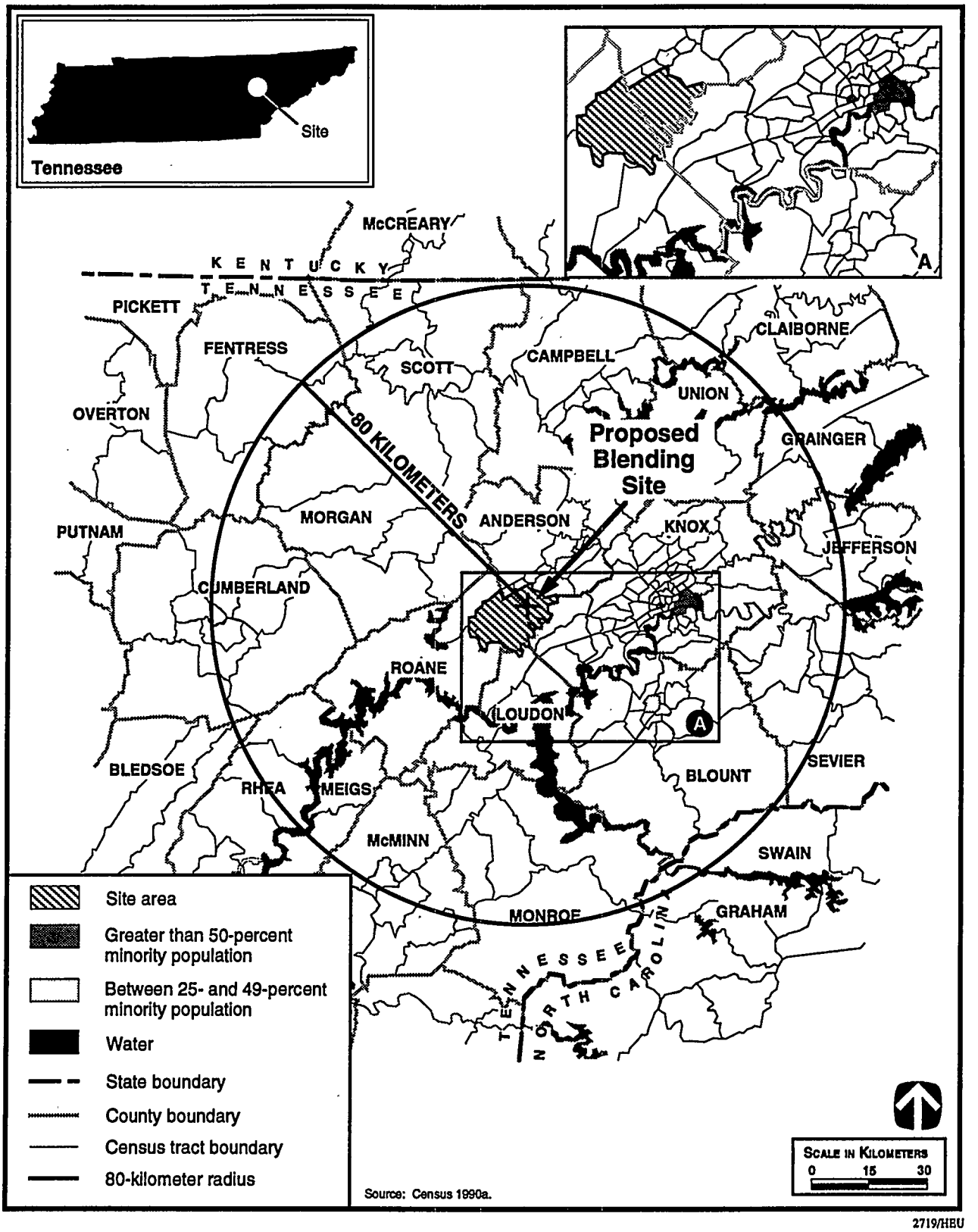


Figure 4.10–1. Minority Population Distribution for Oak Ridge Reservation and Surrounding Area.

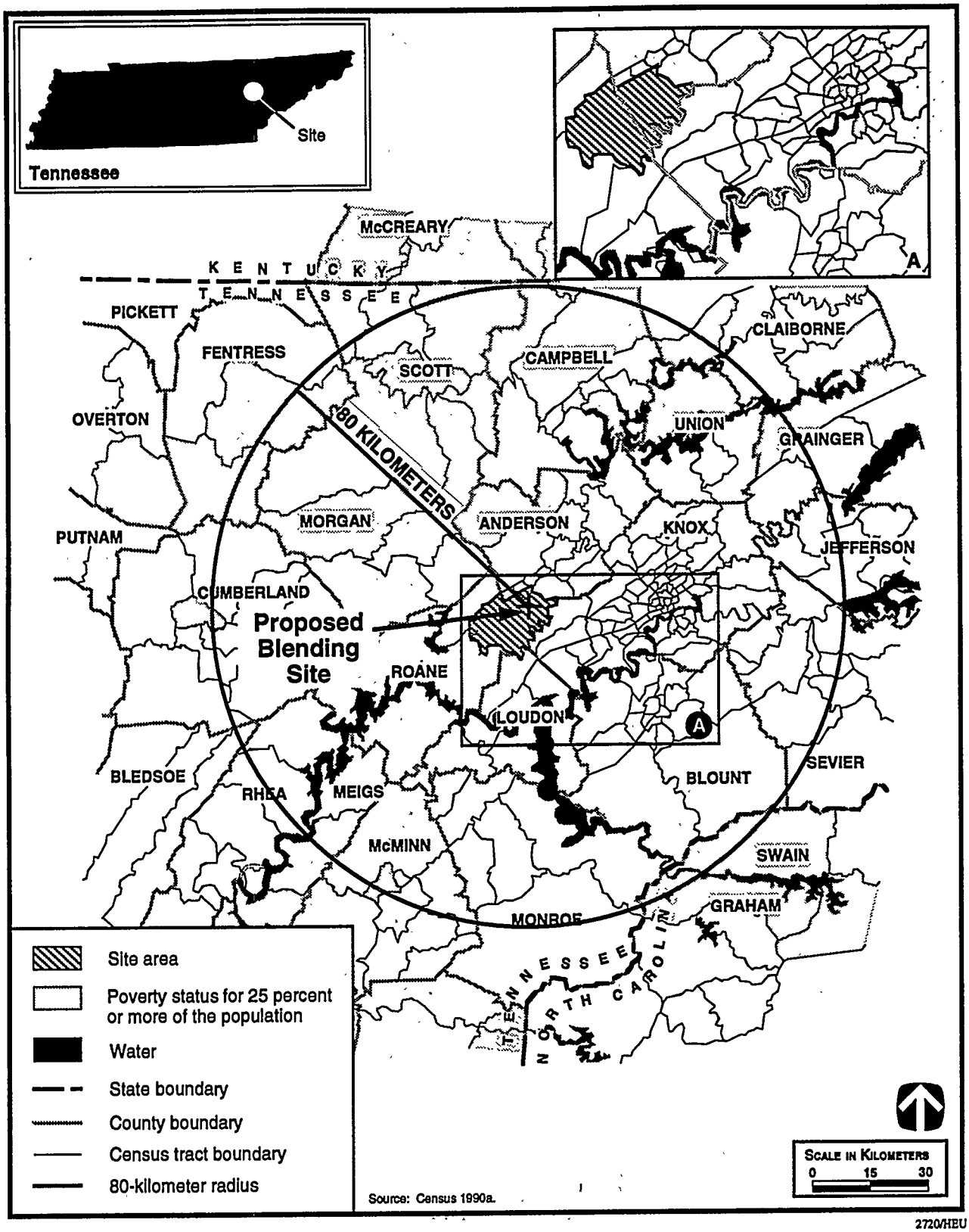


Figure 4.10–2. Low-Income Distribution by Poverty Status for Oak Ridge Reservation and Surrounding Area.

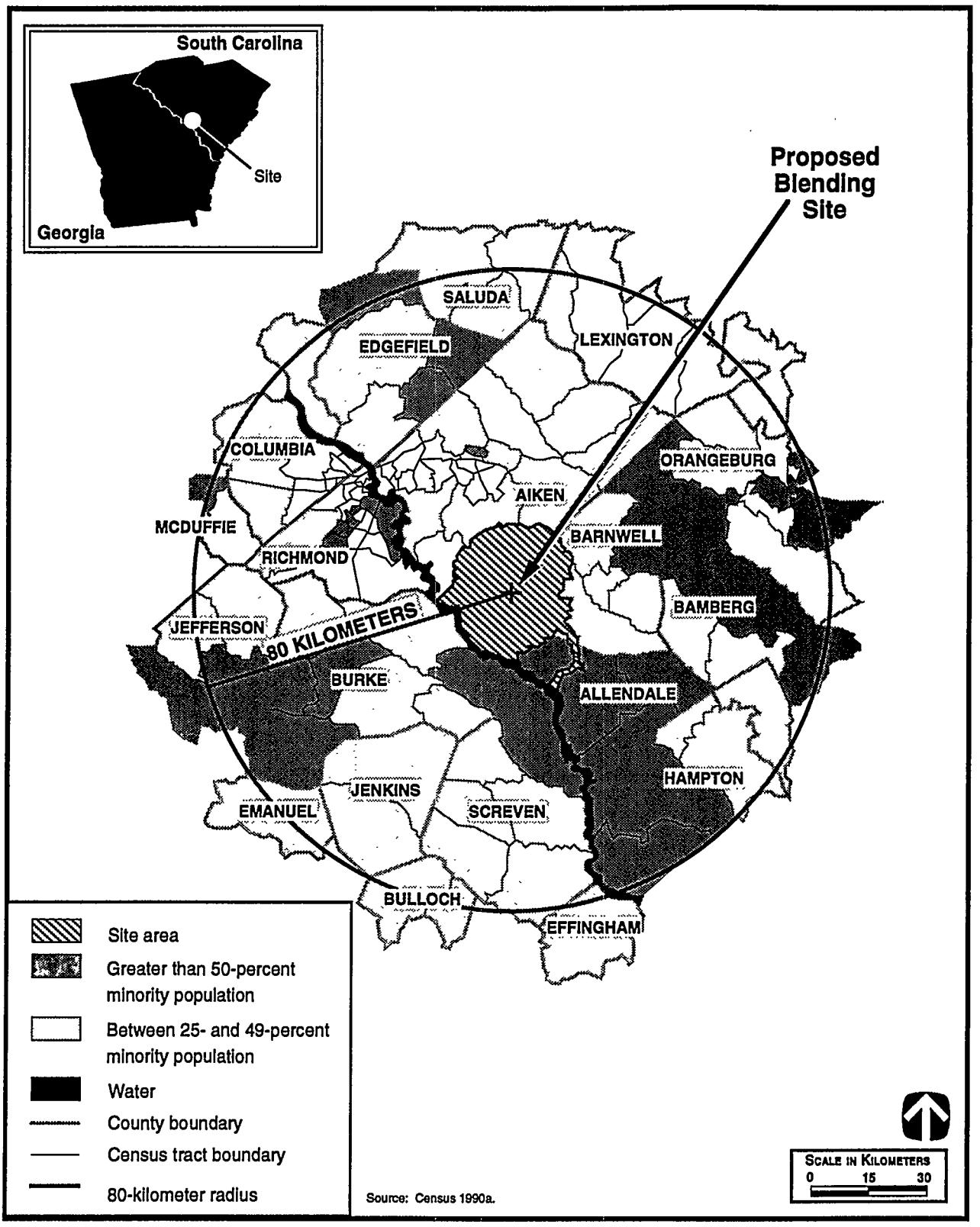


Figure 4.10–3. Minority Population Distribution for Savannah River Site and Surrounding Area.

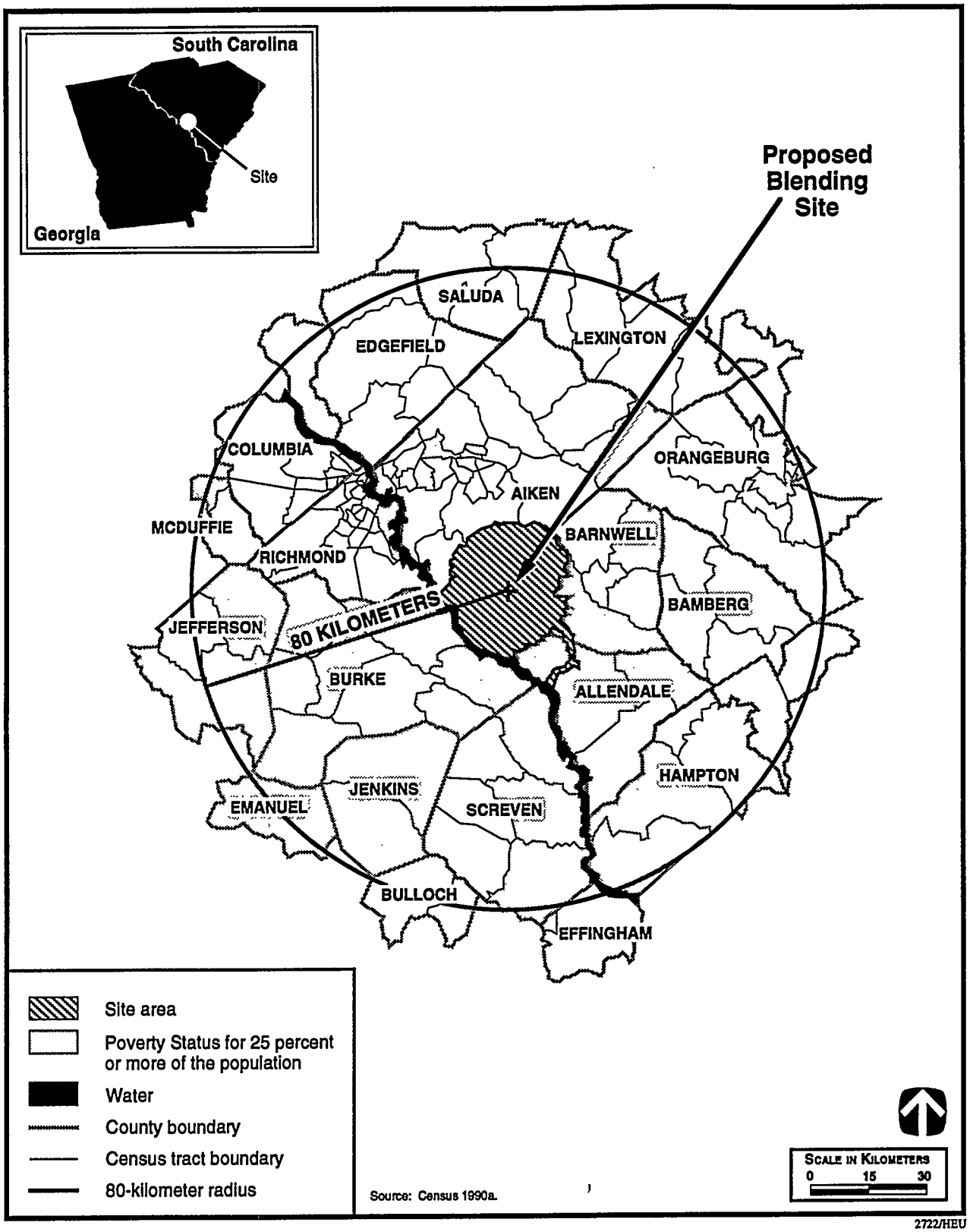


Figure 4.10–4. Low-Income Distribution by Poverty Status for Savannah River Site and Surrounding Area.

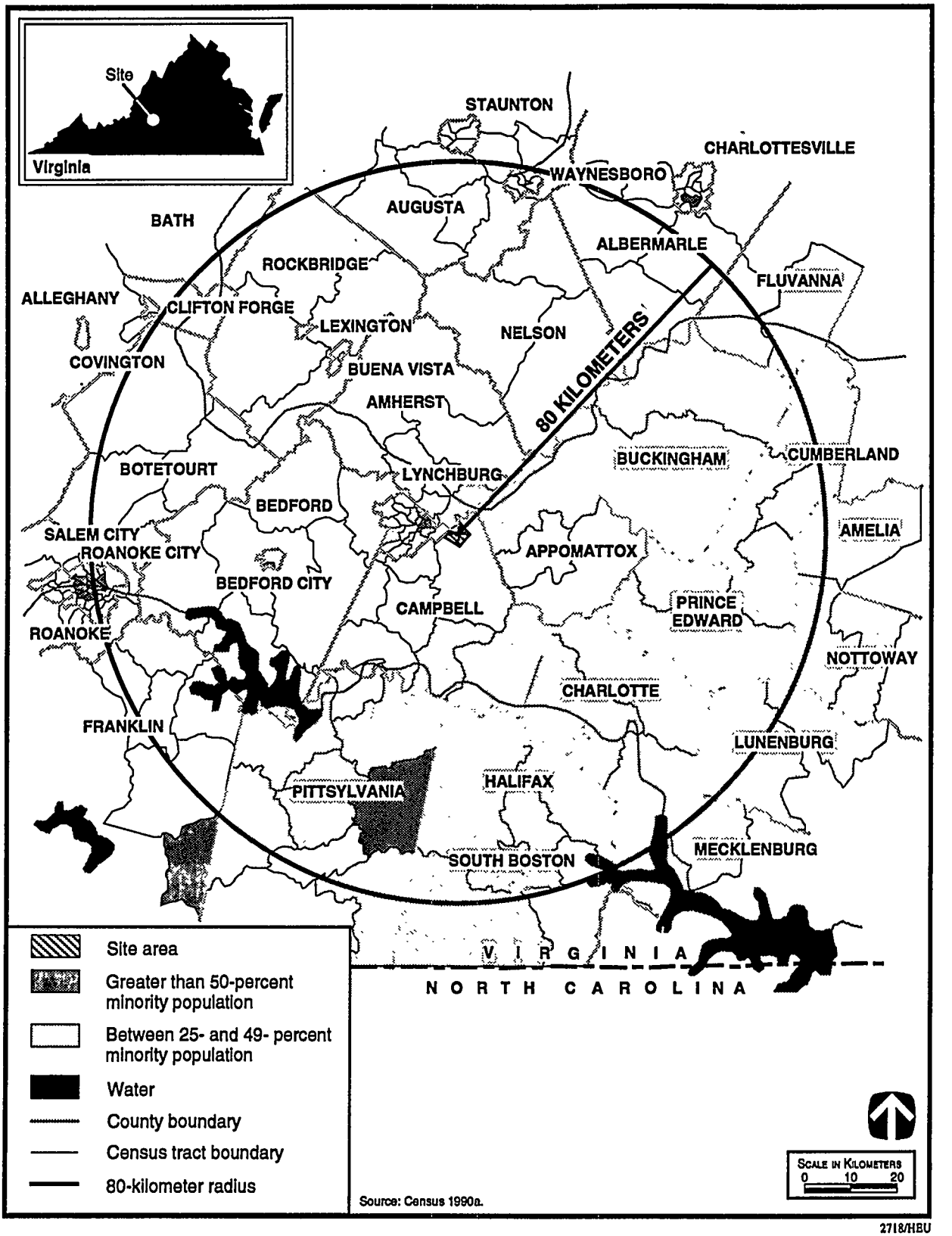


Figure 4.10–5. Minority Population Distribution for Babcock & Wilcox and Surrounding Area.

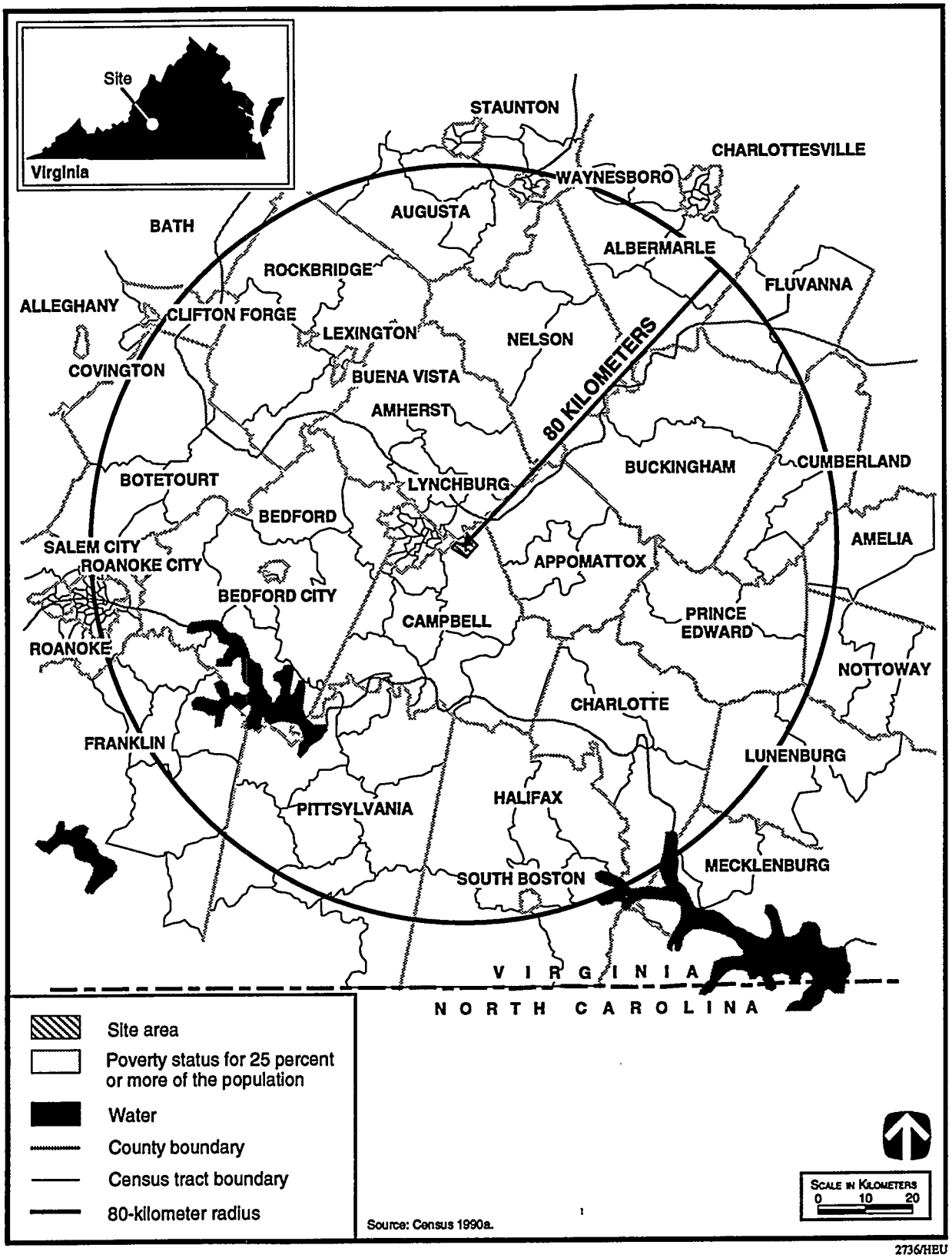


Figure 4.10–6. Low-Income Distribution by Poverty Status for Babcock & Wilcox and Surrounding Area.

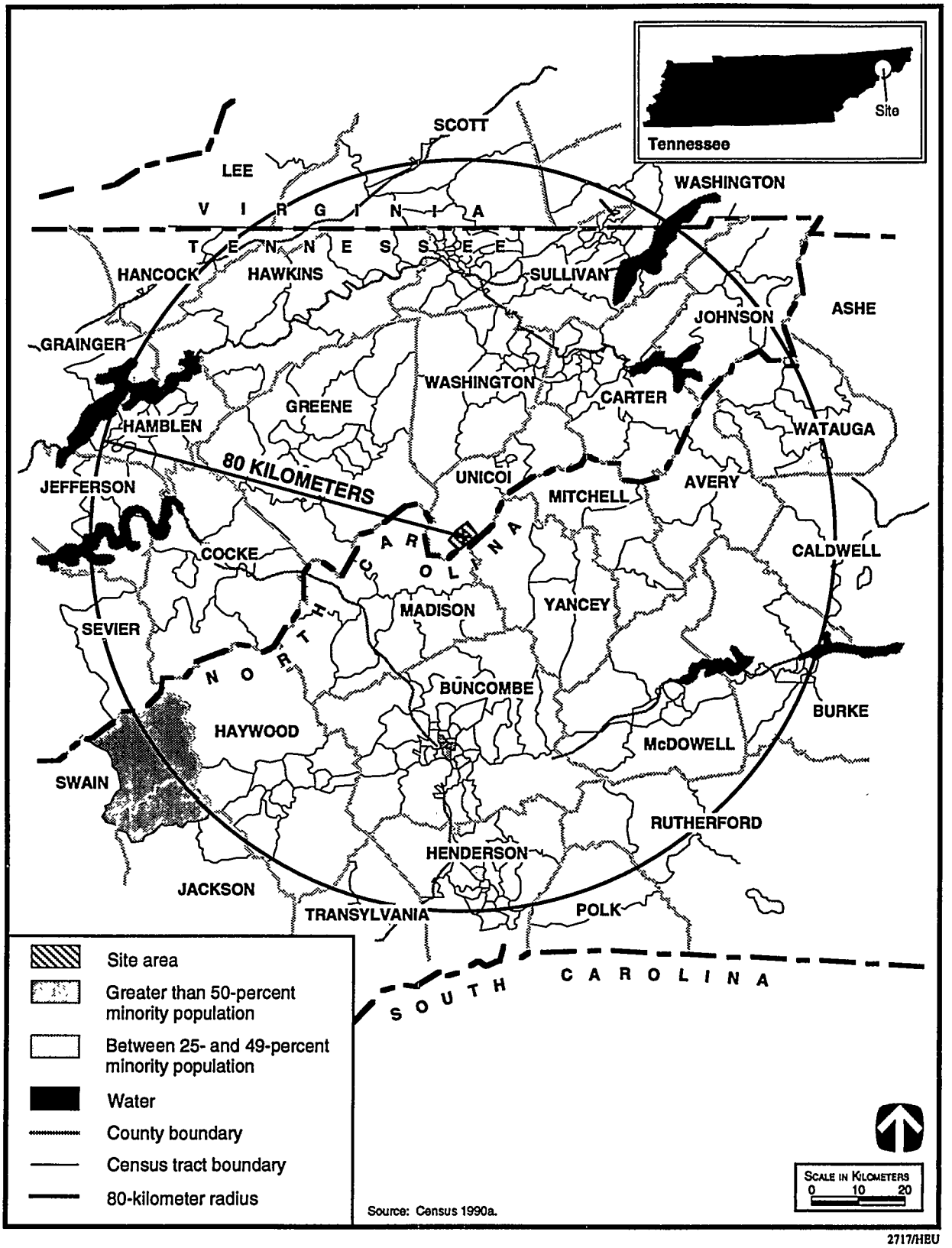


Figure 4.10–7. Minority Population Distribution for Nuclear Fuel Services and Surrounding Area.

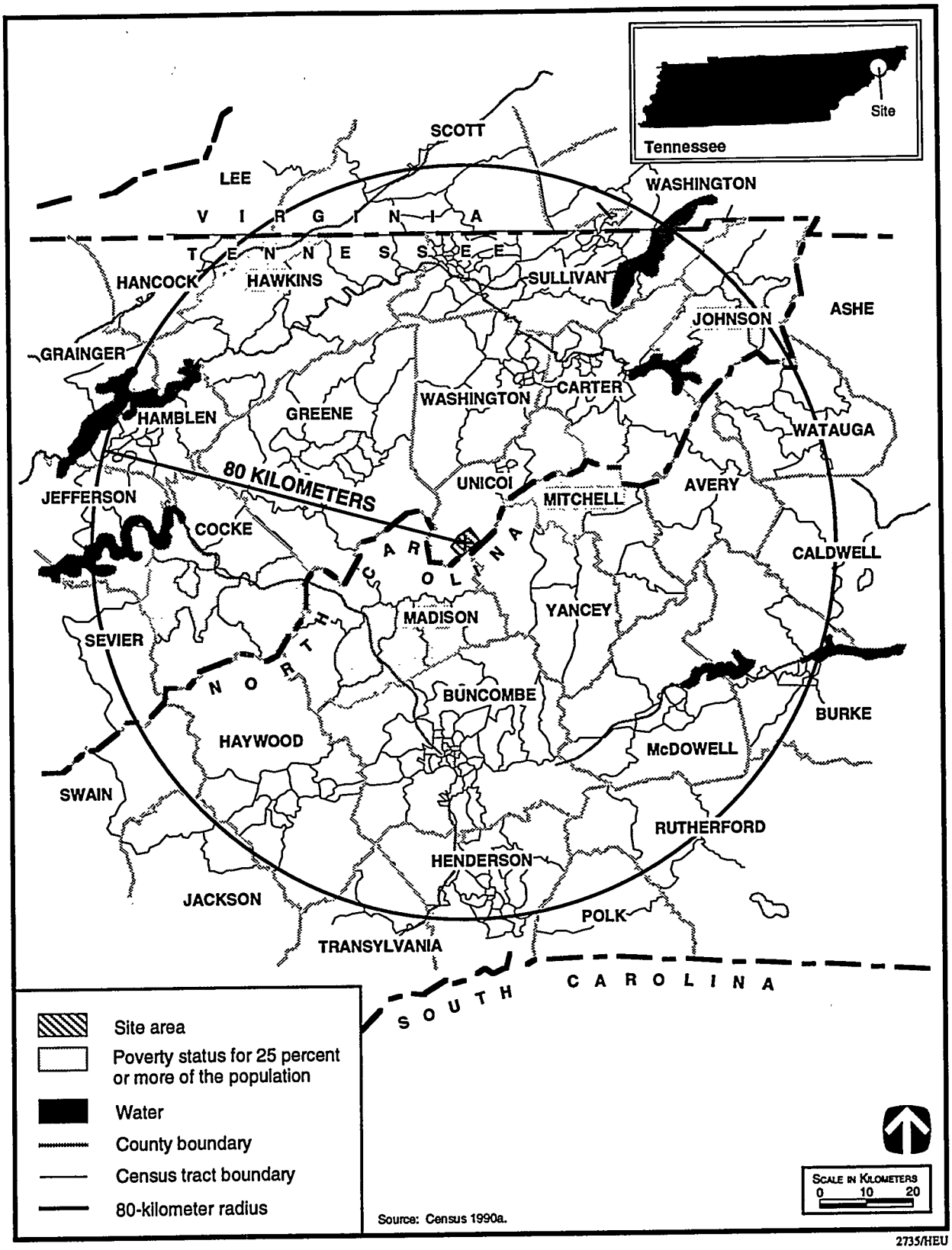


Figure 4.10–8. Low-Income Distribution by Poverty Status for Nuclear Fuel Services and Surrounding Area.

4.11 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Transportation of surplus HEU and blendstock materials and blending facility operation would result in adverse environmental impacts. The impact assessment conducted in this EIS has identified potential adverse impacts along with mitigative measures that could be implemented to either avoid or minimize these impacts. The residual adverse impacts remaining following mitigation are unavoidable and the worst case impacts of all alternatives at all candidate sites are discussed below.

Air pollutant concentrations during operation would be no greater than 63 percent of the NAAQS 3-hour concentration for SO_2 at SRS. This is due to the no action contribution while the HEU blending contribution concentrations are negligible. While the air pollutant concentrations are expected to remain within Federal and State ambient air quality standards, the emission of criteria pollutants represents a minimal unavoidable impact.

Some amount of radiation would be released unavoidably by normal HEU blending operations. The greatest radiation dose to the maximally exposed member of the public would be 1.4 mrem/yr from atmospheric releases and 0.60 mrem/yr from liquid releases at ORR. The associated annual risk of fatal cancers from operations with these doses is 1.0×10^{-6}. The greatest annual population dose from total site operations is 28 person-rem, which occurs at ORR. The associated annual risk of fatal cancers from operations with this dose is 1.4×10^{-2}. The largest average annual dose to a site worker is 115 mrem and would result in an associated annual risk of fatal cancer of 4.6×10^{-5} from operations. The greatest annual dose to the total site workforce is 227 person-rem occurring at SRS and would result in an annual risk of 9.1×10^{-2} fatal cancers. This is due to the no action contribution; the HEU blending contribution concentrations are negligible.

Since hazardous and toxic chemicals are present during operation of HEU blending facilities, worker exposure to these chemicals is unavoidable. The maximum hazard to site workers, based solely on emissions of hazardous chemicals, is represented by a hazards index of 1.16 at SRS, which is greater than the OSHA action level of 1. This is due to the no action contribution while the blending contribution concentrations are negligible. The maximum hazard to the public is represented by a hazard index of 9.76×10^{-2} at NFS, which does not exceed 1. Cancer risks to the site workers and public are 1.94×10^{-4} and 1.31×10^{-7} respectively, at SRS. The site worker cancer risk value exceeds the standard of 1.0×10^{-6}. This is due to the no action contribution while the blending contribution concentrations are negligible.

Although each site would implement waste minimization techniques, generation of additional low-level, hazardous, and nonhazardous wastes is unavoidable. Generation of additional hazardous or mixed wastes would not require expansion of existing or planned treatment, storage, and disposal facilities for these wastes at sites. Generation of additional nonhazardous wastes would not require expansion of existing, or construction of new, liquid and solid waste treatment facilities but would slightly reduce the lifetimes of current solid waste landfills.

Transportation of radioactive materials between sites presents health risks and accident risks to the public and workforce. The maximum annual risk of fatalities for the transportation of HEU to SRS for blending to 4-percent UNH is 6.1×10^{-2}. For this scenario the blendstock would be sent from Hanford and the UNH crystals would be sent for fuel fabrication to the Siemens Nuclear Power Corporation facility.

4.12 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This section describes the major irreversible and irretrievable commitments of resources. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for later use by future generations. This section discusses two major categories that are committed irreversibly or irretrievably to the proposed action: materials and energy.

Material. The irreversible and irretrievable commitment of material resources during the process of blending HEU to LEU includes materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Consumption of miscellaneous chemicals (propylene glycol, nitric acid, etc.) and gases (argon and nitrogen), while irretrievable, would not constitute a permanent drain on local sources or involve any material in critically short supply in the United States as a whole. Materials consumed or reduced to unrecoverable forms of waste are irretrievably lost.

Energy. The irretrievable commitments of resources during operation of blending facilities would include the consumption of natural gas, oil (diesel), and coal. Coal is used at both Y–12 and SRS but not at B&W and NFS. Natural gas is available and used at all sites except SRS which uses oil as the major fuel source. Oil is used at all sites except at Y–12. The electrical energy expended to operate the blending facilities would also be irretrievable. Site infrastructure percent change in energy resource usage at Y–12 and SRS are minimal due to the extensive existing site infrastructure. B&W and NFS both have higher percent increases in energy resources mainly because the facilities are currently operating below capacity.

4.13 FLOODPLAIN ASSESSMENT

As required by DOE's regulations on protection of floodplains and wetlands (10 CFR 1022), this section assesses whether the proposed action would impact or be impacted by the floodplains at the involved sites. The proposed action in this EIS, as described in Section 1.1.2, involves actions (blending activities) that would be accommodated within existing facilities at Y–12, SRS, B&W, and NFS. The locations of facilities at the candidate sites, Y–12, SRS, B&W, and NFS, with respect to delineated floodplains, are presented in the maps shown in Figures 3.3.4–2, 3.4.4–2, 3.5.1–2, and 3.6.4–1, respectively.

Because HEU blending activities associated with the proposed action and its alternatives could be accommodated in existing facilities without structural modifications, no positive or negative impacts on floodplains would be expected at any of the candidate sites. Similarly, since no new construction activity is proposed at any of the candidate sites and blending facilities are not located in the vicinity of wetlands, no impacts to wetlands are anticipated.

In addition to the No Action Alternative, four alternatives are analyzed in this EIS that involve various combinations of end products (fuel or waste), technologies, and facilities to blend down the surplus HEU. As described in detail in Section 2.1.2, Alternative 2 involves no commercial use and represents blending the entire surplus inventory (200 t) to waste using metal and UNH blending processes using all of the candidate blending sites. Alternative 3 involves limited commercial use and assumes that only 25 percent of the surplus inventory would be blended to fuel at the two commercial sites using the UNH and UF_6 processes. The remaining inventory would be blended to waste at all four sites using the metal and UNH processes. Alternatives 4 and 5 involve substantial commercial use (65 percent to fuel and 35 percent to waste), and maximum commercial use (85 percent to fuel and 15 percent to waste), respectively, with blending to be accomplished at one, two, or four sites using the UNH and UF_6 processes for fuel, and metal and UNH processes for waste.

As previously discussed in Sections 3.3.4 and 3.5.4, and shown in Figures 3.3.4–2 and 3.5.1–2, blending operations at the Y–12 Plant and B&W, respectively, would be accommodated in facilities located outside the 100- and 500-year floodplains. At SRS, the F- and H-Canyons that could be used for blending also fall outside the 100-year floodplains of the Fourmile Branch and the Upper Three Runs Creek (Section 3.4.4). However, no information currently is available on 500-year floodplain limits at SRS. The NFS site is partially located on the floodplain of the Nolichucky River and Martin Creek (as determined by FEMA, Flood Insurance Rate Map, January 3, 1985) and is occupied by both 100- and 500- year floodplains. However, as described in Section 3.6.4 and below, mitigation measures have been and would continue to be implemented to reduce potential flooding of the site and the likelihood of adverse impacts to site operations.

The blending alternatives at SRS would not likely affect, or be affected by the 500-year floodplain of either the Fourmile Branch or Upper Three Runs Creek because the F- and H-Canyons are located at an elevation of about 91 m (300 ft) above mean sea level and are approximately 33 m (107 ft) and 64 m (210 ft) above these streams and at distances from these streams of 0.8 km (0.5 mi) to 1.5 km (0.94 mi), respectively. The maximum flow that has occurred on the Upper Three Runs Creek was in 1990, with a flow rate of about 58 m^3/s (2,040 ft^3/s). At that time the creek reached an elevation of almost 30 m (98 ft) above mean sea level (SR USGS 1996a:1). The elevations of the buildings in F- and H-Canyons are located more than 62 m (202 ft) above the highest flow elevation of the Upper Three Runs Creek. The maximum flow that has occurred on the Fourmile Branch was in 1991 with a rate of approximately 5 m^3/s (186 ft^3/s), and an elevation of about 61 m (199 ft) above mean sea level (SR USGS 1996a:1). Elevations of the buildings in F- and H-Areas are located more than approximately 30 m (101 ft) higher than the maximum flow level that has occurred.

4.13.1 PROPOSED STATEMENT OF FINDINGS

Four candidate sites, two DOE (Y–12 and SRS) and two commercial (B&W and NFS), were considered in this EIS as potential sites where the proposed action could be implemented. These candidate sites were selected for evaluation because they currently

have technically viable HEU conversion and blending capabilities and could blend surplus HEU to LEU for commercial fuel or waste. In addition, the commercial sites considered are the only ones in the United States licensed for the processing of HEU.

As described above, all facilities except NFS that are proposed to be used for this proposed action at the candidate sites would be outside the limits of the 100-year floodplain and are at least one foot above the 100-year floodplain elevation and, therefore would conform to both State and local floodplain requirements.

The floodplains of the Nolichucky River and Martin Creek at NFS, as previously presented in Figure 3.6.4–1, cover approximately one- and two-thirds of the NFS site's northern portion under 100-year and 500-year floodplain conditions, respectively. Based on the Flood Insurance Rate Map and the flood profiles, both published by FEMA, floodplain elevations at the NFS site are determined to be 499.5 m (1639 ft) and 500 m (1640 ft) above mean sea level, respectively. As stated in the NFS EA, elevations of the building floors are between 500 m (1640 ft) and 510 m (1660 ft) above mean sea level. At the time of construction of the plant (1956), there were no local, State, or NRC requirements prohibiting construction or operation of nuclear facilities in 100- or 500-year floodplains. Presently, the State of Tennessee has no requirements pertaining to building in 100- or 500-year floodplains. Local standards require that any new construction or substantial improvement of any commercial, industrial, or non-residential structure should have the lowest floor, including basement, elevated no lower than one foot above the level of base flood elevation. Because NFS was built prior to 1974, site operations are grandfathered, and this local requirement does not apply to NFS. NRC, which regulates the NFS site, also has no regulations against building or operating nuclear facilities in floodplains. Nevertheless, with the widening of the site's culvert, upgraded drainage system, rechanneling of the Nolichucky River, and rerouting of Martin Creek to enter the Nolichucky River farther downstream, the chance of flood levels at the site has been slightly lowered. In addition, warning devices and systems have been placed by the State of Tennessee along the river to warn the public and the NFS plant of the chance of possible flooding. In addition, NFS and the State of Tennessee have emergency action plans to mitigate potential flood impacts and protect the public water supply from any possible contamination.

There are two alternatives in addition to no action that could be considered to remediate potential flooding of facilities at NFS. One would be to use the facilities in the 300 Area for blending activities which are outside both the 100- and 500-year floodplain limits. Facilities in the 300 Area have building floor elevations of at least 500.5 m (1642 ft) above mean sea level, which would conform to the local requirement of at least one foot above the 100-year floodplain and would also fall outside of the 500-year floodplain. The second alternative is to eliminate NFS as a candidate blending site.

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Glossary

Air Quality Control Region (AQCR): An interstate area designated by the Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

Air quality standards: The level of pollutants in the air prescribed by regulations. These levels may not be exceeded during a specified time in a defined area.

Alloy: A homogeneous mixture of two or more metals.

Alluvium: Earth, sand, gravel, and other materials that have been carried by moving surface water and deposited at points of weak water flow.

Alpha particle: A positively charged particle (the nucleus of a helium atom) that is emitted from the nucleus of certain elements during radioactive decay. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

Ambient: Surrounding.

***American Indian Religious Freedom Act* of 1978:** Establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions. This includes the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

Anadromous: Migrating from salt water to fresh water to spawn.

Anhydrous: Without water.

Aquatic (biota): The sum total of living organisms within any designated area of water.

Aquifer: An underground layer of the earth's crust (that is, porous rock, etc.) containing water; water in an aquifer is known as groundwater.

Aquitard: An underground layer of the earth's crust that is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

***Archaeological and Historic Preservation Act* of 1974:** Preserves historic and archaeological data that could be destroyed or compromised as a result of Federal construction or other Federally licensed or assisted activities.

Archaeological resources (sites): Any locations where humans have altered the terrain or discarded artifacts during either prehistoric or historic times.

***Archaeological Resources Protection Act* of 1979:** Protects archaeological resources on Federal lands. It requires a permit for archaeological excavations or removal of any archaeological resources located on public or Native American lands. It prohibits interstate or foreign trafficking of archaeological resources taken in violation of state or local laws and requires Federal agencies to develop plans for surveying lands under their control.

Assay: Qualitative or quantitative analysis of a substance. An amount of a particular type of material in a sample.

***Atomic Energy Act* of 1954:** This act was originally enacted in 1946 and amended in 1954. For the purpose of this Environmental Impact Statement, "...a program for Government control of the possession, use, or production of atomic energy and special nuclear material whether owned by the Government or others, so directed as to make the maximum contribution to the common defense and security and the national welfare and to provide continued assurance of the Government's ability to enter into and enforce agreements with nations or groups of nations for the control of special nuclear materials and atomic weapons..." (Section 3(c)).

Atomic Energy Commission: A five-member commission, established by the *Atomic Energy Act*, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the Nuclear Regulatory Commission (NRC) and the Administrator of the Energy Research and Development Administration. The Energy Research and Development Administration was later terminated and the functions vested by law in the

Administrator were transferred to the Secretary of Energy.

Attainment area: An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the *Clean Air Act.* An area may be an attainment area for one pollutant and a non-attainment area for others.

Background radiation: Ionizing radiation present in the environment from cosmic rays and natural sources in the earth; background radiation varies considerably with location.

Badged worker: A worker who has the potential to be exposed to radiation and is equipped with an individual dosimeter.

Bald and Golden Eagle Protection Act: This act states that it is unlawful to take, pursue, molest, or disturb the American bald and golden eagle, and their nests and their eggs, anywhere in the United States.

Baseline: A quantitative expression of conditions, costs, schedule, or technical progress to serve as a base or standard for measurement; the established plan against which the status of resources and the progress of a program can be measured.

Benthic: Dwelling at the bottom of oceans, lakes, rivers, and other surface waters.

Beta particle: A positively or negatively charged particle (with the same mass as an electron) that is emitted from the nucleus of certain elements during radioactive decay. It is more penetrating than an alpha particle and typically less penetrating than gamma radiation.

Biotic: Pertaining to biota; the plant and animal life of a particular region.

Biotic resources: Biotic resources include terrestrial, wetlands, and aquatic resources as well as threatened and endangered species.

Blend down (blending): The dilution of highly enriched uranium by mixing with blendstock of the same chemical form to yield low-enriched uranium material.

Blendstock: Depleted, natural, or low-enriched uranium that is used to dilute highly enriched uranium into low-enriched uranium. The depleted, natural, and low-enriched uranium is in a chemical form identical to the highly enriched uranium that it is being blended with to form the low-enriched uranium product.

Bounding case: A case that would represent the extreme (high or low) boundaries of a possible situation.

Bryozoa: A phylum consisting of various small aquatic animals that reproduce by budding and form colonies attached to stones or seaweed.

Capable fault: A geological fault as defined by 10 CFR 100, Appendix A:

- Movement at or near the ground surface at least once during the past 35,000 years or movement of a recurring nature within the past 500,000 years.
- Macro-seismicity (a high tendency for the occurrence of earthquakes) instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.
- A structural relationship to a capable fault according to characteristics such that movement on one could be reasonably expected to be accompanied by movement on the other.

Carolina bays: Ovate, intermittently flooded depression of a type occurring on the coastal plain from New Jersey to Florida.

***Clean Air Act* Amendments of 1990:** Expands the Environmental Protection Agency's enforcement powers and adds restrictions on air toxics, ozone depleting chemicals, and stationary and mobile emissions implicated in acid rain and global warming.

***Clean Water Act* of 1972, 1987 (CWA):** This Act regulates the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge

Elimination System (NPDES) permit as well as regulates discharges to or dredging of wetlands.

Code of Federal Regulations (CFR): All Federal regulations in force are published in codified form in this document.

Coliform: Normally harmless types of bacteria that reside in the intestinal tract of humans and other animals and whose presence in water is an indicator that the water may be contaminated with other disease-causing organisms found in untreated human and animal waste.

Colluvium: Soil and other nonconsolidated rock material on hill slopes; not transported by water.

Community (biotic): An aggregation of plants and animals having mutual relationships among themselves and to their environment.

***Comprehensive Environmental Response, Compensation, and Liability Act* of 1980 (CERCLA or Superfund):** This Act provides a regulatory framework for remediation of past contamination from hazardous waste. If a site meets the Act's requirements for designation, it is ranked along with other "Superfund" sites and is listed on the National Priorities List. This ranking is the Environmental Protection Agency's way of determining the sites that have the highest priority for cleanup.

Confined aquifer: A permeable geological unit with an upper boundary that is at a pressure higher than atmospheric pressure.

Cosmic radiation: Streams of highly penetrating, charged particles, composed of protons, alpha particles, and a few heavier nuclei, that bombard the earth from outer space.

Coastal Zone Management Act: This act establishes a national policy of preservation, protection from development, and, where possible, the restoration and enhancement of the nation's coastal zone.

Criteria pollutants: Six air pollutants for which national ambient air quality standards are established by the Environmental Protection Agency (EPA): sulfur dioxide, nitric oxides, carbon monoxide, ozone, particulate matter (smaller than 10 microns in diameter), and lead.

Critical habitat: As defined in the *Endangered Species Act* of 1973, specific areas within the geographical area occupied by an endangered or threatened species that are essential to the conservation of the species and that may require special management considerations or protection; and specific areas outside of the geographical area occupied by the species that are essential for the conservation of the species.

Criticality: A reactor state in which a self-sustaining nuclear chain reaction is achieved.

Curie: A unit of radioactivity equal to 37 billion disintegrations per second; also a quantity of any nuclide or mixture of nuclides having 1 curie of radioactivity.

Decay (radioactive): The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous transformation of unstable nuclides into different nuclides or into a different state of the same nuclide. The emission of nuclear radiation (alpha, beta, and gamma) is part of the process.

Decibel: A unit of sound measurement. In general, a sound doubles in volume for every increase of 10 decibels.

Decontamination: The removal of radioactive or chemical contamination from facilities, equipment, or soils by washing, heating, chemical or electro-chemical action, mechanical cleaning, or other techniques.

Depleted uranium (DU): Uranium with a content of the isotope uranium-235 of less than 0.7 percent, which is the uranium-235 content of naturally occurring uranium.

Derived concentration guide: The concentration of a radionuclide in the air or water of which, under conditions of continuous exposure by one exposure mode (for example, ingestion of water) for one year, a "reference person" would receive the most restrictive: 1) an effective dose equivalent or 100

mrem, or 2) a dose equivalent of 5 rem to any tissues, including skin and the lens of the eye.

Design-basis event: A postulated disturbance in a process variable that has the potential to lead to a design-basis accident.

Dolomite: Calcium magnesium carbonate, a limestone-like material.

Dose: The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad.

Dose commitment: The dose an organ or tissue would receive during a specified period of time (for example, 20 to 30 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a defined release, frequently over a year's time.

Dose equivalent: The product of the absorbed dose in rad (or gray) and the effect of this type of radiation in tissue and a quality factor. Dose equivalent is expressed in units of rem or Sievert, where 1 rem equals 0.01 Sievert. The dose equivalent to an organ, tissue, or whole body will be that received from the direct exposure plus 50-year committed dose equivalent received from radionuclides taken into the body during the year.

Dosimeter: A small device (instrument) carried by a worker that measures the cumulative radiation dose (for example, film badge or ionization chamber).

Drawdown: The lowering of the water level in a reservoir, water table, or other body of water.

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

Effluent: A gas or fluid discharged into the environment.

Endangered species: Defined in the *Endangered Species Act* of 1973 as "any species which is in danger of extinction throughout all or a significant portion of its range.

***Endangered Species Act* of 1973:** This act requires Federal agencies, with the consultation and assistance of the Secretaries of the Interior and Commerce, to ensure that their actions will not likely jeopardize the continued existence of any endangered or threatened species or adversely affect the habitat of such species.

Enrichment: A process whereby the proportion of fissile U–235 is increased above its naturally occurring value of 0.7 percent. Enrichment to 3 percent is typical of fuel for power reactors. Weapons-grade uranium may be enriched to 20 percent or more.

Entrainment: The involuntary capture and inclusion of organisms in streams of flowing water, a term often applied to the cooling water systems of power plants or reactors. The organisms involved may include phyto- and zooplankton, fish eggs and larvae (icthyoplankton), shellfish larvae, and other forms of aquatic life.

Environment, safety, and health program: In the context of the Department of Energy, this program encompasses those Department of Energy requirements, activities, and functions in the conduct of all Department of Energy-controlled operations that are concerned with impacts to the biosphere; compliance with environmental laws, regulations, and standards controlling air, water, and soil pollution; limiting risks to the well-being of both operating personnel and the general public to acceptably low levels; and adequately protecting property against loss or damage. Typical activities and functions related to this type of program include, but are not limited to, environmental protection, occupational safety, fire protection, industrial hygiene, health physics, occupational medicine, process and facilities safety, nuclear safety, emergency preparedness, quality assurance, and radioactive and hazardous waste management.

Environmental assessment (EA): A written environmental analysis that is prepared pursuant to the *National Environmental Policy Act* (NEPA) to determine whether a Federal action would significantly affect the environment and thus require the preparation of a more detailed environmental impact statement. If the action does not significantly affect the environment, a Finding of No Significant Impact (FONSI) is prepared.

Environmental impact statement (EIS): A document required of Federal agencies by the *National Environmental Policy Act* for major proposals significantly affecting the environment. A decisionmaking tool, it describes the positive and negative effects of the proposed action and alternatives.

Epidemiology: The science concerned with the study of events that determine and influence the frequency and distribution of disease, injury, and other health-related events and their causes in a defined human population.

Evaluation basis accident: For nuclear facilities, a postulated abnormal event that is used to establish the performance requirements of structures, systems, and components that are necessary to: 1) maintain them in a safe shutdown condition indefinitely; or 2) prevent or mitigate the consequences of such an accident so that the general public and operating staff are not exposed to radiation in excess of appropriate guideline values.

Exposure limit: The level of exposure to a hazardous chemical (set by law or a standard) at or below which adverse human health effects are not expected to occur:

- Reference dose is the chronic exposure dose (mg/kg/day) for a given hazardous chemical at or below which adverse, non-carcinogenic human health effects are not expected to occur.
- Reference concentration is the chronic exposure concentration (mg/m^3) for a given hazardous chemical at or below which adverse non-carcinogenic human health effects are not expected to occur.

Fault: A fracture or zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred.

Fauna: Animals, especially those of a specific region, considered as a group.

Finding of No Significant Impact (FONSI): A document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded, will not have a significant impact on the human environment and will not require an environmental impact statement.

Fish and Wildlife Coordination Act: This act requires that consideration be given to the conservation of fish and wildlife resources during the development of projects that affect water resources directly or indirectly.

Fissile material: An element or isotope that can undergo fission.

Fission: The splitting of a heavy nucleus, as of uranium or plutonium, into two approximately equal parts, accompanied by the conversion of mass to energy, the release of this energy, and the production of free neutrons, gamma rays, and other radiation. Fission can occur spontaneously or be induced by neutron bombardment.

Fission products: Nuclei formed by the fission of heavy elements (primary fission products); also the nuclei formed by the decay of the primary fission products, many of which are radioactive.

Floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas with a chance of 1 percent or greater that the area will be inundated by a flood in any given year. The base floodplain is defined as the 100-year (1-percent) floodplain. The critical action floodplain is defined as the 500-year (0.2-percent) floodplain.

Flora: Plants, especially those of a specific region, considered as a group.

Forward Reactor Requirements: Amount of uranium required to assure uninterrupted operation of nuclear power plants.

Gamma particles: High-energy, short-wavelength electromagnetic particles emitted from the nucleus of atoms of certain elements during fission or decay. Gamma radiation is very penetrating and can be stopped only by dense materials (such as lead) or a thick layer of shielding materials.

Glove box: An airtight box used to work with hazardous material, vented to a closed filtering system, with gloves attached inside of the box to protect the user.

Groundwater: The supply of water found beneath the earth's surface, usually in aquifers, which may supply wells and springs.

Half-life (radiological): The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; this varies from milliseconds to billions of years, depending on the isotope.

Hazard index (HI): A summation of the Hazard Quotients for all chemicals now being used at a site and those proposed to be added to yield cumulative levels for a site. A Hazard Index value of 1.0 or less means that there should be no adverse human health effects (non-carcinogenic).

Hazardous material: Any material, as defined by 40 CFR 171.8, which poses a risk to health, safety, and property when transported or handled.

Hazardous/toxic waste: Any solid, semisolid, liquid, or gaseous material that is ignitable, corrosive, toxic, or reactive, as defined by the *Resource Conservation and Recovery Act* and identified or listed in 40 CFR 261 or by the *Toxic Substances Control Act.*

High efficiency particulate air (HEPA) filter: A filter used to remove solid particles from dry, gaseous effluent streams.

High-level waste (HLW): The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid. High-level waste contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

Highly enriched uranium (HEU): Uranium enriched in isotope U–235 to 20 percent or above, which becomes suitable for weapons use.

Historic resources: Archaeological sites, architectural structures, and objects produced after the advent of written history dating, in the United States, from 1492.

Hydrology: The science dealing with the properties, distribution, and circulation of natural water systems.

Igneous rock: Class of rock formed by the solidification of molten or partly molten parent material.

Impingement: The process by which aquatic organisms that are too large to pass through the screens of a water intake structure become caught on the screens and are unable to escape.

Impoundment: A collection area for water, usually for irrigation purposes.

Incident-free risk: The radiological or chemical impacts resulting from the normal vehicular transport of packages. This includes the radiation of a hazardous chemical exposure of specific populations, such as crew, passengers, and bystanders. No accident or incident risks are involved.

Indirect economic effects: Indirect economic effects result from the need to supply industries experiencing direct economic effects with additional outputs to allow them to increase their production. The additional output from each directly affected industry requires inputs from other industries within a region (that is, purchasers of goods or services). This results in a multiplier effect to show the change in total economic activity as firms increase their labor inputs.

Infrastructure: The basic facilities, services, and installations needed for the functioning of a plant or other site, such as transportation and communication systems.

Interim storage: Providing safe and secure capacity in the near term to support continuing operations in the interim period (10 years).

Intermittent stream: A stream or reach of a stream that flows primarily during seasonal wet periods.

Involved worker: A worker that is directly associated with any of the blending and conversion facility operations.

Ion exchange: A unit physiochemical process that removes ions (both positively and negatively charged), including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.

Ionizing radiation: Radiation that can displace electrons from atoms or molecules, thereby producing ions.

ISCST2: A computerized dispersion program used to calculate ground-level concentrations of air pollutants (Version 2).

Isotope: An atom of an element with a specific atomic number and atomic mass. Isotopes of the same element have the same atomic number (i.e., the same number of protons) but have the different numbers of neutrons and different atomic masses. Isotopes are identified by the name of the element and the total number of protons and neutrons in the nucleus.

Joule: A metric unit of energy, work, or heat that is equivalent to 1 watt-second, 0.239 calories or 1 newton-meter.

Land resources: Land resources are comprised of all of the terrestrial areas available for economic production, residential or recreational use, Government activities (such as military bases), or natural resources consumption.

Latent fatalities: Fatalities associated with acute and chronic environmental exposure to chemical or radiation which occur years after an exposure takes place.

Low-enriched uranium (LEU): Uranium with a content of the uranium isotope U-235 greater than 0.7 percent and less than 20 percent.

Low-level waste (LLW): Waste that contains radioactivity but is not classified as high-level or transuranic waste, spent nuclear fuel, or "11e(2) byproduct material" as defined by Department of Energy Order 5820.2A, *Radioactive Waste Management.* 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.

Maximally exposed individual (MEI): A hypothetical person who could potentially receive the maximum dose of radiation or hazardous chemicals.

Megawatt: A unit of power equal to 1 million watts. "Megawatt thermal" is commonly used to describe heat, while "megawatt electric" describes electricity.

Metamorphic rocks: Class of rock formed in the solid state in response to pronounced changes in the temperature, pressure or chemical environment.

Mixed waste: Waste that contains both radioactive and hazardous wastes as described in this glossary.

Migration: The seasonal movement of animals from one area to another.

Migratory Bird Treaty Act: This act states that it is unlawful to pursue, take, attempt to take, capture, possess, or kill and migratory bird, or any part, nest, or egg of any such bird other than permitted activities.

Modified Mercalli Intensity 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).

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act,* as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety. The secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emissions 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 were implemented in the *Clean Air Act* Amendments of 1977.

***National Environmental Policy Act* of 1969 (NEPA):** This Act is the basic national charter for the protection of the environment. It requires the preparation of an environmental impact statement for every major Federal action that may significantly affect the quality of the human or natural environment. Its main purpose is to provide environmental information to decision-makers so that their actions are based on an understanding of the potential environmental consequences of a proposed action and its reasonable alternatives.

National Environmental Research Park: An outdoor laboratory set aside for ecological research to study the environmental impacts of energy developments. National environmental research parks 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* of 1966, as amended:** This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal Code, if a proposed action might impact a historic property, it mandates consultation with the appropriate agencies.

National Pollution Discharge Elimination System (NPDES): The Federal permitting system required for hazardous effluents 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, historic, local, state, or national significance that is 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.C. 462) and Section 101(a)(1)(A) of the *National Historic Preservation Act* of 1966, as amended.

Natural uranium (NU): Uranium that has the same isotopic composition as naturally occurring uranium. The isotopic composition of natural uranium is approximately 99.3 percent U-238 and 0.71 percent U-235.

***Native American Graves and Repatriation Act* of 1990:** Established to protect Native American graves and associated funerary objects. This law requires Federal agencies and museums to inventory human remains and associated funerary objects and to provide culturally affiliated tribes with the inventory of collections. Requires repatriation, on request, to the culturally affiliated tribes.

Neutron: An uncharged elementary particle with a mass slightly greater than that of a proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays, with a half-life of about 13 minutes, into a proton and an electron.

Nitrogen oxides: Refers to the oxides of nitrogen, primarily nitrogen oxide (NO) and nitrogen dioxide (NO_2). These are produced in the combustion of fossil fuels and can constitute an air pollution problem. When nitrogen dioxide combines with volatile organic compounds, such as ammonia or carbon monoxide, ozone is produced.

***Noise Control Act* of 1972:** This Act directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

Noninvolved worker: A worker that is located onsite but is not associated with any of the blending facility operation.

Normal operation: A predetermined set of facility processes or functions whereby and expected or "standard" output is the result.

Notice of Intent (NOI): A notice printed in the *Federal Register* announcing that a Federal agency is going to prepare an environmental impact statement.

Nuclear power plant: A facility that converts nuclear energy into electrical power. Heat produced in a nuclear reactor is used to make steam, which in

turn drives a turbine connected to an electric generator.

Nuclear reactor: A device in which a fission chain reaction is maintained and which is used for irradiation of materials or to produce heat for the generation of electricity.

Nuclide: A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.

Occupational dose limit: The NRC's promulgated radiological exposure limits to occupational workers. To the whole body, it is established to be 5,000 millirem per year.

Occupational Safety and Health Administration (OSHA): Oversees and regulates workplace health and safety, created by the *Occupational Safety and Health Act* of 1970.

Outfall: The discharge point of a drain, sewer, or pipe as it enters a body of water.

Overfeeding: The process that involves increasing the rate at which uranium feed is used in gaseous diffusion plants with a corresponding decrease in energy consumed for separative work.

Oxidation: The combination of a substance with oxygen. During this reaction, the atoms in the element combined with oxygen lose electrons and the element's valence (the capacity to combine with other elements) is correspondingly increased.

Packaging: The assembly of components necessary to perform containment function and ensure compliance with Federal regulations. It may consist of one or more materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or for absorbing mechanical shocks. The vehicle tie-down system and auxiliary equipment may be designated as part of the packaging.

Paleontology: The study of extinct plant and animal life that existed in former geologic times, especially fossils.

Paleozoic Era: The longest era of geological time that extends from the Cambrian through the Permian periods, occurring 230 million to 600 million years ago, characterized by the appearance of marine invertebrates, primitive fishes, amphibians, reptiles, and seed-bearing land plants.

Palustrine wetland: Nontidal wetlands dominated by trees, shrubs, and emergent vegetation.

Pathway: A route or course through which a human can be exposed to radiation or chemicals (that is, ingestion, inhalation, absorption, etc.).

PCB: PCBs (polychlorinated biphenyl) are any of a family of chlorinated chemicals that are noted as dangerous environmental pollutants that can accumulate in animal tissues with resultant pathogenic or teratogenic (causing birth defects) effects.

Perennial stream or creek: A stream or reach of a stream that flows continually throughout the year and whose upper surface generally stands lower than the water table in the region adjoining the stream.

Permeable: In geology, rock or soil that is able to transmit a fluid.

Person-rem: The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a segment of the population.

pH: A numeric value that indicates the relative acidity or alkalinity of a substance on a scale of 0 to 14, with the neutral point at 7.0. Acid solutions have pH values lower than 7.0 and basic (alkaline) solutions have pH values higher than 7.0.

Piedmont region: An area of rolling topography between the Appalachian Mountains and the coastal plain that extends from New Jersey to Alabama.

Plume: The elongated pattern of contaminated air or water originating at a point source, such as a smokestack or hazardous waste disposal site.

Plutonium: A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombarding uranium with neutrons.

Plutonium is used in the production of nuclear weapons.

Prehistoric: Predating written history. In North America, before 1492.

Prevention of Significant Deterioration (PSD): Regulations established by the 1977 *Clean Air Act* Amendments to limit increases in criteria air pollutant concentrations above baseline.

Prime farmland: Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oil-seed, and other agricultural crops with a minimum input of fuel, fertilizer, pesticides, and labor without intolerable soil erosion, as determined by the Secretary of Agriculture (*Farmland Protection Policy Act* of 1981, 7 CFR 7, paragraph 658).

Protected area: An area encompassed by physical barriers, subject to access controls, surrounding material access areas, and meeting standards of Department of Energy Order 5632.1C, *Protection and Control of Safeguards and Security Interests.*

Quaternary: The second geologic period of the Cenozoic Era, occurring from 2 million years ago to the present, characterized by the appearance of human beings.

Rad: The unit of measure expressing the physical absorption of radiation. It is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram of absorbing material.

Radiation: The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced.

Radioactive waste: Materials from nuclear operations that are radioactive or contaminated with radioactive materials and for which use, reuse, or recovery are impractical.

Radioactivity: The emission of radiation, either spontaneously from unstable atomic nuclei or as a consequence of a nuclear reaction.

Radioisotopes: Radioactive nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons.

Radionuclide: A radioactive, naturally occurring or manmade element characterized according to its atomic mass and atomic number. Radionuclides can have a long life as soil or water pollutants and are believed to have potentially mutagenic or carcinogenic effects on the human body.

Radon: A gaseous, radioactive element with the atomic number 86 that results from the radioactive decay of radium. Radon occurs naturally in the environment and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

RADTRAN: A computer code that combines user-determined, demographic, transportation, packaging, and materials with health physics data to calculate the expected radiological consequences and accident risk of transporting radioactive material.

Raptor: A bird of prey, such as an eagle, hawk, or falcon.

Receiving waters: Rivers, lakes, oceans, or other bodies of water into which wastewaters are discharged.

Recharge: Replenishment of water to an aquifer.

Record of Decision (ROD): A public document that records the final decision(s) concerning a proposed action. The Record of Decision is based in whole or in part on information and technical analysis generated during the *Comprehensive Environmental Release, Compensation, and Liability Act* (CERCLA) process or the *National Environmental Policy Act* (NEPA) process, both of which take into consideration public comments and community concerns.

Regional Economic Area (REA): Geographical area defined by the Bureau of Economic Analysis (BEA) that is used to assess economic impacts of proposed alternatives.

Region of Influence (ROI): Geographical area where approximately 90 percent of DOE and

contractor employees reside. ROI's are used to assess demographic, housing or public service impacts of proposed alternatives.

Rem: The abbreviation for "roentgen equivalent man," which is the unit of radiation dose for biological absorption. It is equal to the product of the absorbed dose, in rads, and a quality factor that accounts for the variation in biological effectiveness of different types of radiation. Abbreviated as "rem."

***Resource Conservation and Recovery Act*, as amended (RCRA):** The Act that provides a "cradle to grave" regulatory program for hazardous waste and that established, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

Richter Scale: A logarithmic scale used to express the total amount of energy released by an earthquake; it has 10 divisions, from 1 (not felt by humans) to 10 (nearly total damage).

Riparian: On or around rivers or streams.

Risk: A qualitative or quantitative expression of possible loss that considers both the probability that a hazard will cause harm and the consequences of that event.

Runoff: The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually enters a stream.

***Safe Drinking Water Act*, as amended:** This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

Safe secure trailer (SST): A specially designed semi-trailer, pulled by an armored tractor, that is used for the safe, secure transportation of cargo containing nuclear weapons or special nuclear material.

Safety analysis report (SAR): A report, prepared in accordance with DOE Orders 5481.1B and 5480.23, that summarizes the hazards associated with the operation of a particular facility and defined minimum safe requirements.

Safety document: A document prepared specifically to ensure that the safety aspects of part or all of the activities conducted at a nuclear facility are formally and thoroughly analyzed, evaluated, and recorded (for example, technical specifications, safety analysis reports and addenda, and documented reports of special safety reviews and studies). Safety Analysis Reports (SAR) and Safety Evaluation Reports (SER) are similar except that the governing regulatory agency is DOE or NRC, respectively.

Sanitary wastes: Wastes generated by normal housekeeping activities, liquid or solid (includes sludge), that are not hazardous or radioactive.

Sedimentary Rocks: These rocks are composed of materials that have been transported and then deposited, materials that have been precipitated from marine waters, or remains of organisms.

Sedimentation: The settling out of soil and mineral solids from suspension in water.

Seepage basin: An unlined pit in the ground that receives aqueous effluent.

Seismic: Pertaining to any earth vibration, especially an earthquake.

Seismic zone: An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: 1) Zone 0—no damage; 2) Zone 1—minor damage, corresponds to intensities V and VI of the Modified Mercalli Intensity Scale; 3) Zone 2A—moderate damage, corresponds to intensity VII of the Modified Mercalli Intensity Scale (eastern United States); 4) Zone 2B—slightly more damage than 2A (western United States); 5) Zone 3—major damage, corresponds to intensity VIII or higher of the Modified Mercalli Intensity Scale; 6) Zone 4—areas within Zone 3 determined by proximity to major fault systems.

Separate Work Unit (SWU): A measure of the separation achieved in a uranium enrichment plant after separating uranium of a given U-235 content into two components, one having a higher percentage of U-235 than the other component.

Severe accident: An accident with a frequency rate of less than 10^{-6} per year that would have more severe consequences than a design-basis accident, in terms of damage to the facility, offsite consequences, or both.

Siltstone: A sedimentary rock composed of fine textured minerals.

Source term: The estimated quantities of radionuclides or chemical pollutants released to the environment.

Spallation: Any nuclear reaction where several particles result from a collision, e.g., a chain reaction in a nuclear reactor.

Special nuclear materials: As defined in Section 11 of the *Atomic Energy Act* of 1954: (1) plutonium, uranium enriched in the isotopes 233 or 235, and any other material which the Nuclear Regulatory Commission determines to be special nuclear material; (2) any material artificially enriched by any of the aforementioned materials.

Spent nuclear fuel: Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

Standardization (Epidemiology): Techniques used to control the effects of differences (e.g., age) between populations when comparing disease experience. There are two main methods:

- Direct method, in which specific disease rates in the study population are averaged, using the distribution of the comparison population as a weight.
- Indirect method, in which the specific disease rates in the comparison population are averaged, using the distribution of the study population as a weight.

State Historic Preservation Officer: State officer established to carry out the duties associated with the *National Historic Preservation Act,* for identification and protection of prehistoric and historic resources.

Sulfur oxides: Common air pollutants, primarily sulfur dioxide (SO_2) considered a major air pollutant, a heavy, bad-smelling, colorless gas usually formed in the combustion of coal and sulfur trioxide (SO_3).

Surface water: Water on the earth's surface, as distinguished from water beneath the surface (groundwater).

Tailwaters: Water below a dam.

Terrestrial (biotic): The sum total of living organisms within any designated land area.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

***Toxic Substances Control Act* of 1976 (TSCA):** This Act authorizes the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the EPA before they are manufactured for commercial purposes.

Transuranic waste: Waste contaminated with alpha particles emitting radionuclides with half-lives greater than 100 nanocuries per gram at the time of assay. It is not a mixed waste.

Tributary: Any stream which contributes water to another stream or river.

Tritium: A radioactive isotope of the element hydrogen with two neutrons and one proton. Common symbols for the isotope are H-3 and T.

Unconfined aquifer: A permeable geological unit that has a water-filled pore space (saturated), the capability to transmit significant quantities of water under ordinary differences in pressure, and an upper water boundary that is at atmospheric pressure.

Unsaturated zone (vadose): A region in a porous medium in which the pore space is not filled with water.

Uranium: A heavy, silvery-white metallic element with an atomic number of 92. It has many radioactive isotopes: Uranium-235 is most commonly used as a fuel for nuclear fission; Uranium-238 is transformed into fissionable Plutonium-239 following its capture of a neutron in a nuclear reactor.

Visual Resource Management Class: A Visual Resource Management (VRM) Class defines the different degrees of modifications to the basic elements of the landscape: (1) Class 1 is applied to wilderness areas, wild and scenic rivers, and other similar environments; (2) Class 2 contrasts are seen but do not attract attention; (3) Class 3 contrasts caused by a cultural activity are evident, but remain subordinate to the existing landscape; (4) Class 4 contrasts attract attention and are dominant features of the landscape in terms of scale but repeat the contrast of the characteristic landscape; (5) Class 5 is applied to areas where unacceptable cultural modifications have lowered the scenic quality (where the natural characteristics of the landscape have been disturbed to the point where rehabilitation is needed to bring it up to one of the other four classes).

Vitrification: A waste treatment process that uses glass (for example, borosilicate glass) to encapsulate or immobilize radioactive wastes to prevent them from reacting in disposal sites.

Volatile organic compounds (VOCs): A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures (for example, benzene, chloroform, and methyl alcohol).

Wastewater: Spent water originating from all aspects of human sanitary water use (domestic wastewater) and from a myriad of industrial processes that use water for a variety of purposes (industrial wastewater).

Water quality standards and criteria: Concentration limit of constituents or characteristics allowed in water; often based on water use classifications (for example, drinking water, recreation use, propagation of fish and aquatic life, and agriculture and industry use). Water quality standards are legally enforceable; water quality criteria are non-enforceable recommendations based on biotic impacts.

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.

Weapons-grade: Fissionable material in which the abundance of fissionable isotopes is high enough that the material is suitable for use in thermonuclear weapons.

Wetland: Land or areas exhibiting hydric soil conditions, 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.

Appendix A
Nonproliferation and Export Control Policy Fact Sheet

This appendix contains a copy of the fact sheet on the President's Nonproliferation and Export Control Policy released by the White House on September 27, 1993. The fact sheet describes the major principles that guide the policy and the key elements of the policy.

THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release September 27, 1993

FACT SHEET

NONPROLIFERATION AND EXPORT CONTROL POLICY

The President today established a framework for U.S. efforts to prevent the proliferation of weapons of mass destruction and the missiles that deliver them. He outlined three major principles to guide our nonproliferation and export control policy:

- Our national security requires us to accord higher priority to nonproliferation, and to make it an integral element of our relations with other countries.

- To strengthen U.S. economic growth, democratization abroad and international stability, we actively seek expanded trade and technology exchange with nations, including former adversaries, that abide by global nonproliferation norms.

- We need to build a new consensus -- embracing the Executive and Legislative branches, industry and public, and friends abroad -- to promote effective nonproliferation efforts and integrate our nonproliferation and economic goals.

The President reaffirmed U.S. support for a strong, effective nonproliferation regime that enjoys broad multilateral support and employs all of the means at our disposal to advance our objectives.

Key elements of the policy follow.

Fissile Material

The U.S. will undertake a comprehensive approach to the growing accumulation of fissile material from dismantled nuclear weapons and within civil nuclear programs. Under this approach, the U.S. will:

- Seek to eliminate where possible the accumulation of stockpiles of highly-enriched uranium or plutonium to ensure that where these materials already exist they are subject to the highest standards of safety, security, and international accountability.

- Propose a multilateral convention prohibiting the production of highly-enriched uranium or plutonium for nuclear explosives purposes or outside of international safeguards.

- Encourage more restrictive regional arrangements to constrain fissile material production in regions of instability and high proliferation risk.

- Submit U.S. fissile material no longer needed for our deterrent to inspection by the International Atomic Energy Act.

- Pursue the purchase of highly-enriched uranium from the former Soviet Union

and other countries and its conversion to peaceful use as reactor fuel.

- Explore means to limit the stockpiling of plutonium from civil nuclear programs, and seek to minimize the civil use of highly-enriched uranium.

- Initiate a comprehensive review of long-term options for plutonium disposition, taking into account technical, nonproliferation, environmental, budgetary and economic considerations. Russia and other nations with relevant interests and experience will be invited to participate in this study.

The United States does not encourage the civil use of plutonium and, accordingly, does not itself engage in plutonium reprocessing for either nuclear power or nuclear explosive purposes. The United States, however, will maintain its existing commitments regarding the use of plutonium in civil nuclear programs in Western Europe and Japan.

Export Controls

To be truly effective, export controls should be applied uniformly by all suppliers. The United States will harmonize domestic and multilateral controls to the greatest extent possible. At the same time, the need to lead the international community or overriding national security or foreign policy interests may justify unilateral export controls in specific cases. We will review our unilateral dual-use export controls and policies, and eliminate them unless such controls are essential to national security and foreign policy interests.

We will streamline the implementation of U.S. nonproliferation export controls. Our system must be more responsible and efficient, and not inhibit legitimate exports that play a key role in American economic strength while preventing exports that would make a material contribution to the proliferation of weapons of mass destruction and the missile that deliver them.

Nuclear Proliferation

The U.S. will make every effort to secure the indefinite extension of the Non-Proliferation Treaty in 1995. We will seek to ensure that the International Atomic Energy Agency has the resources needed to implement its vital safeguards responsibilities, and will work to strengthen the IAEA's ability to detect clandestine nuclear activities.

Missile Proliferation

We will maintain our strong support for the Missile Technology Control Regime. We will promote the principles of the MTCR Guidelines as a global missile nonproliferation norm and seek to use the MTCR as a mechanism for taking joint action to combat missile proliferation. We will support prudent expansion of the MTCR's membership to include additional countries that subscribe to international nonproliferation standards, enforce effective export controls and abandon offensive ballistic missile programs. The United States will also promote regional efforts to reduce the demand for missile capabilities.

The United States will continue to oppose missile programs of proliferation concern, and will exercise particular restraint in missile-related cooperation. We will continue to retain a strong presumption of denial against exports to any country of complete space launch vehicles or major components.

The United States will not support the development or acquisition of space-launch vehicles in countries outside the MTCR.

For MTCR member countries, we will not encourage new space launch vehicle programs, which raise questions on both nonproliferation and economic viability grounds. The United States will, however, consider exports of MTCR-controlled items to MTCR member countries for peaceful space launch programs on a case-by-case basis. We will review whether additional constraints or safeguards could reduce the risk of misuse of space launch technology. We will seek adoption by all MTCR partners of policies as vigilant as our own.

Chemical and Biological Weapons

To help deter violations of the Biological Weapons Convention, we will promote new measures to provide increased transparency of activities and facilities that could have biological weapons applications. We call on all nations -- including our own -- to ratify the Chemical Weapons Convention quickly so that it may enter into force by January 13, 1995. We will work with others to support the international Organization for the Prohibition of Chemical Weapons created by the Convention.

Regional Nonproliferation Initiatives

Nonproliferation will receive greater priority in our diplomacy, and will be taken into account in our relations with countries around the world. We will make special efforts to address the proliferation threat in regions of tension such as the Korean peninsula, the Middle East and South Asia, including efforts to address the underlying motivations for weapons acquisition and to promote regional confidence-building steps.

In Korea, our goal remains a non-nuclear peninsula. We will make every effort to secure North Korea's full compliance with its nonproliferation commitments and effective implementation of the North-South denuclearization agreement.

In parallel with our efforts to obtain a secure, just, and lasting peace in the Middle East, we will promote dialogue and confidence-building steps to create the basis for a Middle East free of weapons of mass destruction. In the Persian Gulf, we will work with other suppliers to contain Iran's nuclear, missile, and CBW ambitions, while preventing reconstruction of Iraq's activities in these areas. In South Asia, we will encourage India and Pakistan to proceed with multilateral discussions of nonproliferation and security issues, with the goal of capping and eventually rolling back their nuclear and missile capabilities.

In developing our overall approach to Latin America and South Africa, we will take account of the significant nonproliferation progress made in these regions in recent years. We will intensify efforts to ensure that the former Soviet Union, Eastern Europe and China do not contribute to the spread of weapons of mass destruction and missiles.

Military Planning and Doctrine

We will give proliferation a higher profile in our intelligence collection and analysis and defense planning, and ensure that our own force structure and military planning address the potential threat from weapons of mass destruction and missile around the world.

Conventional Arms Transfers

We will actively seek greater transparency in the area of conventional arms transfers and promote regional confidence-building measures to encourage restraint on such transfers to regions of instability. The U.S. will undertake a comprehensive review of conventional arms transfer policy, taking into account national security, arms control, trade, budgetary and economic competitiveness consideration.

Appendix B
Nonproliferation of Weapons of Mass Destruction and the Means of Their Delivery

THE WHITE HOUSE

Office of the Press Secretary

JOINT STATEMENT
BY THE PRESIDENT OF THE RUSSIAN FEDERATION
AND
THE PRESIDENT OF THE UNITED STATES OF AMERICA
ON NON-PROLIFERATION OF WEAPONS OF MASS DESTRUCTION
AND THE MEANS OF THEIR DELIVERY

President Clinton and President Yeltsin, during their meeting in Moscow on January 14, 1994, agreed that the proliferation of weapons of mass destruction and their missile delivery systems represents an acute threat to international security in the period following the end of the Cold War. They declared the resolve of their countries to cooperate actively and closely with each other, and also with other interested states, for the purpose of preventing and reducing this threat.

The Presidents noted that the proliferation of nuclear weapons creates a serious threat to the security of all states, and expressed their intention to take energetic measures aimed at prevention of such proliferation.

- Considering the Treaty on the Non-proliferation of Nuclear Weapons as the basis for efforts to ensure the nonproliferation of nuclear weapons, they called for its indefinite and unconditional extension at conference of its participants in 1995, and they urged that all states that have not yet done so accede to this treaty.

- They expressed their resolve to implement effective measures to limit and reduce nuclear weapons. In this connection, they advocated the most rapid possible entry into force of the START I and START II treaties.

- They agreed to review jointly appropriate ways to strengthen security assurances for the states which have renounced the possession of the nuclear weapons and that comply strictly with their nonproliferation obligations.

- They expressed their support for the International Atomic Energy Agency in its efforts to carry out its safeguards responsibilities. They also expressed their intention to provide assistance to the Agency in the safeguards field, including through joint efforts of their relevant laboratories to improve safeguards.

- They supported the Nuclear Suppliers Group, and agreed with the need for effective implementation of the principle of full-scope IAEA safeguard as a condition for nuclear exports with the need for export controls on dual-use materials and technology in the nuclear field.

- They reaffirmed their countries' commitment to the conclusion as soon as possible.

Appendix C
Air Quality and Noise

C.1 AIR QUALITY

C.1.1 INTRODUCTION

This appendix provides detailed data that support impact assessments to air quality and noise addressed in Sections 3.3.3, 3.4.3, 3.5.3, and 3.6.3, Affected Environment, and 4.3.1.2, 4.3.2.2, 4.3.3.2, 4.3.4.2, and 4.6.2.2, Environmental Consequences. The data presented include emission inventories from site-related activities and highly enriched uranium (HEU) blending facilities. Section C.1.2 presents the methodology and models used in the air quality assessment. Section C.1.3 presents supporting data applicable to each site. The tables included in Sections C.1.4 through C.1.7 contain information applicable to the air quality assessments at each site, and the figures contain wind rose data at each site. Section C.2 presents the emission rates for the blending facilities considered as alternatives. Section C.3 presents noise data for those sites where noise regulations apply.

C.1.2 METHODOLOGY AND MODELS

The assessment of potential impacts to air quality is based on the comparison of proposed project effects with applicable standards and guidelines. The Industrial Source Complex Short-Term Model Version 2 (ISCST2) is used to estimate concentrations of pollutants from emission sources at each site.

The air quality modeling analysis performed for the candidate sites is considered to be a screening level analysis that incorporates conservative assumptions applied to each site so that the impacts associated with the respective alternatives can be compared among the sites. These conservative assumptions will tend to overestimate the pollutant concentrations at each site.

The assumptions incorporated into the air quality analysis at each site are as follows: major source criteria pollutant emissions were modeled using actual source locations and stack parameters to determine no action criteria pollutant concentrations; toxic/hazardous pollutant emissions were modeled from a single source centrally located within the complex of facilities on each site assuming a 10-meter (m) (32.8-feet [ft]) stack height, a stack diameter of 0.3 m (1 ft), a stack exit temperature equal to ambient temperature, and a stack exit velocity equal to 0.03 meter per second (m/s) (0.1 ft/s), unless otherwise specified.

These assumptions will tend to overestimate pollutant concentrations since no credit is given to spatial and temporal variations of emission sources. More technical information can be found in the Environmental Protection Agency's (EPA's) *User's Guide for the Industrial Source Complex (ISC2) Dispersion Models*, EPA-450/4-92-008a, March 1992.

C.1.3 SUPPORTING DATA

C.1.3.1 Overview

This section presents supporting information for each of the four candidate sites considered for blending HEU to low-enriched uranium (LEU). Table C.1.3.1–1 presents the air quality standards applicable to each site. Subsequent sections present supporting information used in the air quality analysis at Oak Ridge Reservation (ORR), Savannah River Site (SRS), Babcock & Wilcox Facility (B&W) at Lynchburg, Virginia, and Nuclear Fuel Services, Inc. (NFS) at Erwin, Tennessee.

C.1.4 OAK RIDGE RESERVATION

This section provides information on meteorology and climatology, emission rates, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (Figure C.1.4–1) at ORR. Table C.1.4–1 presents emission rates of criteria and toxic/hazardous pollutants at ORR. This information supports data presented in the Environmental Consequences section for air quality.

Meteorology and Climatology. The wind direction above the ridge tops and within the valley at ORR tends to follow the orientation of the valley. On an annual basis, the prevailing winds at the National

Table C.1.3.1–1. Ambient Air Quality Standards Applicable to the Candidate Sites

Pollutant	Averaging Time	Primary NAAQS[a] ($\mu g/m^3$)	Secondary NAAQS ($\mu g/m^3$)	South Carolina (SRS) ($\mu g/m^3$)	Tennessee (ORR & NFS) ($\mu g/m^3$)	Virginia (B&W) ($\mu g/m^3$)
Criteria Pollutants						
Carbon monoxide (CO)	8 hours	10,000	[b]	10,000	10,000	10,000
	1 hour	40,000	[b]	40,000	40,000	40,000
Lead (Pb)	Calendar Quarter	1.5	1.5	1.5	1.5	1.5
Nitrogen dioxide (NO_2)	Annual	100	100	100	100	100
Ozone (O_3)	1 hour	235	235	235	235	235
Particulate matter (PM_{10})	Annual	50	50	50	50	50
	24 hours	150	150	150	150	150
Sulfur dioxide (SO_2)	Annual	80	[b]	80	80	80
	24 hours	365	[b]	365	365	365
	3 hours	[b]	1,300	1,300	1,300	1,300
State Mandated Pollutants						
Total suspended particulates (TSP)	Annual	[b]	[b]	75	[b]	60
	24 hours	[b]	[b]	[b]	150	150
Gaseous fluorides (as HF)	1 month	[b]	[b]	0.8	1.2	[b]
	1 week	[b]	[b]	1.6	1.6	[b]
	24 hours	[b]	[b]	2.9	2.9	[b]
	12 hours	[b]	[b]	3.7	3.7	[b]
	8 hours	[b]	[b]	[b]	250	[b]

[a] The National Ambient Air Quality Standards, other than those for ozone, particulate matter, and those based on annual averages, are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per year with maximum hourly average concentrations above the standard is less than or equal to one. The 24-hour particulate matter standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to one. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

[b] There is no standard.

Note: NAAQS=National Ambient Air Quality Standards; µg=micrograms; m^3=cubic meters.

Source: 40 CFR 50; SC DHEC 1992b; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a.

Weather Service (NWS) station in the city of Oak Ridge are either up-valley, from west to southwest, or down-valley, from east to northeast. Figure C.1.4–1 shows mean wind speeds and direction frequencies for 1990 measured at the 30-m (98-ft) level of the ORR meteorology tower. The prevailing wind directions are from the southwest and northeast quadrants. Annual mean wind speeds measured in the region are relatively low, averaging 2 m/s (4.4 mph) at the 14-m (46-ft) level at the Oak Ridge NWS station and 2.1 m/s (4.7 miles per hour [mph]) at the 10-m (32.8-ft) level at the ORR Bethel Valley monitoring station.

The average annual temperature at ORR is 13.7 Celsius (°C) (56.6 Fahrenheit [°F]); temperatures vary from an average daily minimum of -3.8 °C (25.1 °F) in January to an average daily maximum of 30.4 °C (86.7 °F) in July. Relative humidity readings taken four times per day range from 51 percent in April to 92 percent in August and September (NOAA 1994c:3).

The average annual precipitation measured at ORR in Bethel Valley is 131 centimeters (cm) (51.6 inches [in]), while the average annual precipitation for the Oak Ridge NWS station is 137 cm (53.8 in). The maximum monthly precipitation recorded at the Oak Ridge NWS station was 48.9 cm (19.3 in) in July 1967, while the maximum rainfall in a 24-hour period observed was recorded in August 1960 at 19 cm (7.5 in). The average annual snowfall as measured at the Oak Ridge NWS station is 24.9 cm (9.8 in).

Damaging winds are uncommon in the region. Peak gusts recorded in the area range from 26.8 to

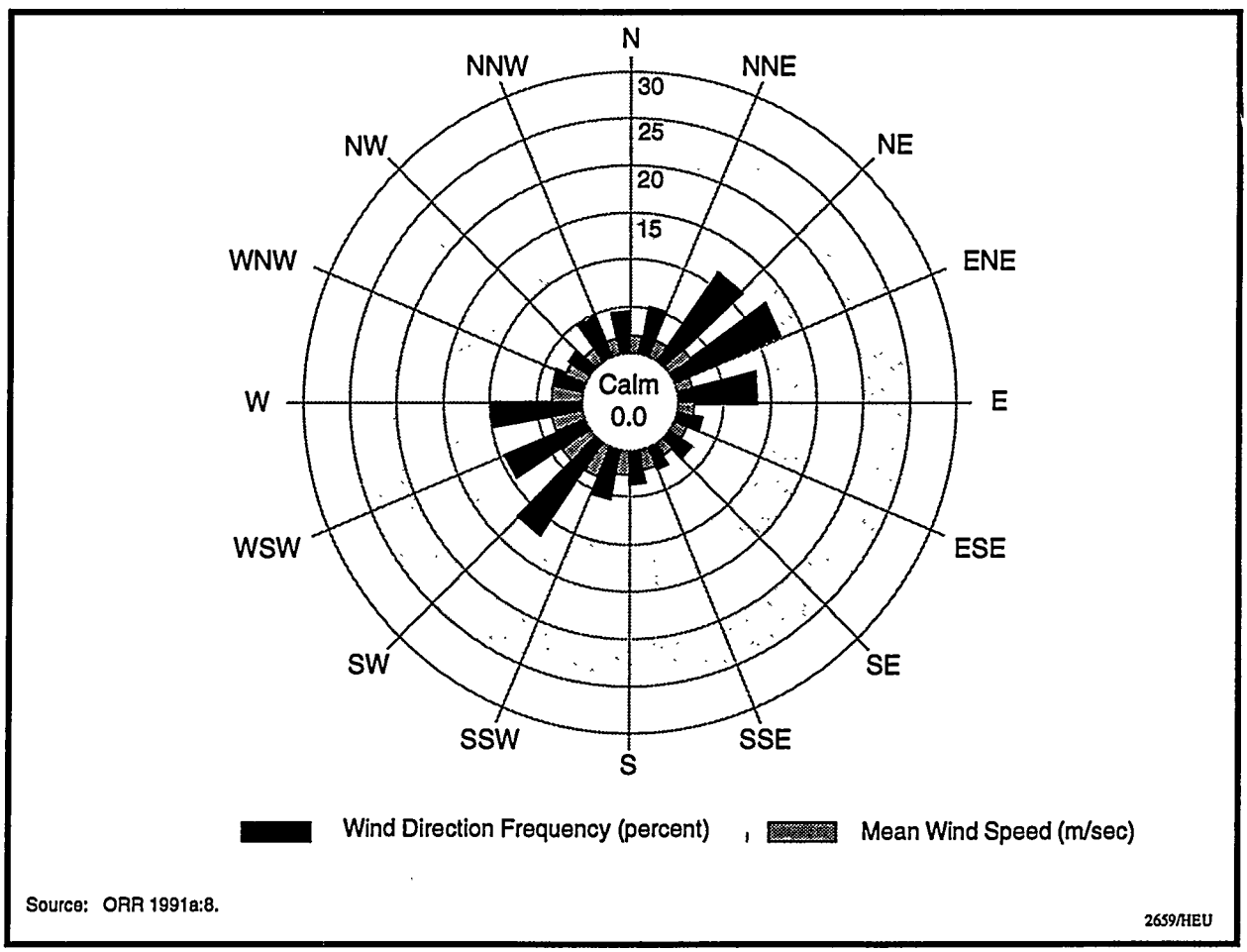

Figure C.1.4–1. Oak Ridge Reservation Meteorological Data, 1990.

30.8 m/s (60 to 68.9 mph) for the months of January through July; from 21.9 to 26.8 m/s (49 to 60 mph) for August, September, and December; and 16.1 to 20.1 m/s (36 to 45 mph) in October and November (ORNL 1982a:2-72). The fastest mile wind speed (the 1.6 kilometer [km] [1-mile (mi)] passage of wind with the highest speed for the day) recorded at the Oak Ridge NWS station for the period of record 1958 through 1979 was 26.4 m/s (59.1 mph) in January 1959 (NOAA 1994c:3).

The extreme mile wind speed at a height of 9.1 m (30 ft) that is predicted to occur near ORR once in 100 years is approximately 40.2 m/s (89.9 mph). The approximate values for occurrence intervals of 10, 25, and 50 years are 29.1 m/s (65.1 mph), 33.1 m/s (74 mph), and 34 m/s (76.1 mph), respectively.

Between 1916 and 1972 there were 25 tornadoes reported in the counties of Tennessee, having borders within about 64.4 km (40 mi) of ORR. The probability of a tornado striking a particular point in the vicinity of ORR is estimated to be 6.0×10^{-5} per year. The recurrence interval associated with this probability is 16,550 years (ORNL 1981a:3.3-7).

On February 21, 1993, a tornado passed through the northeastern edge of ORR and caused considerable damage to a number of structures in the nearby Union Valley Industrial Park. Damage from this tornado to ORR was relatively light. The wind speeds associated with this tornado ranged from 17.9 m/s (40 mph) to those approaching 58.1 m/s (130 mph) (OR DOE 1993c:iii).

Emission Rates. Table C.1.4–1 presents the emission rates of criteria and toxic/hazardous pollutants at ORR. The toxic/hazardous pollutant emissions presented in the table represent those pollutants with estimated concentrations at or beyond the ORR boundary that exceed 1 percent of Tennessee Department of Environment and Conservation (TDEC) air quality standards. These emission rates were used as input into the ISCST2 model to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the ORR site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature that were taken from operating permits issued by the Tennessee Air Pollution Control Board pursuant to the *Tennessee Air Quality Act*; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the Y–12 complex at a height of 10 m (32.8 ft), a stack diameter of 0.3 m (1 ft), an exit velocity of 0.03 m/s (0.1 ft/s), and an exit temperature equal to ambient temperature.

Table C.1.4–1. Emission Rates of Criteria and Toxic/Hazardous Pollutants at Oak Ridge Reservation, 1992

Pollutant	Emission Rate (kg/yr)
Carbon monoxide (CO)	94,648
Lead (Pb)	[a]
Nitrogen dioxide (NO_2)	887,911
Particulate matter (PM_{10})[b]	21,655
Sulfur dioxide (SO_2)	1,674,980
Total suspended particulates (TSP)[b]	21,655
Toxic/Hazardous Pollutants	
Chlorine	1,651
Hydrogen chloride	7,004
Nitric acid	9,526
Sulfuric acid	2,459

[a] No source indicated.

[b] It is conservatively assumed that PM_{10} emissions are TSP emissions.

Note: kg=kilogram; yr=year.

Source: OR DOE 1993a.

Atmospheric Dispersion Characteristics. Data collected at the ORR meteorological monitoring station (Y–12 Plant east tower) for the calendar year 1990 indicate that unstable conditions occur approximately 23 percent of the time, neutral conditions approximately 31 percent of the time, and stable conditions approximately 46 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The Oak Ridge meteorological data for wind speed and direction for 1990 are presented in Figure C.1.4–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the east-northeast with a secondary maximum from the

northeast. The mean wind speed from the east-northeast is 1.7 m/s (3.8 mph) and from the northeast is 2.3 m/s (5.1 mph), while the maximum mean wind speed is 3.3 m/s (7.4 mph) from the southwest.

C.1.5 SAVANNAH RIVER SITE

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (Figure C.1.5–1) at SRS.

Meteorology and Climatology. Figure C.1.5–1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 60-m (200-ft) level of the SRS H–Area Weather Station. The wind data from the site indicate that there is no predominant wind direction at SRS. The highest directional frequency is from the northeast. The average annual wind speed measured is 2.9 m/s (6.5 mph) and average monthly wind speeds range from 2.4 m/s (5.4 mph), from June through August, to 3.5 m/s (7.8 mph) in February.

The average annual temperature at SRS is 17.3 °C (63.2 °F); average daily temperatures vary from 0 °C (32 °F) in January to 33.2 °C (91.7 °F) in July. Relative humidity readings taken four times per day range from 45 percent in April to 92 percent in August and September.

The average annual precipitation at SRS is 113 cm (44.5 in). Precipitation is distributed fairly evenly throughout the year, with the highest precipitation in summer (32.7 cm [12.9 in]) and the lowest in autumn (21.2 cm [8.3 in]). Although snow can fall from November through April, the average annual snowfall is only 2.8 cm (1.1 in); large snowfalls are rare.

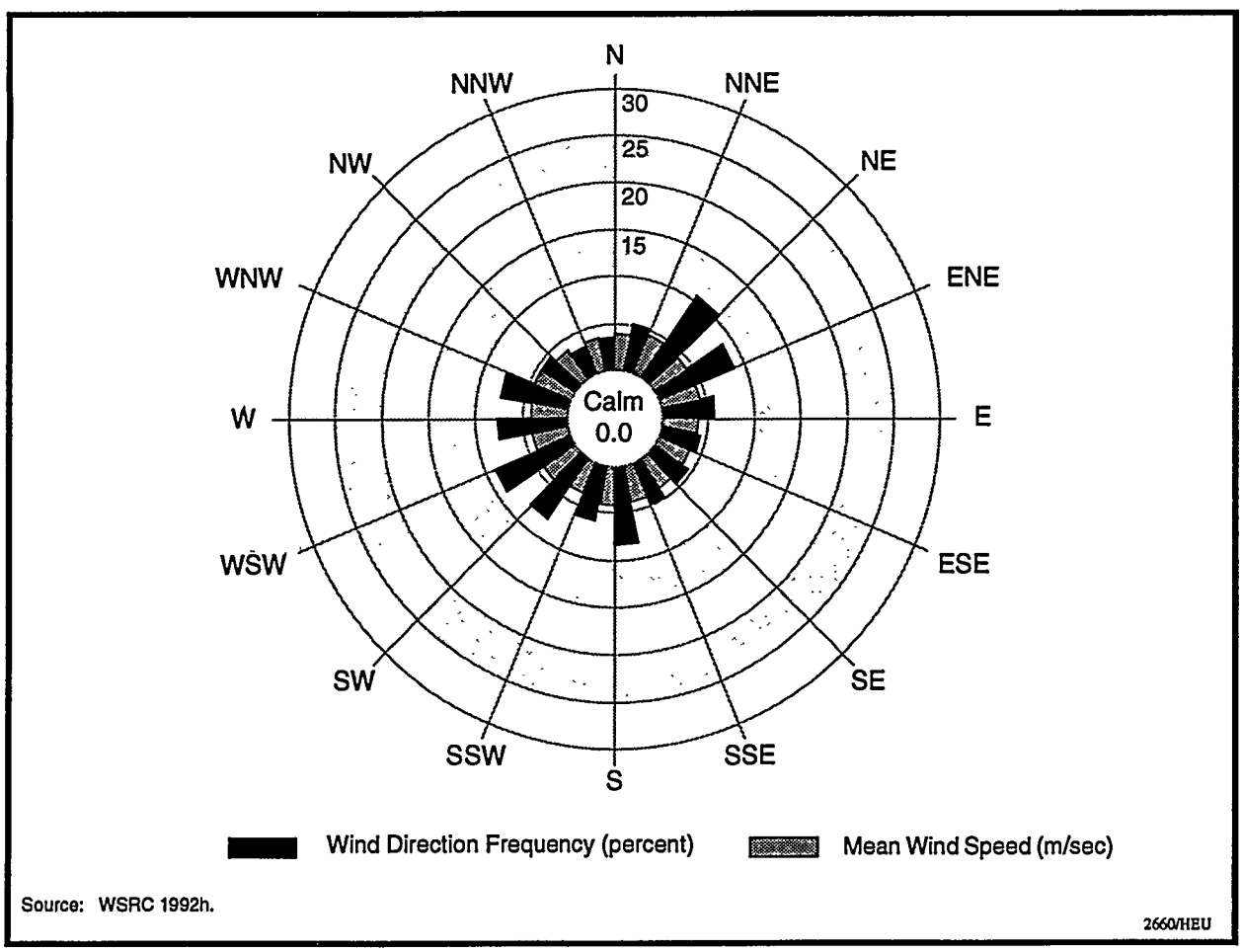

Figure C.1.5–1. Savannah River Site Meteorological Data, 1991.

Winter storms in the SRS area occasionally bring strong and gusty surface winds with speeds as high as 22.8 m/s (51 mph). Thunderstorms can generate winds with speeds as high as 21.5 m/s (48.1 mph) and even stronger gusts. The fastest 1-minute wind speed recorded at Augusta between 1952 and 1993 was 27.7 m/s (62 mph) (NOAA 1994c:3).

The average number of thunderstorm days per year at SRS is 56. From 1954 to 1983, 37 tornadoes were reported for a 1-degree square of latitude and longitude that includes SRS. This frequency of occurrence amounts to an average of about one tornado per year. The estimated probability of a tornado striking a point at SRS is 7.1×10^{-5} per year (NRC 1986a:32). Since operations began at SRS in 1953, six tornadoes have been confirmed on the site or near SRS. Nothing more than light damage was reported in any of these storms, except for a tornado in October 1989. That tornado caused considerable damage to timber resources in an undeveloped wooded area of SRS (WSRC 1990b:1).

From 1899 to 1980, 13 hurricanes occurred in Georgia and South Carolina, for an average frequency of about one hurricane every 6 years. Three hurricanes were classified as major. Because SRS is about 160 km (99.4 mi) inland, the winds associated with hurricanes have usually diminished below hurricane force (greater than or equal to a sustained speed of 33.5 m/s [75 mph]) before reaching the site (DOE 1992e:4-115).

Emission Rates. Table C.1.5–1 presents the emission rates of criteria pollutants at SRS. Toxic/hazardous pollutant emissions presented in the table represent those pollutants with estimated concentrations at or beyond the SRS boundary that exceed 1 percent of South Carolina State standards (SRS 1993a:4).

Modeling Assumptions. Emission rates for criteria and toxic/hazardous pollutants were based on actual site emissions data for the year 1990. Additional model input used to estimate maximum criteria and toxic/hazardous pollutant concentrations at or beyond the SRS site boundary includes the following: pollutant emissions modeled from actual stack heights, actual effective stack diameters, actual exit velocity, and actual exit temperature.

Table C.1.5–1. Emission Rates of Criteria and Toxic/Hazardous Pollutants at Savannah River Site, 1990

Pollutant	Emission Rate (kg/yr)
Carbon monoxide (CO)	404,449
Lead (Pb)	509
Nitrogen dioxide (NO_2)	4,278,380
Particulate matter (PM_{10})	1,963,180
Sulfur dioxide (SO_2)	9,454,199
Total suspended particulates (TSP)	4,430,890

Toxic/Hazardous Pollutants	Point & Volume Source (kg/yr)	Area Source ($kg/yr/m^2$)
3,3-Dichlorobenzidine	211	[a]
Acrolein	[a]	1.94×10^{-3}
Benzene	129,772	0.21
Bis (chloromethyl) ether	211	[a]
Cadmium oxide	243	[a]
Chlorine	21,147	10.1
Chloroform	1,035,006	13.6
Cobalt	5,970	4.58×10^{-4}
Formic acid	46,949	[a]
Manganese	27,882	2.61
Mercury	918	1.15×10^{-3}
Nickel	23,023	6.02
Nitric acid	1,151,526	[a]
Parathion	[b]	[b]
Phosphoric acid	14,860	[a]

[a] No sources indicated.

[b] Data not available.

Note: kg=kilogram; yr=year; m^2=square meter.

Source: SRS 1993a:4; SRS 1995a:10.

Atmospheric Dispersion Characteristics. Data collected at the SRS meteorological monitoring station for 1991 indicate that unstable conditions occur approximately 38 percent of the time, neutral conditions approximately 43 percent of the time, and stable conditions approximately 19 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The SRS meteorological data for wind speed and direction for 1991 are presented in Figure C.1.5–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is

from the northeast with a secondary maximum from the east-northeast. The mean wind speed from the northeast is 3.8 m/s (8.5 mph) and from the east-northeast is 3.8 m/s (8.5 mph), while the maximum mean wind speed is 4.1 m/s (9.2 mph) from the west-northwest.

C.1.6 BABCOCK & WILCOX

This section provides information on climatology and meteorology, emission rates, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (Figure C.1.6–1) at B&W located at Lynchburg, Virginia.

Meteorology and Climatology. The climate of the Lynchburg area has mild summers and winters. Rainfall is fairly evenly distributed throughout the year, but there is a distinct summertime rainfall, occasioned by afternoon thunderstorms. There are occasional snow showers, but the mountains to the immediate west act as a barrier and shelter the area from many storms and high winds. The mountains also act as a barrier to extremely cold weather. Temperatures have fallen below zero only on a few days, and 37.8 °C (100 °F) heat is almost as rare, although this mark has been exceeded in the months of May through September (NOAA 1994b:7).

The average annual temperature at the Lynchburg NWS station is 13.3 °C (55.9 °F); temperatures may vary from an average daily minimum of -4.1 °C (24.7 °F) in January to an average daily maximum of 30 °C (86 °F) in July. Relative humidity readings taken three times per day range from 45 percent in April to 89 percent in August (NOAA 1994b:3).

The annual precipitation at the Lynchburg NWS station is 104 cm (40.9 in). The maximum monthly precipitation recorded at the Lynchburg NWS station was 29 cm (11.4 in) in October 1976, while the maximum precipitation observed in a 24-hour period was 15.9 cm (6.3 in) recorded in June 1972. The average annual snowfall as measured at the Lynchburg NWS station is 46 cm (18.1 in).

Prevailing wind directions at B&W are predominantly from the southwest with a mean speed of 3.4 m/s (7.7 mph). The fastest mile wind speed recorded at the Lynchburg NWS station for the period of record 1944 through 1993 was 25 m/s (55.9 mph) in May 1958. Peak gust wind recorded was 33.1 m/s (74 mph) in June 1993 (NOAA 1994b:3).

Severe weather in the Lynchburg area is generally limited to thunderstorms with a low probability of tornadoes. The average number of thunderstorm days per year at Lynchburg is 40.5 (NOAA 1994b:3). The probability of a tornado actually striking the site is 3.0×10^{-4} per year, with a recurrence interval of 3,333 years (BW NRC 1986a:3-4).

Emission Rates. Table C.1.6–1 presents the emission rates of criteria and toxic/hazardous pollutants determined from the AIRS Facility Subsystem (AFS) Plant Emissions Inventory maintained by the Commonwealth of Virginia, Department of Environmental Quality, Air Division. Toxic/hazardous pollutant emissions presented in the table were obtained from the Toxic Chemical Release Form R required by Section 313 of the *Emergency Planning and Community Right-to-Know Act* of 1986, also known as Title III of the *Superfund Amendments and Reauthorization Act*. These emission rates were used as input into the ISCST2 model to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the B&W site boundary includes the following: criteria pollutant emissions were modeled using actual stack locations and heights, stack diameters, exit velocity, and exit temperature; toxic/hazardous pollutant emissions were modeled from a centrally located stack within the complex of facilities at a height of 10 m (32.8 ft), a stack diameter of 0.3 m (1 ft), an exit velocity of 0.03 m/s (0.1 ft/s), and an exit temperature equal to ambient temperature.

Atmospheric Dispersion Characteristics. Meteorological data collected at Lynchburg NWS for 1994 indicate that unstable atmospheric conditions occur approximately 18 percent of the time, neutral conditions approximately 76 percent of the time, and stable conditions approximately 6 percent of the time.

The wind speed and direction data at Lynchburg NWS are recorded during daylight hours only. The inclusion of observations during nighttime hours would increase the percentage of stable conditions significantly. This increase of stable conditions would tend to raise the

Table C.1.6–1. Emission Rates of Criteria and Toxic/Hazardous Pollutants at Babcock & Wilcox, 1994

Pollutant	Emission Rate (kg/yr)
Carbon monoxide (CO)	1,678
Lead (Pb)	[a]
Nitrogen dioxide (NO_2)	36,760
Particulate matter (PM_{10})	176
Sulfur dioxide (SO_2)	2,447
Total suspended particulates (TSP)	232
Toxic/Hazardous Pollutants	
Copper compounds	218
Nitric acid	213
Sulfuric acid	53
Trichloroethylene	14,697

[a] No source indicated.

Note: kg=kilogram; yr=year.

Source: BW EPA 1995a; VA DEQ 1995b.

concentrations of pollutants at or beyond the site boundary. The calculated concentrations of pollutants are such a small percentage of the standards that any increase due to meteorological conditions would still be well below the standards.

Annual Mean Wind Speeds and Direction Frequencies. The Lynchburg NWS meteorological data for wind speed and direction for 1994 are presented in Figure C.1.6–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the south-southwest with a secondary maximum from the southwest. The mean wind speed from the south-southwest is 1.7 m/s (3.8 mph) and from the southwest is 1.8 m/s (4 mph), while the maximum mean wind speed is 2.1 m/s (4.7 mph) from the west.

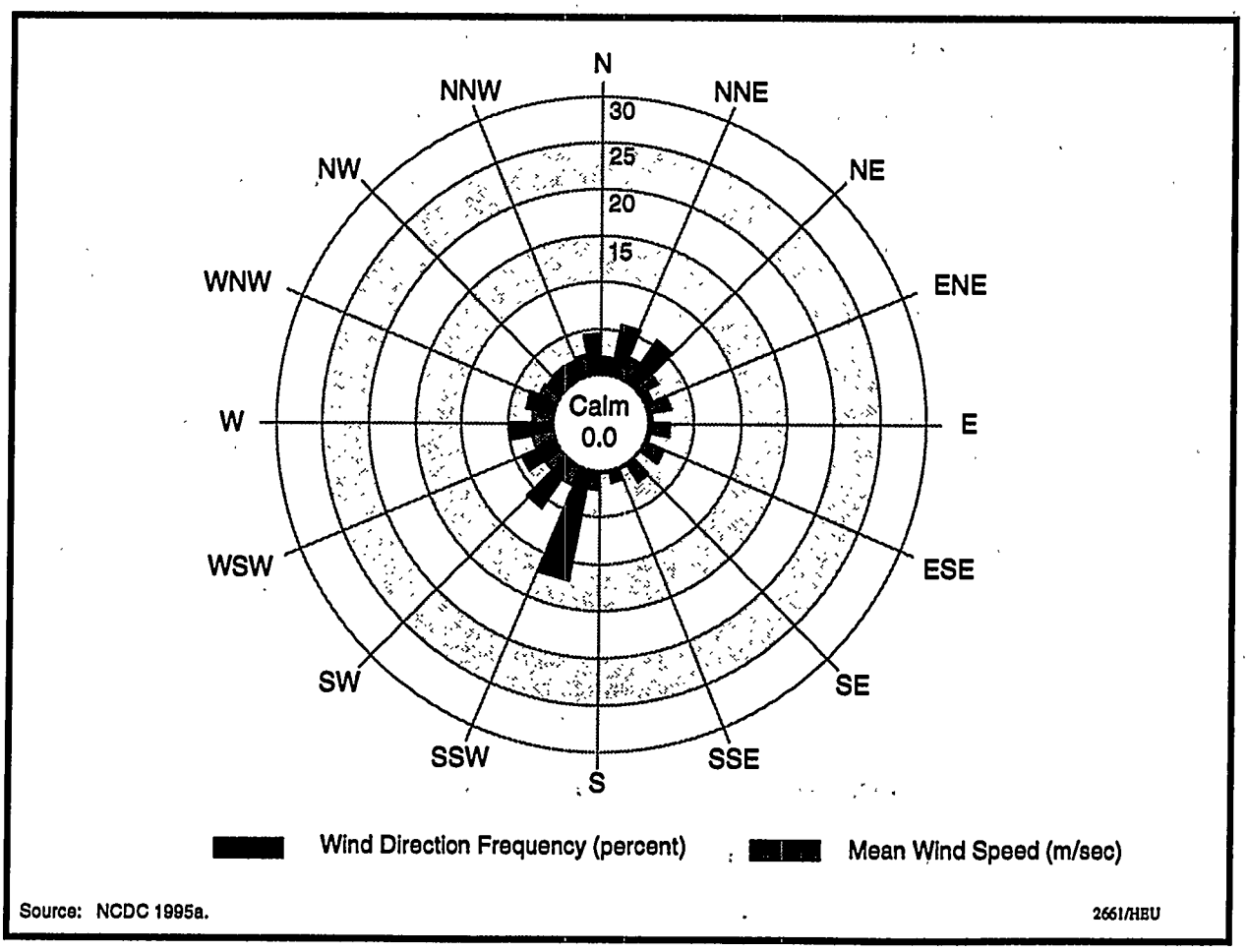

Figure C.1.6–1. Lynchburg, Virginia–National Weather Service Meteorological Data, 1994.

C.1.7 Nuclear Fuel Services, Inc.

This section provides information on climatology and meteorology, emission rates, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (Figure C.1.7–1) at NFS located at Erwin, Tennessee.

Climatology and Meteorology. The climate of the Erwin vicinity is characterized by warm, humid summers and relatively mild winters. Cooler, drier weather in the area is usually associated with polar continental air masses, whereas warmer, wetter weather is associated with gulf maritime air masses.

The average annual temperature in the Erwin area is 13.1 °C (55.5 °F); temperatures may vary from an average daily minimum of -4.3 °C (24.3 °F) in January to an average daily maximum of 29.2 °C (84.6 °F) in July. Relative humidity readings taken four times per day range from 51 percent in April to 93 percent in August and September (NOAA 1994c:3).

The annual precipitation in the Erwin area is 103 cm (40.7 in). The maximum monthly precipitation recorded near Erwin was 24.7 cm (9.7 in) in July 1949, while the maximum precipitation observed in a 24-hour period was 9.3 cm (3.7 in) recorded in October 1964. The average annual snowfall as measured near Erwin is 40.1 cm (15.8 in).

The annual average wind speed is approximately 2.5 m/s (5.5 mph). The fastest mile wind speed recorded at the Bristol, Johnson City, Kingsport NWS station was 22.4 m/s (50.1 mph) in May 1951. Peak gust wind recorded was 28.2 m/s (63.1 mph) in April 1991 (NOAA 1994c:3).

The average number of thunderstorm days per year near Erwin is 42.8 (NOAA 1994c:3).

Severe storms are infrequent in the Erwin region, which is east of the center of tornado activity, south of most blizzard conditions, and too far inland to be often affected by hurricanes. Only one tornado has been recorded in Unicoi County since 1950 (NRC 1991a:3-1, 3-3).

Emission Rates. Table C.1.7–1 presents the emission rates of criteria pollutants determined from operating permits issued between 1981 and 1994 by the Tennessee Air Pollution Control Board pursuant to the *Tennessee Air Quality Act*. Toxic/hazardous pollutant emissions presented in the table were obtained from the Toxic Chemical Release Form R required by Section 313 of the *Emergency Planning and Community Right-to-Know Act* of 1986, also known as Title III of the *Superfund Amendments and Reauthorization Act*. These emission rates were used as input into the ISCST2 model to estimate pollutant concentrations.

Table C.1.7–1. Emission Rates of Criteria and Toxic/Hazardous Pollutants at Nuclear Fuel Services, 1994

Pollutant	Emission Rate (kg/yr)
Carbon monoxide (CO)	7,146
Lead (Pb)	[a]
Nitrogen dioxide (NO_2)	33,865
Particulate matter (PM_{10})[b]	1,558
Sulfur dioxide (SO_2)	1,081
Total suspended particulates (TSP)[b]	1,558
Volatile organic compounds (VOC)	6,918
Hydrogen fluoride (HF)	405
Toxic/Hazardous Pollutants	
Ammonia	9,573
Nitric acid	242

[a] No source indicated.

[b] It is conservatively assumed that all PM_{10} emissions are TSP emissions.

Note: kg=kilogram; yr=year.

Source: NF DEC nda; NF EPA 1994a.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the NFS site boundary includes: criteria pollutant emissions modeled from stack 416 at a height of 33 m (108 ft), a stack diameter of 1.52 m (5 ft), an exit velocity of 11.57 m/s (38 ft/s) (NF NRC 1991a:2-14), and an exit temperature of 177 °C (350 °F); toxic/hazardous pollutant emissions were modeled from a centrally located stack in the Building 300 complex at a height of 10 m (32.8 ft), a stack diameter of 0.3 m (1 ft), an exit velocity of 0.03 m/s (0.1 ft/s), and an exit temperature equal to ambient temperature.

Atmospheric Dispersion Characteristics. Meteorological data collected at NFS for the period March 1994 through February 1995 indicate that unstable atmospheric conditions occur approximately

77 percent of the time, neutral conditions approximately 22 percent of the time, and stable conditions approximately 1 percent of the time.

Annual Mean Wind Speeds and Direction Frequencies. The onsite meteorological data for wind speed and direction for the period March 1994 through February 1995 are presented in Figure C.1.7–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the south-southwest with a secondary maximum from the north-northwest. The mean wind speed from the south-southwest is 3 m/s (6.7 mph) and from the north-northwest is 3 m/s (6.7 mph), while the maximum mean wind speed is 3.6 m/s (8.1 mph) from the south-southeast.

C.2 AIR QUALITY IMPACTS OF BLENDING FACILITIES

Potential ambient air quality impacts of the emissions that result from operating the HEU conversion and blending facilities at each site were analyzed using ISCST2 as described in Section C.1.2. The source of the blending facility emissions is assumed to be that which is described under the section, Modeling Assumptions, for each of the candidate sites. The model input data include the emission inventories for each of the blending facilities as presented in Tables C.2–1 through C.2–4.

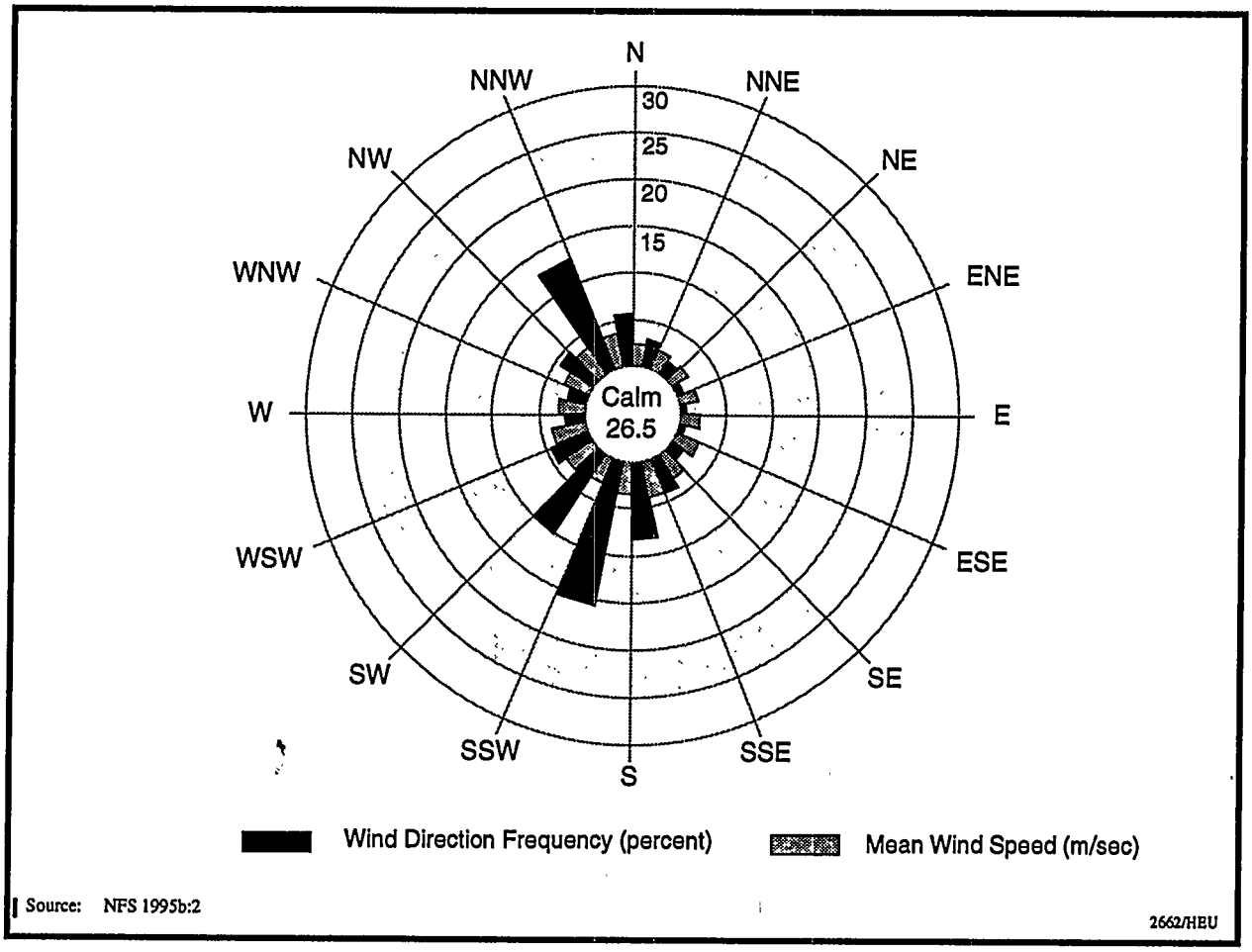

Figure C.1.7–1. Nuclear Fuel Services, Meteorological Data, March 1994 through February 1995.

Table C.2–1. Emission Rates of Pollutants for a Conversion and Blending Facility—Highly Enriched Uranium to Low-Enriched Uranium as Uranyl Nitrate Hexahydrate for the Department of Energy Sites

Pollutant	Emission Rate (kg/yr)
Carbon monoxide (CO)	2,160
Lead (Pb)	[a]
Nitrogen dioxide (NO_2)	7,300
Ozone (O_3)[b]	215
Particulate matter (PM_{10})	170
Sulfur dioxide (SO_2)	13,500
Total suspended particulates (TSP)	37,000

[a] No emissions from this process.

[b] Based on estimated generation of volatile organic compounds (VOCs).

Note: kg=kilogram; yr=year.

Source: OR LMES 1995b.

[Table deleted.]

Table C.2–2. Emission Rates of Pollutants for a Conversion and Blending Facility—Highly Enriched Uranium to Low-Enriched Uranium as Metal for the Y–12 Plant

Pollutant	Emission Rate (kg/yr)
Carbon monoxide (CO)	1,260
Lead (Pb)	[a]
Nitrogen dioxide (NO_2)	2,600
Ozone (O_3)[b]	106
Particulate matter (PM_{10})	125
Sulfur dioxide (SO_2)	4,700
Total suspended particulates (TSP)	13,000

[a] No emissions from this process.

[b] Based on estimated generation of VOCs.

Note: kg=kilogram; yr=year.

Source: OR LMES 1995c.

[Table deleted.]

C.3 NOISE

C.3.1 INTRODUCTION

This section provides a summary of local noise regulations. A qualitative discussion of operation noise sources and the potential for noise impacts is provided in Sections 3.3.3, 3.4.3, 3.5.3, and 3.6.3, Affected Environment, and 4.3.1.2, 4.3.2.2, 4.3.3.2, 4.3.4.2, and 4.6.2.2, Environmental Consequences.

Table C.2–3. Emission Rates of Pollutants for a Conversion and Blending Facility—Highly Enriched Uranium to Low-Enriched Uranium as Uranyl Nitrate Hexahydrate for Two Commercial Sites

Pollutant	Emission Rate (kg/yr)
Carbon monoxide (CO)	2,172
Lead (Pb)	[a]
Nitrogen dioxide (NO_2)	1,089
Ozone (O_3)[b]	200
Particulate matter (PM_{10})[c]	169
Sulfur dioxide (SO_2)	1,956
Total suspended particulates (TSP)[c]	169

[a] No emissions for this process.

[b] Based on estimated generation of VOCs.

[c] It is conservatively assumed that all PM_{10} emissions are TSP emissions.

Note: kg=kilogram; yr=year.

Source: OR LMES 1995b; ORR 1995a:9.

Table C.2–4. Emission Rates of Pollutants for a Conversion and Blending Facility—Highly Enriched Uranium to Low-Enriched Uranium as Uranium Hexafluoride for Two Commercial Sites

Pollutant	Emission Rate (kg/yr)
Carbon monoxide (CO)	2,258
Lead (Pb)	[a]
Nitrogen dioxide (NO_2)	1,433
Ozone (O_3)[b]	200
Particulate matter (PM_{10})[c]	203
Sulfur dioxide (SO_2)	2,934
Total suspended particulates (TSP)[c]	203
Gaseous fluorides (as HF)	[d]

[a] No emissions for this process.

[b] Based on estimated generation of VOCs.

[c] It is conservatively assumed that all PM_{10} emissions are TSP emissions.

[d] Trace.

Note: kg=kilogram; yr=year.

Source: OR LMES 1995a; ORR 1995a:9.

The Occupational Safety and Health Administration (OSHA) standards for occupational noise exposure (29 CFR 1910) are applicable for worker protection at the site.

C.3.2 SUPPORTING DATA

This section provides a discussion of local noise regulations and presents any available sound level monitoring data for the sites. There are no community noise regulations applicable to B&W and NFS.

C.3.2.1 Oak Ridge Reservation

Maximum allowable noise limits for the city of Oak Ridge are presented in Table C.3.2.1–1.

Table C.3.2.1–1. City of Oak Ridge Maximum Allowable Noise Limits Applicable to Oak Ridge Reservation

Adjacent Use	Where Measured	Maximum Sound Level (dBA)
All residential districts	Common lot line	50
Neighborhood business district	Common lot line	55
General business district	Common lot line	60
Industrial district	Common lot line	65
Major street	Street lot line	75
Secondary residential street	Street lot line	60

Note: dBA=decibel, A-weighted.

Source: OR City 1985a.

C.3.2.2 Savannah River Site

Ambient sound level data collected at SRS in 1989 and 1990 are summarized in *Sound-Level Characterization of the Savannah River Site* (NUS-5251, August 1990). The States of Georgia and South Carolina, and the counties where SRS is located, have not yet established noise regulations that specify acceptable community noise levels except for a provision of the Aiken County Nuisance Ordinance, which limits daytime and nighttime noise by frequency band (Table C.3.2.2–1).

Table C.3.2.2–1. Aiken County Maximum Allowable Noise Levels[a]

Frequency Band (Hz)	Nighttime (9:00 p.m.-7:00 a.m.) Sound Pressure Levels (dB)	
	Nonresidential Lot Line	Residential Lot Line
20-75	69	65
75-150	60	50
150-300	56	43
300-600	51	38
600-1,200	42	33
1,200-2,400	40	30
2,400-4,800	38	28
4,800-10,000	35	20

[a] For daytime (7:00 a.m.-9:00 p.m.) sound pressure levels, apply one of the following corrections (dB) to the nighttime levels above: daytime operation only, +5; source operates less than 20 percent of any 1-hour period, +5; source operates less than 5 percent of any 1-hour period, +10; source operates less than 1 percent of any 1-hour period, +15; noise of impulsive character, -5; noise of periodic character, -5.

Note: dB=decibel; Hz=Hertz.

Source: SR County 1991a.

Appendix D
Biotic Resources

D.1 INTRODUCTION

This appendix includes a listing of the scientific names of common, nonthreatened, and nonendangered plant and animal species found in the text. Additionally, tables are presented listing flora and fauna identified by the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service, and State governments as threatened, endangered, or other special status. Special status species include State classifications such as species of concern, or species in need of management. [Text deleted.] The threatened, endangered, and special status lists include all such species as could potentially occur in a site area regardless of their residence status (that is, breeding, year round, summer, winter, or migratory) or likelihood of being affected by project actions. Table D.1–1 lists nonthreatened and nonendangered plant and animal species for the four sites. Tables D.1–2 through D.1–5 list Federal- and State-listed threatened, endangered, and other species' status for all four sites. All tables list species in alphabetical order by common name.

Table D.1–1. Scientific Names of Common Nonthreatened and Nonendangered Plant and Animal Species Referred to in the Text

Common Name	Scientific Name	Common Name	Scientific Name
Mammals		**Fish (continued)**	
Beaver	*Castor canadensis*	Catfish	*Ictalurus spp.*
Black bear	*Ursus americanus*	Central stoneroller	*Campostoma*
Eastern cottontail	*Sylvilagus floridanus*	Common carp	*Cyprinus carpio*
Eastern gray squirrel	*Sciurus carolinensis*	Crappie	*Pomoxis spp.*
Feral hog	*Sus scrofa*	Drum	*Aplodinotus sp.*
Gray fox	*Urocyon cinereoargenteus*	Herring	*Alosa sp.*
House mouse	*Mus musculus*	Hickory shad	*Alosa mediocris*
Mink	*Mustela vison*	Lake chubsucker	*Erimyzon sucetta*
Opossum	*Didelphis marsupialis*	Largemouth bass	*Micropterus salmoides*
Raccoon	*Procyon lotor*	Mosquitofish	*Gambusia affinis*
Red fox	*Vulpes vulpes*	Mud sunfish	*Acantharchus pomotis*
White-footed mouse	*Peromyscus leucopus*	Olive darter	*Percina squamata*
Whitetail deer	*Odocoileus virginianus*	Pickerel	*Esox spp.*
Birds		Redfin pickerel	*Esox americanus*
Carolina chickadee	*Parus carolinensis*	Sauger	*Stizostedion canadense*
Common crow	*Corvus brachyrhynchos*	Shad	*Clupeidae*
European starling	*Sturnus vulgaris*	Smallmouth bass	*Micropterns dolomieu*
Great horned owl	*Bubo virginianus*	Spotted bass	*Micropterus punctulatus*
Mourning dove	*Zenaida macroura*	Striped bass	*Morone saxatilis*
Northern bobwhite	*Colinus virginianus*	Sunfish	*Lepomis spp.*
Northern cardinal	*Cardinalis cardinalis*	White crappie	*Pomoxis annularis*
Red-tailed hawk	*Buteo jamaicensis*	**Plants**	
Ruffed grouse	*Bonasa umbellus*	Hemlock	*Tsuga canadensis*
Wild turkey	*Meleagris gallopavo*	Hickory	*Carya spp.*
Reptiles		Loblolly pine	*Pinus taeda*
Eastern box turtle	*Terrapene carolina*	Longleaf pine	*Pinus palustris*
Eastern garter snake	*Thamnophis sirtalis*	Oak	*Quercus spp.*
Amphibians		Post oak	*Quercus stelata*
American toad	*Bufo americanus*	Red oak	*Quercus rubra*
Slimy salamander	*Plethodon glutinosus*	Shortleaf pine	*Pinus echinata*
Fish		Slash pine	*Pinus elliottii*
American shad	*Alosa sapidissima*	Virginia pine	*Pinus virginiana*
Black crappie	*Pomoxis nigromaculatus*	White oak	*Quercus alba*
Bluegill	*Lepomis macrochirus*	White pine	*Pinus strobus*
Bream	*Lepomis spp.*	Yellow-poplar	*Liriodendron tulipfera*

Table D.1–2. Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on the Site or in the Vicinity of Oak Ridge Reservation

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Alleghany woodrat	*Neotoma magister*	NL	D
Eastern cougar[b]	*Felis concolor couguar*	E	E
Eastern small-footed bat	*Myotis leibii*	NL	D
Gray bat[b]	*Myotis grisescens*	E	E
Indiana bat[b]	*Myotis sodalis*	E	E
Rafinesque's big-eared bat	*Plecotus rafinesquii*	NL	D
River otter	*Lutra canadensis*	NL	T
Smoky shrew	*Sorex fumeus*	NL	D
Southeastern shrew	*Sorex longirostris*	NL	D
Birds			
American peregrine falcon[b]	*Falco peregrinus anatum*	E	E
Appalachian Bewick's wren	*Thryomanes bewickii altus*	NL	T
Arctic peregrine falcon	*Falco peregrinus tundrius*	E (S/A)	E
Bachman's sparrow	*Aimophila aestivalis*	NL	E
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	T
Barn owl[d]	*Tyto alba*	NL	D
Cooper's hawk[d]	*Accipiter cooperii*	NL	D
Grasshopper sparrow	*Ammodramus savannarum*	NL	D
Northern harrier	*Circus cyaneus*	NL	D
Osprey[d]	*Pandion haliaetus*	NL	T
Red-cockaded woodpecker	*Picoides borealis*	E	E
Sharp-shinned hawk[d]	*Accipiter striatus*	NL	D
Swainson's warbler	*Limnothlypis swainsonii*	NL	D
Reptiles			
Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*	NL	D
Northern pine snake	*Pituophis melanoleucus melanoleucus*	NL	T
Amphibians			
[Text deleted.]			
Hellbender[d]	*Cryptobranchus alleganiensis*	NL	D
Tennessee cave salamander	*Gyrinophilus palleucus*	NL	T
Fish			
Alabama shad	*Alosa alabamae*	NL	D
Amber darter	*Percina antesella*	E	E
Blue sucker	*Cycleptus elongatus*	NL	T
Flame chub	*Hemitremia flammea*	NL	D
Frecklebelly madtom	*Noturus munitus*	NL	T
Highfin carpsucker	*Carpiodes velifer*	NL	D
Spotfin chub[b]	*Cyprinella monacha*	T	E
Tennessee dace[d]	*Phoxinus tennesseensis*	NL	D
Yellowfin madtom[b]	*Noturus flavipinnis*	T	E

Table D.1–2. Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on the Site or in the Vicinity of Oak Ridge Reservation—Continued

Common Name	Scientific Name	Status[a]	
		Federal	State
Invertebrates			
Alabama lampmussel[b]	*Lampsilis virescens*	E	E
Appalachian monkeyface pearlymussel[b]	*Quadrula sparsa*	E	E
Birdwing pearlymussel[b]	*Conradilla caelata*	E	E
Cumberland bean pearlymussel[b]	*Villosa trabalis*	E	E
Cumberland monkeyface pearlymussel[b]	*Quadrula intermedia*	E	E
Dromedary pearlymussel[b]	*Dromus dromas*	E	E
Fine-rayed pigtoe[b]	*Fusconaia cuneolus*	E	E
Green-blossom pearlymussel[b]	*Epioblasma torulosa gubernaculum*	E	E
Orange-footed pearlymussel[b]	*Plethobasus cooperianus*	E	E
Painted snake coiled forest snail	*Anguispira picta*	T	E
Pale lilliput pearlymussel[b]	*Toxolasma cylindrellus*	E	E
Pink mucket pearlymussel[b]	*Lampsilis abrupta*	E	E
Rough pigtoe[b]	*Pleurobema plenum*	E	E
Shiny pigtoe[b]	*Fusconaia cor*	E	E
Tan riffleshell[b]	*Epioblasma walkeri*	E	E
Tubercled-blossom pearlymussel[b]	*Epioblasma torulosa torulosa*	E	E
Turgid-blossom pearlymussel[b]	*Epioblasma turgidula*	E	E
White wartyback pearlymussel[b]	*Plethobasus cicatricosus*	E	E
Yellow-blossom pearlymussel[b]	*Epioblasma florentina florentina*	E	E
Plants			
American barberry	*Berberis canadensis*	NL	SpC
American ginseng[d]	*Panax quinquefolius*	NL	T
Appalachian bugbane[d]	*Cimicifuga rubifolia*	NL	T
Auriculate false-foxglove	*Tomanthera auriculata*	NL	E
Branching whitlowgrass	*Draba ramosissima*	NL	SpC
Butternut[d]	*Juglans cinerea*	NL	T
Canada (wild yellow) lily[d]	*Lilium canadense*	NL	T
Carey's saxifrage[d]	*Saxifraga careyana*	NL	SpC
Fen orchid[d]	*Liparis loeselii*	NL	E
Golden seal[d]	*Hydrastis canadensis*	NL	T
Gravid sedge[d]	*Carex gravida*	NL	SpC
Heartleaf meehania	*Meehania cordata*	NL	T
Heller's catfoot	*Gnaphalium helleri*	NL	SpC
Lesser ladies' tresses[d]	*Spiranthes ovalis*	NL	SpC
Michigan lily[d]	*Lilium michiganense*	NL	T
Mountain honeysuckle	*Lonicera dioica*	NL	SpC
Mountain witch alder[d]	*Fothergilla major*	NL	T
Northern bush honeysuckle[d]	*Diervilla lonicera*	NL	T
Nuttall waterweed[d]	*Elodea nuttallii*	NL	SpC
Pink lady's-slipper[d]	*Cypripedium acaule*	NL	E

Table D.1–2. Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on the Site or in the Vicinity of Oak Ridge Reservation—Continued

Common Name	Scientific Name	Status[a]	
		Federal	State
Plants (continued)			
Prairie goldenrod	*Solidago ptarmicoides*	NL	E
Purple fringeless orchid[d]	*Platanthera peramoena*	NL	T
Slender blazing star	*Liatris cylindracea*	NL	E
Spreading false foxglove[d]	*Aureolaria patula*	NL	T
Swamp lousewort	*Pedicularis lanceolata*	NL	T
Tall larkspur[d]	*Delphinium exaltatum*	NL	E
Tennessee purple coneflower[b]	*Echinacea tennesseenis*	E	E
Tubercled rein-orchid[d]	*Platanthera flava var. herbiola*	NL	T
Virginia spirea	*Spiraea virginiana*	T	E
Whorled mountainmint	*Pycnanthemum verticillatum*	NL	E-P

[a] Status codes: D=deemed in need of management; E=endangered; NL=not listed; P=possibly extirpated; S/A=protected under the similarity of appearances provision of the *Endangered Species Act*; SpC=special concern; T=threatened.

[b] USFWS Recovery Plan exists for this species.

[c] Observed near ORR on Melton Hill and Watts Bar Lakes.

[d] Recent record of species occurrence on ORR.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1995w; OR DOE 1990a; OR FWS 1992b; OR NERP 1993a; ORNL 1981a; ORNL 1984b; ORNL 1988c; TN DEC 1995a; TN DEC 1995b; TN DEC 1995c; TN DEC 1995d; TN WRC 1991a; TN WRC 1991b.

Table D.1–3. Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on the Site or in the Vicinity of Savannah River Site

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Meadow vole	*Microtus pennsylvanicus*	NL	SC
Rafinesque's big-eared bat[b]	*Plecotus rafinesquii*	NL	SE
Southern Appalachian eastern woodrat[b]	*Neotoma floridana haematoreia*	NL	SC
Spotted skunk[b]	*Spilogale putorius*	NL	SC
Star-nosed mole[b]	*Condylura cristata parva*	NL	SC
Swamp rabbit	*Sylvilagus aquaticus*	NL	SC
Birds			
American peregrine falcon[b,c]	*Falco peregrinus anatum*	E	SE
American swallow-tailed kite	*Elanoides forficatus*	NL	SE
Appalachian Bewick's wren[b]	*Thryomanes bewickii altus*	NL	ST
Arctic peregrine falcon[b]	*Falco peregrinus tundrius*	E (S/A)	ST
[Text deleted.]			
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	SE
Barn owl[b]	*Tyto alba*	NL	SC
Common ground dove[b]	*Columbina passerina*	NL	ST
Cooper's hawk[b]	*Accipiter cooperii*	NL	SC
[Text deleted.]			
Kirtland's warbler[b]	*Dendroica kirtlandii*	E	SE
Mississippi kite[b]	*Ictinia mississippiensis*	NL	SC
Red-cockaded woodpecker[b,c]	*Picoides borealis*	E	SE
Red-headed woodpecker[b]	*Melanerpes erythrocephalus*	NL	SC
Swainson's warbler[b]	*Limnothlypis swainsonii*	NL	SC
Wood stork[b]	*Mycteria americana*	E	SE
Reptiles			
American alligator[b]	*Alligator mississippiensis*	T (S/A)	NL
Carolina swamp snake[b]	*Seminatrix pygaea*	NL	SC
Eastern coral snake[b]	*Micrurus fulvius fulvius*	NL	SC
Green water snake[b]	*Nerodia cyclopion*	NL	SC
[Text deleted.]			
Spotted turtle[b]	*Clemmys guttata*	NL	SC
Amphibians			
Carolina crawfish frog[b]	*Rana areolata capito*	NL	SC
Eastern bird-voiced treefrog[b]	*Hyla avivoca ogechiensis*	NL	SC
Eastern tiger salamander[b]	*Ambystoma tigrinum tigrinum*	NL	SC
Northern cricket frog[b]	*Acris crepitans crepitans*	NL	SC
Pickerel frog[b]	*Rana palustris*	NL	SC
Upland chorus frog[b]	*Pseudacris triseriata feriarum*	NL	SC

Table D.I–3. Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on the Site or in the Vicinity of Savannah River Site—Continued

Common Name	Scientific Name	Status[a] Federal	State
Fish			
[Text deleted.]			
Shortnose sturgeon[b,c]	*Acipenser brevirostrum*	E	SE
Invertebrates			
[Text deleted.]			
Brother spike mussel	*Elliptio fraterna*	NL	SE
Plants			
[Text deleted.]			
Beak-rush[b]	*Rhynchospora inundata*	NL	SC
Beak-rush[b]	*Rhynchospora tracyi*	NL	SC
Bog spice bush[b]	*Lindera subcoriacea*	NL	RC
[Text deleted.]			
Cypress stump sedge[b]	*Carex decomposita*	NL	SC
Durand's White Oak[b]	*Quereus durandi*	NL	SC
Dwarf bladderwort[b]	*Utricularia olivacea*	NL	SC
Dwarf burhead[b]	*Echinodorus parvulus*	NL	SC
Elliott's croton[b]	*Croton elliottii*	NL	SC
Few-fruited sedge[b]	*Carex oligocarpa*	NL	SC
Florida bladderwort[b]	*Utricularia floridana*	NL	SC
Florida false loosestrife[b]	*Ludwigia spathulata*	NL	SC
Gaura[b]	*Gaura biennis*	NL	SC
Green-fringed orchid[b]	*Platanthera lacera*	NL	SC
Leafy pondweed[b]	*Potamogeton foliosus*	NL	SC
Loose water-milfoil[b]	*Myriophyllum laxum*	NL	RC
Milk-pea[b]	*Astragalus villosus*	NL	SC
Nailwort[b]	*Paronychia americana*	NL	SC
Nestronia[b]	*Nestronia umbellula*	NL	SC
Nutmeg hickory[b]	*Carya myristiciformis*	NL	RC
Oconee azalea[b]	*Rhododendrom flammeum*	NL	SC
Pink tickseed[b]	*Coreopsis rosea*	NL	RC
Quill-leaved swamp potato[b]	*Sagittaria isoetiformis*	NL	SC
Sandhill lily[b]	*Nolina georgiana*	NL	SC
Smooth coneflower[b]	*Echinacea laevigata*	E	-[d]
Trepocarpus[b]	*Trepocarpus aethusae*	NL	SC
Wild water-celery[b]	*Vallisneria americana*	NL	SC
Yellow cress[b]	*Rorippa sessiliflora*	NL	SC
Yellow wild indigo[b]	*Baptisia lanceolata*	NL	SC

[a] Status codes: E=endangered; NL=not listed; RC= regional of concern (unofficial, plants only); S/A=protected under the similarity of appearances provision of the *Endangered Species Act*; SC=state of concern; SE=State endangered (official state list-animals only); ST=State threatened (official state list-animals only); T=threatened.

[b] Species occurrence recorded on SRS.

[c] USFWS Recovery Plan exists for this species.

[d] There is no official threatened or endangered status for plant species; defer to Federal standard.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1992e; SC WD 1995a; SR NERP 1990b; WSRC 1989e; WSRC 1993b.

Table D.1–4. Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on the Site or in the Vicinity of the Babcock & Wilcox Facility

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Eastern cougar[b]	*Felis concolor couguar*	E	E
Indiana bat	*Myotis sodalis*	E	E
River otter	*Lutra canadensis*	NL	SpC
Virginia big-eared bat	*Plecotus townsendii virginianus*	E	E
Birds			
Alder flycatcher	*Empidonax alnorum*	NL	SpC
Appalachian Bewick's wren	*Thryomanes bewickii altus*	NL	E
Bachman's sparrow	*Aimophila aestivalis*	NL	T
Bald eagle[b]	*Haliaeetus leucocephalus*	T	E
Barn-owl	*Tyto alba*	NL	SpC
Brown creeper	*Certhia americana*	NL	SpC
[Text deleted.]			
Common moorhen	*Gallinula chloropus cachinnans*	NL	SpC
Dickcissel	*Spiza americana*	NL	SpC
Golden-crowned kinglet	*Regulus satrapa*	NL	SpC
Golden-winged warbler	*Vermivora chrysoptera*	NL	SpC
Henslow's sparrow	*Ammodramus henslowii*	NL	T
Hermit thrush	*Catharus guttatus*	NL	SpC
[Text deleted.]			
Long-eared owl	*Asio otus*	NL	SpC
Magnolia warbler	*Dendroica magnolia*	NL	SpC
Migrant loggerhead shrike	*Lanius ludovicianus migrans*	NL	T
Mourning warbler	*Oporornis philadelphia*	NL	SpC
Northern harrier	*Circus cyaneus*	NL	SpC
Northern saw-whet owl	*Aegolius acadicus*	NL	SpC
Peregrine falcon[b]	*Falco peregrinus*	E (S/A)	E
Purple finch	*Carpodacus purpureus*	NL	SpC
Red-breasted nuthatch	*Sitta canadensis*	NL	SpC
Red crossbill	*Loxia curvirostra*	NL	SpC
Sedge wren	*Cistothorus platensis*	NL	SpC
Swainson's warbler	*Limnothlypis swainsonii*	NL	SpC
Winter wren	*Troglodytes troglodytes*	NL	SpC
Yellow-bellied flycatcher	*Empidonax flaviventris*	NL	SpC
Reptiles			
Canebrake rattlesnake	*Crotalus horridus atricaudatus*	NL	E

[a] Status codes: E=endangered; NL=not listed; S/A=protected under the similarity of appearances provision of the *Endangered Species Act*; SpC=special concern; T=threatened.

[b] USFWS Recovery Plan exists for this species.

Source: 50 CFR 17.11; VA DGIF 1993a; VA DGIF 1993b.

Table D.1–5. Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on the Site or in the Vicinity of the Nuclear Fuel Services Facility

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Eastern cougar[b]	*Felis concolor couguar*	E	E
Gray bat[b]	*Myotis grisescens*	E	E
Indiana bat[b]	*Myotis sodalis*	E	E
River otter	*Lutra canadensis*	NL	T
Birds			
Appalachian Bewick's wren	*Thryomanes bewickii altus*	NL	T
Bachman's sparrow	*Aimophila aestivalis*	NL	E
Bald eagle[b]	*Haliaeetus leucocephalus*	T	T
[Text deleted.]			
Common raven	*Corvus corax*	NL	T
Cooper's hawk	*Accipiter cooperii*	NL	D
Golden eagle	*Aquila chrysaetos*	NL	T
Grasshopper sparrow	*Ammodramus savannarum*	NL	D
Northern harrier	*Circus cyaneus*	NL	D
Osprey	*Pandion haliaetus*	NL	T
Peregrine falcon[b]	*Falcon peregrinus*	E (S/A)	E
Red-cockaded woodpecker[b]	*Picoides borealis*	E	E
Sharp-shinned hawk	*Accipiter striatus*	NL	D
Reptiles			
Northern pine snake	*Pituophis melanoleucus melanoleucus*	NL	T
Amphibians			
Tennessee cave salamander	*Gyrinophilus palleucus*	NL	T
Fish			
Highfin carpsucker	*Carpiodes velifer*	NL	D
Sharphead darter	*Etheostoma acuticeps*	NL	D

[a] Status codes: D=deemed in need of management; E=endangered; NL=not listed; S/A=protected under the similarity of appearances provision of the *Endangered Species Act*; T=threatened.

[b] USFWS Recovery Plan exists for this species.

Source: 50 CFR 17.11; NF NRC 1991a; TN DEC 1995a.

Appendix E
Human Health

E.1 INTRODUCTION

Supplemental information on the potential impacts to humans from the normal operational releases of radioactivity and hazardous chemicals from the various blending technologies and their associated facilities is presented in this appendix. This information is intended to support assessments of normal operation for the highly enriched uranium (HEU) blending options described in the public and occupational health subsections of Sections 4.2 through 4.3 of this environmental impact statement (EIS). Section E.2 provides information on radiological impacts during normal operations, while Section E.3 provides information on hazardous chemical impacts during normal operations. Section E.4 provides information on health effects studies. Section E.5 describes radiological and hazardous chemical impacts during accident conditions.

E.2 RADIOLOGICAL IMPACTS TO HUMAN HEALTH

Section E.2 presents supporting information on the potential radiological impacts to humans during normal site operations. This section provides background information on the nature of radiation (Section E.2.1), the methodology used to calculate radiological impacts (Section E.2.2), and radiological releases from potential sites that could assume HEU blending processes (Section E.2.3).

E.2.1 BACKGROUND

E.2.1.1 Nature of Radiation and Its Effects on Humans

What is Radiation? Humans are constantly exposed to radiation from the solar system and from the earth's rocks and soil. This radiation contributes to the natural background radiation that has always surrounded us. But there are also man-made sources of radiation, such as medical and dental x-rays, household smoke detectors, and materials released from nuclear and coal-fired powerplants.

All matter in the universe is composed of atoms, and radiation comes from the activity of these tiny particles. Atoms are made up of even smaller particles (protons, neutrons, and electrons). The number and arrangement of these particles distinguishes one atom from another.

Atoms of different types are known as elements. There are over 100 natural and man-made elements. Some of these elements, such as uranium, radium, plutonium, and thorium, share a very important quality: they are unstable. As they change into more stable forms, invisible waves of energy or particles, known as ionizing radiation, are released. Radioactivity is the emitting of this radiation.

Ionizing radiation refers to the fact that this energy force can ionize, or electrically charge atoms by stripping off electrons. Ionizing radiation can cause a change in the chemical composition of many things, including living tissue (organs), which can affect the way they function.

The effects on people of radiation that is emitted during disintegration (decay) of a radioactive substance depends on the kind of radiation (alpha and beta particles, and gamma and x-rays) and the total amount of radiation energy absorbed by the body. Alpha particles are the heaviest of these direct types of ionizing radiation, and, despite a speed of about 16,000 kilometers per second (km/s) (9,940 miles per second [mi/s]), they can travel only several centimeters in the air. Alpha particles lose their energy almost as soon as they collide with anything. They can easily be stopped by a sheet of paper or the skin's surface.

Beta particles are much lighter than alpha particles. They can travel as fast as 160,000 km/s (99,400 mi/s) and can travel in the air for a distance of about 3 meters (m) (9.8 feet [ft]). Beta particles can pass through a sheet of paper but may be stopped by a thin sheet of aluminum foil or glass.

Gamma and x-rays, unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light (300,000 km/s [186,000 mi/s]). Gamma

radiation is very penetrating and requires a thick wall of concrete, lead, or steel to stop it.

The neutron is another particle that contributes to radiation exposure, both directly and indirectly. Indirect exposure is associated with the gamma rays and alpha particles that are emitted following neutron capture in matter. A neutron has about one quarter the weight of an alpha particle and can travel at speeds of up to 39,000 km/s (24,200 mi/s). Neutrons are more penetrating than beta particles, but less than gamma rays.

The radioactivity of a material decreases with time. The time it takes a material to lose half of its original radioactivity is its half-life. For example, a quantity of iodine-131, a material that has a half-life of 8 days, will lose half of its radioactivity in that amount of time. In 8 more days, one-half of the remaining radioactivity will be lost, and so on. Eventually, the radioactivity will essentially disappear. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements may vary from millionths of a second to millions of years.

As a radioactive element gives up its radioactivity, it often changes to an entirely different element, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation may take place in several steps and is known as a decay chain. Radium, for example, is a naturally occurring radioactive element with a half-life of 1,622 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays to polonium and, through a series of steps, to bismuth, and ultimately to lead.

Units of Radiation Measure. Scientists and engineers use a variety of units to measure radiation. These different units can be used to determine the amount, type, and intensity of radiation. Just as heat can be measured in terms of its intensity or its effects using units of calories or degrees, amounts of radiation can be measured in curies, rads, or rems.

The curie, named after the French scientists Marie and Pierre Curie, describes the "intensity" of a sample of radioactive material. The rate of decay of 1 gram of radium is the basis of this unit of measure. It is equal to 3.7×10^{10} disintegrations (decays) per second.

The total energy absorbed per unit quantity of tissue is referred to as absorbed dose. The rad is the unit of measurement for the physical absorption of radiation. Much like sunlight heats the pavement by giving up an amount of energy to it, radiation gives up rads of energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram of absorbing material.

A roentgen equivalent man (rem) is a measurement of the dose from radiation based on its biological effects. The rem is used to measure the effects of radiation on the body, much like degrees Celsius can be used to measure the effects of sunlight heating pavement. Thus, 1 rem of one type of radiation is presumed to have the same biological effects as 1 rem of any other type of radiation. This standard allows comparison of the biological effects of radionuclides that emit different types of radiation.

An individual may be exposed to ionizing radiation externally from a radioactive source outside the body and/or internally from ingesting radioactive material. The external dose is different from the internal dose. An external dose is delivered only during the actual time of exposure to the external radiation source. An internal dose, however, continues to be delivered as long as the radioactive source is in the body, although both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time. The dose from internal exposure is calculated over 50 years following the initial exposure.

The three types of doses calculated in this EIS include an external dose, an internal dose, and a combined external and internal dose. Each type of dose is discussed below.

External Dose. The external dose can arise from several different pathways. The radiation causing the exposure is external to the body in all of these pathways. In this EIS, these pathways include exposure to a cloud of radiation passing over the receptor, standing on ground that is contaminated with radioactivity, swimming in contaminated water, and boating in contaminated water. The appropriate measure of dose is called the effective dose equivalent. It should be noted that if the receptor departs from the source of radiation exposure, his

dose rate will be reduced. It is assumed that external exposure occurs uniformly during the year.

Internal Dose. The internal dose arises from a radiation source entering the human body through either ingestion of contaminated food and water or inhalation of contaminated air. In this EIS, pathways for internal exposure include ingestion of crops contaminated either by airborne radiation depositing on the crops or by irrigation of crops using contaminated water sources, ingestion of animal products from animals that ingested contaminated food, ingestion of contaminated water, inhalation of contaminated air, and absorption of contaminated water through the skin during swimming. Unlike external exposures, once the radiation enters the body, it remains there for various periods of time, depending on decay and biological elimination rates. The unit of measure for internal doses is the committed dose equivalent. It is the internal dose that each body organ receives from 1 "year intake" (ingestion plus inhalation). Normally, a 50- or 70-year dose-commitment period is used (that is, the 1-year intake period plus 49 or 69 years). The dose rate increases during the 1 year of intake. After the 1 year of intake, the does rate slowly declines as the radioactivity in the body continues to produce a dose. The integral of the dose rate over the 50 or 70 years gives the committed dose equivalent. In this EIS, a 50-year dose-commitment period was used.

The various organs of the body have different susceptibilities to harm from radiation. The quantity that takes these different susceptibilities into account to provide a broad indicator of the risk to the health of an individual from radiation is called the committed effective dose equivalent. It is obtained by multiplying the committed dose equivalent in each major organ or tissue by a weighting factor associated with the risk susceptibility of the tissue or organ, then summing the totals. It is possible that the committed dose equivalent to an organ is larger than the committed effective dose equivalent if that organ has a small weighting factor. The concept of committed effective dose equivalent applies only to internal pathways.

Combined External and Internal Dose. For convenience, the sum of the committed effective dose equivalent from internal pathways and the effective dose equivalent from external pathways is also called the committed effective dose equivalent in this EIS (note that in DOE Order 5400.5, this quantity is called the effective dose equivalent).

The units used in this EIS for committed dose equivalent, effective dose equivalent, and committed effective dose equivalent to an individual are the rem and mrem (1/1000 of 1 rem). The corresponding unit for the collective dose to a population (the sum of the doses to members of the population, or the product of the number of exposed individuals and their average dose) is the person-rem.

Sources of Radiation. The average person in the United States receives a total of about 350 millirem per year (mrem/yr) from all sources of radiation, both natural and man-made. The sources of radiation can be divided into six different categories: cosmic radiation, terrestrial radiation, internal radiation, consumer products, medical diagnosis and therapy, and other sources. Each category is discussed below.

Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting the earth's atmosphere. These particles and the secondary particles and photons they create are cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with altitude above sea level. For the sites considered in this EIS, the cosmic radiation ranged from about 27 to 45 mrem/yr. The average annual dose to the people in the United States is about 27 mrem.

External terrestrial radiation is the radiation emitted from the radioactive materials in the earth's rocks and soils. The average annual dose from external terrestrial radiation is about 28 mrem. The external terrestrial radiation for the sites in this EIS ranged from about 28 to 70 mrem/yr.

Internal radiation arises from the human body metabolizing natural radioactive material that has entered the body by inhalation or ingestion. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributor to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon, which contribute about

200 mrem/yr. The average dose from other internal radionuclides is about 39 mrem/yr.

Consumer products also contain sources of ionizing radiation. In some products, like smoke detectors and airport x-ray machines, the radiation source is essential to the products' operation. In other products, such as television and tobacco, the radiation occurs incidentally to the product function. The average annual dose is about 10 mrem.

Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic x-rays result in an average annual exposure of 39 mrem. Nuclear medical procedures result in an average annual exposure of 14 mrem.

There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The dose from nuclear fuel cycle facilities, such as uranium mines, mills and fuel processing plants, nuclear power plants, and transportation routes, has been estimated to be less than 1 mrem/yr. Radioactive fallout from atmospheric atomic bomb tests, emissions of radioactive material from Department of Energy (DOE) and Nuclear Regulatory Commission (NRC) facilities, emissions from certain mineral extraction facilities, and transportation of radioactive materials contributes less than 1 mrem/yr to the average dose to an individual. Air travel contributes approximately 1 mrem/yr to the average dose.

The collective (or population) dose to an exposed population is calculated by summing the estimated doses received by each member of the exposed population. This total dose received by the exposed population is measured in person-rem. For example, if 1,000 people each received a dose of 1 millirem (0.001 rem), the collective dose is 1,000 persons x 0.001 rem = 1 person-rem. Alternatively, the same collective dose (1 person-rem) results from 500 people, each of whom received a dose of 2 millirem (500 persons x 2 millirem = 1 person-rem).

Limits of Radiation Exposure. The amount of man-made radiation that the public may be exposed to is limited by Federal regulations. Although most scientists believe that radiation absorbed in small doses over several years is not harmful, U.S. Government regulations assume that the effects of all radiation exposures are cumulative.

The exposure to a member of the general public from DOE facility releases into the atmosphere is limited by the Environmental Protection Agency (EPA) to an annual dose of 10 mrem, in addition to the natural background and medical radiation normally received (40 CFR 61, Subpart H). DOE also limits to 10 mrem the dose annually received from material released into the atmosphere (DOE Order 5400.5). EPA and DOE also limit the annual dose to a member of the general public from radioactive releases to drinking water to 4 mrem (40 CFR 141; DOE Order 5400.5). The annual dose from all radiation sources from a site is limited by the EPA to 25 mrem (40 CFR 190). The DOE annual limit of radiation dose to a member of the general public from all DOE facilities is 100 mrem total from all pathways (DOE Order 5400.5).

The NRC limits depend on whether the site contains nuclear power reactors or other NRC-licensed facilities. For other-than-power-reactors, the EPA limits discussed above apply. For power-reactor sites, the guideline dose values that demonstrate compliance with the as low as reasonably achievable (ALARA) philosophy apply. These limit the annual doses to a member of the public to 5 mrem from airborne emissions and to 3 mrem (per reactor) from liquid releases (10 CFR 50 Appendix I). The annual total dose limit from all pathways combined is the same as the EPA limit of 25 mrem (40 CFR 190). For people working in an occupation that involves radiation, DOE and the NRC limit doses to 5 rem (5,000 mrem) in any one year (10 CFR 20; 10 CFR 835).

E.2.1.2 Health Effects

Radiation exposure and its consequences are topics of interest to the general public. For this reason, this EIS places much emphasis on the consequences of exposure to radiation, even though the effects of radiation exposure under most circumstances evaluated in this EIS are small. This section explains the basic concepts used in the evaluation of radiation effects in order to provide the background for later discussion of impacts.

Radiation can cause a variety of ill-health effects in people. The most significant ill-health effect to depict

the consequences of environmental and occupational radiation exposure is induction of cancer fatalities. This effect is referred to as "latent" cancer fatalities because the cancer may take many years to develop and for death to occur and may not actually be the cause of death. In the discussions that follow, it should be noted that all fatal cancers are latent and the term "latent" is not used.

Health impacts from radiation exposure, whether from sources external or internal to the body, generally are identified as "somatic" (affecting the individual exposed) or "genetic" (affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects than genetic effects. Therefore, for this EIS, only the somatic risks are presented. The somatic risks of most importance are the induction of cancers. Except for leukemia, which can have an induction period (time between exposure to carcinogen and cancer diagnosis) of as little as 2 to 7 years, most cancers have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues; the thyroid and skin demonstrate a greater sensitivity than other organs. However, such cancers also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because of the readily available data for cancer mortality rates and the relative scarcity of prospective epidemiologic studies, somatic effects leading to cancer fatalities rather than cancer incidence are presented in this EIS. The number of cancer fatalities can be used to compare the risks among the various alternatives.

The fatal cancer risk estimators presented in this appendix for radiation technically apply only to low-Linear Energy Transfer radiation (gamma rays and beta particles). However, on a per rem rather than a per rad basis, the fatal risk estimators are higher for this type of radiation than for high-Linear Energy Transfer radiation (alpha particles). In this EIS, the low-Linear Energy Transfer risk estimators are conservatively assumed to apply to all radiation exposures.

The National Research Council's Committee on the Biological Effects of Ionizing Radiations (BEIR) has prepared a series of reports to advise the U.S. Government on the health consequences of radiation exposures. The latest of these reports, *Health Effects of Exposure to Low Levels of Ionizing Radiation BEIR V,* published in 1990, provides the most current estimates for excess mortality from leukemia and cancers other than leukemia expected to result from exposure to ionizing radiation. The BEIR V report updates the models and risk estimates provided in the earlier report of the BEIR III Committee, *The Effects of Populations of Exposure to Low Levels of Ionizing Radiation,* published in 1980. BEIR V models were developed for application to the U.S. population.

BEIR V provides estimates that are consistently higher than those in BEIR III. This is attributed to several factors, including the use of a linear dose response model for cancers other than leukemia, revised dosimetry for the Japanese atomic bomb survivors, and additional followup studies of the atomic bomb survivors and other cohorts. BEIR III employs constant relative and absolute risk models, with separate coefficients for each of several sex-and-age-at-exposure groups, while BEIR V develops models in which the excess relative risk is expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. BEIR III models were based on the assumption that absolute risks are comparable between the atomic bomb survivors and the U.S. population, while BEIR V models were based on the assumption that the relative risks are comparable. For a disease such as lung cancer, where baseline risks in the United States are much larger than those in Japan, the BEIR V approach leads to larger risk estimates than the BEIR III approach.

The models and risk coefficients in BEIR V were derived through analyses of relevant epidemiologic data including the Japanese atomic bomb survivors, ankylosis spondylitis patients, Canadian and Massachusetts fluoroscopy patients (breast cancer), New York postpartum mastitis patients (breast cancer), Israel Tinea Capitis patients (thyroid cancer), and Rochester thymus patients (thyroid cancer). Models for leukemia, respiratory cancer, digestive cancer, and other cancers used only the atomic bomb survivor data, although results of analyses of the ankylosis spondylitis patients were considered. Atomic bomb survivor analyses were based on revised dosimetry with an assumed Relative Biological Effectiveness of 20 for neutrons and were restricted to doses of less than 400 rads. Estimates of

risks of fatal cancers other than leukemia were obtained by totaling the estimates for breast cancer, respiratory cancer, digestive cancer, and other cancers.

Risk Estimates for Doses Received During an Accident. BEIR V includes risk estimates for a single exposure of 10 rem to a population of 100,000 people (10^6 person-rem). In this case, fatality estimates for leukemia, breast cancer, respiratory cancer, digestive cancer, and other cancers are given for both sexes and nine age-at-exposure groups. These estimates, based on the linear model, are summarized in Table E.2.1.2–1. The average risk estimate from all ages and both sexes is 885 excess cancer fatalities per million person-rem. This value has been conservatively rounded up to 1,000 excess cancer fatalities per million person-rem

Although values for other health effects are not presented in this EIS, the risk estimators for non-fatal cancers and for genetic disorders to future generations are estimated to be approximately 200 and 260 per million person-rem, respectively. These values are based on information presented in *1990 Recommendations of the International Commission on Radiological Protection* (International Commission on Radiological Protection [ICRP] Publication 60) and are seen to be 20 and 26 percent, respectively, of the fatal cancer estimator. Thus, for example, if the number of excess fatal cancers is projected to be "X," the number of excess genetic disorders would be 0.26 times "X."

Risk Estimates for Doses Received During Normal Operation. For low doses and dose rates, a linear-quadratic model was found to provide a significantly better fit to the data for leukemia than a linear one, and leukemia risks were based on a linear-quadratic function. This reduces the effects by a factor of 2 over estimates that are obtained from the linear model. For other cancers, linear models were found to provide an adequate fit to the data and were used for extrapolation to low doses. However, the BEIR V Committee recommended reducing these linear estimates by a factor between 2 and 10 for doses received at low dose rates (20 rem total). For this EIS, a risk reduction factor of 2 was adopted for conservatism.

Based on the above discussion, the resulting risk estimator would be equal to one-half the value

Table E.2.1.2–1. Lifetime Risks per 100,000 Persons Exposed to a Single Exposure of 10 Rem

	Type of Fatal Cancer		
Gender	Leukemia[a]	Cancers Other Than Leukemia	Total Cancers
Male	220	660	880
Female	160	730	890
Average	190	695	885[b]

[a] These are the linear estimates and are double the linear-quadratic estimates provided in BEIR V for leukemia at low doses and dose rates.

[b] This value has been rounded up to 1,000 excess cancer fatalities per million person-rem.

Source: NAS 1990a.

observed for accident situations or approximately 500 excess fatal cancer per million person-rem (0.0005 excess fatal cancer per person-rem). This is the risk value used in this EIS to calculate fatal cancers to the general public during normal operations. For workers, a value of 400 excess fatal cancers per million person-rem (0.0004 excess fatal cancer per person-rem) is used in this EIS. This lower value reflects the absence of children in the workforce. Again, based on information provided in ICRP Publication 60, the health risk estimators for non-fatal cancers and genetic disorders among the public are 20 and 26 percent, respectively, of the fatal cancer risk estimator. For workers, they are both 20 percent of the fatal cancer risk estimator. For this EIS, only fatal cancers are presented.

The risk estimates may be applied to calculate the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to natural background radiation (0.3 rem/yr), 15 latent cancer fatalities per year of exposure would be inferred to be caused by the radiation (100,000 persons x 0.3 rem/yr x 0.0005 latent cancer fatalities per person-rem = 15 latent cancer fatalities per year).

Sometimes, calculations of the number of excess cancer fatalities associated with radiation exposure do not yield whole numbers and, especially in environmental applications, may yield numbers less than 1.0. For example, if a population of 100,000 were exposed as above, but to a total dose of only 0.001 rem, the collective dose would be 100 person-rem, and the corresponding estimated number of latent cancer fatalities would be 0.05

(100,000 persons x 0.001 rem x 0.0005 latent cancer fatalities/person-rem = 0.05 latent fatal cancers).

[Text deleted.] Since 0.05 is not an integral number, the interpreting of nonintegral numbers of latent cancer fatalities needs to be defined. The answer is to interpret the result as a statistical estimate. That is, 0.05 is the average number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no person (zero people) would incur a latent cancer fatality from the 0.001 rem dose each member would have received. In a small fraction of the groups, one latent fatal cancer would result; in exceptionally few groups, two or more latent fatal cancers would occur. The *average* number of deaths over all the groups would be 0.05 latent fatal cancers (just as the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome is zero latent cancer fatalities.

These same concepts apply to estimating the effects of radiation exposure on a single individual. Consider the effects, for example, of exposure to background radiation over a lifetime. The "number of latent cancer fatalities" corresponding to a single individual's exposure over a (presumed) 72-year lifetime to 0.3 rem/yr is the following:

- 1 person x 0.3 rem/yr x 72 years x 0.0005 latent cancer fatalities/person-rem = 0.011 latent cancer fatalities.

Again, this should be interpreted in a statistical sense; that is, the estimated effect of background radiation exposure on the exposed individual would produce a 1.1-percent chance that the individual might incur a latent fatal cancer caused by the exposure. Presented another way, this method estimates that approximately 1.1 percent of the population might die of cancers induced by the background radiation.

E.2.2 Methodology for Estimating Radiological Impacts of Normal Operation

The radiological impacts of normal operation of reactors and support facilities were calculated using Version 1.485 of the GENII computer code (GENII–*The Hanford Environmental Radiation Dosimetry Software System* [December 1988]). Site-specific and technology-specific input data were used, including location, meteorology, population, food production and consumption, and source terms. The GENII code was used for analysis of normal operations and design basis accidents. Section E.2.2.1 briefly describes GENII and outlines the approach used for normal operations.

E.2.2.1 GENII Computer Code

The GENII computer model, developed by Pacific Northwest Laboratory for DOE, is an integrated system of various computer modules that analyze environmental contamination resulting from acute or chronic releases to, or initial contamination in, air, water, or soil. The model calculates radiation doses to individuals and populations. The GENII computer model is well documented for assumptions, technical approach, methodology, and quality assurance issues. The GENII computer model has gone through extensive quality assurance and quality control steps. These include the comparison of results from model computations against those from hand calculations, and the performance of internal and external peer reviews. Recommendations given in these reports were incorporated into the final GENII computer model, as deemed appropriate.

For this EIS, only the ENVIN, ENV, and DOSE computer modules were used. The codes are connected through data transfer files. The output of one code is stored in a file that can be used by the next code in the system. In addition, a computer code called CREGENII was prepared to aid the user with the preparation of input files into GENII.

CREGENII. The CREGENII code helps the user, through a series of interactive menus and questions, prepare a text input file for the environmental dosimetry programs. In addition, CREGENII prepares a batch processing file to manage the file handling needed to control the operations of subsequent codes and to prepare an output report.

ENVIN. The ENVIN module of the GENII code controls the reading of the input files prepared by CREGENII and organizes the input for optimal use in the environmental transport and exposure module, ENV. The ENVIN code interprets the basic input, reads the basic GENII data libraries and other optional input files, and organizes the input into

sequential segments on the basis of radionuclide decay chains.

A standardized file that contains scenario, control, and inventory parameters is used as input to ENVIN. Radionuclide inventories can be entered as functions of releases to air or water, concentrations in basic environmental media (air, soil, or water), or concentrations in foods. If certain atmospheric dispersion options have been selected, this module can generate tables of atmospheric dispersion parameters that will be used in later calculations. If the finite plume air submersion option is requested in addition to the atmospheric dispersion calculations, preliminary energy-dependent finite plume dose factors also are prepared. The ENVIN module prepares the data transfer files that are used as input by the ENV module; ENVIN generates the first portion of the calculation documentation—the run input parameters report.

ENV. The ENV module calculates the environmental transfer, uptake, and human exposure to radionuclides that result from the chosen scenario for the user-specified source term. The code reads the input files from ENVIN and then, for each radionuclide chain, sequentially performs the precalculations to establish the conditions at the start of the exposure scenario. Environmental concentrations of radionuclides are established at the beginning of the scenario by assuming decay of preexisting sources, considering biotic transport of existing subsurface contamination, and defining soil contamination from continuing atmospheric or irrigation depositions. Then, for each year of postulated exposure, the code estimates air, surface soil, deep soil, groundwater, and surface water concentrations of each radionuclide in the chain. Human exposures and intakes of each radionuclide are calculated for the following: (1) pathways of external exposure from atmospheric plumes, (2) inhalation, (3) external exposure from contaminated soil, sediments, and water, (4) external exposure from special geometries (that is, shielding parameters promulgated from topographic/geologic trends), and (5) internal exposures from consumption of terrestrial foods, aquatic foods, drinking water, animal products, and inadvertent intake of soil. The intermediate information on annual media concentrations and intake rates are written to data transfer files. Although these may be accessed directly, they are usually used as input to the DOSE module of GENII.

GENII is a general purpose computer code used to model dispersion, transport, and long-term exposure effects of specific radionuclides and pathways. [Text deleted.] GENII was chosen because it can model both air and surface transport pathways and is not restricted to any radionuclides.

DOSE. The DOSE module reads the annual intake and exposure rates defined by the ENV module and converts the data to radiation dose. External dose is calculated with precalculated factors from the EXTDF module or from a data file prepared outside of GENII. Internal dose is calculated with precalculated factors from the INTDF module.

EXTDF. The EXTDF module calculates the external dose-rate factors for submersion in an infinite cloud of radioactive materials, immersion in contaminated water, and direct exposure to plane or slab sources of radionuclides. EXTDF was not used. Instead, the dose rate factors listed in *External Dose Rate Factors for Calculation of Dose to the Public* (DOE/EH-0070, July 1988) were used for this EIS.

INTDF. Using *Limits for Intakes of Radionuclides by Workers* (ICRP Publication 30) model, the INTDF module calculates the internal (inhalation and ingestion) dose conversion factors of radionuclides for specific organs. The factors generated by INTDF were used for the calculations presented in this EIS.

E.2.2.2 Data and Assumptions

In order to perform the dose assessments for this EIS, different types of data must be collected and/or generated. In addition, calculational assumptions have to be made. This section discusses the data collected and/or generated for use in the dose assessment and assumptions made for this EIS.

Meteorological Data. The meteorological data used for both DOE sites were in the form of joint frequency data files. A joint frequency data file is a table listing the fractions of time the wind blows in a certain direction, at a certain speed, and within a certain stability class. The joint frequency data files were based on measurements over a 1-year period at various locations and at different heights at these two

sites. Average meteorological conditions (averaged over the 1-year period) were used for normal operation. For use in design basis accidents, the 50 percentile option was used. For the other two sites, the meteorological data presented in *Environmental Assessment for Renewal of Special Nuclear Material License No. SNM-42, Babcock & Wilcox Company, Naval Nuclear Fuel Division, Lynchburg, Virginia* (Docket No. 70-27, August 1991) and *Environmental Assessment for Renewal of Special Nuclear Material License No. SNM-124, Nuclear Fuel Services, Inc., Erwin Plant, Erwin, Tennessee* (Docket No. 70-143, August 1991) were used.

Population Data. Population distributions were based on *1990 Census of Population and Housing* data. Projections were determined for the year 2010 for areas within 80 km (50 mi) of the proposed facilities at each candidate site. The site population in 2010 was assumed to be representative of the population over the operational period evaluated and was used in the impact assessments. The population was spatially distributed on a circular grid with 16 directions and 10 radial distances up to 80 km (50 mi). The grid was centered on the facility from which the radionuclides were assumed to be released.

Source Term Data. The source terms (quantities of radionuclides released into the environment over a given period) were estimated on the basis of latest conceptual designs of facilities, and experience with similar facilities. The source terms used to generate the estimated impacts of normal operation are provided in Section E.2.3 for the potential sites that could assume HEU blending process facilities. Source terms for site-dependent facilities are included within this section.

Food Production and Consumption Data. Data from the *1987 Census of Agriculture* were used to generate site-specific data for food production. Food production was spatially distributed on the same circular grid as was used for the population distributions. The consumption rates were those used in GENII for the maximum individual and average individual. People living within the 80-km (50-mi) assessment area were assumed to consume only food grown in that area.

Calculational Assumptions. Dose assessments were performed for members of the general public and workers. Dose assessments for members of the public were performed for two different types of receptors considered in this EIS: a maximally exposed offsite individual and the general population living within 80 km (50 mi) of the facility. It was assumed that the maximally exposed individual (MEI) was located at a position on the site boundary that would yield the highest impacts during normal operation of a given alternative. If more than one facility was assumed to be operating at a site, the dose to this individual from each facility was calculated. The doses were then summed to give the total dose to this individual. An 80-km (50-mi) population dose was calculated for each operating facility at a site. These doses then were added to give the total population dose at that site.

To estimate the radiological impacts from normal operation of HEU blending facilities, additional assumptions and factors were considered in using GENII, as follows:

- No prior deposition of radionuclides on ground surfaces was assumed.
- For the maximally exposed offsite individual, the annual exposure time to the plume and to soil contamination was 0.7 years (NRC 1977b:1.109-68).
- For the population, the annual exposure time to the plume and to soil contamination was 0.5 years (NRC 1977b:1.109-68).
- A semi-infinite/finite plume model was used for air immersion doses. Other pathways evaluated were ground exposure, inhalation, ingestion of food crops and animal products contaminated by either deposition of radioactivity from the air or irrigation, ingestion of fish and other aquatic food raised in contaminated water, swimming and boating in contaminated surface water, and drinking contaminated water. It should be noted that not all pathways were available at every site.
- For atmospheric releases, it was assumed that ground level releases would occur for

all HEU blending facilities. For site-dependent facilities, reported release heights were used and assumed to be the effective stack height. Ignoring plume rise makes the resultant doses conservative.

- The calculated doses were 50-year committed doses from 1 year of intake.

- Resuspension of particulates was not considered because calculations of dust loading in the atmosphere showed that this pathway was negligible compared with others.

The exposure, uptake, and usage parameters used in the GENII model are provided in Tables E.2.2.2–1 through E.2.2.2–4.

Annual average doses to workers for no action at Oak Ridge Reservation (ORR) and Savannah River Site (SRS) were based on measured values received by radiation workers during 1992. At Babcock and Wilcox (B&W) and Nuclear Fuel Services (NFS), annual average doses to workers for no action were based on measured values received by radiation workers during 1993. The average no action dose received by a worker at these sites in future years was assumed to remain the same as the average during these earlier years. The total workforce dose in future years was calculated by multiplying the average worker dose by a projected future number of workers.

Doses to workers directly associated with HEU blending process technologies and associated facilities were taken from the reports prepared by Lockheed Martin Energy Systems, Inc. To obtain the total workforce dose at a site with a particular HEU blending process technology and associated facilities in operation, the site dose from no action was added to that from the technology and facility being evaluated. The average dose to a site worker was then calculated by dividing this dose by the total number of radiation workers at the site.

All doses to workers include a component associated with the intake of radioactivity into the body and another component resulting from external exposure to direct radiation.

E.2.2.3 Health Effects Calculations

Doses calculated by GENII were used to estimate health effects using the risk estimators presented in Section E.2.1.2. The incremental cancer fatalities in the general population and in groups of workers from radiation exposure were therefore estimated by multiplying the collective combined effective dose equivalent by 0.0005 and 0.0004 fatal cancers/person-rem, respectively. In this EIS, the collective combined effective dose equivalent is the sum of the collective committed effective dose equivalent (internal dose) and the collective effective dose equivalent (external dose) (see Section E.2.1.1).

Although health risk factors are statistical factors and therefore not strictly applicable to individuals, they have been used in the past to estimate the incremental risk to an individual from exposure to radiation. Therefore, the factors of 0.0005 and 0.0004 per rem of individual committed effective dose equivalent for a member of the public and for a worker, respectively, have also been used in this EIS to calculate the individual's incremental fatal cancer risk from exposure to radiation.

For the public, the health effects expressed in this EIS are the risk of fatal cancers to the maximally exposed individual and the number of fatal cancers to the 80-km (50-mi) population from exposure to radioactivity released from any site over the assumed operational period. For workers, the health effects expressed are the risk to the average worker at a site and the number of fatal cancers to all workers at that site from the associated period of site operations.

Table E.2.2.2–1. GENII Annual Exposure Parameters to Plumes and Soil Contamination

Maximal Individual				General Population			
External Exposure		Inhalation of Plume		External Exposure		Inhalation of Plume	
Plume (hours)	Soil Contamination (hours)	Exposure Time (hours)	Breathing Rate (cm^3/s)	Plume (hours)	Soil Contamination (hours)	Exposure Time (hours)	Breathing Rate (cm^3/s)
6,140	6,140	6,140	270	4,380	4,380	4,380	270

Note: cm^3=cubic centimeters.

Source: HNUS 1995a.

Table E.2.2.2–2. GENII Annual Usage Parameters for Consumption of Terrestrial Food

	Maximum Individual				General Population			
Food Type	Growing Time (days)	Yield (kg/m^2)	Holdup Time (days)	Consumption Rate (kg/yr)	Growing Time (days)	Yield (kg/m^2)	Holdup Time (days)	Consumption Rate (kg/yr)
Leafy Vegetables	90	1.5	1	30	90	1.5	14	15
Root Vegetables	90	4	5	220	90	4	14	140
Fruit	90	2	5	330	90	2	14	64
Grains/Cereals	90	0.8	180	80	90	0.8	180	72

Note: kg=kilograms; m^2=square meter

Source: HNUS 1995a.

Table E.2.2.2–3. GENII Annual Usage Parameters for Consumption of Animal Products

	Maximum Individual									
	Human		Stored Feed				Fresh Forage			
Food Type	Consumption Rate (kg/yr)	Holdup Time (days)	Diet Fraction	Growing Time (days)	Yield (kg/m^3)	Storage Time (days)	Diet Fraction	Growing Time (days)	Yield (kg/m^3)	Storage Time (days)
Beef	80	15	0.25	90	0.8	180	0.75	45	2	100
Poultry	18	1	1	90	0.8	180				
Milk	270	1	0.25	45	2	100	0.75	30	1.5	0
Eggs	30	1	1	90	0.8	180				
	General Population									
Beef	70	34	0.25	90	0.8	180	0.75	45	2	100
Poultry	8	34	1	90	0.8	180				
Milk	230	4	0.25	45	2	100	0.75	30	1.5	0
Eggs	20	18	1	90	0.8	180				

Note: kg=kilograms; m^3=cubic meters.

Source: HNUS 1995a.

Table E.2.2.2–4. GENII Annual Usage Parameters for Aquatic Activities

	Maximum Individual			General Population		
Activity	Transit Time to Usage Point (days)	Holdup Time (days)	Usage Rate (per year)	Transit Time to Usage Point (days)	Holdup Time (days)	Usage Rate
Drinking Water	0	0	730 l	0	0	Site dependent
Swimming	0	0	100 hr	0	0	Site dependent
Boating	0	0	100 hr	0	0	Site dependent
Shoreline	0	0	500 hr	0	0	Site dependent
Ingestion of Fish	0	0	40 kg	0	0	Site dependent
Ingestion of Mollusks	0	0	6.9 kg	0	0	Site dependent
Ingestion of Crustaceans	0	0	6.9 kg	0	0	Site dependent
Ingestion of Plants	0	0	6.9 kg	0	0	Site dependent

Source: HNUS 1995a.

E.2.3 NORMAL OPERATION RELEASES

This section presents source terms and descriptions of radiological releases to the environment from normal operation of the four potential sites (ORR, SRS, B&W, NFS), which could assume incumbent HEU blending process operations. Each site-specific table presents the source terms for each individual facility located on its particular site, as annotated in site environmental reports and referenced datacalls.

In addition, the source terms associated with the technology-specific blending process operations themselves are presented in Table E.2.3–1. It should be noted that the volume of radioisotopes released from the actual blending processes is small compared to that of normal site operation releases (as illustrated in Tables E.2.3–2 through E.2.3–8).

All of the aforementioned values were used in support of the public radiological dose (and subsequent cancer risk) calculations, which are presented in Sections 4.2 and 4.3.

The "site-specific" source terms are assumed to be the no action quantities that would exist at the time HEU blending operations would supposedly commence at the given sites; these source terms were utilized in the promulgation of the no action doses that are given in the respective environmental reports and referenced datacalls, and are also presented in Sections 4.2 and 4.3.

For further information on how source terms relate to radiological dose, see Section E.2.1.

Table E.2.3–1. Annual Atmospheric Radioactive Releases[a] From the Various Blending Process Technologies (curies)

	Technology		
Isotope	Metal	UF_6	UNH
U-235	$1.1x10^{-5}$	$1.1x10^{-4}$	$6.9x10^{-5}$
U-238	$2.5x10^{-4}$	$6.2x10^{-4}$	$3.2x10^{-4}$

[a] There are no liquid releases anticipated from the various blending technology processes.

Note: UF_6 = uranium hexaflouride; UNH = uranyl nitrate hexahydrate.

Source: OR LMES 1995a; OR LMES 1995b; OR LMES 1995c.

Table E.2.3–2. Annual Atmospheric Radioactive Releases From the Oak Ridge Reservation (curies)

	Site Facility		
Isotope	ORNL	K–25	Y–12
H-3	240	-	-
Be-7	$3.8x10^{-4}$	-	-
K-40	-	$4.0x10^{-2}$	-
Ar-41	1,800	-	-
Co-57	-	$1.2x10^{-4}$	-
Co-60	$2.6x10^{-6}$	$4.4x10^{-3}$	-
Sr-90[a]	$3.8x10^{-4}$	-	-
Tc-99	-	$1.2x10^{-1}$	-
Ru-106	-	$4.5x10^{-3}$	-
Cd-109	-	$7.6x10^{-3}$	-
I-129	$2.5x10^{-4}$	-	-
I-130	$5.5x10^{-5}$	-	-
I-131	$5.3x10^{-2}$	-	-
I-132	$9.3x10^{-1}$	-	-
I-133	$2.0x10^{-1}$	-	-
I-135	$4.7x10^{-1}$	-	-
Xe-135	50	-	-
Xe-138	71	-	-
Cs-134	$5.2x10^{-7}$	-	-
Cs-137	$5.1x10^{-4}$	$5.0x10^{-3}$	-
Cs-138	71	-	-
Ba-140	$4.8x10^{-4}$	-	-
Ce-141	-	$2.0x10^{-4}$	-
Eu-152	$1.6x10^{-6}$	-	-
Eu-154	$2.5x10^{-6}$	-	-
Eu-155	$5.2x10^{-6}$	-	-
Os-191	$1.7x10^{-1}$	-	-
Pb-212	$3.7x10^{-1}$	-	-
Th-228	$1.5x10^{-6}$	$3.8x10^{-4}$	-
Th-230	$5.7x10^{-8}$	$5.9x10^{-5}$	-
Th-232	$3.3x10^{-8}$	$1.1x10^{-4}$	-
Th-234	-	$1.8x10^{-2}$	-
U-234[b]	$8.6x10^{-6}$	$4.0x10^{-3}$	$4.7x10^{-2}$
U-235[b]	$4.7x10^{-7}$	$1.8x10^{-4}$	$1.5x10^{-3}$
U-236[b]	$3.8x10^{-8}$	-	$1.9x10^{-4}$
U-238[b]	$2.8x10^{-5}$	$4.2x10^{-3}$	$6.5x10^{-3}$
Np-237	-	$5.7x10^{-4}$	-
Pu-238	$2.8x10^{-6}$	$2.5x10^{-4}$	-
Pu-239	$8.0x10^{-6}$	-	-
Am-241	$4.6x10^{-6}$	-	-
Cm-244	$7.3x10^{-5}$	-	-

[a] Gross beta total is included within this value; total Sr is assumed to be Sr-90.

[b] Gross alpha total is included within these values.

Source: OR DOE 1994c.

Table E.2.3–3. Annual Atmospheric Radioactive Releases From the Savannah River Site (curies)

Isotope	Site Facility					
	DWPF[a]	SRTC	K-Reactor	L-Reactor	F-Canyon	H-Canyon
H-3	20	-	35,000	1,900	-	-
C-14	2.1×10^{-2}	-	-	-	1.5×10^{-2}	2.1×10^{-3}
S-35	-	-	-	-	-	-
Ar-41	-	-	-	-	-	-
Cr-51	-	-	-	-	-	-
Co-60	6.1×10^{-8}	-	-	-	-	-
Ni-63	-	-	-	-	-	-
Se-79	8.8×10^{-9}	-	-	-	-	-
Sr-89	-	-	-	-	-	-
Sr-90[b]	2.3×10^{-5}	1.2×10^{-5}	2.0×10^{-6}	1.8×10^{-4}	1.6×10^{-3}	2.5×10^{-4}
Y-90	2.4×10^{-5}	-	-	-	-	-
Y-91	-	-	-	-	-	-
Zr-95	-	-	-	-	-	-
Nb-95	-	-	-	-	-	-
Tc-99	3.8×10^{-7}	-	-	-	-	-
Ru-106	3.2×10^{-5}	-	-	4.0×10^{-6}	-	-
Rh-106	-	-	-	-	-	-
Sn-126	6.9×10^{-8}	-	-	-	-	-
Sb-125	6.7×10^{-7}	-	-	-	-	-
Te-125m	1.0×10^{-5}	-	-	-	-	-
Te-127m	4.5×10^{-9}	-	-	-	-	-
Te-127	4.4×10^{-9}	-	-	-	-	-
I-129	8.2×10^{-5}	-	-	-	2.5×10^{-3}	2.4×10^{-3}
I-131	-	5.9×10^{-5}	-	-	2.9×10^{-6}	8.6×10^{-5}
I-133	-	2.0×10^{-3}	-	-	-	-
I-135	-	-	-	-	-	-
Xe-135	-	3.2×10^{-2}	-	-	-	-
Cs-134	2.9×10^{-5}	-	-	-	1.4×10^{-6}	-
Cs-135	9.4×10^{-7}	-	-	-	-	-
Cs-137	4.1×10^{-3}	1.5×10^{-6}	1.1×10^{-6}	1.0×10^{-4}	4.6×10^{-4}	4.0×10^{-5}
Ce-144	3.0×10^{-6}	-	-	-	-	-
Pr-144	3.0×10^{-6}	-	-	-	-	-
Pm-147	7.6×10^{-6}	-	-	-	-	-
Sm-151	1.6×10^{-7}	-	-	-	-	-
Eu-152	1.4×10^{-9}	-	-	-	-	-
Eu-154	2.3×10^{-7}	-	-	-	-	-
Eu-155	1.6×10^{-7}	-	-	-	-	-
U-235	-	2.9×10^{-8}	-	-	1.8×10^{-3}	9.5×10^{-5}
Pu-238	7.9×10^{-7}	1.0×10^{-8}	-	-	3.3×10^{-4}	8.8×10^{-4}
Pu-239[c]	7.1×10^{-9}	9.4×10^{-6}	4.4×10^{-8}	4.1×10^{-6}	8.6×10^{-4}	1.8×10^{-4}
Pu-240	4.8×10^{-9}	-	-	-	-	-
Pu-241	7.7×10^{-7}	-	-	-	-	-
Am-241	8.6×10^{-9}	1.3×10^{-6}	-	-	6.1×10^{-5}	8.1×10^{-5}
Cm-244	2.7×10^{-8}	6.8×10^{-6}	-	-	4.3×10^{-5}	6.5×10^{-6}

Table E.2.3–3. Annual Atmospheric Radioactive Releases From the Savannah River Site (curies)—Continued

Isotope	Site Facility					
	CIF[a]	H-3 Facilities	RBOF	M-Area	F-Area Waste	H-Area Waste
H-3	1,200	94,000	-	-	-	1.7
C-14	-	-	-	-	-	-
S-35	-	-	-	-	-	-
Ar-41	-	-	-	-	-	-
Cr-51	$1.5x10^{-2}$	-	-	-	-	-
Co-60	$1.4x10^{-4}$	-	-	-	$5.9x10^{-9}$	-
Ni-63	-	-	-	-	-	-
Se-79	-	-	-	-	-	-
Sr-89	$6.0x10^{-4}$	-	-	-	-	-
Sr-90[b]	$2.2x10^{-2}$	-	-	$8.3x10^{-5}$	-	-
Y-90	$7.6x10^{-5}$	-	-	-	-	-
Y-91	$4.5x10^{-4}$	-	-	-	-	-
Zr-95	$4.7x10^{-4}$	-	-	-	-	-
Nb-95	$1.5x10^{-3}$	-	-	-	-	-
Tc-99	-	-	-	-	-	-
Ru-106	$1.8x10^{-4}$	-	-	-	-	$5.8x10^{-9}$
Rh-106	$1.8x10^{-4}$	-	-	-	-	-
Sn-126	-	-	-	-	-	-
Sb-125	-	-	-	-	-	-
Te-125m	-	-	-	-	-	-
Te-127m	-	-	-	-	-	-
Te-127	-	-	-	-	-	-
I-129	-	-	-	-	-	-
I-131	-	-	-	-	-	-
I-133	-	-	-	-	-	-
I-135	-	-	-	-	-	-
Xe-135	-	-	-	-	-	-
Cs-134	-	-	-	-	-	$1.1x10^{-7}$
Cs-135	-	-	-	-	-	-
Cs-137	$2.4x10^{-4}$	-	$2.1x10^{-7}$	-	$3.8x10^{-6}$	$2.2x10^{-5}$
Ce-144	$2.3x10^{-4}$	-	-	-	-	-
Pr-144	$2.3x10^{-4}$	-	-	-	-	-
Pm-147	$9.1x10^{-4}$	-	-	-	-	-
Sm-151	-	-	-	-	-	-
Eu-152	-	-	-	-	-	-
Eu-154	-	-	-	-	-	-
Eu-155	-	-	-	-	-	-
U-235	-	-	-	$1.6x10^{-5}$	$2.4x10^{-6}$	-
Pu-238	$1.4x10^{-4}$	-	-	-	$3.4x10^{-7}$	-
Pu-239[c]	$5.2x10^{-7}$	-	-	$3.5x10^{-6}$	$2.7x10^{-7}$	-
Pu-240	-	-	-	-	-	-
Pu-241	-	-	-	-	-	-
Am-241	-	-	-	-	$1.0x10^{-7}$	-
Cm-244	-	-	-	-	-	-

Table E.2.3–3. Annual Atmospheric Radioactive Releases From the Savannah River Site (curies)—Continued

Isotope	Site Facility			
	Diffuse & Fugitive	C-Reactor	P-Reactor	D-Area
H-3	43	150	1,300	450
C-14	4.0×10^{-6}	-	-	-
S-35	2.0×10^{-6}	-	-	-
Ar-41	-	-	-	-
Cr-51	-	-	-	-
Co-60	3.3×10^{-17}	-	-	-
Ni-63	2.0×10^{-7}	-	-	-
Se-79	-	-	-	-
Sr-89	-	-	-	-
Sr-90[b]	1.1×10^{-4}	-	-	7.2×10^{-6}
Y-90	-	-	-	-
Y-91	-	-	-	-
Zr-95	2.4×10^{-14}	-	-	-
Nb-95	-	-	-	-
Tc-99	-	-	-	-
Ru-106	-	-	-	-
Rh-106	-	-	-	-
Sn-126	-	-	-	-
Sb-125	-	-	-	-
Te-125m	-	-	-	-
Te-127m	-	-	-	-
Te-127	-	-	-	-
I-129	6.9×10^{-7}	-	-	-
I-131	-	-	-	-
I-133	-	-	-	-
I-135	-	-	-	-
Xe-135	-	-	-	-
Cs-134	1.4×10^{-17}	-	-	-
Cs-135	-	-	-	-
Cs-137	4.3×10^{-11}	-	-	-
Ce-144	1.1×10^{-13}	-	-	-
Pr-144	-	-	-	-
Pm-147	-	-	-	-
Sm-151	-	-	-	-
Eu-152	-	-	-	-
Eu-154	3.4×10^{-13}	-	-	-
Eu-155	1.6×10^{-13}	-	-	-
U-235	4.7×10^{-5}	-	-	-
Pu-238	4.6×10^{-12}	-	-	-
Pu-239[c]	4.7×10^{-7}	-	-	8.4×10^{-7}
Pu-240	-	-	-	-
Pu-241	-	-	-	-
Am-241	8.9×10^{-13}	-	-	-
Cm-244	7.3×10^{-12}	-	-	-

[a] Values are projected; facility presently not in operating status.

[b] Gross beta total is included within this value; total Sr is assumed to be Sr-90.

[c] Gross alpha total is included within these values.

Note: CIF=Consolidated Incineration Facility; DWPF=Defense Waste Processing Facility; RBOF=Receiving Basin Offsite Fuel; SRTC=Savannah River Technology Center.

Source: WSRC 1994f.

Table E.2.3–4. Annual Atmospheric[a] Radioactive Releases From the Babcock & Wilcox Site (curies)

Isotope	Site facility		
	NNFD[b]	CNFP	LTC
Co-60	-	3.2×10^{-5}	-
Kr-85	-	-	13.4
Sr-90	-	-	4.9×10^{-6}
U-234	-	4.0×10^{-6}	-
U-235	-	2.2×10^{-7}	1.8×10^{-7}
U-238	-	9.3×10^{-7}	-

[a] There was a release of 0.016 curies in 1994 due to liquid effluents from NNFD.

[b] Specific radionuclide release terms for this facility were not utilized in support of the impact analyses presented in Chapter 4 of this EIS, due to doses being directly supplied from B&W.

Note: NNFD=Naval Nuclear Fuel Division; CNFP=Commercial Nuclear Fuel Plant; LTC=Lynchburg Technology Center.

Source: BW 1995b:1; BW NRC 1991a.

Table E.2.3–5. Annual Atmospheric Radioactive Releases From the Nuclear Fuel Services Site (curies)

Isotope	Release
Th-228	6.62×10^{-7}
Th-230	2.10×10^{-7}
Th-232	7.33×10^{-7}
U-234	7.12×10^{-5}
U-235	1.21×10^{-6}
U-236	7.23×10^{-9}
U-238	5.23×10^{-7}
Pu-238	2.71×10^{-9}
Pu-239	1.45×10^{-9}
Pu-240	1.31×10^{-9}
Pu-241	1.78×10^{-7}
Pu-242	1.86×10^{-12}
Am-241	1.67×10^{-9}

Source: NFS 1995b:2.

Table E.2.3–6. Annual Liquid Radioactive Releases from the Oak Ridge Reservation Site (curies)

Isotope	Site Facility		
	ORNL	K–25	Y–12
H-3	1.8×10^{3}	-	-
K-40	-	1.9×10^{-2}	-
Co-60	4.0×10^{-2}	-	-
Sr-90	6.6×10^{0}	-	-
Tc-99	-	3.0×10^{-2}	-
Ru-106	-	3.8×10^{-2}	-
Cs-137	5.5×10^{-1}	1.2×10^{-3}	-
Ce-143	-	2.0×10^{-1}	-
Th-228	-	2.0×10^{-1}	-
Th-230	-	2.4×10^{-5}	-
Th-232	-	-	-
Th-234	-	3.6×10^{-2}	-
U-234	1.8×10^{-2}	7.7×10^{-3}	1.5×10^{-1}
U-235	9.5×10^{-4}	1.4×10^{-2}	4.6×10^{-3}
U-236	-	5.8×10^{-4}	6.1×10^{-4}
U-238	5.6×10^{-2}	6.0×10^{-3}	2.1×10^{-2}
Np-237	-	1.2×10^{-3}	-
Pu-238	-	1.6×10^{-4}	-
Pu-239	-	-	-

Source: OR DOE 1994c.

Table E.2.3–7. Annual Liquid Radioactive Releases From the Savannah River Site (curies)

Isotope	Release
H-3	1.3×10^{4}
Sr-90	4.8×10^{-1}
I-129	2.2×10^{-2}
Cs-137	2.5×10^{-1}
Pm-147	7.0×10^{-3}
U-235	1.1×10^{-5}
Pu-239	9.6×10^{-3}

Source: WSRC 1994f.

Table E.2.3–8. Annual Liquid Radioactive Releases From the Nuclear Fuel Services Site (curies)

Isotope	Release
Tc-99	3.0×10^{-3}
Th-228	1.1×10^{-4}
Th-230	1.0×10^{-4}
Th-232	8.4×10^{-5}
Th-234	3.5×10^{-3}
U-234	1.7×10^{-2}
U-235	5.1×10^{-4}
U-238	2.4×10^{-3}
Pu-238	1.2×10^{-4}
Pu-239	5.6×10^{-4}

Source: NFS 1995b:2.

E.3 HAZARDOUS CHEMICAL IMPACTS TO HUMAN HEALTH

E.3.1 BACKGROUND

Two general types of adverse human health effects are assessed for hazardous chemical exposure in this EIS. These are carcinogenic and noncarcinogenic effects. For this reason, two tables were developed to assist the risk assessor in the evaluation process. Table E.3.2–1, Chemical Toxicity Profiles, characterizes each chemical in terms of physical properties, potential exposure routes, and the effects on target tissues/organs that might be expected. It is to be used qualitatively by the risk assessor to determine how exposure might occur (exposure route), what tissue or organ system might be impacted (for example, central nervous system dysfunction and liver cancer), and whether the chemical might possess other properties affecting its bioavailability in a given matrix (for example, air, water, or soil). Table E.3.3–1, Exposure Limits, provides the risk assessor with the necessary information to calculate risk or expected adverse effects should an individual be exposed to a hazardous chemical for a long time at low levels (chronic exposure) or to higher concentrations for a short time (acute exposure). Where a dose effect calculation is required (mg/kg/day), the Reference Dose (RfD) is applicable, and where an inhalation concentration effect is required, the Reference Concentration (that is, RfC in mg/m^3) is applicable for chronic exposures. The Permissible Exposure Limit (PEL) values, which regulate worker exposures over 8-hour periods, determine the concentration allowed for occupational exposures that would be without adverse acute effects. Other values, such as the Threshold Limit Value (TLV) are presented because they are prepared by the American Conference of Governmental Industrial Hygienists (ACGIH) for guidance on exposures of 8-hour periods and can be used to augment PELs or serve as exposure levels in the absence of a PEL. All currently regulated chemicals associated with each site and every hazardous chemical are presented in Table E.3.2–1.

It was assumed that under normal operation conditions, members of the public would only receive chronic exposures at low levels in the form of air emissions from a centrally located source term at each site; since hazardous chemicals are not released into surface or groundwaters or onto soil, inhalation is assumed to be the only route of exposure; however, all chemical quantities are accounted for as air emissions that are several orders of magnitude greater than all other possible routes combined. It was further assumed that the MEI member of the public would be at the site boundary, and this assumption was used when calculating all public exposures, which under normal operating conditions are expected to be chronic and at very low levels. For worker exposures to hazardous chemicals, it was assumed that individuals were exposed only to low air emission concentrations during an 8-hour day for a 40-hour week for a maximum working lifetime of 40 years. The point of exposure chosen was 100 m (328 ft) from a centrally located source term, since the precise placement of source terms onsite could not be made. Further, it could not be determined where the involved and noninvolved workers would be relative to the emission sources.

For every site involved in the analysis, Hazard Indexes (HIs) were calculated for every alternative action relative to the site. The exposure concentrations of hazardous chemicals for the public and the onsite workers were developed using the Industrial Source Complex Short-Term (ISCST) model for point, area, and volume sources. This model, which estimates dispersion of emissions from these sources, has been field tested and recommended by EPA. The modeled concentrations were compared with the RfC and PEL values unique to each chemical to yield Hazard Quotients (HQs) for the public and onsite workers, respectively. The HQs were summed to give the HIs for each alternative action at each site, as well as total HIs (that is, no action HI + alternative HI). For cancer risk estimation, the inhaled concentrations were converted to doses in mg/kg/day, which were then multiplied by the slope factors unique to each identified carcinogen. The risks for all carcinogens associated with each alternative (incremental risk) at each site were summed, and the no action cancer risk for each site was added in order to show the total risk should that alternative action be implemented at a given site.

E.3.2 CHEMICAL TOXICITY PROFILES

Table E.3.2–1 provides the reader with pertinent facts about each chemical that is included in the risk assessment of this EIS. This includes the Chemical Abstracts Service (CAS) number, which aids in the search for information available on any specific chemical and ensures a positive identity regardless of which name or synonym is used. It also contains physical information (that is, solubility, vapor pressure, and flammability) as well as presents incompatibility data that are useful in determining whether a hazard might exist and the nature of the hazard. The route of exposure, target organs/tissues, and carcinogenicity provide an abbreviated summary of how individuals may get exposed, what body functions could be affected, and whether chronic exposure could lead to increased cancer incidence in an exposed population.

E.3.3 REGULATED EXPOSURE LIMITS

Hazardous chemicals are regulated by various agencies in order to provide protection to the public (EPA) and to workers (Occupational Safety and Health Administration [OSHA]), while others (National Institute for Occupational Safety and Health [NIOSH] and the ACGIH) provide guidelines. The RfDs and RfCs set by EPA represent exposure limits for long-term (chronic) exposure at low doses and concentrations, respectively, that can be considered safe from adverse noncancer effects. The PEL represents concentration levels set by OSHA that are safe for 8-hour exposures for the working lifetime without causing adverse noncancer effects. The slope factor or the unit risk are used to convert the daily uptake of a carcinogenic chemical averaged over a lifetime to the incremental risk of an individual developing cancer. Table E.3.3–1 presents the information on exposure limits used to develop HQs for each of the hazardous chemicals and the HIs derived from their summation, and the slope factors used to calculate cancer risk for each chemical at the exposure concentrations identified at the various sites or associated with a proposed alternative action.

Table E.3.2–1. Chemical Toxicity Profiles

Compound	CAS No.	Solubility	Vapor Pressure	Flammability[a]	Incompatibilities	Route of Exposure[b]	Target Organs	Carcinogenicity[c]
1,1,1-Trichloroethane (TCA; methyl chloroform)	71-55-6	0.4%[d]	100 mm[d]	Combustible liquid, burns with difficulty[d]	Strong caustics; strong oxidizers; chemically active metals (for example, Zn, Al, Mg powders, Na, K); water[d]	Inh, ing, con[d]	CNS, eyes, skin, CVS, liver[d]	EPA Group D[e]
Acetic acid	64-19-7	Miscible[e]	11 mm[d]	Class II[d]	Strong oxidizers, strong caustics, corrosive to metals[d]	Inh, con[d]	Eyes, skin, resp sys, teeth[d]	Not classified
Ammonia	7664-41-7	34%[d]	8.5 atm[d]	Treat as a flammable gas[d]	Strong oxidizers, acids, halogens, salts of Ag and Zn[d]	Inh, ing (soln), con (soln/liq)[d]	Eyes, skin, resp sys[d]	EPA Group D[f]
Benzene	71-43-2	0.07%[d]	75 mm[d]	Class IB Flammable liquid[d]	Strong oxidizers, many fluorides and perchlorates, nitric acid[d]	Inh, abs, ing, con[d]	Eyes, skin, resp sys, blood, CNS, bone marrow (Leukemia)[d]	EPA Group A[f]
Carbon monoxide	630-08-0	2%[d]	>35 atm[d]	Flammable gas[d]	Strong oxidizers, bromine trifluoride, chlorine trifluoride, Li[d]	Inh, con (liq)[d]	CVS, lungs, blood, CNS[d]	Not classified
Chlorine	7782-50-5	0.7%[d]	6.8 atm	Nonflammable gas[d]	Reacts explosively or forms explosive compds with many common substances (for example, acetylene, ether, turpentine, ammonia, fuel gas, hydrogen, finely divided metals)[d]	Inh, con[d]	Eyes, skin, resp sys[d]	EPA Group D[f]
Chloroform	67-66-3	0.5%[d] (77 °F)	160 mm[d]	Noncombustible liquid[d]	Strong caustics, chemically active metals (for example, Al or Mg powder), K, strong oxidizers[d]	Inh, abs, ing, con[d]	Liver, kidneys, heart, skin, CNS[d] (In animals: liver and kidney cancer)	EPA Group B2[f]
Chromium (Trivalent)	7440-47-3	Varies with cmpd[d]	Varies with cmpd[d]	Varies with cmpd[d]	Varies with cmpd[d]	Inh, ing, con[d]	Eyes, skin[d]	Not classified

Table E.3.2–1. Chemical Toxicity Profiles—Continued

Compound	CAS No.	Solubility	Vapor Pressure	Flammability[a]	Incompatibilities	Route of Exposure[b]	Target Organs	Carcinogenicity[c]
Cobalt (metal dust and fume)	7440-48-4	Insoluble[d]	0 mm (approx)[d]	Noncombustible solid in bulk form; fine dust burns at high temp[d]	Strong oxidizers, ammonium nitrate[d]	Inh, ing, con[d]	Eyes, resp sys [d]	
Copper (dusts and mists)	7440-50-8	Insoluble[d]	0 mm (approx)[d]	Noncombustible solid in bulk; fine powder may ignite[d]	Oxidizers, alkalis, sodium azide, acetylene[d]	Inh, ing, con[d]	Eyes, skin, resp sys, liver, kidneys (Increase risk with Wilson's disease)[d]	EPA Group C[f]
[Text deleted.]								
Hydrogen chloride	7647-01-0	67%[d] (86 F)	40.5 atm[d]	Nonflammable gas[d]	Hydroxides, amines, alkalis, copper, brass, Zn. Highly corrosive to most metals[d]	Inh, ing (soln), con[d]	Resp sys, skin, eyes[d]	Not classified
Hydrogen fluoride	7664-39-3	Miscible[d]	783 atm[d]	Nonflammable gas[d]	Metals, water or steam. (Corrosive to metals. Will attack glass and concrete)[d]	Inh, abs(liq), ing (soln), con[d]	Eyes, resp sys, bones, skin[d]	Not classified
[Text deleted.]								
Mercury (Cmpds except organo alkyls; as Hg)	7439-97-6	Insoluble[d]	0.0012 mm[d]	Metal: Non-combustible liquid[d]	Acetylene, ammonia, chlorine dioxide, azides, calcium, sodium carbide, Li, Rb, Cu[d]	Inh, abs, con[d]	Eyes, skin, resp sys, CNS, kidneys[d]	EPA Group D[f]
Methanol (methyl alcohol)	67-56-1	Miscible[d]	96 mm[d]	Class IB Flammable liquid[d]	Strong oxidizers[d]	Inh, abs, ing, con[d]	Eyes, skin, resp sys, CNS, GI tract[d]	Not classified
[Text deleted.]								
Nickel (refinery dust)	7440-02-0	Insoluble[d]	0 mm (approx)[d]	Metal: combustible solid, Ni sponge catalyst ignites spontaneously in air[d]	Strong acids, S, Se, wood and other combustibles, nickel nitrate[d]	Inh, ing, con[d]	Lungs, skin, nasal cavities (lung and nasal cancer)	EPA Group A
Nitric acid	7697-37-2	Miscible[d]	48 mm[d]	Noncombustible liquid, but increases flammability of combustible materials[d]	Combustible materials; metallic powders; hydrogen sulfide; carbides; alcohols[d] (Corrosive to metals)	Inh, ing, con[d]	Eyes, resp sys, skin, teeth[d]	Not classified

Table E.3.2–1. Chemical Toxicity Profiles—Continued

Compound	CAS No.	Solubility	Vapor Pressure	Flammability[a]	Incompatibilities	Route of Exposure[b]	Target Organs	Carcinogenicity[c]
[Text deleted.]								
Phosphoric acid	7664-38-2	Miscible[d]	0.03 mm[d]	Noncombustible liquid[d]	Strong caustics, most metals (Do not mix with solutions containing bleach or ammonia)[d]	Inh, ing, con[d]	Eyes, skin, resp sys[d]	Not classified
Sulfuric acid	7664-93-9	Miscible[d]	0.001 mm	Noncombustible liquid, but capable of igniting finely divided combustible materials[d]	Organic materials, chlorates, carbides, fulminates, water, powdered metals[d]	Inh, ing, con[d]	Resp sys, eyes, skin, teeth[d]	Not classified
Toluene	108-88-3	0.07% (74 F)[d]	21 mm[d]	Class IB Flammable liquid[d]	Strong oxidizers[d]	Inh, abs, ing, con[d]	CNS, eyes, resp sys, liver, kidneys, skin[d]	EPA Group D[g]
Trichloroethylene (TCE)	79-01-6	0.0001% (77 F)[d]	58 mm[d]	Combustible liquid, but burns with difficulty[d]	Strong caustics and alkalis; chemically active metals (for example, B.A., Li, Na, Mg, Ti, and Be)[d]	Inh, abs, ing, con[d]	Eyes, resp sys, heart, liver, kidneys, CNS, skin (In animals: liver and kidney cancer)[d]	EPA Group B2[f]
Uranium (Metal; insoluble cmpds)[d]	7440-61-1	Insoluble[d]	0 mm (approx)[d]	Combustible solid[d]	Carbon dioxide, carbon tetrachloride, nitric acid, fluorine[d]	Inh, ing, con[d]	Skin, kidneys, bone marrow, lymphatic sys, (lung cancer)[d]	EPA Group A[h]
[Text deleted.]								
[Text deleted.]								

[a] Flammable liquids are classified by OSHA (29 CFR 1910.106) as follows: Class IA-Fl.P below 73 °F and BP below 100 °F; Class IB-Fl.P below 73 °F and BP at or above 100 °F; Class IC-Fl.P at or above 73 °F and below 100 °F; Class II-Fl.P at or above 100 °F and below 140 °F; Class IIIA-Fl.P at or above 140 °F and below 200 °F; Class IIIB-Fl.P at or above 200 °F (DHHS 1992a).

[b] Routes of exposure abbreviated as follows: inh = inhalation, abs = skin absorption, ing = ingestion, con = skin and/or eye contact.

[c] EPA Groups for Carcinogenicity are Classified as Follows: EPA Group A: Human Carcinogen; EPA Group B1: Probable Human Carcinogen-limited evidence in human studies; EPA Group B2: Probable Human Carcinogen-sufficient evidence from animal studies, inadequate evidence or no data from human studies; EPA Group C: Possible Human Carcinogen; EPA Group D: Not Classifiable as to Human Carcinogenicity.

[d] NIOSH 1994a.

[e] EPA 1993a.

[f] ORNL 1994b.

[g] ORNL 1994a.

[h] EPA 1994a.

Note: °F=Fahrenheit.

Table E.3.3–1. Exposure Limits

Compound	Chemical Abstracts Service No.	Reference Dose (oral) (mg/kg/day)	Reference Concentration (inhalation) (mg/m^3)	Cancer Class[a]	Slope Factor $(mg/kg/day)^{-1}$	Occupational Exposure Level[b, c]
1,1,1-Trichloroethane (TCA; methyl chloroform)	71-55-6	0.035[d]	1.0[e]	EPA Group D[f]	None found	OSHA-PEL: 1,900 mg/m^3 ACGIH-TLV: 1,910 mg/m^3, STEL: 2,460 mg/m^3 NIOSH-REL: 1,900 mg/m^3, (ceiling, 15 min.) IDLH: 3,885 mg/m^3
Acetic acid	64-19-7	0.175[g]	0.6125[h]	Not classified	None found	OSHA-PEL: 25 mg/m^3 ACGIH-TLV: 25 mg/m^3, STEL: 37 mg/m^3 NIOSH-REL: 25 mg/m^3, STEL: 37 mg/m^3, IDLH: 125 mg/m^3
[Text deleted.]						
Ammonia	7664-41-7	0.0286[i] (34 mg/l, chronic)[j]	0.1[f]	EPA Group D[d]	None found	OSHA-STEL: 35 mg/m^3 ACGIH-TLV: 17 mg/m^3, STEL: 24 mg/m^3 MOSH-REL: 18 mg/m^3, STEL: 27 mg/m^3, IDLH: 213 mg/m^3
Benzene	71-43-2	2.28×10^{-2}[g]	0.0796[h]	EPA Group A[f]	0.029 (oral)[f] 0.029 (inhal)[j]	OSHA-PEL: 3.25 mg/m^3, STEL: 16.25 mg/m^3, ACGIH-TLV: 32 mg/m^3, NIOSH-REL: 0.325 mg/m^3, STEL: 3.25 mg/m^3, IDLH: 5 mg/m^3
Carbon monoxide	630-08-0	0.385[g]	1.35[h]	Not classified	None found	OSHA-PEL: 55 mg/m^3 ACGIH-TLV: 29 mg/m^3 NIOSH-REL: 40 mg/m^3, IDLH: 1,392 mg/m^3
Chlorine	7782-50-5	0.1[f]	0.35[h]	EPA Group D[d]	None found	OSHA-PEL: 3 mg/m^3 (ceiling) ACGIH-TLV: 1.5 mg/m^3, STEL: 2.9 mg/m^3 NIOSH-REL: 1.45 mg/m^3 (ceiling, 15 min.), IDLH: 29.5 mg/m^3
Chloroform	67-66-3	0.01[f]	0.035[h]	EPA Group B2[f]	6.1×10^{-3} (oral)[f] 0.081 (inhal)[j]	OSHA-PEL: 240 mg/m^3 (ceiling) ACGIH-TLV: 49 mg/m^3 NIOSH-REL: 9.78 mg/m^3 (60 min.), IDLH: 2480 mg/m^3
Chromium (Trivalent)	16065-83-1	1.0[f]	3.5[h]	Not classified	None found	OSHA-PEL: 0.5 mg/m^3 ACGIH-TLV: 0.5 mg/m^3 NIOSH-REL: 0.5 mg/m^3, IDLH: 25 mg/m^3

Table E.3.3–1. Exposure Limits—Continued

Compound	Chemical Abstracts Service No.	Reference Dose (oral) (mg/kg/day)	Reference Concentration (inhalation) (mg/m^3)	Cancer Class[a]	Slope Factor $(mg/kg/day)^{-1}$	Occupational Exposure Level[b, c]
Cobalt (metal dust and fume)	7440-48-4	$7x10^{-4}$ [g]	$2.45x10^{-3}$ [h]	Not classified	None found	OSHA-PEL: 0.1 mg/m^3 ACGIH-TLV: 0.05 mg/m^3 NIOSH-REL: 0.05 mg/m^3, IDLH: 20 mg/m^3
Copper (dusts and mists)	7440-50-8	$7x10^{-3}$ [g]	0.0245[h]	EPA Group D[f]	None found	OSHA-PEL: 1 mg/m^3 ACGIH-TLV: 1 mg/m^3 NIOSH-REL: 1 mg/m^3, IDLH: 100 mg/m^3
[Text deleted.]						
Hydrogen chloride	7647-01-0	$2x10^{-3}$ [i]	$7x10^{-3}$ [f]	Not classified	None found	OSHA-PEL: 7 mg/m^3 ACGIH-TLV: 7.5 mg/m^3 (ceiling) NIOSH-REL: 7 mg/m^3, IDLH: 76 mg/m^3
Hydrogen fluoride	7664-39-3	0.06[e]	0.21[h]	Not classified	None found	OSHA-PEL: 2.49 mg/m^3 ACGIH-TLV: 2.6 mg/m^3 (ceiling) NIOSH-REL: 2.5 mg/m^3, 5.0 mg/m^3 (ceiling, 15 min), IDLH: 24.9 mg/m^3
[Text deleted.]						
Mercury (vapor + compound)	7439-97-6	$3x10^{-4}$ (inorganic, chronic)[j]	$3x10^{-4}$ [e]	EPA Group D[f]	None found	OSHA-PEL: 0.1 mg/m3 (ceiling), ACGIH-TLV: 0.05 mg/m3, NIOSH-REL: 0.05 mg/m3 (skin), IDLH: 10 mg/m3
Methanol (methyl alcohol)	67-56-1	0.5[f]	1.75[h]	Not classified	None found	OSHA-PEL: 260 mg/m^3 ACGIH-TLV: 262 mg/m^3 (skin), STEL: 328 mg/m^3 NIOSH-REL: 260 mg/m^3, STEL: 325 mg/m^3 (skin), IDLH: 7,980 mg/m^3
[Text deleted.]						
Nickel (refinery dust)	7440-02-0	0.007[g]	0.0245[h]	EPA Group A[k]	0.84 (inhal)[h]	OSHA-PEL: 1 mg/m^3 (metal and other compds) ACGIH-TLV: 1 mg/m^3 NIOSH-REL: 0.015 mg/m^3
Nitric acid	7697-37-2	0.035[e]	0.1225[h]	None	None	OSHA-PEL: 5 mg/m^3 (metal and other cmpds) ACGIH-TLV: 5.2 mg/m^3, STEL: 10 mg/m^3 NIOSH-REL:5 mg/m^3, STEL: 10 mg/m^3 IDLH:65.5 mg/m^3
[Text deleted.]						

Table E.3.3–1. Exposure Limits—Continued

Compound	Chemical Abstracts Service No.	Reference Dose (oral) (mg/kg/day)	Reference Concentration (inhalation) (mg/m^3)	Cancer Class[a]	Slope Factor $(mg/kg/day)^{-1}$	Occupational Exposure Level[b, c]
Phosphoric acid	7664-38-2	0.007[g]	0.0245[h]	Not classified	None found	OSHA-PEL: 1 mg/m^3, ACGIH-TLV: 1 mg/m^3, STEL: 3 mg/m^3, NIOSH-REL: 1 mg/m^3, STEL: 3 mg/m^3, IDLH: 1,000 mg/m^3
Sulfuric acid	7664-93-9	0.007[g]	2.45×10^{-2} [h]	Not classified	None found	OSHA-PEL: 1 mg/m^3 ACGIH-TLV: 1 mg/m^3, STEL: 3 mg/m^3 NIOSH-REL: 1 mg/m^3, IDLH: 15 mg/m^3
Toluene	108-88-3	0.2[f]	0.4[f]	EPA Group D[f]	None found	OSHA-PEL: 766 mg/m^3, STEL: 1,149 mg/m^3, (ceiling) ACGIH-TLV: 188 mg/m^3 (skin) NIOSH-REL: 375 mg/m^3, STEL: 560 mg/m^3, IDLH: 1,915 mg/m^3
Trichloroethylene (TCE)	79-01-6	3.82[g]	13.377[h]	EPA Group B2[d]	6.0×10^{-3} (inhal)[j]	OSHA-PEL: 546 mg/m^3, 1,092 mg/m^3 (ceiling) ACGIH-TLV: 269 mg/m^3, STEL: 1,070 mg/m^3 NIOSH-REL: 5,460 mg/m^3
Uranium 235 + 238	7440-61-1	3.0×10^{-3} [f]	0.0105[h]	EPA Group A[d]	Inhalation[j] (Risk/pCi) U^{235} 2.5×10^{-8} U^{238} 2.4×10^{-8} Average SF: 2.45×10^{-8}	OSHA-PEL: 0.25 mg/m^3 (insol cpds/metal) ACGIH-TLV: 0.2 mg/m^3, STEL: 0.6 mg/m^3 (insol cpds/metal) NIOSH-REL: 0.2 mg/m^3, STEL: 0.6 mg/m^3 (insol cpds/metal), IDLH: 10 mg/m^3 (as U)

[Text deleted.]

[a] EPA Groups for carcinogenicity are classified as follows: EPA Group A: Human Carcinogen; EPA Group B1: Probable Human Carcinogen - limited evidence in human studies; EPA Group B2: Probable Human Carcinogen - sufficient evidence from animal studies, inadequate evidence or no data from human studies; EPA Group C: Possible Human Carcinogen; EPA Group D: Not Classifiable as to Human Carcinogenicity.

[b] OSHA and NIOSH exposure levels were taken from NIOSH 1994a unless otherwise indicated.

[c] American Conference of Governmental Industrial Hygienists (ACGIH) exposure levels were taken from ACGIH nda unless otherwise indicated.

[d] EPA 1993a.

[e] PNL, 1995a.

[f] ORNL 1994b.

[g] Reference Dose calculated from OSHA-PEL, formula from the Center for Risk Management, Oak Ridge National Laboratories (ORNL 1992d).

[h] Reference Concentration calculated from Reference Dose, formula from the Center for Risk Management, Oak Ridge National Laboratories (ORNL 1992d).

[i] Reference Dose calculated from Reference Concentration, formula from the Center for Risk Management, Oak Ridge National Laboratories (ORNL 1992d).

[j] EPA 1994a.

[k] ORNL 1994a.

Note: mg=milligram; kg=kilogram.

E.3.4 HAZARDOUS CHEMICAL RISK/ EFFECTS CALCULATIONS

Tables E.3.4–1 through E.3.4–15 show the chemicals associated with the various alternative activities (that is, no action or blend to low enriched uranium) and Tables E.3.4–16 through E.3.4–19 summarize the alternatives for each of the four sites and give the totals associated with the activities if implemented at each of the four sites (that is, ORR, SRS, B&W, and NFS). Table E.3.4–20 contains the emission rates and the corresponding PELs for hazardous chemicals for the In-Tank Precipitation Facility and the Consolidated Incineration Facility at SRS. The terms associated with calculations are given in the footnotes for each table so that verification of each calculated value can be made.

Table E.3.4–1. Risk Assessments From Exposure to Hazardous Chemicals at Oak Ridge Reservation: No Action

Chemical	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 hours[f] (mg/m^3)
1,1,1-Trichloroethane	1	1,900	–	$7.26x10^{-6}$	$4.63x10^{-3}$	$7.26x10^{-6}$	$2.29x10^{-6}$	0	0
Acetic acid	0.6125	25	–	$3.30x10^{-8}$	$1.98x10^{-5}$	$5.39x10^{-8}$	$7.93x10^{-7}$	0	0
Carbon monoxide	1.35	55	–	$3.14x10^{-3}$	1.88	$2.32x10^{-3}$	$3.42x10^{-2}$	0	0
Chlorine	0.35	3	–	$5.78x10^{-5}$	$3.47x10^{-2}$	$1.65x10^{-4}$	$1.16x10^{-2}$	0	0
Hydrogen chloride	0.007	7	–	$2.12x10^{-4}$	$1.27x10^{-1}$	$3.03x10^{-2}$	$1.82x10^{-2}$	0	0
Hydrogen fluoride	0.21	2.49	–	$2.31x10^{-6}$	$1.39x10^{-3}$	$1.10x10^{-5}$	$5.57x10^{-4}$	0	0
Methanol	1.75	260	–	$8.72x10^{-4}$	$5.23x10^{-1}$	$4.98x10^{-4}$	$2.01x10^{-3}$	0	0
Nitric acid	0.1225	5	–	$3.14x10^{-4}$	$1.88x10^{-1}$	$2.56x10^{-3}$	$3.76x10^{-2}$	0	0
Sulfuric acid	0.0245	1	–	$8.25x10^{-5}$	$4.95x10^{-2}$	$3.37x10^{-3}$	$4.95x10^{-2}$	0	0
VOC (toluene)	0.4	766	–	$1.22x10^{-4}$	$7.33x10^{-2}$	$3.05x10^{-4}$	$9.57x10^{-5}$	0	0
Health Risk									
Hazard Index[g]						$3.95x10^{-2}$	$1.54x10^{-1}$		
Total Cancer Risk[h]								0	0

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Source: OR MMES 1995i.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Table E.3.4–2. Risk Assessments From Exposure to Hazardous Chemicals at Savannah River Site: No Action

Chemical	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 hours[f] (mg/m^3)
Benzene	0.0796	3.25	0.029	$1.25x10^{-6}$	$1.37x10^{-2}$	$1.57x10^{-5}$	$4.20x10^{-3}$	$1.04x10^{-8}$	$1.53x10^{-5}$
Carbon monoxide	1.35	55	–	$5.41x10^{-3}$	59.1	$4.01x10^{-3}$	1.07	0	0
Chlorine	0.35	3	–	$9.27x10^{-9}$	$1.01x10^{-4}$	$2.65x10^{-8}$	$3.37x10^{-5}$	0	0
Chloroform	0.035	240	0.0061	$4.79x10^{-6}$	$5.24x10^{-2}$	$1.37x10^{-4}$	$2.18x10^{-4}$	$8.36x10^{-9}$	$1.24x10^{-5}$
Cobalt	0.00245	0.1	–	$7.46x10^{-9}$	$8.15x10^{-5}$	$3.05x10^{-6}$	$8.15x10^{-4}$	0	0
Hydrogen fluoride	0.21	2.49	–	$4.29x10^{-8}$	$4.69x10^{-4}$	$2.04x10^{-7}$	$1.88x10^{-4}$	0	0
Mercury (vapor)	0.0003	0.1	–	$1.89x10^{-7}$	$2.06x10^{-3}$	$6.29x10^{-4}$	$2.06x10^{-2}$	0	0
Nickel (vapor & compounds)	0.0245	1	0.84	$4.31x10^{-8}$	$4.70x10^{-4}$	$1.76x10^{-6}$	$4.70x10^{-4}$	$1.03x10^{-8}$	$1.53x10^{-5}$
Nitric acid	0.1225	5	–	$3.73x10^{-6}$	$4.07x10^{-2}$	$3.04x10^{-5}$	$8.15x10^{-3}$	0	0
Phosphoric acid	0.0245	1	–	$1.50x10^{-7}$	$1.63x10^{-3}$	$6.11x10^{-6}$	$1.63x10^{-3}$	0	0

Table E.3.4–2. Risk Assessments From Exposure to Hazardous Chemicals at Savannah River Site: No Action—Continued

Chemical	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 hours[f] (mg/m^3)
Benzene (DWPF)[g]	0.0796	3.25	0.029	$1.23x10^{-5}$	$1.35x10^{-1}$	$1.55x10^{-4}$	$4.15x10^{-2}$	$1.02x10^{-7}$	$1.51x10^{-4}$
Hydrogen fluoride (DWPF)[g]	0.21	2.49	–	$8.39x10^{-12}$	$9.16x10^{-8}$	$3.99x10^{-11}$	$3.68x10^{-8}$	0	0
Mercury (DWPF)[g]	0.0003	0.1	–	$5.17x10^{-8}$	$5.65x10^{-4}$	$1.72x10^{-4}$	$5.65x10^{-3}$	0	0
Mercury oxide (DWPF)[g]	0.0003	0.1	–	$6.36x10^{-18}$	$6.95x10^{-14}$	$2.12x10^{-14}$	$6.95x10^{-13}$	0	0
Nickel compounds (DWPF)[g]	0.0245	1	0.84	$3.16x10^{-16}$	$3.45x10^{-12}$	$1.29x10^{-14}$	$3.45x10^{-12}$	$7.60x10^{-17}$	$1.12x10^{-13}$
Health Risk									
Hazard Index[h]						$5.16x10^{-3}$	1.16		
Total Cancer Risk[i]								$1.31x10^{-7}$	$1.94x10^{-4}$

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] The Defense Waste Processing Facility (DWPF), In-Tank Precipitation (ITP) facility, and Consolidated Incineration Facility (CIF) were not in operation during 1994, but potential emissions from DWPF based on limited trials are used to generate DWPF potential emissions.

The ITP and CIF data were not included because only the inventory of chemicals to be processed through these facilities was available. Table E.3.4–20 presents the list of possible ITP/CIF chemicals and their regulated levels.

[h] Hazard index=sum of individual hazard quotients.

[i] Total cancer risk=sum of individual cancer risks.

Note: 1994 actual emissions scaled to the year 2005. Scaling Factor=1.0 for all except: Bechtel (0.6), Separations (0.8), Power (0.8), and Reactors (0.1).

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: SRS 1995a:2; SRS 1996a:1.

Table E.3.4–3. Risk Assessments From Exposure to Hazardous Chemicals at Babcock & Wilcox: No Action

Chemical	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Onsite 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Chromium compounds (III)	3.5	0.5	–	$5.96x10^{-10}$	$1.03x10^{-5}$	$1.70x10^{-10}$	$2.07x10^{-5}$	0	0
Cobalt compounds	0.00245	0.1	–	$5.96x10^{-10}$	$1.03x10^{-5}$	$2.43x10^{-7}$	$1.03x10^{-4}$	0	0
Copper compounds	0.0245	1	–	$1.43x10^{-7}$	$2.48x10^{-3}$	$5.84x10^{-6}$	$2.48x10^{-3}$	0	0
Hydrogen chloride	0.007	7	–	$1.43x10^{-8}$	$2.48x10^{-4}$	$2.04x10^{-6}$	$3.54x10^{-5}$	0	0
Hydrogen fluoride	0.21	2.49	–	$2.98x10^{-9}$	$5.17x10^{-5}$	$1.42x10^{-8}$	$2.08x10^{-5}$	0	0
Nickel compounds	0.0245	1	0.84	$8.94x10^{-10}$	$1.55x10^{-5}$	$3.65x10^{-8}$	$1.55x10^{-5}$	$2.15x10^{-10}$	$5.04x10^{-7}$
Nitric acid	0.1225	5	–	$1.40x10^{-7}$	$2.43x10^{-3}$	$1.14x10^{-6}$	$4.86x10^{-4}$	0	0
Sulfuric acid	0.0245	1	–	$3.49x10^{-8}$	$6.05x10^{-4}$	$1.42x10^{-6}$	$6.05x10^{-4}$	0	0
Trichloroethylene (TCE)	13.377	546	0.006	$9.66x10^{-6}$	$1.67x10^{-1}$	$7.22x10^{-7}$	$3.07x10^{-4}$	$1.66x10^{-8}$	$3.89x10^{-5}$
Health Risk									
Hazard Index[g]						$1.15x10^{-5}$	$4.07x10^{-3}$		
Total Cancer Risk[h]	–							$1.68x10^{-8}$	$3.94x10^{-5}$

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers=(emissions for 8 hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: VA DEQ 1995a.

Table E.3.4–4. Risk Assessments From Exposure to Hazardous Chemicals at Nuclear Fuel Services: No Action

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Onsite 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Ammonia	0.1	35	–	9.17×10^{-3}	1.50×10^{-1}	9.17×10^{-2}	4.27×10^{-3}	0	0
Hydrogen fluoride	0.21	2.49	–	3.88×10^{-4}	6.33×10^{-3}	1.85×10^{-3}	2.54×10^{-3}	0	0
Nitric acid	0.1225	5	–	2.32×10^{-4}	3.78×10^{-3}	1.89×10^{-3}	7.56×10^{-4}	0	0
Health Risk									
Hazard Index[g]						9.55×10^{-2}	7.57×10^{-3}		
Total Cancer Risk[h]								0	0

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: NFS 1995b:2.

Table E.3.4–5. Risk Assessments From Exposure to Hazardous Chemicals at Oak Ridge Reservation: Blend to 4-Percent Uranyl Nitrate Hexahydrate for Commercial Reactor Fuel

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	3.70×10^{-4}	6.22×10^{-2}	2.74×10^{-4}	1.13×10^{-3}	0	0
Uranium-235	0.0105	0.25	2.5×10^{-8}	5.73×10^{-9}	9.62×10^{-7}	5.46×10^{-7}	3.85×10^{-6}	4.17×10^{-17}	9.31×10^{-16}
Uranium-238	0.0105	0.25	2.4×10^{-8}	1.71×10^{-7}	2.87×10^{-5}	1.63×10^{-5}	1.15×10^{-4}	1.17×10^{-15}	2.66×10^{-14}
VOC (toluene)	0.4	766	–	3.70×10^{-5}	6.22×10^{-3}	9.26×10^{-5}	8.12×10^{-6}	0	0
Health Risk									
Hazard Index[g]						3.84×10^{-4}	1.26×10^{-3}		
Total Cancer Risk[h]								1.21×10^{-15}	2.75×10^{-14}

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime Cancer Risk for Workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995b.

Table E.3.4–6. Risk Assessments From Exposure to Hazardous Chemicals at Savannah River Site: Blend to 4-Percent Uranyl Nitrate Hexahydrate for Commercial Reactor Fuel

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	4.12×10^{-5}	5.57×10^{-2}	3.05×10^{-5}	1.01×10^{-3}	0	0
Uranium-235	0.0105	0.25	2.5×10^{-8}	6.37×10^{-10}	8.61×10^{-7}	6.06×10^{-8}	3.44×10^{-6}	4.55×10^{-18}	8.33×10^{-16}
Uranium-238	0.0105	0.25	2.4×10^{-8}	1.90×10^{-8}	2.56×10^{-5}	1.81×10^{-6}	1.03×10^{-4}	1.30×10^{-16}	2.38×10^{-14}
VOC (toluene)	0.4	766	–	4.12×10^{-6}	5.57×10^{-3}	1.03×10^{-5}	7.27×10^{-6}	0	0
Health Risk									
Hazard Index[g]						4.26×10^{-5}	1.13×10^{-3}		
Total Cancer Risk[h]								1.35×10^{-16}	2.47×10^{-14}

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995b.

Table E.3.4–7. Risk Assessments From Exposure to Hazardous Chemicals at Babcock & Wilcox: Blend to 4-Percent Uranyl Nitrate Hexahydrate for Commercial Reactor Fuel

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	$1.34x10^{-6}$	$2.32x10^{-2}$	$9.89x10^{-7}$	$4.21x10^{-4}$	0	0
Uranium-235	0.0105	0.25	$2.5x10^{-8}$	$2.07x10^{-11}$	$3.58x10^{-7}$	$1.97x10^{-9}$	$1.43x10^{-6}$	$1.48x10^{-19}$	$3.47x10^{-16}$
Uranium-238	0.0105	0.25	$2.4x10^{-8}$	$6.15x10^{-10}$	$1.07x10^{-5}$	$5.86x10^{-8}$	$4.27x10^{-5}$	$4.22x10^{-18}$	$9.91x10^{-15}$
VOC (toluene)	0.4	766	–	$1.34x10^{-7}$	$2.32x10^{-3}$	$3.34x10^{-7}$	$3.02x10^{-6}$	0	0
Health Risk									
Hazard Index[g]						$1.38x10^{-6}$	$4.68x10^{-4}$		
Total Cancer Risk[h]								$4.37x10^{-18}$	$1.03x10^{-14}$

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995b.

Table E.3.4–8. Risk Assessments From Exposure to Hazardous Chemicals at Nuclear Fuel Services: Blend to 4-Percent Uranyl Nitrate Hexahydrate for Commercial Reactor Fuel

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	$1.95x10^{-3}$	$3.18x10^{-2}$	$1.44x10^{-3}$	$5.77x10^{-4}$	0	0
Uranium-235	0.0105	0.25	$2.5x10^{-8}$	$3.01x10^{-8}$	$4.91x10^{-7}$	$2.87x10^{-6}$	$1.96x10^{-6}$	$2.15x10^{-16}$	$4.75x10^{-16}$
Uranium-238	0.0105	0.25	$2.4x10^{-8}$	$8.97x10^{-7}$	$1.46x10^{-5}$	$8.54x10^{-5}$	$5.85x10^{-5}$	$6.16x10^{-15}$	$1.24x10^{-14}$
VOC (toluene)	0.4	766	–	$1.95x10^{-4}$	$3.18x10^{-3}$	$4.87x10^{-4}$	$4.15x10^{-6}$	0	0
Health Risk									
Hazard Index[g]						$2.02x10^{-3}$	$6.42x10^{-4}$		
Total Cancer Risk[h]								$6.37x10^{-15}$	$1.41x10^{-14}$

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks..

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995b

Table E.3.4–9. Risk Assessments From Exposure to Hazardous Chemicals at Babcock & Wilcox: Blend to 4-Percent Uranium Hexafluoride for Commercial Reactor Fuel

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	$1.34x10^{-6}$	$2.32x10^{-2}$	$9.89x10^{-7}$	$4.21x10^{-4}$	0	0
Uranium-235	0.0105	0.25	$2.5x10^{-8}$	$3.28x10^{-11}$	$5.68x10^{-7}$	$3.12x10^{-9}$	$2.27x10^{-6}$	$2.34x10^{-19}$	$5.50x10^{-16}$
Uranium-238	0.0105	0.25	$2.4x10^{-8}$	$1.20x10^{-9}$	$2.07x10^{-5}$	$1.14x10^{-7}$	$8.29x10^{-5}$	$8.21x10^{-18}$	$1.93x10^{-14}$
VOC (toluene)	0.4	766	–	$1.34x10^{-7}$	$2.32x10^{-3}$	$3.34x10^{-7}$	$3.02x10^{-6}$	0	0
Health Risk									
Hazard Index[g]						$1.44x10^{-6}$	$5.09x10^{-4}$		
Total Cancer Risk[h]								$8.44x10^{-18}$	$1.98x10^{-14}$

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995a.

Table E.3.4–10. Risk Assessments From Exposure to Hazardous Chemicals at Nuclear Fuel Services: Blend to 4-Percent Uranium Hexafluoride for Commercial Reactor Fuel

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	$1.95x10^{-3}$	$3.18x10^{-2}$	$1.44x10^{-3}$	$5.77x10^{-4}$	0	0
Uranium-235	0.0105	0.25	$2.5x10^{-8}$	$4.78x10^{-8}$	$7.80x10^{-7}$	$4.55x10^{-6}$	$3.12x10^{-6}$	$3.42x10^{-16}$	$7.54x10^{-16}$
Uranium-238	0.0105	0.25	$2.4x10^{-8}$	$1.74x10^{-6}$	$2.84x10^{-5}$	$1.66x10^{-4}$	$1.14x10^{-4}$	$1.20x10^{-14}$	$2.64x10^{-14}$
VOC (toluene)	0.4	766	–	$1.95x10^{-4}$	$3.18x10^{-3}$	$4.87x10^{-4}$	$4.15x10^{-6}$	0	0
Health Risk									
Hazard Index[g]						$2.10x10^{-3}$	$6.98x10^{-4}$		
Total Cancer Risk[h]								$1.23x10^{-14}$	$2.72x10^{-14}$

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995a.

Table E.3.4–11. Risk Assessments From Exposure to Hazardous Chemicals at Oak Ridge Reservation: Blend to 0.9-Percent Uranyl Nitrate Hexahydrate and Discard as Waste

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	3.70×10^{-4}	6.22×10^{-2}	2.74×10^{-4}	1.13×10^{-3}	0	0
Uranium-235	0.0105	0.25	2.5×10^{-8}	5.73×10^{-9}	9.62×10^{-7}	5.46×10^{-7}	3.85×10^{-6}	4.10×10^{-17}	9.31×10^{-16}
Uranium-238	0.0105	0.25	2.4×10^{-8}	1.71×10^{-7}	2.87×10^{-5}	1.63×10^{-5}	1.15×10^{-4}	1.17×10^{-15}	2.66×10^{-14}
VOC (toluene)	0.4	766	–	3.70×10^{-5}	6.22×10^{-3}	9.26×10^{-5}	8.12×10^{-6}	0	0
Health Risk									
Hazard Index[g]						3.84×10^{-4}	1.26×10^{-3}		
Total Cancer Risk[h]								1.21×10^{-15}	2.75×10^{-14}

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995d.

Table E.3.4–12. Risk Assessments From Exposure to Hazardous Chemicals at Savannah River Site: Blend to 0.9-Percent Uranyl Nitrate Hexahydrate and Discard as Waste

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	4.12×10^{-5}	5.57×10^{-2}	3.05×10^{-5}	1.01×10^{-3}	0	0
Uranium-235	0.0105	0.25	2.5×10^{-8}	6.37×10^{-10}	8.61×10^{-7}	6.06×10^{-8}	3.44×10^{-6}	4.55×10^{-18}	8.33×10^{-16}
Uranium-238	0.0105	0.25	2.4×10^{-8}	1.90×10^{-8}	2.56×10^{-5}	1.81×10^{-6}	1.03×10^{-4}	1.30×10^{-16}	2.38×10^{-14}
VOC (toluene)	0.4	766	–	4.12×10^{-6}	5.57×10^{-3}	1.03×10^{-5}	7.27×10^{-6}	0	0
Health Risk									
Hazard Index[g]						4.26×10^{-5}	1.13×10^{-3}		
Total Cancer Risk[h]								1.35×10^{-16}	2.47×10^{-14}

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995d.

Table E.3.4–13. Risk Assessments From Exposure to Hazardous Chemicals at Babcock & Wilcox: Blend to 0.9-Percent Uranyl Nitrate Hexahydrate and Discard as Waste

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	$1.34x10^{-6}$	$2.32x10^{-2}$	$9.89x10^{-7}$	$4.21x10^{-4}$	0	0
Uranium-235	0.0105	0.25	$2.5x10^{-8}$	$2.07x10^{-11}$	$3.58x10^{-7}$	$1.97x10^{-9}$	$1.43x10^{-6}$	$1.48x10^{-19}$	$3.47x10^{-16}$
Uranium-238	0.0105	0.25	$2.4x10^{-8}$	$6.15x10^{-10}$	$1.07x10^{-5}$	$5.86x10^{-8}$	$4.27x10^{-5}$	$4.22x10^{-18}$	$9.91x10^{-15}$
VOC (toluene)	0.4	766	–	$1.34x10^{-7}$	$2.32x10^{-3}$	$3.34x10^{-7}$	$3.02x10^{-6}$	0	0
Health Risk									
Hazard Index[g]						$1.38x10^{-6}$	$4.68x10^{-4}$		
Total Cancer Risk[h]								$4.37x10^{-18}$	$1.03x10^{-14}$

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995d.

Table E.3.4–14. Risk Assessments From Exposure to Hazardous Chemicals at Nuclear Fuel Services: Blend to 0.9-Percent Uranyl Nitrate Hexahydrate and Discard as Waste

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	$1.95x10^{-3}$	$3.18x10^{-2}$	$1.44x10^{-3}$	$5.77x10^{-4}$	0	0
Uranium-235	0.0105	0.25	$2.5x10^{-8}$	$3.01x10^{-8}$	$4.91x10^{-7}$	$2.87x10^{-6}$	$1.96x10^{-6}$	$2.15x10^{-16}$	$4.75x10^{-16}$
Uranium-238	0.0105	0.25	$2.4x10^{-8}$	$8.97x10^{-7}$	$1.46x10^{-5}$	$8.54x10^{-5}$	$5.85x10^{-5}$	$6.16x10^{-15}$	$1.36x10^{-14}$
VOC (toluene)	0.4	766	–	$1.95x10^{-4}$	$3.18x10^{-3}$	$4.87x10^{-4}$	$4.15x10^{-6}$	0	0
Health Risk									
Hazard Index[g]						$2.02x10^{-3}$	$6.42x10^{-4}$		
Total Cancer Risk[h]								$6.37x10^{-15}$	$1.41x10^{-14}$

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995d.

Table E.3.4–15. Risk Assessments From Exposure to Hazardous Chemicals at Oak Ridge Reservation: Blend to 0.9-Percent Uranyl Metal and Discard as Waste

	Regulated Exposure Limits/Risk Factors			Emissions Concentrations		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor $(mg/kg/day)^{-1}$	Boundary Annual MEI[b] (mg/m^3)	Worker 100 Meters 8 hours (mg/m^3)	Boundary Annual MEI[b,c] (mg/m^3)	Worker 100 Meters 8 Hours[d] (mg/m^3)	Boundary Annual MEI[b,e] (mg/m^3)	Worker 100 Meters 8 Hours[f] (mg/m^3)
Carbon monoxide	1.35	55	–	2.22×10^{-4}	4.26×10^{-2}	1.65×10^{-4}	7.74×10^{-4}	0	0
Uranium-235	0.0105	0.25	2.5×10^{-8}	9.10×10^{-10}	1.74×10^{-7}	8.66×10^{-8}	6.97×10^{-7}	6.50×10^{-18}	1.69×10^{-16}
Uranium-238	0.0105	0.25	2.4×10^{-8}	1.34×10^{-7}	2.56×10^{-5}	1.27×10^{-5}	1.03×10^{-4}	9.18×10^{-16}	2.38×10^{-14}
VOC (toluene)	0.4	766	–	1.85×10^{-5}	3.55×10^{-3}	4.63×10^{-5}	4.63×10^{-6}	0	0
Health Risk									
Hazard Index[g]						2.24×10^{-4}	8.82×10^{-4}		
Total Cancer Risk[h]								9.25×10^{-16}	2.40×10^{-14}

[a] See Appendix E, Table E.3.3–1 for the OSHA-PEL, ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI=maximally exposed individual of the public.

[c] Hazard quotient for MEI=boundary annual emissions/reference concentration.

[d] Hazard quotient for workers=100-meter, 8-hr emissions/permissible exposure limit.

[e] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[f] Lifetime cancer risk for workers: (Emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

[g] Hazard index=sum of individual hazard quotients.

[h] Total cancer risk=sum of individual cancer risks.

Note: mg=milligram; m^3=cubic meter; kg=kilogram.

Source: OR LMES 1995c.

[Table deleted.]

Table E.3.4–16. Risk Assessments From Exposure to Hazardous Chemicals at Oak Ridge Reservation

Alternatives	Hazard Index		Cancer Risk	
	Boundary Annual MEI[a,b]	Worker[c] 100 Meters 8 Hours	Boundary Annual MEI[a,d]	Worker[e] 100 Meters 8 Hours
No Action	3.95×10^{-2}	0.154	0	0
Blend to LEU as 4% UNH for commercial reactor fuel	3.84×10^{-4}	1.26×10^{-3}	1.21×10^{-15}	2.75×10^{-14}
Blend to LEU as 0.9% UNH and discard as waste	3.84×10^{-4}	1.26×10^{-3}	1.21×10^{-15}	2.75×10^{-14}
Blend to LEU as 0.9% metal and discard as waste	2.24×10^{-4}	8.82×10^{-4}	9.25×10^{-16}	2.40×10^{-14}
No Action + Alternative				
No Action + 4% UNH	3.99×10^{-2}	0.155	1.21×10^{-15}	2.75×10^{-14}
No Action + 0.9% UNH	3.99×10^{-2}	0.155	1.21×10^{-15}	2.75×10^{-14}
No Action + 0.9% metal	3.97×10^{-2}	0.155	9.25×10^{-16}	2.40×10^{-14}

[a] MEI=maximally exposed individual of the public.

[b] Hazard index=sum of Individual Hazard Quotients (noncancer adverse health effects) for MEI.

[c] Hazard index=sum of Individual Hazard Quotients (noncancer adverse health effects) for Workers.

[d] Lifetime cancer risk=(Emissions Concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[e] Lifetime cancer risk=(emissions for 8 hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor [exposed]) x (0.571 [Fraction of lifetime working]) x (Slope Factor).

Note: UNH=uranyl nitrate hexahydrate.

Source: OR LMES 1995b; OR LMES 1995c; OR LMES 1995d; OR MMES 1995i.

Table E.3.4–17. Risk Assessments From Exposure to Hazardous Chemicals at Savannah River Site

Alternatives	Hazard Index		Cancer Risk	
	Boundary Annual MEI[a,b]	Worker[c] 100 Meters 8 Hours	Boundary Annual MEI[a,d]	Worker[e] 100 Meters 8 Hours
No Action	5.16×10^{-3}	1.16	1.31×10^{-7}	1.94×10^{-4}
Blend to LEU as 4% UNH for commercial reactor fuel	4.26×10^{-5}	1.13×10^{-3}	1.35×10^{-16}	2.47×10^{-14}
Blend to LEU as 0.9% UNH and discard as waste	4.26×10^{-5}	1.13×10^{-3}	1.35×10^{-16}	2.47×10^{-14}
[Text deleted.]				
No Action + Alternative				
No Action + 4% UNH	5.20×10^{-3}	1.16	1.31×10^{-7}	1.94×10^{-4}
No Action + 0.9% UNH	5.20×10^{-3}	1.16	1.31×10^{-7}	1.94×10^{-4}
[Text deleted.]				

[a] MEI=maximally exposed individual of the public.

[b] Hazard index=sum of Individual Hazard Quotients (noncancer adverse health effects) for MEI.

[c] Hazard index=sum of Individual Hazard Quotients (noncancer adverse health effects) for Workers.

[d] Lifetime cancer risk=(Emissions Concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[e] Lifetime cancer risk=(emissions for 8 hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor [exposed]) x (0.571 [Fraction of lifetime working]) x (Slope Factor).

Note: UNH=uranyl nitrate hexahydrate.

Source: OR LMES 1995b; OR LMES 1995d; SRS 1995a:2: SRS 1996a:1.

Table E.3.4–20. In-Tank Precipitation Facility and Consolidated Incineration Facility Chemicals and Regulated Levels—Continued

Chemical	Maximum Emission Rate (lb/hr)	PEL (mg/m^3)
Chromium (hexavalent) compounds	0.009	1
Cresols (m-, o-, p-)	0.0531	22
Cumene	0.0531	245
Dibutyl phthalate	0.0531	5
Dichloroethyl ether	0.0531	90
Dimethyl phthalate	0.0531	5
Dimethyl sulfate	0.0531	5
Dioxane	0.0531	360
Epichlorohydrin	0.0531	19
Ethyl benzene	0.0531	435
Ethylene dibromide	0.0531	156.2
Ethylene dichloride	0.0531	411
Ethylene glycol	0.0531	286
Ethylene imine (aziridine)	0.0531	–
Ethylene oxide	0.0531	1.83
Ethylene thiourea	0.0531	–
Formic acid	0.0531	9
Furfural	0.0531	20
Heptachlor	0.217	0.5
Hexachlorobenzene	0.0531	–
Hexachlorobutadiene	0.0531	–
Hexachloroethane	0.0531	10
Hexachlorocyclopentadiene	0.0531	1.3
Hydrazine	0.0531	–
Hydrochloric acid	4	7
Hydrogen cyanide	3.81	11
Hydrogen fluoride	3.81	2.49
Lead	0.09	0.05
Lindane (all isomers)	0.0531	0.5
Maleic anhydride	0.0531	1
Mercury (vapor)	0.02	0.1
MEK	0.0531	–
Methanol	0.0531	260
Methoxychlor	0.0531	15
Methyl chloride	0.0531	210
Methylene chloride	0.0531	1765
Methyl hydrazine	0.0531	0.35
Methyl iodide	0.0531	28
Methyl methacrylate	0.0531	410
MIBK	0.0531	–
Napthalene	0.0531	50
Nickel oxide	0.054	–
Nitrobenzene	0.0531	5

Table E.3.4–20. In-Tank Precipitation Facility and Consolidated Incineration Facility Chemicals and Regulated Levels—Continued

Chemical	Maximum Emission Rate (lb/hr)	PEL (mg/m^3)
Parathion	0.217	0.1
Pentachloronitrobenzene	0.0531	–
Pentachlorophenol	0.0531	0.5
Phenol	0.0531	19
Phosgene	0.0531	0.4
Phthalic anhydride	0.0531	12
Selenium	0.0011	0.2
Sodium hydroxide	0.05	2
Tetrachloroethylene	0.0531	689
Toluene	0.0531	766
Toxaphene	0.217	0.5
Trichloroethylene (TCE)	0.0531	546
Vinyl chloride	0.0531	–
Vinylidine chloride	0.0531	–

* These rates are the maximum potential emissions and would be in compliance with the most stringent applicable standards (for example, SC DHEC Standards).

Note: The Consolidated Incineration Facility incinerates a wide range of combustible hazardous mixed and low-level wastes so that the chemicals included in this table would become innocuous. The In-Tank Precipitation Facility is part of the pre-treatment to remove metals/metal salts from materials potentially released from the Defense Waste Processing Facility. When these facilities are integrated into the Defense Waste Processing Facility, hazardous chemical releases are expected to be reduced by several orders of magnitude.

Note: lb=pound; hr=hour; mg=milligram; m^3=cubic meter.

Source: SR DOE 1995b; SR DOE 1996a.

E.4 HEALTH EFFECTS STUDIES: EPIDEMIOLOGY

Various epidemiologic studies have been conducted at some of the sites evaluated in this EIS due to concern regarding potential adverse health effects associated with the manufacture and testing of nuclear weapons. With a few exceptions, most epidemiological studies of the populations living near the site have been descriptive in nature and are what epidemiologists refer to as "ecologic" or "correlational" studies. Occupational epidemiologic studies (that is, studies of works) have been mostly analytical. The various epidemiologic studies, along with their assumptions and limitation are described in Section E.4.2 through E.4.5. These studies focus on the workforce and residents of communities surrounding DOE and commercial sites. The epidemiology articles related to the disposition of surplus HEU include studies conducted at ORR, SRS, B&W, and NFS and in communities surrounding these sites. Currently, the only action being taken with surplus HEU is interim storage, which takes place only at the Y–12 Plant at Oak Ridge, Tennessee. A number of options are under consideration, which may affect activities at the Y–12 facility and the SRS. Two other locations that are not DOE facilities, but may be affected, are B&W and NFS.

E.4.1 STUDY DESIGNS

Adverse health effects associated with ionizing radiation exposure were first identified about 60 years ago. Studies published in the 1930s first documented cancer among painters who used radium to paint watch dials from 1910 to 1920. Radiation therapy for disease has been used since the 1930s, and studies have shown that the risk of cancer is related to the amounts of radiation received. Nuclear weapons research and manufacture, and consequent exposure to radiation, began in the late 1930s. Exposure to radionuclides has changed over time, with higher levels occurring in the early days of research and production. Due to concern regarding potential adverse health effects, numerous epidemiologic studies have been conducted among workers who manufactured and tested nuclear weapons. More recently, concerns about offsite radiologic contaminants have resulted in health studies among communities that surround DOE facilities. The following section gives an overview of epidemiology followed by a review of epidemiologic studies for sites evaluated in this EIS.

Epidemiology is the study of the distribution and determinants of disease in human populations. The distribution of disease is considered in relation to time, place, and person. Relevant population characteristics should include the age, race, and sex distribution of a population, as well as other characteristics related to health, such as social characteristics (for example, income and education), occupation, susceptibility to disease, and exposure to specific agents. Determinants of disease include the causes of disease, as well as factors that influence the risk of disease.

E.4.1.1 Ecologic Studies

Ecologic studies compare the frequency of a disease in groups of people in conjunction with simple descriptive studies of geographical information in an attempt to determine how health events among populations vary with levels of exposure. These groups may be identified as the residents of a neighborhood, a city, or a county where demographic information and disease or mortality data are available. Exposure to specific agents may be defined in terms of residential location or proximity to a particular area, such as distance from a waste disposal site. An example of an ecologic study would be an examination of the rate of heart disease among community residents in relation to the quality of their drinking water.

The major disadvantage of ecologic studies is that the measure of exposure is based on the average level of exposure in the community, when what is needed is each individual's exposure. Ecologic studies do not take into account other factors, such as age and race, that may also be related to disease. These types of studies may lead to incorrect conclusions, known as "ecologic fallacies." For the above example, it would be incorrect to assume that the level of water hardness influences the risk of getting heart disease. Despite the obvious problems with ecologic studies, they can be a useful first step in identifying possible associations between risk of disease and environmental exposures. However, because of their potential for bias ecologic studies should never be

considered as more than an initial step in an investigation of the cause of a disease.

E.4.1.2 Cohort Studies

The cohort study design is a type of epidemiologic study frequently used to examine occupational exposures within a defined workforce. A cohort study requires a defined population that can be classified as being exposed or not exposed to an agent of interest, such as radiation or chemicals that influence the probability of occurrence of a given disease. Characterization of the exposure may be qualitative (for example, high, low, or no exposure) or very quantitative (for example, radiation measured in rem, chemicals in parts per million). Surrogates for exposure, such as job titles, are frequently used in the absence of quantitative exposure data.

Individuals included in the study population are tracked for a period of time and fatalities recorded. In general, overall fatality rates and cause-specific fatality rates have been determined for workers at the EIS sites. Fatality rates for the exposed worker population are compared with fatality rates for workers who did not have the exposure (internal comparison), or are compared with expected fatality rates based on the U.S. population or State fatality rates (external comparison). If the fatality rates differ from what is expected, an association is said to exist between the disease and exposure. In cohorts where the exposure has not been characterized, excess mortality can be identified. However, these fatalities cannot be attributed to a specific exposure, and additional studies may be warranted. More recent studies have looked at other disease endpoints, such as overall and cause-specific cancer incidence (newly diagnosed) rates.

Most cohort studies at the EIS sites have been historical cohort studies (that is, the exposure occurred some time in the distant past). These studies rely on past records to document exposure. This type of study can be problematic if exposure records are incomplete or were destroyed. Cohort studies require extremely large populations that have been followed for 20 to 30 years. They are generally difficult to conduct and are very expensive. These studies are not well suited to studying diseases that are rare. Cohort studies do, however, provide a direct estimate of the risk of fatality from a specific disease, and allow an investigator to look at many disease endpoints.

E.4.1.3 Case-Control Studies

The case-control study design starts with the identification of persons with the disease of interest (case) and a suitable comparison (control) population of persons without the disease. Controls must be persons who are at risk for the disease and are representative of the population that generated the cases. The selection of an appropriate control group is often quite problematic. Cases and controls are then compared with respect to the proportion of individuals exposed to the agent of interest. Case-control studies require fewer persons than cohort studies, and, therefore, are usually less costly and less time consuming, but are limited to the study of one disease (or cause of fatality). This type of study is well suited for the study of rare diseases and is generally used to examine the relationship between a specific disease and exposure.

E.4.1.4 Definitions

Unfamiliar terms frequently used in epidemiologic studies, including those used in this document, are defined below.

Age, gender, and cigarette smoking are the principal determinants of mortality. Standardization is a statistical method used to control for the effects of age, gender, or other characteristics so that fatality rates may be compared among different population groups. There are two ways to standardize rates: the indirect method and the direct method. In general, the indirect method of standardization is most frequently used.

- Indirect standardization: The disease rates in the reference (comparison) population are multiplied by the number of individuals in the same age and gender groups in the study population to obtain the expected rate of disease for the study population.

- Direct standardization: The disease rates in the study population are multiplied by the number of individuals in the same age and gender groups in the reference

(comparison) population. This gives the expected rates of disease for the reference population if these rates had prevailed in that group.

Standardized mortality ratio (SMR): The SMR is the ratio of the number of fatalities observed in the study population to the number of *expected* fatalities. The expected number of fatalities is based on a reference (or comparison population). Fatality rates for the U.S. (or State) population are most frequently used as the comparison to obtain expected rates. An SMR of 1 indicates a similar risk of disease in the study population compared with the reference population. An SMR greater than 1 indicates excess risk of disease in the study population compared with the reference group, and an SMR less than 1 indicates a deficit of disease.

Relative risk: The ratio of the risk of disease among the exposed population to the risk of disease in the unexposed population. Relative risks are estimated from cohort studies.

Odds ratio: The ratio of the odds of disease if exposed to the odds of disease if not exposed. Under certain conditions, the odds ratio approximates the relative risk. Odds ratios are estimated from case-control studies.

E.4.2 OAK RIDGE RESERVATION, OAK RIDGE, TN

E.4.2.1 Surrounding Communities

The population-based National Cancer Institute mortality survey for selected nuclear facilities (NIH Publication No. 90-874, July 1990; JAMA 1991a:1403-1408) examined the cancer mortality within a 50-mile radius around several nuclear facilities, including Anderson and Roane counties. No excess cancer mortality was observed in the population living in the exposed counties when compared to the U.S. white male population, nor when compared to the population of the control counties (Blount, Bradley, Coffee, Jefferson, Hamblen, TN, and Henderson, NC), nor when time trends were assessed.

Tennessee Medical Management, Inc., used data from the Tennessee Cancer Reporting System to compare mortality and incidence data for counties near Oak Ridge, Tennessee to the U.S. population for the 3-year period 1988 to 1990 (TMM 1993a). For Oak Ridge, total fatalities from all causes was significantly lower than expected. For Anderson County, the observed number of fatalities from uterine cancer and from cancer of respiratory and intrathoracic organs was statistically greater than expected, and the number of fatalities from brain cancer, breast cancer, and the "all other sites" category were lower than expected for Anderson County. For Roane County, the number of fatalities from cancer of the respiratory and intrathoracic organs was statistically greater than expected; the number of fatalities from cancer of the digestive organs and the peritoneum, from uterine cancer and from lip, oral cavity, and pharynx cancer was lower than expected.

Tennessee Medical Management, Inc., examined new (incident) cancer cases and identified the following statistically significant: For Anderson County, the observed numbers of cases of cancer of the prostate, lung, and bronchus were greater than expected. Leukemia, stomach and small intestine cancers, and cancers of the colon and intestinal tract were lower than expected. For Roane County, the number of cases of cancer of the lung and bronchus was greater than expected. Non-Hodgkins lymphoma, female breast cancer, esophageal cancer, cancer of the pancreas, and cancer in all sites were lower than expected. The only consistent excess reported for both cancer mortality and cancer incidence was for cancer of respiratory and intrathoracic organs.

Because of a concern for possible contamination of the population by mercury, the Tennessee Department of Environment and Conservation (previously the Tennessee Department of Health and Environment) conducted a pilot study in 1984 (TN DHE 1984a). The study showed no difference in urine or hair mercury exposures (residence or activity in contaminated of fish caught in the contaminated areas) compared to those with little potential exposure. Mercury levels in some soils measured as high as 2,000 parts per million (ppm). Analysis of a few soil samples showed that most of the mercury in the soil, however, was inorganic, thereby lowering the probability of bioaccumulation and health effects. Examination of the long-term effects of exposure to mercury and other chemicals continues.

E.4.2.2 State Health Agreement Program

Under the State Health Agreement program managed by the DOE's Office of Epidemiologic Studies, a grant was awarded to the Tennessee Department of Environment and Conversation (previously the Tennessee Department of Health and Environment). The purpose of the grant was to determine the extent of exposure to contaminants among workers and residents of the surrounding community as a result of ORR operations, and to assess the current status of health outcomes and determine their potential association with these exposures.

A dose reconstruction feasibility study began in 1992, with the contract awarded by the State of Tennessee to ChemRisk. After performing an extensive review of Oak Ridge documents ChemRisk concluded that sufficient information exists to reconstruct past releases and offsite doses caused by radioactive and hazardous materials. They also concluded that doses from mercury, polychlorinated biphenyl (PCBs), radioactive iodine, and radioactive cesium may have been great enough to cause harmful health effects in the offsite population. Based on this information, a full dose reconstruction study was initiated in August 1994.

Other activities supported under the grant include development of a birth defects registry; a quality improvement program for the Tennessee cancer registry; a review and evaluation of the DOE occupational medical program; and the implementation of a community participation/public information program.

Technical support to the State health department is provided by a 12 member Oak Ridge Health Agreement Steering Panel. The Health Advisory Panel provides direction and oversight to those working on health studies, ensures public input, and informs the public of activities related to the health studies. A representative of the Centers for Disease Control and Prevention's National Center for Environmental Health is a member of the advisory panel. A representative from DOE serves as an *ex-officio* member.

E.4.2.3 Workers

Between 1943 and 1985, there were 118,588 male and female individuals of all races who were ever employed in any of the Oak Ridge facilities. These included Oak Ridge National Laboratory (ORNL) for nuclear research (also called the X–10 Facility), Y–12 under management of the Tennessee-Eastman Corporation (1943 to 1947) which produced enriched uranium by the electromagnetic separation process, Y–12 under management of Union Carbide (1948 to 1984) which fabricated and certified nuclear weapons parts, and K–25 (Oak Ridge Gaseous Diffusion Plant) which produced enriched uranium through the gaseous process. Analyses at the Oak Ridge facilities have been carried out mostly for white males, and for specific cohorts taking into consideration time-related exposure risks.

Oak Ridge National Laboratory. The mortality experience of 8,375 white males employed at least a month between 1943 and 1972 at ORNL was compared with the U.S. white male population using SMR analyses in a 1985 paper by Checkoway, et al. (BJIM 1985a;525-533). Increases in fatalities from leukemia (SMR=1.49, 16 observed, 95 percent confidence interval [CI] for range 0.31-4.38), cancer of the prostate (SMR=1.16, 14 observed, 11.9 expected), and Hodgkin's disease (SMR=1.10, 5 observed, 3.7 expected) were observed, although none were statistically significant. Dose response analyses were performed for all causes of fatalities combined, all cancers combined, leukemia, and prostate cancer comparing exposed worker fatality rates with non-exposed worker fatality rates. Dosimetry data were available for the entire period of the study with the total population external radiation dose measuring 13,500 person-rem. No dose response gradients were observed. Fatality rates were calculated for 11 different job categories by length of time in each job in an attempt to determine whether specific work environments were related to cancer and leukemia. Leukemia mortality was observed to be related to length of employment in engineering and maintenance jobs.

Followup of this cohort was expanded through 1984 in an updated study by Wing et al. (JAMA 1991a:1397-1402). Again, fatality rates in the worker population were compared with those in the U.S. population. Non-statistically significant increases

were noted for cancers of the pancreas (SMR=1.09, 25 observed, 95 percent CI for range 0.71-1.61), prostate (SMR=1.05, 26 observed, 95 percent CI for range 0.68-1.53), brain (SMR=1.04, 15 observed, 95 percent CI for range 0.58-1.72), and lymphosarcoma and/or reticulosarcoma (SMR=1.05, 9 observed, 95 percent CI for range 0.48-1.99). There was a significant increase in fatalities from leukemia (SMR=1.63, 28 observed, 95 percent CI for range 1.08-2.35). The total population external radiation dose was 14,400 person-rem. Dose response analyses performed for all causes except cancer, lung cancer, and leukemia did not demonstrate a relationship between level of external radiation and increased risk of fatality from these outcomes. There was a significant dose response relationship (4.94 percent per rem) between cancer fatalities and level of external radiation dose using models with a 20-year lag. A subgroup of workers who were monitored for internal contamination had non-statistically elevated SMRs for cancer of the prostate (SMR=1.12, 10 observed, 95 percent CI for range 0.53-2.05) and lymphosarcoma and/or reticulosarcoma (SMR=1.65, 6 observed, 95 percent CI for range 0.60-3.59). The workers monitored for internal contamination had a statistically significant elevated SMR for leukemia (SMR=2.23 16 observed, 95 percent CI for range 1.27-3.62).

A second publication on the above data set examined the effect of controlling for a number of possible selection and confounding factors on the risk coefficient for all cancer dose responses (AJIM 1993a:265-279). Models were adjusted for the following variables with little change in the previously reported risk coefficients: employment during the World War II era, short-term employment, job category, and exposure to beryllium, lead, and mercury. The authors concluded that the previously calculated dose response estimate was fairly stable when adjustments were made for a wide range of potential confounders that were not explored in the earlier study.

Y–12 Plant. The Y–12 Plant is a nuclear weapons materials fabrication plant where the radiologic exposure of greatest concern is internal exposure from the inhalation of uranium compounds. The Tennessee Eastman Corporation managed the plant from 1943 to 1947. Polednak and Frome reported a followup through 1974 of all 18,869 white male workers employed at Y–12 from 1943 to 1947 (JOM 1981a:169-178). The workers included those exposed to internal (alpha) and external (beta) radiation through the inhalation of uranium dusts, electrical workers who performed maintenance in the exposed areas, and other non-exposed workers. Individual measures of exposure were not available for any members of this cohort, so exposure levels were inferred from plant areas of work and jobs. High average air levels of uranium dust were documented in departments employing chemical workers. Elevated SMRs were observed for mental, psychoneurotic, personality disorders (SMR=1.36, 33 observed, 24.2 expected), emphysema (SMR=1.16, 100 observed, 85.89 expected), diseases of the bones and organs of movement (SMR=1.22, 11 observed, 8.49 expected), lung cancer (SMR=1.09, 324 observed, 296.47 expected), and external causes of fatality (SMR=1.09, 623 observed, 571.77 expected). The lung cancer SMR was greater among workers employed for 1 year or more compared with workers employed less than 1 year and was more pronounced in workers hired at the age of 45 or older (SMR=1.51; 95 percent CI for range 1.01-2.31). Of the workers employed after the age of 44, the SMR for lung cancer was greatest for electrical workers (SMR=1.55, 7 observed, Freeman-Tukey deviation [D] is 1.11), alpha chemistry workers (SMR=3.02, 7 observed, D is 2.27) and beta process workers (SMR=1.51, 11 observed, D is 1.30).

During the early operation of the Y–12 Plant, from 1942 to 1947, a group of male workers was exposed to phosgene gas on a chronic basis (N=694), and a smaller group of males received acute exposures (N=106) along with a group of females (N=91) (ER 1980a:357-367; TIH 1985a:137-147). A control group of 9,280 workers who also worked at Y–12 during the same era, but who did not have phosgene exposure, was also described. All groups were followed through the end of 1978. The SMRs for the chronically exposed group and the control group were similar for all causes examined. There was no evidence of increased mortality from respiratory diseases in this group, and the SMR for lung cancer, while elevated, was similar to the lung cancer SMR for workers in the rest of the plant. Among those with acute exposures, the SMR for respiratory diseases was elevated (SMR=2.66, 5 observed, confidence factor not provided), and this elevation may be related to residual lung damage from the acute

phosgene exposure. It was difficult to trace the vital status of the 91 women; therefore, description of these highly-exposed workers was limited to listing the frequency of their initial symptoms after exposure. As expected, nausea, vomiting, and cough were the most frequently reported symptoms. Unexpectedly, the women experienced a lower frequency of pneumonitis than their male counterparts.

The portion of the Y–12 cohort employed between 1947 and 1974 was described in a study by Checkoway et al. (AJE 1988a:255-366). This study included 6,781 white male workers first employed at Y–12 between 1947 and 1974 who were employed for at least 30 days. Mortality data were collected for the cohort through the end of 1979 and were used to perform SMR and cause-specific dose-response analyses. Non-statistically significant increases were observed for all cancers (SMR=1.01, 196 observed, 95 percent CI for range 0.88-1.17), diseases of the blood-forming organs (SMR=1.48, 3 observed, 95 percent CI for range 0.31-4.38), kidney cancer (SMR=1.22, 6 observed, 95 percent CI for range 0.45-2.66), brain cancer (SMR=1.80, 14 observed, 95 percent CI for range 0.98-3.03), and other lymphatic cancers (SMR=1.86, 9 observed, 95 percent CI for range 0.85-3.53). A statistically significant increase in fatalities from lung cancer (SMR=1.36, 89 observed; 95 percent CI for range 1.09-1.67) was observed compared with the U.S. lung cancer rates, but not with Tennessee lung cancer rates (SMR=1.18, 95 percent CI for range 0.95-1.45). Dose-response analyses for lung cancer and internal alpha radiation dose and external gamma radiation dose did not reveal a positive relationship for a 0-year or 10-year lag. Examination of lung cancer rates distributed across both internal and external dose categories suggested a dose-response with external radiation dose among individuals who had 5 rem or more of internal dose. Brain cancer was not related to the level of internal or external radiation dose.

The Y–12 cohort studied by Checkoway was updated through the end of 1990 by Loomis and Wolf and included African-American and white female workers (AJIM 1996a:131-141). The dose-response analyses were not included in the update; therefore, only SMR analyses are reported here. For all workers examined as a group, non-statistically significant elevations were observed for cancer of the pancreas (SMR=1.36, 34 observed, 95 percent CI for range 0.94-1.90), skin cancer (SMR=1.07, 11 observed, 95 percent CI for range 0.59-1.92), breast cancer (females only, SMR=1.21, 11 observed, 95 percent CI for range 0.60-2.17), prostate cancer (SMR=1.31, 36 observed, 95 percent CI for range 0.91-1.81), kidney cancer (SMR=1.30, 16 observed, 95 percent CI for range 0.74-2.11), brain cancer (SMR=1.29, 20 observed, 95 percent CI for range 0.79-2.00), cancers of other lymphatic tissues (SMR=1.32, 22 observed, 95 percent CI for range 0.82-1.99), and diseases of the blood-forming organs (SMR=1.23, 6 observed, 95 percent CI for range 0.45-2.68). The SMR for lung cancer was statistically significant (SMR=1.17, 202 observed; 95 percent CI for range 1.01-1.34), particularly in the white male segment of the population (SMR=1.20, 194 observed 95 percent CI for range 1.04-1.38). Examination of the lung cancer mortality by year of hire, latency, duration of employment, and calendar year at risk indicated the excess was confined to those who were first hired before 1954 (SMR=1.27, 161 observed, confidence factor not provided), and was greatest in persons employed 5 to 20 years with 10 to 30 years of followup. Elevated lung cancer fatalities were first evident between 1955 and 1964 and continued to increase from 1975 to 1979, followed by a decrease in lung cancer fatality rates.

Between 1953 and 1963 the Y–12 Plant used mercury in a process to produce large quantities of enriched lithium. Cragle et al. studied all workers employed at Y–12 at least 5 months between January 1, 1953, and April 30, 1958 (N=5663) (JOM 1984a:817-821). This group was categorized into workers exposed to mercury and workers not exposed to mercury based on results of urinalysis data supplied by the plant. Vital status followup was complete through the end of 1978, and SMRs were calculated. Compared with non-exposed workers, there were no differences in the mortality patterns for (1) mercury exposed workers as a whole, (2) workers with the highest mercury exposures, and (3) workers employed more than a year in a mercury process. The authors of this study acknowledge that mortality is not the optimal endpoint to assess health effects related to mercury exposure.

The mercury workers were involved in a clinical study by Albers et al. who examined 502 Y–12 workers, 247 of whom worked in the mercury

process 20 to 35 years prior to the examination (AN 1988a:651-659) . Correlations between declining neurological function and increasing exposure were identified. An exposure assessment was determined for each mercury worker during the time of employment in the mercury process. Study subjects who had at least one urinalysis equal to or greater than 0.6 mg/l of mercury showed decreased strength, coordination, and sensation along with increased tremor, and prevalence of Babinski and snout reflexes when compared with the 255 unexposed workers. Clinical polyneuropathy was associated with the level of the highest exposure, but not with the duration of exposure.

K–25 Site. The K–25 Site enriched uranium beginning in 1945 using a gaseous diffusion process. There was potential exposure to uranium dust, oxidized uranium compounds, uranium hexafluoride, and a number of chemical compounds used in the process. In later years of operation, the gas centrifuge process was used to enrich uranium. No analyses of fatality rates for this population have been published; however, health effects have been studied.

Powdered nickel was used at K–25 in the production of the barrier material used to separate and enrich uranium. Workers who fabricated the barrier material were exposed to nickel powder through inhalation. Cragle et al. (IARC 1984a:57-63 updated an earlier study by Godbold et al. (JOM 1979a:799-806) of 814 workers who were employed in the manufacture of barrier material between 1948 and 1953. A comparison group of white males employed at K–25 sometime between 1948 and 1953 (N=7552) was also selected. The SMRs in the barrier group were similar to those in the non-barrier worker group for most noncancer outcomes. The nickel workers were noted to have a higher rate of fatality from cancers of the buccal cavity and pharynx (SMR=2.92, 3 observed, 95 percent CI for range 0.59-8.54) than the non-nickel workers (SMR=0.23, 3 observed, 95 percent CI for range 0.05-0.67). When the directly standardized rates were compared, the rate of buccal cavity and pharynx cancer in the nickel workers was approximately 19 times higher than the rate in the non-nickel workers. The authors of this study acknowledged that the number of cases is quite small and recommended additional followup to determine if this trend continued. There were no nasal sinus cancers observed in the worker population exposed to metallic nickel, in contrast to the results of studies of workers in nickel refineries, where the rates of sinus cancer related to nickel compounds are quite high.

K–25 workers employed in the gas centrifuge process were the focus of an interview study by Cragle et al. (AOEH 1992a:826-834). The study was conducted in order to determine the incidence rate for cancer and illness symptoms among workers exposed to epoxy resin and solvents prevalent in the process. A total of 263 workers determined to have worked longest and closest to the process were compared with 271 employees employed at the plant during the same time, but who did not work in the centrifuge process. The centrifuge workers and the non-centrifuge workers had similar overall cancer incidence rates. However, the centrifuge workers reported five incident bladder cancers versus none reported by the non-centrifuge group. The centrifuge workers also reported significantly more rashes, dizziness, and numb or tingling limbs during employment, which are symptoms associated with high solvent exposure. One of the epoxy resins used in the early years of the process was a potential bladder carcinogen, but none of the workers with bladder cancer had jobs that required routine, hands-on work with that material. A specific causative agent for the increase in bladder cancer was not identified.

Combined Oak Ridge Reservation Facilities. Frome et al. reported on the mortality experience of World War II workers employed at three ORR facilities between 1943 and 1947 (RR 1990a:138-152). Poisson regression analyses were used to control for potential confounders such as facility of employment, socioeconomic status, period of followup, and birth year. The cohort included white males employed at any Oak Ridge facility at least 30 days between the start of the operation and 1947 and were never employed at an Oak Ridge facility after 1947 (N=28,008). Elevated mortality was statistically significant for all causes (SMR=1.11, 11,671 observed, 10,537 expected), tuberculosis (SMR=1.37, 108 observed, 78 expected), mental, psychoneurotic, and personality disorders (SMR=1.60, 81 observed, 50 expected), cerebrovascular disease (SMR=1.11, 833 observed, 753 expected), diseases of the respiratory system (SMR=1.25, 792 observed, 634 expected), emphysema (SMR=1.24, 209 observed, 168

expected), all accidents (SMR=1.28, 694 observed, 542 expected), and motor vehicle accidents (SMR=1.44, 339 observed, 235 expected). The only elevated site-specific cancer that was statistically significant was lung cancer (SMR=1.27, 850 observed, 667 expected). A surrogate for radiation exposure based on a worker's job and department was used to indicate the probability of exposure. This surrogate for actual radiation exposure was not associated with increased rates of cancer.

Carpenter investigated earlier reports of an association between brain cancer and employment at Y–12 by conducting a case-control study of workers employed between 1943 and 1977 at ORNL or Y–12 (JOM 1987a:601-604). Cases consisted of 72 white males and 17 white females with brain cancer. Four controls were selected for each case matched on age, sex, cohort, year of birth, and year of hire. Analyses with respect to internal and external radiation exposures indicated no association with brain cancer. Two companion papers were also published from this case-control study, one examined relationships between brain cancer and chemical exposures (AJIM 1988a:351-362), and the other examined nonoccupational risk factors (AJPH 1987a:1180-1182). No statistically significant association between the use of 26 chemicals evaluated and the risk of brain cancer was observed. The chemicals evaluated included those encountered in welding fumes, beryllium, mercury, 4,4-methylene bis 2-chloroaniline or MOCA, cutting oils, thorium, methylene chloride, and other solvents. Excess brain cancer was observed, however, among individuals employed for more than 20 years (odds ratio=7.0, 9 cases; 95 percent CI 1.2-41.1). Analysis of 82 cases with complete medical records revealed an association with a previous diagnosis of epilepsy (odds ratio=5.7, 4 cases; 95 percent CI 1.0-32.1) recorded for pre-employment and health status followup.

Causes of fatality among white male welders (N=1,059) employed between 1943 and 1973 at the Y–12 Plant, the K–25 Site, and ORNL were studied by Polednak (AEH 1981a:235-242). Based on fatalities reported through 1974, mortality from all causes for welders was slightly lower than that expected based on fatality rates for U.S. white males (SMR=0.87, 173 observed, 199 expected, 95 percent confidence for range 0.75-1.01). Non-statistically significant decreases in mortality were also observed for all cancers (SMR=0.88, 32 observed, 36.57 expected, 95 percent confidence for range 0.60-1.23), especially digestive cancer (SMR=0.49, 5 observed, 10.3 expected, 95 percent confidence for range 0.16-1.14); diseases of the circulatory system (SMR=0.74, 72 observed, 97.51 expected, 95 percent confidence for range 0.58-0.94); diseases of the digestive system (SMR=0.76, 9 observed, 11.86 expected, 95 percent confidence for range 0.35-1.44); and accidents (SMR=0.89, 16 observed, 17.86 expected, 95 percent confidence for range 0.51-1.44). Non-statistically significant increases were noted for lung cancer (SMR=1.50, 17 observed, 11.37 expected, 95 percent confidence for range 0.87-2.40); diseases of the respiratory system (SMR=1.33, 13 observed, 9.77 expected, 95 percent confidence for range 0.71-2.27), especially emphysema (SMR=2.21, 6 observed, 2.71 expected, 95 percent confidence for range 0.81-4.82); and suicide (SMR=1.64, 10 observed, 6.09 expected, 95 percent confidence for range 0.79-3.02). A subgroup of welders (N=536) exposed to nickel oxides (possible respiratory carcinogens) at K–25 were compared with welders at the other two facilities (N=523). The risk of lung cancer and other respiratory diseases did not differ between the two groups.

Combined Nuclear Sites. Workers at ORR have been included in several studies that have examined occupational risks across the nuclear complex, both in the United States and internationally. These combined studies have been undertaken in an attempt to increase the statistical power of the studies to detect the effects of low-level chronic radiation exposure.

Y–12 workers were included in a lung cancer case-control study of workers from the Fernald Feed Materials and Production Center cohort and the Mallinckrodt Chemical Works cohort. Dupree et al. conducted a nested case-control study of lung cancer (N=787) to investigate the relationship between lung cancer and uranium dust exposure (Epidemiology 1995a:370-375). Eligible cases were employed at least 183 days in any of the facilities and died before January 1, 1983, with lung cancer listed anywhere on the death certificate. Inclusion of fatalities through 1982 allowed over 30 years of observation at each facility. One control was matched to each case on facility, race, gender, and birth and

hire dates within 3 years. Data collected on all study members included smoking history, first pay code (a surrogate for socioeconomic status), complete work histories, and occupational radiation monitoring records. Annual radiation lung dose from deposited uranium was estimated for each study member. Annual external whole body doses from gamma radiation were determined for workers who had personal monitoring data available. Potential confounders considered in the analysis were smoking (ever/never used tobacco) and pay code (monthly/non-monthly). With a 10-year lag, cumulative lung doses ranged from 1 to 137 rad for cases and from 0 to 80 rad for controls. The odds ratios for lung cancer mortality for seven cumulative internal dose groups did not demonstrate increasing risk with increasing dose. An odds ratio of 2.0 was estimated for those exposed to 25 rad or more, but the 95 percent confidence interval of -.20 to 20 showed great uncertainty in the estimate. There was a suggestion of an exposure effect for workers hired at age 45 years or older.

A combined site mortality study included workers from ORNL, the Hanford Site, and the Rocky Flats Plant (RR 1993a:408-421). Earlier analyses of these cohorts indicated that risk estimates calculated through extrapolation from high-dose data to low-dose data did not seriously underestimate risks of exposure to low-dose radiation (AJE 1990a:917-927; RR 1989a:19-35). The updated analyses were performed in order to determine whether the extrapolated risks represented an overestimation of the true risk at low doses. The study population consisted of white males employed at one of the three facilities for at least 6 months and monitored for external radiation. The Hanford population also included females and nonwhite workers. The total population dose was 123,700 person-rem. Analyses included trend tests for site-specific cancer fatalities and several broad noncancer categories. Statistically significant trends were noted for cancer of the esophagus, cancer of the larynx, and Hodgkin's disease. These cancers were not related to radiation exposure levels in previously published studies. Excess relative risk models were calculated for the combined DOE populations and for each DOE site separately. Without exception, all risk estimates included the possibility of zero risk (that is, the confidence interval for the risk coefficient went from below zero to above zero). There was evidence of an increase in the excess relative risk for cancer with increasing age in the Hanford and ORNL populations; both populations showed significant correlations of all cancer with radiation dose among those 75 years and older.

An international effort to pool data from populations exposed to external radiation included the ORNL population, in addition to other radiation worker populations in the United States, Canada, and Britain (RR 1995a:117-132). The cohort comprised 95,673 workers (85.4 percent men) employed 6 months or longer, and the population dose was 384,320 person-rem. There was no evidence of an association between radiation dose and mortality from all causes or from all cancers. There was a significant dose-response relationship with leukemia, excluding chronic lymphocytic leukemia (excess relative risk=2.18 per SV; 90 percent CI for range 0.1-5.7) and multiple myeloma (excess relative risk not computed; 44 observed). The study results do not suggest that current radiation risk estimates for cancer at low levels of exposure are appreciably in error.

E.4.2.4 Memorandum of Understanding

The Department of Energy entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The NIOSH is responsible for the conduct and management of worker studies.

The following studies at ORR are managed by NIOSH with funding from DOE: a study of multiple myeloma among workers at the K–25 Site at Oak Ridge (expected completion date 1996); a multisite study to assess the potential association between paternal exposure to ionizing radiation and the risk of leukemia in offspring of exposed male workers; a study of neurologic health outcomes in workers exposed to high levels of mercury between 1953 and 1963; studies of mortality among Oak Ridge workers; a multisite study of mortality among female nuclear workers; a multisite exposure assessment of hazardous waste/cleanup workers; a chronic beryllium disease study; and a multisite study of heat stress and performance among carpenters.

E.4.3 SAVANNAH RIVER SITE, AIKEN, SC

The SRS, established in 1953 in Aiken, South Carolina, produces plutonium, tritium, and other nuclear materials. There are reports that millions of curies of tritium have been released over the years both in plant exhaust plumes and in surface and groundwater streams (ED 1982a:135-152).

E.4.3.1 Surrounding Communities

In 1984, Sauer and Associates examined mortality rates in Georgia and South Carolina by distance from the Savannah River Plant (now known as the Savannah River Site) (SR duPont 1984a). Mortality rates for areas near the plant were compared with U.S. rates and with rates for counties located more than 50 miles away. Breast cancer, respiratory cancer, leukemia, thyroid cancer, bone cancer, malignant melanoma of the skin, non-respiratory cancer, congenital anomalies or birth defects, early infancy fatality rates, stroke, or cardiovascular disease in the populations living within 50 miles of the plant did not show any excess risk compared with the reference populations.

E.4.3.2 State Health Agreement Program

Under the State Health Agreement program managed by the DOE Office of Epidemiologic Studies, a grant was awarded to the Medical University of South Carolina in 1991 to develop the Savannah River Region Health Information System. The purpose of the Savannah River Region Health Information System database was to assess the health of populations surrounding SRS by tracking cancer rates and birth defects rates in the area. Information from the registry is available to public and private health care providers for use in evaluating cancer control efforts. A steering committee provides advice to the Savannah River Region Health Information System and communicates public concerns to Savannah River Region Health Information System. It consists of 12 community members and persons with technical expertise representing South Carolina and Georgia.

E.4.3.3 Workers

A descriptive mortality study was conducted that included 9,860 white male workers who had been employed at lease 90 days at SRS between 1952 and the end of 1974 (AJIM 1988b:379-401). Vital status was followed through the end of 1980, and mortality was compared with the U.S. population. SMRs were computed separately for hourly and salaried employees. For hourly employees, non-statistically significant increases were seen for cancer of the rectum (SMR=1.09, 5 observed, 95 percent CI for range 0.35-2.54), cancer of the pancreas (SMR=1.08, 10 observed, 95 percent CI for range 0.59-2.13), leukemia and aleukemia (SMR=1.63, 13 observed, 95 percent CI for range 0.87-2.80), other lymphatic tissue (SMR=1.06, 5 observed, 95 percent CI for range 0.34-2.48), benign neoplasms (SMR=1.33, 4 observed, 95 percent CI for range 0.36-3.40), and motor vehicle accidents (SMR=1.10, 63 observed, 95 percent CI for range 0.84-1.40). Salaried employees exhibited non-statistically significant increases in cancer of the liver (SMR=1.84, 3 observed, 95 percent CI for range 0.38-5.38), cancer of the prostate (SMR=1.35, 5 observed, 95 percent CI for range 0.44-3.16), cancer of the bladder (SMR=1.87, 4 observed, 95 percent CI for range 0.51-4.79), brain cancer (SMR=1.06, 4 observed, 95 percent CI for range 0.29-2.72), leukemia and aleukemia (SMR=1.05, 4 observed, 95 percent CI for range 0.29-2.69), and other lymphatic tissue (SMR=1.23, 3 observed, 95 percent CI for range 0.26-3.61). No trends between increasing duration of employment and SMRs were observed. A statistically significant excess of leukemia fatalities was observed for hourly workers employed between 5 and 15 years (SMR=2.75, 6 observed, 95 percent CI for range 1.01-5.99). Review of the plant records and job duties of the workers who died from leukemia indicated that two of the cases had potential routine exposure to solvents, four had potential occasional exposure to solvents and one had potential for minimal exposure. Benzene, a known carcinogen, was reportedly not used at the plant.

The Department of Energy's Office of Epidemiologic Studies has implemented an Epidemiologic Surveillance Program at SRS to monitor the health of current workers. This program will evaluate the occurrence of illness and injury in the workforce on a continuing basis, and the results will be issued in annual reports. The implementation of this program will facilitate an ongoing assessment of the health and safety of SRS's workforce and will help identify emerging health issues.

Currently operational at a number of DOE sites, including production sites and research and development facilities, epidemiologic surveillance uses routinely collected health data, including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and OSHA recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data for an extended period of time become available, time trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring the health of the workforce provides a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate the need for more detailed study or increased health and safety measures to ensure adequate protection for workers.

E.4.3.4 Memorandum of Understanding

The Department of Energy entered into a Memorandum of Understanding with Health and Human Services to conduct health studies at DOE sites. The Centers for Disease Control and Prevention's NCEH is responsible for dose reconstruction studies, and NIOSH is responsible for worker studies. These activities are funded by DOE.

A study of mortality among SRS workers employed from 1952 to 1974 that examined whether risks of fatalities due to selected causes may be related to occupational exposures at SRS is being conducted by NIOSH. SRS is also included in several multisite studies managed by NIOSH. The first study is to assess the potential association between paternal work-related exposure to ionizing radiation and the risk of leukemia in offspring of exposed male workers. The second study is to examine causes of fatality among female workers at nuclear weapons facilities to develop risk estimates based on exposures to external and internal ionizing radiation and to hazardous chemicals. A third multisite project is a case-control study of multiple myeloma, a type of blood cell cancer.

A dose reconstruction project around the SRS is being conducted by NCEH to determine the type and amount of contaminants to which people living around the site may have been exposed, to identify exposure pathways of concern, and to quantify the doses people may have received as a result of SRS operations. The estimated completion date is 1999 or 2000.

E.4.4 BABCOCK & WILCOX SITE, LYNCHBURG, VA

E.4.4.1 Surrounding Communities and Workers

Several potential sources of information were searched for epidemiologic or health studies of persons living near or working at the B&W site. No information was found in the medical literature or other accessible databases (for example, Toxline). The Campbell County Health Department has no information regarding studies conducted at the local level. The Virginia State Health Department Office of Health Hazards Control and the Virginia State Department of Environmental Quality had no information on any studies conducted by the State of Virginia.

E.4.5 NUCLEAR FUEL SERVICES SITE, ERWIN, TN

E.4.5.1 Surrounding Communities and Workers

Several potential sources of information were searched for epidemiologic or health studies of persons living near or working in the NFS site. No information was found in the medical literature. One report was found in Toxline. A study was conducted of kidney disease among plant workers, with guards, and local dairy farmers used as comparison groups (NIOSH 1988a:1). Workers had a higher prevalence of kidney stones than the guards, but a lower prevalence than the dairy workers. NFS employees had a higher prevalence of urinary tract infections than both the guards and dairy farmers. Kidney function was similar in all groups. The authors concluded that the urinary tract disorders in the NFS

workers were not the result of occupational hazards. In 1979, the Centers for Disease Control investigated newspaper reports of increased rates of cancer fatalities in Unicoi County. The investigators compared the rates with four surrounding counties and also conducted occupational and environmental surveys. The investigators found that increasing cancer rates over time were due to aging of the population, that age-adjusted rates had not changed significantly, and that there did not appear to be any observable risks from exposures or emissions from the NFS site.

The Unicoi County Health Department and the Tennessee State Health Department Epidemiology Program Office were not aware of any studies conducted by local or State personnel.

E.5 FACILITY ACCIDENTS

E.5.1 EVALUATION METHODOLOGIES AND ASSUMPTIONS

The potential for facility accidents and the magnitudes of their consequences are important factors in the evaluation of the alternatives being addressed in this EIS. The health risk issues are twofold and consider the following:

- Whether accidents at any of the blending sites pose unacceptable health risks to workers or the general public.
- Whether alternative locations for facilities can provide lesser public or worker health risks. These lesser risks may arise from differences in meteorology that reduce environmental concentrations, from a greater isolation of the site from the public, or from a reduced frequency of such external accident initiators as seismic events and aircraft crashes.

E.5.1.1 Analysis Methodology

The *MELCOR Accident Consequence Code System* (MACCS) (NUREG/CR-6059, SAND92-2146, October 1993)was used to estimate the consequences of accidents involving the release of radioactivity. (The GENII code was also exercised for one case to investigate the effect of using different meteorological data at one site. A discussion of the GENII code is provided in Section E.2.2.1.)

The enhanced Chemical Hazard Evaluation Methodologies computer code was used to estimate the consequences of accidents involving the release of hazardous chemicals. The program was developed to provide several integrated estimation methods to assess toxic vapor dispersion, fire, and explosion impacts associated with episodic discharges of hazardous materials into the environment. The modules of Chemical Hazard Evaluation Methodologies used in this analysis were estimation of the discharge rate and duration of a gas or liquid released from a tank or pipeline, the size of liquid pools that form on the ground, and the size of the downwind area impacted by the release of a toxic gas or vapor into the air. The vapor dispersion model is the straight line Gaussian type, which is similar to that used in GENII.

E.5.1.2 MELCOR Accident Consequence Code System Overview

MACCS models the onsite and offsite consequences of an accident that releases a plume of radioactive materials to the atmosphere. Should such an accidental release occur, the radioactive gases and aerosols in the plume would be transported by the prevailing wind while dispersing in the atmosphere. The environment would be contaminated by radioactive materials deposited from the plume, and the population would be exposed to radiation. The objectives of a MACCS calculation are to estimate the range and probability of the health effects induced by the radiation exposures not avoided by protective actions, and to estimate the economic costs and losses that would result from the contamination of the environment.

In order to understand MACCS, one must understand its essential elements: the division of the time scale after the accident into various "phases," and the division of the region surrounding the nuclear facility into a polar-coordinate grid.

The time scale after the accident is divided into three phases: emergency phase, intermediate phase, and long-term phase. The emergency phase begins immediately after the accident and could last up to 7 days following the accident. In this period, the exposure of a population to both radioactive clouds and contaminated ground is modeled. Various protective measures can be specified for this phase, including evacuation, sheltering, and dose-dependent relocation.

The intermediate phase can be used to represent a period in which evaluations are performed and decisions are made regarding the types of protective measure actions which need to be taken. In this period, the radioactive clouds are assumed to be gone, and the only exposure pathways are those from the contaminated ground. The protective measure that can be taken during this period is temporary relocation.

The long-term phase represents all time subsequent to the intermediate phase. The only exposure pathways considered here are those resulting from the contaminated ground. A variety of protective measures can be taken in the long-term phase to reduce doses to acceptable levels: decontamination, interdiction, and condemnation of property.

The spatial grid used to represent the region is centered on the facility itself. The user specifies the number of radial divisions as well as their endpoint distances. Up to 35 of these divisions may be defined, extending out to a maximum distance of 9,999 km (6,213 mi). The angular divisions used to define the spatial grid correspond to the 16 directions of the compass.

Since the emergency phase calculations utilize highly nonlinear dose-response models, due to higher doses for early fatality and early injury, those calculations must be performed on a finer grid than the calculations of the intermediate and long-term phases. For this reason, the 16 compass sectors are divided into 3, 5, or 7 user-specified subdivisions in the calculations of the emergency phase.

The increased likelihood of cancer fatality to a member of the public is taken as $5x10^{-4}$ times the dose in rem for values of dose less than 20 rem or when the rate of exposure is less than 10 rad/hr. For doses greater than 20 rem or dose rates greater than 10 rad/hr, the cancer fatalities are doubled. The MACCS code was applied in a probabilistic manner using a weather bin sampling technique. The weather bins consist of hourly data for the windspeed, wind direction, and stability class. Centerline doses as a function of distance were calculated for each of approximately 100 meteorological sequence samples; the mean value of these doses and increased likelihoods of cancer fatality for the distance corresponding to the location of the MEI at each site were reported for that individual. Mean values were selected instead of median values because they yielded higher dose values for each candidate site.

Offsite population doses, noninvolved worker population doses, and latent cancer fatalities are calculated by MACCS using a methodology similar to that described for the individuals. In the case of a population, each of the sampled meteorological sequences was applied to the population distribution across 16 sectors. The weather bin sampling technique accounted for the frequency of occurrence of the wind blowing in each direction. Population doses are the sum of the individual doses in each sector. Once again, the mean value of the calculated population doses and latent cancer fatalities for each of the trials were reported. Mean values were selected instead of median values because they yielded higher dose values for each candidate site. Doses to noninvolved workers were calculated similarly, except that these workers will experience cancer fatalities of $4x10^{-4}$ times the dose in rem for doses less than 20 rem or exposure rates less than 10 rad/hr. For larger doses, above 20 rem and when the dose rate of exposure is greater than 10 rad/hr, the cancer fatalities are doubled.

A detailed description of the MACCS model is available in a three-volume report (NUREG/CR-6059, SAND92-2146).

E.5.1.3 Application of Models

For the analysis of accidents involving the release of radioactivity at the four facilities of interest (ORR Y–12, SRS H-Canyon, B&W, and NFS), the MACCS calculations used the source term data presented in Section E.5.2. Elevated releases were assumed to be from existing stacks at B&W (11 m [36 ft]) and NFS (33 m [108 ft]); SRS and ORR stack releases were calculated at 10 m (33 ft). For each of the latter three sites, sequences from 1 year of hourly onsite meteorological data were sampled; for B&W, the closest available complete (24 hour) data set was that from Woodrum Airport in Roanoke, Virginia, 93 km (61 mi) west of B&W and Richmond International Airport, 144 km (90 mi) east of B&W.

Since the only B&W onsite digital data consisted of a (windspeed-wind direction-stability class) joint frequency distribution file, which is suitable input to the GENII code (but not to MACCS), data from the Roanoke airport and the Richmond International Airport were obtained and reduced to joint frequency distribution files. Each of these distributions was used as input to the GENII code with all other B&W site data (for example, population) being equivalent. The evaluation basis earthquake for the uranium hexafluoride (UF_6) process was the scenario chosen for comparing GENII and MACCS results since it gave the maximum dose to workers and the public.

The dose to the MEI from the GENII code is 0.034, 0.072, and 0.080 rem and to the general population within 80 km (50 mi) is 17, 46, and 28 person-rem using meteorological data from the B&W site, Roanoke, and Richmond, respectively. From this it is concluded that use of the Roanoke airport data in the MACCS code may result in a factor of 2 to 3 higher doses than if onsite B&W data were used.

The dose to the MEI and to the general population within 80 km (50 mi) was calculated with the GENII code using meteorological data from both B&W and Roanoke airport for all six accidents (a filter fire, an earthquake induced criticality, an evaluation basis earthquake for the uranyl nitrate hexahydrate (UNH) process, a fluid bed, an evaluation basis earthquake for the UF_6 process, and a UF_6 cylinder release). The dose for all six accidents to the MEI and the general population was an average 2.1 and 2.7 times larger, respectively, using the Roanoke airport meteorological data. This is consistent with the previous analysis reported in the B&W EA, which notes:

> The onsite information is extremely valuable due to the unique nature of the site. The site has an unusual microclimate that would not mirror that of Lynchburg in terms of wind speeds, directions, or stabilities. The presence of a river on three sides of the site imposes unusual temperature conditions and reduces the stability of the air mass. The river will be cooler than the peninsula during the spring and the summer and warmer during the fall and winter. Diurnal variations of the river are minimal while the land surface will normally experience a 21-degree Fahrenheit diurnal variation. On clear cloudless nights, the valley bottoms in the area are often 10 to 15 degrees cooler than higher elevations. This can cause periods of both high stability and unstable conditions depending on cloud cover and wind speed during the following day. The deep river valley will also tend to divert the winds near surface level from the prevailing wind direction and cause additional instability. However, the river valley will tend to limit the directionality of the wind as compared to conditions observed at Lynchburg (BW NRC 1991a:38).

Radiation doses to the affected individuals and populations were calculated in the dosimetry models using the concentrations of radionuclides obtained from the dispersion models. Dose conversion factors were used to convert the radionuclide concentrations to organ dose equivalents and whole-body effective dose equivalents. Exposure pathways considered in the MACCS calculations for the period following an accident were direct radiation from the passing plume and from radioactive material deposited on the ground, inhalation from the plume, deposition on skin and inhalation of resuspended ground contamination. Ingestion of produce and animal products raised within 80 km (50 mi) of the release is not considered; this pathway would be easily interdicted in the case of an accident by bringing food in from outside this area. Liquid exposure pathways were not considered because interdiction is assumed. No credit was taken for short-term reactions such as evacuation and relocation. However, it was assumed that noninvolved workers would be shielded from the inhalation of radioactive materials for approximately half the time that the radioactive plume would be present at the site.

Three types of receptors were considered for quantitative evaluation of impacts: the offsite population, the MEI of the general public, and the noninvolved (collocated) worker. The offsite population consists of individuals residing within 80 km (50 mi) of a site. The MEI at NFS was taken as the nearest residence, located 250 m (820 ft) south of the plant and, in essence, across the street from the site fence (NF NRC 1991a:4-33). The MEI at B&W was assumed to be along the site boundary, 540 m (1,772 ft) west-southwest of the plant (BW NRC 1991a:73). For the SRS and ORR sites, the site boundary in the direction of minimum atmospheric plume attenuation was chosen; these values were found (from perusal of GENII runs) as 11,750 m (38,550 ft) north-northwest and 619 m (2,031 ft) north-northwest, respectively.

Noninvolved worker populations, used in the radiation dose calculations, were based on total site worker populations less those involved in the blending process. Workers within the processing area are all of NFS and B&W, H-Area at SRS, and Y–12 at ORR. Workers in the processing areas were spatially distributed based on local building locations. Workers at facilities distant from the

process area (for example, M-Area at SRS, ORNL at ORR) were considered to be concentrated within one sector. The total worker populations used in the MACCS calculation were approximately 325 at NFS, 2,200 at B&W (including the Naval Nuclear Fuel Division (NNFD) Research Laboratory and the Commercial Fuel Facility), 17,000 at ORR (including 6,400 at Y–12), and 12,000 at SRS (including 3,800 in H-Area).

Data on the surrounding population by sector at Y–12 and SRS are listed in *Health Risk Data for Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* technical report (February 1996). Data on the surrounding population at NFS were obtained from Table 3.4 of the NRC *Environmental Assessment for Renewal of Special Nuclear Material License No. SNM-124* prepared for NFS (Docket No. 10-143, August 1991). Data on the surrounding population at B&W were obtained from Table 3.7 of the NRC *Environmental Assessment for Renewal of Special Nuclear Material License No. SNM-42* prepared for B&W (Docket No. 70-27, August 1991). Data on meteorology and stack heights at each site are given in Appendix C.

For SRS, the accident analysis was performed for the H-Area. If blending were to occur in the F-Area, the doses from an accidental release would be similar to an accidental release in H-Area. The dose to the MEI would be slightly larger due to the decreased distance of 9,646 m (31,649 ft) from F-Area to the site boundary. The dose to the offsite population within 80 km (50 mi) would be slightly smaller due to F-Area being further from the offsite population than H-Area. The dose to the noninvolved workers would be smaller due to the smaller workforce in the F-Area. The dose to noninvolved workers in the processing area is the dominant portion of the dose to the total site noninvolved workers. The dose to noninvolved workers not in the processing area would be a minimal effect due to the distance to the other areas.

The noninvolved (collocated) worker was considered for the chemical accident impact analysis. All of the workers at NFS are in the immediate vicinity of the blending process; because of the short distance to the site boundary and for the purpose of comparison with the other sites, the distance and direction to the MEI was also used for the noninvolved worker. For the B&W site, the noninvolved worker is 230 m (755 ft) northeast of the facility being analyzed (at the experimental facility). For both SRS and ORR, the noninvolved worker was located 644 m (2,113 ft) from the facility. The direction of minimum atmospheric plume attenuation (southeast and north-northeast, respectively) was chosen.

Estimates of release durations from the chemical tanks involved in the accidents described in Section E.5.2 were performed using CHEMS-PLUS. It was found that assuming a release of the entire contents of any of the chemical tanks over 1 hour was reasonable. Atmospheric chemical concentrations experienced by the MEIs and noninvolved workers described above were calculated and compared with health-based criteria, Immediately Dangerous to Life or Health (IDLH) concentrations, TLV for 15-min Short Term Exposure Limits (STEL) and 8-hour Time Weighted Average (TWA) concentrations. The latter two limits are included to indicate exposure to levels which are occupationally acceptable for short- and long-term exposure, respectively.

The meteorological conditions used to estimate chemical impacts were approximations of mean conditions. The average site windspeeds given in Chapter 3 of this EIS were used together with the median stability class for each site (as obtained from the joint frequency distribution described above). The windspeeds for ORR, SRS, B&W, and NFS were 2.0, 2.9, 3.4, and 2.5 m/s (4.4, 6.5, 7.7, and 4.4 ft/s), respectively, and the stability classes were D, C, D, and A, respectively.

E.5.2 Bounding Accidents

The postulated accidents for each conversion/ blending process were analyzed at each of the candidate sites (a subset of Y–12, SRS, NFS, and B&W). It was assumed that the inventory of hazardous/radioactive materials, the process, and the facilities were the same at all four facilities. The differentiating parameters of the analyses were distances to the site boundary (or nearest resident), surrounding population, distribution of collocated workers, meteorology, and stack height.

A set of potential accidents was postulated for which there may be releases of radioactivity and hazardous

chemicals that could impact noninvolved onsite workers and the offsite population. A set of accident scenarios was selected to represent bounding cases. In assessing the bounding accident scenarios for the Conversion and Blending Facility, the following parameters were evaluated: (1) material at risk; (2) energy sources (fires, explosions, earthquakes, and process design-related events); (3) barriers to release; and (4) protective features of the facility. It is expected that each of these parameters would be unchanged for the range of LEU enrichment considered, except in the case of the evaluation basis earthquake accident scenario.

The bounding chemical release accidents could include a spill from nitric acid and sodium hydroxide storage tanks, and the rupture of processing lines resulting in the emptying of a hydrogen fluoride tank and a fluorine cylinder, depending on the alternative process considered. The details of chemical release quantities and resulting impacts are provided under each alternative in Chapter 4.

E.5.2.1 Facility Accidents Postulated for Blending Highly Enriched Uranium to Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and an evaluation basis earthquake. With the exception of the filter fire (with continuous exhaust flow), all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake. Therefore, it is concluded that the evaluation basis earthquake would result in the highest atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality and other release scenarios.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and the high-efficiency particulate air filters and releases it to the atmosphere through the stacks in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU. The accident annual frequency was estimated to be in the range of 10^{-4} to 10^{-2}; 10^{-3} was chosen for use in comparing alternatives. The source term analyzed and the resulting doses are shown in Tables E.5.2.1–1 and E.5.2.1–2.

Table E.5.2.1–1. Source Term for a Filter Fire Accident

Nuclide	Release Activity (curies)
U-232	1.3×10^{-4}
U-234	4.0×10^{-3}
U-235	1.6×10^{-4}
U-236	2.2×10^{-5}
U-238	2.4×10^{-5}

Source: OR LMES 1995b.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium powder and uranyl nitrate solution are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost and moderators are added as water from the fire system or organic solutions. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1×10^{19} fissions occur before reaching a stable, subcritical condition and that all material releases occur within a 2-hour period. The amount of radioactive material released as fission products created by the nuclear criticality is 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes. The accident annual frequency was estimated to be in the range of 10^{-5} to 10^{-3}; 10^{-4} was chosen for use in comparing alternatives. The source term analyzed and the resulting doses are shown in Tables E.5.2.1–3 and E.5.2.1–4.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping and tanks releasing uranium solutions, water, toxic gases, flammable gases, and toxic and reactive liquids. This is assumed to result in the release of 0.076 Ci of uranium isotopes for processing to 4-percent UNH (67 percent of the activity is U-234); and the release of 0.19 Ci of uranium isotopes for processing to 0.9-percent UNH (54 percent of the activity is U-234). The accident annual frequency was estimated to be in the range of 10^{-5} to 10^{-3}; 10^{-4} was chosen for use in comparing alternatives. The source terms analyzed and the resulting doses are shown in Tables E.5.2.1–5 through E.5.2.1–8.

Table E.5.2.1–2. Resulting Doses for a Filter Fire Accident

Site	Receptor Dose: Noninvolved Workers (person-rem)	Receptor Dose: Maximally Exposed Individual (rem)	Receptor Dose: Population Within 80 km (person-rem)
Y–12	11	1.0×10^{-2}	1.5
SRS	2.3	6.6×10^{-5}	0.37
B&W	24	1.2×10^{-2}	0.9
NFS	1.6	2.3×10^{-3}	1.3

Source: Results shown are derived from MACCS runs.

Table E.5.2.1–3. Source Term for a Criticality Accident

Nuclide	Release Activity (curies)
Kr-83m	160
Kr-85m	150
Kr-85	1,600
Kr-87	990
Kr-88	650
Kr-89	42,000
Xe-131m	8.2×10^{-2}
Xe-133m	1.8
Xe-133	27
Xe-135m	2,200
Xe-135	360
Xe-137	49,000
Xe-138	13,000
I-131	2.2
I-132	280
I-133	40
I-134	1,100
I-135	130

Source: OR LMES 1995b.

Table E.5.2.1–4. Resulting Doses for a Criticality Accident

Site	Receptor Dose: Noninvolved Workers (person-rem)	Receptor Dose: Maximally Exposed Individual (rem)	Receptor Dose: Population Within 80 km (person-rem)
Y–12	38	5.1×10^{-2}	3
SRS	8.5	3.0×10^{-4}	0.33
B&W	80	5.6×10^{-2}	1.9
NFS	8.7	1.4×10^{-2}	2.2

Source: Results shown are derived from MACCS runs.

Table E.5.2.1–5. Source Term for an Evaluation Basis Earthquake Accident (4-percent Uranyl Nitrate Hexahydrate)

Nuclide	Release Activity (curies)
U-232	1.7×10^{-2}
U-234	5.1×10^{-2}
U-235	2.1×10^{-3}
U-236	2.5×10^{-4}
U-238	5.9×10^{-3}

Source: OR LMES 1995d.

Table E.5.2.1–6. Resulting Doses for an Evaluation Basis Earthquake Accident (4-percent Uranyl Nitrate Hexahydrate)

Site	Receptor Dose: Noninvolved Workers (person-rem)	Receptor Dose: Maximally Exposed Individual (rem)	Receptor Dose: Population Within 80 km (person-rem)
Y–12	320	0.31	44
SRS	70	1.9×10^{-3}	11
B&W	760	0.36	26
NFS	67	7.8×10^{-2}	38

Source: Results shown are derived from MACCS runs.

Table E.5.2.1–7. Source Term for an Evaluation Basis Earthquake Accident (0.9-percent Uranyl Nitrate Hexahydrate)

Nuclide	Release Activity (curies)
U-232	6.0×10^{-2}
U-234	0.1
U-235	4.1×10^{-3}
U-236	4.3×10^{-4}
U-238	2.2×10^{-2}

Source: OR LMES 1995d.

Table E.5.2.1–8. Resulting Doses for an Evaluation Basis Earthquake Accident (0.9-percent Uranyl Nitrate Hexahydrate)

	Receptor Dose		
Site	Noninvolved Workers (person-rem)	Maximally Exposed Individual (rem)	Population Within 80 km (person-rem)
Y–12	960	0.94	130
SRS	210	$58x10^{3}$	32
B&W	2,300	1.1	79
NFS	200	0.23	110

Source: Results shown are derived from MACCS runs.

E.5.2.2 Facility Accidents Postulated for Blending Highly Enriched Uranium to Low-Enriched Uranium as Uranium Hexafluoride

The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and a evaluation basis earthquake. With the exception of the fluidized bed release and the filter fire (with continuous exhaust flow), all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake. Therefore, it is concluded that the evaluation basis earthquake would result in the highest atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality, UF_6, and other release scenarios.

In a fluidized bed release, it is assumed that the high temperature filters are removed for replacement but the filter housing is closed without new filters inside. The inventory of one bed is swept out of the stack by the nitrogen used to fluidize the bed. The quantity of material assumed to be released is 7.5 kg (16.5 lb) of HEU. The accident annual frequency was estimated to be in the range of 10^{-4} to 10^{-2}; 10^{-3} was chosen for use in comparing alternatives. The source term analyzed and the resulting doses are shown in Tables E.5.2.2–1 and E.5.2.2–2.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and the filters, and releases it to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU. The source term analyzed and the resulting doses are shown in Tables E.5.2.1–1 and E.5.2.1–2.

Table E.5.2.2–1. Source Term for a Fluidized Bed Release

Nuclide	Release Activity (curies)
U-232	$5.5x10^{-3}$
U-234	0.16
U-235	$6.5x10^{-3}$
U-236	$9.1x10^{-4}$
U-238	$1.0x10^{-3}$

Source: OR LMES 1995a.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium powder and uranyl nitrate solution are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost, and moderators are added as water from the fire system or organic solutions. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that $1x10^{19}$ fissions occur before reaching a stable, subcritical condition and that all material releases occur within a 2-hour period. The amount of radioactive material released as fission products created by the nuclear criticality is 46,000 ci of krypton isotopes, 65,000 ci of xenon isotopes, and 1,600 ci of iodine isotopes. The source term analyzed and the resulting doses are shown in Tables E.5.2.1–3 and E.5.2.1–4.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium solutions, water, toxic gases, flammable gases, and toxic and reactive liquids. This is assumed to result in the release of 0.061 Ci of uranium (76 percent of the activity is U-234). The source term analyzed and the resulting doses are shown in Tables E.5.2.2–3 and E.5.2.2–4.

In the UF_6 accident release, the evaluation basis earthquake causes equipment failures and a pressurized release of a UF_6 cylinder. Thirty percent of a cylinder containing UF_6 gas is assumed to be released into the atmosphere consistent with the NRC's *Nuclear Fuel Cycle Facility Accident*

Analysis Handbook (NUREG-1320, May 1988). After the accident, it is estimated that there would be a release of thirty percent of the material to equalize the pressure inside and outside the cylinder. The thirty percent release of UF_6 gas was derived from the relationship provided in NRC's Handbook:

$$\text{Percent Release} = 30\ MF_g^{0.91}$$

In this relationship, MF_g is the mole fraction of the pressurized gas. It is reported in the NRC Handbook that this relationship was developed using measured data, and bounds observed releases of aerosols produced from pressurized powders. When MF_g equals one, all the material in the cylinder would be a gas under normal temperature and pressure, which is a conservative assumption for the analysis in this EIS. Therefore, for a pressurized release during cylinder filling operation, the source is calculated to be 30 percent of 6,300 kg (13,600 lb), which is 1,900 kg (4,100 lb) of 1.5 percent assay LEU. The accident annual frequency was estimated to be in the range of 10^{-5} to 10^{-3}; 10^{-4} was chosen for use in comparing alternatives. The source term analyzed and the resulting doses are shown in Tables E.5.2.2–5 and E.5.2.2–6.

Table E.5.2.2–2. Resulting Doses for a Fluidized Bed Release

	Receptor Dose		
Site	Noninvolved Workers (person-rem)	Maximally Exposed Individual (rem)	Population Within 80 km (person-rem)
B&W	990	0.49	38
NFS	68	9.7×10^{-2}	53

Source: Results shown are derived from MACCS runs.

Table E.5.2.2–3. Source Term for an Evaluation Basis Earthquake Accident (Uranium Hexafluoride)

Nuclide	Release Activity (curies)
U-232	9.3×10^{-3}
U-234	4.6×10^{-2}
U-235	1.8×10^{-3}
U-236	2.4×10^{-4}
U-238	3.2×10^{-3}

Source: OR LMES 1995a.

Table E.5.2.2–4. Resulting Doses for an Evaluation Basis Earthquake Accident (Uranium Hexafluoride)

	Receptor Dose		
Site	Noninvolved Workers (person-rem)	Maximally Exposed Individual (rem)	Population Within 80 km (person-rem)
B&W	524	0.25	18
NFS	46	5.4×10^{-2}	26

Source: Results shown are derived from MACCS runs.

Table E.5.2.2–5. Source Term for a Uranium Hexafluoride Cylinder Accident

Nuclide	Release Activity (curies)
U-232	1.6
U-234	1.6
U-235	5.8×10^{-2}
U-236	6.5×10^{-3}
U-238	0.6

Source: OR LMES 1995a.

Table E.5.2.2–6. Resulting Doses for a Uranium Hexafluoride Cylinder Accident

	Receptor Dose		
Site	Noninvolved Workers (person-rem)	Maximally Exposed Individual (rem)	Population Within 80 km (person-rem)
B&W	54,000	26	1,900
NFS	5,000	5.7	3,000

Source: Results shown are derived from MACCS runs.

E.5.2.3 Facility Accidents Postulated for Blending Highly Enriched Uranium to Low-Enriched Uranium as Metal

The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and an evaluation basis earthquake. With the exception of the filter fire (with continuous exhaust flow), all of the accident scenarios that are potentially bounding can be initiated by the evaluation basis earthquake. Therefore, it is concluded that the evaluation basis earthquake would result in the worst-case atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality and other release scenarios.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and the high-efficiency particulate air filters, and releases it to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU. The source term analyzed and the resulting doses are shown in Tables E.5.2.1–1 and E.5.2.1–2.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium metal are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost and moderators added as water from the fire system. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that $1x10^{19}$ fissions occur before reaching a stable, subcritical condition and that all material releases occur within a 2-hour period. The amount of radioactive material released as fission products created by the nuclear criticality is 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes. The source term analyzed and the resulting doses are shown in Tables E.5.2.1–3 and E.5.2.1–4.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses resulting in ruptured containers, piping and tanks releasing uranium mixtures, water and reactive liquids. This is assumed to result in the release of $2.1x10^{-3}$ Ci of uranium isotopes (48 percent of the activity is U-232 and 33 percent of the activity is U-234). The source

Appendix F
Socioeconomics

F.1 INTRODUCTION

Appendix F includes the supporting data used for assessing potential impacts in the socioeconomics sections of this environmental impact statement (EIS). The socioeconomic analysis involved two major steps: 1) the characterization and projection of existing social, economic, and infrastructure conditions surrounding each of the candidate sites (that is, the affected environment) and 2) the evaluation of potential changes in socioeconomic conditions that could result from the operation of highly enriched uranium (HEU) blending facilities in the regions addressed (that is, the environmental consequences). Data and analyses used to support the assessments made for the Affected Environment and Environmental Consequences sections are presented in the following tables. The tables are organized by resource area and site. For example, Table F.1–2 is the first resource area, Employees by Place of Residence, and the four sites: Oak Ridge Reservation (ORR); Savannah River Site (SRS); Babcock & Wilcox (B&W); and Nuclear Fuel Services (NFS).

Table F.1–1. Regional Economic Areas for Candidate Sites (Counties and Independent Cities)

ORR		SRS		B&W		NFS	
Tennessee	**Tennessee (cont.)**	**Georgia**	**South Carolina**	**Virginia**	**Virginia (cont.)**	**Tennessee**	**Virginia**
Anderson	Jefferson	Burke	Aiken	Amherst	Montgomery	Carter	Scott
Blount	Knox	Columbia	Allendale	Appomattox	Redford City	Greene	Smyth
Campbell	Loudon	Glascock	Bamberg	Bedford	Pulaski	Hawkins	Washington
Cocke	Morgan	Jefferson	Barnwell	Bedford City	Roanoke	Sullivan	
Grainger	Roane	Jenkins	Edgefield	Botetourt	Roanoke City	Unicoi	
Hamblen	Scott	Lincoln		Campbell	Salem City	Washington	
Hancock	Sevier	McDuffie		Lynchburg City	Wythe		
	Union	Richmond		Carroll			
		Wilkes		Craig			
		Warren		Floyd	**West Virginia**		
				Franklin	Monroe		
				Giles			
				Grayson	**North Carolina**		
				Galax City	Alleghany		
				Halifax			

Note: The independent cities of Virginia are listed separately from the counties of Virginia.
Source: DOC 1995a.

Table F.1–2. Distribution of Employees by Place of Residence in Oak Ridge Reservation Region of Influence, 1990

County/City	Number of Employees	Total Site Employment (%)
Anderson County	5,053	33.1
Clinton	1,035	6.8
Oak Ridge	3,292	21.6
Knox County	5,490	36
Knoxville	4,835	31.7
Loudon County	848	5.6
Lenoir City	638	4.2
Roane County	2,537	16.6
Harriman	802	5.3
Kingston	1,033	6.8
Total ROI	13,928	91.3
Total Employees	15,273	100

Note: City values are included within county totals.
Source: ORR 1991a:4.

Table F.1–3. Distribution of Employees by Place of Residence in Savannah River Site Region of Influence, 1991

County/City	Number of Employees	Total Site Employment (%)
Aiken County	9,978	51.9
Aiken	4,928	25.7
North Augusta	2,666	13.9
Allendale County	217	1.1
Bamberg County	329	1.7
Barnwell County	1,401	7.3
Columbia County	2,036	10.6
Richmond County	3,358	17.5
Augusta	2,780	14.5
Total ROI	17,319	90.1
Total Employees	19,208	100

Note: City values are included within county totals.
Source: SRS 1991a:3.

Table F.1–4. Distribution of Employees by Place of Residence in Babcock & Wilcox Region of Influence, 1995

County/City	Number of Employees	Total Site Employment (%)
Amherst County	220	11.9
Appomattox County	177	9.6
Bedford County	261	14.1
Campbell County	341	18.5
Lynchburg	681	36.9
Total ROI	1,680	91
Total Employees	1,846	100

Note: Lynchburg is not included in county values.

Source: BW 1995b:1.

Table F.1–5. Distribution of Employees by Place of Residence in Nuclear Fuel Services Region of Influence, 1995

County	Number of Employees	Total Site Employment (%)
Carter County	27	8.3
Sullivan County	9	2.8
Unicoi County	133	40.9
Washington County	129	39.7
Total ROI	298	91.7
Total Employees	325	100

Source: NFS 1995b:2.

Table F.1–6. Oak Ridge Reservation Regional Economic Area Employment and Local Economy, 1995-2000, No Action Alternative

Regional Economic Area	1995	1996	1997	1998	1999	2000
Civilian labor force	486,400	491,800	497,100	502,600	508,000	513,600
Total employment	462,900	467,900	473,000	478,200	483,400	488,700
Unemployment rate (percentage)	4.9	4.9	4.9	4.9	4.9	4.9
Personal income (thousand dollars)	16,498,303	16,860,612	17,230,877	17,609,273	17,995,979	18,391,177
Per capita income (dollars per person)	18,198	18,397	18,598	18,801	19,007	19,214

Source: Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a.

Table F.1–7. Savannah River Site Regional Economic Area Employment and Local Economy, 1995-2000, No Action Alternative

Regional Economic Area	1995	1996	1997	1998	1999	2000
Civilian labor force	261,400	264,600	267,900	271,300	274,700	278,100
Total employment	243,800	246,800	249,900	253,100	256,200	259,400
Unemployment rate (percentage)	6.7	6.7	6.7	6.7	6.7	6.7
Personal income (thousand dollars)	10,608,794	10,875,892	11,149,716	11,430,433	11,718,219	12,013,250
Per capita income (dollars per person)	17,789	18,011	18,237	18,465	18,696	18,930

Source: Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a.

Table F.1–8. Babcock & Wilcox Regional Economic Area Employment and Local Economy, 1995-2000, No Action Alternative

Regional Economic Area	1995	1996	1997	1998	1999	2000
Civilian labor force	338,100	340,900	343,600	346,400	349,300	352,100
Total employment	321,400	324,000	326,700	329,400	332,000	334,700
Unemployment rate (percentage)	4.9	4.9	4.9	4.9	4.9	4.9
Personal income (thousand dollars)	14,357,210	14,592,163	14,830,960	15,073,665	15,320,342	15,571,056
Per capita income (dollars per person)	18,041	18,188	18,336	18,486	18,636	18,788

Source: Census 1993a; Census 1993d; Census 1993g; Census 1993h; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a.

Table F.1–9. Nuclear Fuel Services Regional Economic Area Employment and Local Economy, 1995-2000, No Action Alternative

Regional Economic Area	1995	1996	1997	1998	1999	2000
Civilian labor force	269,600	272,000	274,500	277,000	279,500	282,100
Total employment	253,800	256,100	258,400	260,800	263,100	265,500
Unemployment rate (percentage)	5.9	5.9	5.9	5.9	5.9	5.9
Personal income (thousand dollars)	9,355,762	9,526,817	9,700,999	9,878,366	10,058,976	10,242,887
Per capita income (dollars per person)	16,814	16,967	17,122	17,278	17,435	17,594

Source: Census 1993a; Census 1993b; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a.

Table F.1–10. Oak Ridge Reservation Region of Influence Population, 1990-2000, No Action Alternative

County/City	1990	1992	1994	1996	1998	2000
Anderson County	68,250	70,525	72,400	74,100	75,800	77,400
Clinton	8,972	9,484	9,700	10,000	10,200	10,400
Oak Ridge	27,310	25,313	26,000	26,600	27,200	27,800
Knox County	335,749	347,583	356,700	365,300	373,300	381,500
Knoxville	165,121	167,287	171,700	175,800	179,700	183,600
Loudon County	31,255	33,242	34,100	34,900	35,700	36,500
Lenoir City	6,147	6,807	7,000	7,200	7,300	7,500
Roane County	47,227	48,094	49,400	50,500	51,700	52,800
Harriman	7,119	7,157	7,300	7,500	7,700	7,900
Kingston	4,552	4,631	4,800	4,900	5,000	5,100
Total ROI	482,481	499,444	512,600	524,800	536,500	548,200

Note: City values are included in county totals.

Source: Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.

Table F.1–11. Savannah River Site Region of Influence Population, 1990-2000, No Action Alternative

County/City	1990	1992	1994	1996	1998	2000
Aiken County	120,940	128,566	133,000	137,000	140,400	144,000
Aiken	19,872	22,429	23,200	23,900	24,500	25,100
North Augusta	15,351	16,379	16,900	17,500	17,900	18,300
Allendale County	11,722	11,744	12,200	12,500	12,800	13,200
Bamberg County	16,902	16,991	17,600	18,100	18,600	19,000
Barnwell County	20,293	21,089	21,800	22,500	23,000	23,600
Columbia County	66,031	73,000	75,500	77,800	79,700	81,800
Richmond County	189,719	202,434	209,400	215,700	221,100	226,700
Augusta	44,639	44,467	46,000	47,400	48,600	49,800
Total ROI	425,607	453,824	469,500	483,600	495,600	508,300

Note: City values are included in county totals.

Source: Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j.

Table F.1–12. Babcock & Wilcox Region of Influence Population, 1990-2000, No Action Alternative

County/City	1990	1992	1994	1996	1998	2000
Amherst County	28,578	29,031	29,800	30,500	31,000	31,500
Appomattox County	12,298	12,542	12,900	13,200	13,400	13,600
Bedford County	51,729	54,562	56,100	57,300	58,300	59,200
Campbell County	47,572	48,703	50,100	51,200	52,000	52,900
Lynchburg	66,049	66,097	68,000	69,500	70,600	71,800
Total ROI	206,226	210,935	216,900	221,700	225,300	229,000

Note: Lynchburg is not included in county totals.

Source: Census 1993a; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j.

Table F.1–13. Nuclear Fuel Services Region of Influence Population, 1990-2000, No Action Alternative

County	1990	1992	1994	1996	1998	2000
Carter County	51,505	52,029	53,400	54,600	55,600	56,600
Sullivan County	143,596	146,676	150,500	153,800	156,600	159,500
Unicoi County	16,549	16,791	17,200	17,600	17,900	18,300
Washington County	92,315	94,934	97,400	99,600	101,400	103,200
Total ROI	303,965	310,430	318,500	325,600	331,500	337,600

Source: Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.

Table F.1–14. Oak Ridge Reservation Region of Influence Housing Units, 1990-2000, No Action Alternative

County/City	1990	1992	1994	1996	1998	2000
Anderson County	29,323	30,300	31,100	31,800	32,500	33,300
Clinton	4,006	4,200	4,300	4,500	4,500	4,600
Oak Ridge	12,694	11,800	12,100	12,400	12,600	12,900
Knox County	143,582	148,600	152,500	156,200	159,700	163,200
Knoxville	76,453	77,500	79,500	81,400	83,200	85,000
Loudon County	12,995	13,800	14,200	14,500	14,800	15,200
Lenoir City	2,734	3,000	3,100	3,200	3,300	3,300
Roane County	20,334	20,700	21,300	21,800	22,200	22,700
Harriman	3,234	3,300	3,300	3,400	3,500	3,600
Kingston	2,071	2,100	2,200	2,200	2,300	2,300
Total ROI	206,234	213,400	219,100	224,300	229,200	234,400

Note: City values are included in county totals.

Source: Census 1991c; Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.

Table F.1–15. Savannah River Site Region of Influence Housing Units, 1990-2000, No Action Alternative

County/City	1990	1992	1994	1996	1998	2000
Aiken County	49,266	52,400	54,200	55,800	57,200	58,700
Aiken	8,543	9,600	10,000	10,300	10,500	10,800
North Augusta	6,810	7,300	7,500	7,700	7,900	8,100
Allendale County	4,242	4,300	4,400	4,500	4,600	8,100
Bamberg County	6,408	6,400	6,700	6,900	7,000	7,200
Barnwell County	7,854	8,200	8,400	8,700	8,900	9,100
Columbia County	23,745	26,300	27,200	28,000	28,700	29,400
Richmond County	77,288	82,500	85,300	87,900	90,100	92,400
Augusta	21,588	21,500	22,300	22,900	23,500	24,100
Total ROI	168,803	180,100	186,200	191,800	196,500	201,600

Note: City values are included in county totals.

Source: Census 1991a; Census 1991b; Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j.

Table F.1–16. Babcock & Wilcox Region of Influence Housing Units, 1990–2000, No Action Alternative

County/City	1990	1992	1994	1996	1998	2000
Amherst County	10,598	10,800	11,100	11,300	11,500	11,700
Appomattox County	4,913	5,000	5,200	5,300	5,400	5,400
Bedford County	22,226	23,400	24,100	24,600	25,000	25,500
Campbell County	19,008	20,300	20,900	21,400	21,700	22,100
Lynchburg	27,233	27,300	28,000	28,600	29,100	29,600
Total ROI	83,978	86,800	89,300	91,200	92,700	94,300

Note: Lynchburg is not included in the county totals.

Source: Census 1991u; Census 1993a; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j.

Table F.1–17. Nuclear Fuel Services Region of Influence Housing Units, 1990–2000, No Action Alternative

County	1990	1992	1994	1996	1998	2000
Carter County	21,779	22,000	22,600	23,100	23,500	23,900
Sullivan County	60,623	61,900	63,500	64,900	66,100	67,300
Unicoi County	7,076	7,200	7,400	7,500	7,700	7,800
Washington County	38,378	39,500	40,500	41,400	42,100	42,900
Total ROI	127,856	130,600	134,000	136,900	139,400	141,900

Source: Census 1991c; Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.

Table F.1–18. Candidate Sites–Total Student Enrollments, 1995–2000, No Action Alternative

Site ROI	1995	1996	1997	1998	1999	2000
ORR	83,400	84,300	85,200	86,100	87,100	88,000
SRS	88,200	89,300	90,400	91,600	92,700	93,900
B&W	34,200	34,400	34,700	35,000	35,300	35,600
NFS	52,500	53,000	53,500	53,900	54,400	54,900

Source: BW School 1995a; NF School 1995a; OR School 1995a; SR School 1995a; Appendix Tables F.1–10 through 13.

Table F.1–19. Candidate Sites–Total Teachers, 1995–2000, No Action Alternative

Site ROI	1995	1996	1997	1998	1999	2000
ORR	5,140	5,190	5,250	5,310	5,370	5,420
SRS	5,060	5,120	5,180	5,250	5,310	5,380
B&W	2,400	2,420	2,440	2,460	2,480	2,500
NFS	2,920	2,950	2,980	3,000	3,030	3,060

Source: BW School 1995a; NF School 1995a; OR School 1995a; SR School 1995a; Appendix Tables F.1–10 through 13.

Table F.1–20. Candidate Sites–Total Number of Sworn Police Officers, 1995–2000, No Action Alternative

Site ROI	1995	1996	1997	1998	1999	2000
ORR	792	801	809	818	827	836
SRS	956	968	980	992	1,010	1,020
B&W	358	361	364	367	370	373
NFS	556	561	566	571	577	582

Source: BW Police 1995a; DOJ 1994a; NF Police 1995a; OR Police 1995a; Appendix Tables F.1–10 through 13.

Table F.1–21. Candidate Sites–Total Number of Firefighters, 1995–2000, No Action Alternative

Site ROI	1995	1996	1997	1998	1999	2000
ORR	1,120	1,130	1,150	1,160	1,170	1,180
SRS	1,363	1,380	1,400	1,420	1,430	1,450
B&W	960	968	976	984	992	1,000
NFS	1,201	1,210	1,220	1,230	1,250	1,260

Note: Kingsport Fire Department in Sullivan County and Limestone Cove Volunteer Fire Department in Unicoi County were excluded from the NFS ROI total because firefighter data were unattainable.

Source: BW Fire 1995a; NF Fire 1995a; OR Fire 1995a; SR Fire 1995a; Appendix Tables F.1–10 through 13.

Table F.1–22. Candidate Sites–Total Number of Physicians, 1995–2000, No Action Alternative

Site ROI	1995	1996	1997	1998	1999	2000
ORR	1,300	1,320	1,330	1,350	1,360	1,380
SRS	1,370	1,390	1,410	1,420	1,440	1,460
B&W	299	302	304	307	309	312
NFS	870	878	886	894	902	910

Source: AMA 1994a; Appendix Tables F.1–10 through 13.

Table F.1–23. Candidate Sites–Hospital Occupancy Rates, 1995–2000, No Action Alternative

Site ROI	1995	1996	1997	1998	1999	2000
ORR	73	74	75	76	77	78
SRS	65	66	66	67	68	69
B&W	70	71	71	72	72	73
NFS	61	62	63	63	64	64

Source: AHA 1994a; Appendix Tables F.1–10 through 13.

Table F.1–24. Changes to Total Employment, Unemployment Rate, and Per Capita Income During Full Operation of the Uranyl Nitrate Hexahydrate Blending Facility

Site	No Action	UNH	Percent Change
Oak Ridge Reservation			
Unemployment rate	4.9	4.8	NA
Total employment	488,700	489,144	0.1
Per capita income (dollars per person)	19,214	19,225	0.1
Savannah River Site			
Unemployment rate	6.7	6.6	NA
Total employment	259,400	259,770	0.1
Per capita income (dollars per person)	18,930	18,952	0.1
Babcock & Wilcox			
Unemployment rate	4.9	4.8	NA
Total employment	334,700	335,111	0.1
Per capita income (dollars per person)	18,788	18,802	<0.1
Nuclear Fuel Services			
Unemployment rate	5.9	5.7	NA
Total employment	265,500	265,879	0.1
Per capita income (dollars per person)	17,594	17,612	0.1

Note: NA=not applicable.

Source: BEA 1995c; BW 1995b:1; Census 1992a; Census 1993b; Census 1993c; Census 1993d; Census 1993e; Census 1993g; Census 1993h; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; NFS 1995b:2; OR LMES 1995b; ORR 1991a:4; SRS 1991a:3.

Table F.1–25. Changes to Total Employment, Unemployment Rate, and Per Capita Income During Full Operation of the Uranium Hexafluoride Blending Facility

Site	No Action	UF_6	Percent Change
Babcock & Wilcox			
Unemployment Rate	4.9	4.8	NA
Total employment	334,700	335,111	0.1
Per capita income (dollar per person)	18,788	18,802	<0.1
Nuclear Fuel Services			
Unemployment rate	5.9	5.7	NA
Total employment	265,500	265,879	0.1
Per capita income (dollar per person)	17,594	17,612	0.1

Note: NA=not applicable.

Source: BEA 1995c; BW 1995b:1; Census 1992a; Census 1993b; Census 1993d; Census 1993g; Census 1993h; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; NFS 1995b:2; OR LMES 1995a.

Table F.1–26. Changes to Total Employment, Unemployment Rate, and Per Capita Income During Full Operation of the Metal Blending Facility

Site	No Action	Metal	Percent Change
Oak Ridge Reservation			
Unemployment rate	4.9	4.8	NA
Total employment	488,700	489,144	0.1
Per capita income (dollar per person)	19,214	19,220	<0.1
[Text deleted.]			

Note: NA=not applicable.

Source: BEA 1995c; Census 1992a; Census 1993b; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; OR LMES 1995c; ORR 1991a:4.

Appendix G
Intersite Transportation

G.1 TRANSPORTATION RISK ANALYSIS METHODOLOGY

Health impacts from transportation are presented in this appendix for four blending options: 1) uranyl nitrate hexahydrate (UNH) crystals as commercial reactor fuel feed material, 2) UNH as low-level waste (LLW), 3) uranium hexafluoride (UF_6) as fuel feed material, and 4) metal LLW.

This assessment estimates the health effects, in terms of annual fatalities, from the transportation of radioactive materials needed for blending highly enriched uranium (HEU) to low-enriched uranium (LEU) with appropriate blendstock material and from the transportation of the blended products to a site for either fuel fabrication or disposal as LLW. Calculations were performed using RADTRAN Version 4 to estimate unit risks, that is, the risk of transporting each type of material over a distance of 1 kilometer (km) (0.62 miles [mi]) through different population zones. In a series of linked spreadsheets, the impacts were calculated for each alternative using actual distances and population zones, and summed for total health effects. The data used and health risk impacts are summarized in Tables G.1–1 through G.1–8.

Highly enriched uranium would be transported via safe secure trailers (SSTs). The blendstock would consist of natural uranium (NU), depleted uranium (DU), or LEU in oxide as triuranic-octaoxide (U_3O_8), metal, or UF_6 form. The shipments of LEU and LLW would be transported in Department of Transportation (DOT)-approved packages by commercial carriers. The number of packages per shipment would be in accordance with regulatory requirements. Trucks would be loaded to capacity, as determined by either weight or radiological dose limitations.

RADTRAN combines user-determined demographic, transportation, packaging, and material factors with health physics data to calculate the expected radiological consequences of accident-free and accident risk of transporting radioactive material. Tables G.1–1 and G.1–2 give the isotopic compositions used for each material type considered. HEU was assumed to be 93-percent U-235; even though the average assay of surplus HEU was

Table G.1–1. Isotopic Composition by Percent of Uranium Materials

Material	U-232	U-234	U-235	U-236	U-238
HEU (93% U-235)	0	1	93.1	0.5	5.4
DU (0.2% U-235)	4.0×10^{-6}	3.6×10^{-3}	0.2	0	99.8
NU (0.71% U-235)	4.0×10^{-6}	5.4×10^{-3}	0.71	0	99.3
LEU1 (0.9% U-235)	4.0×10^{-6}	9.5×10^{-3}	0.9	3.3×10^{-3}	99
LEU4 (4% U-235)	4.0×10^{-6}	3.3×10^{-2}	4	1.5×10^{-2}	96
Specific activity (curie/kilogram)	2.2×10^{4}	6.2	2.1×10^{-3}	6.3×10^{-2}	3.3×10^{-4}

Source: ORR 1995a:3.

Table G.1–2. Contribution by Isotope to Total Specific Activity (curies per kilogram)

Material	U-232	U-234	U-235	U-236	U-238	Total
HEU (93% U-235)	0	6.2×10^{-2}	2.0×10^{-3}	3.2×10^{-4}	1.8×10^{-5}	6.4×10^{-2}
DU (0.2% U-235)	8.8×10^{-4}	2.2×10^{-4}	4.2×10^{-6}	0	3.3×10^{-4}	1.4×10^{-3}
NU (0.71% U-235)	8.8×10^{-4}	3.4×10^{-4}	1.5×10^{-5}	0	3.3×10^{-4}	1.6×10^{-3}
LEU1 (0.9% U-235)	8.8×10^{-4}	5.9×10^{-4}	1.9×10^{-5}	2.1×10^{-6}	3.3×10^{-4}	1.8×10^{-3}
LEU4 (4% U-235)	8.8×10^{-4}	2.1×10^{-3}	8.4×10^{-5}	9.5×10^{-6}	3.2×10^{-4}	3.4×10^{-3}

Source: ORR 1995a:3.

estimated to be lower, 93 percent was used in transportation analyses to assess the highest potential impact. The blendstock materials were NU with 0.71-percent U-235 or DU with 0.2-percent U-235. The product materials were fuel feed material with 4-percent U-235 or LLW with 0.9-percent U-235.

The transport index is a regulatory characteristic of a package and is equal to the radiation dose rate in millirem per hour at a distance of 1 meter (m) (3.3 feet [ft]) from the outside of the package. The transport index values were estimated to be the maximum allowed by regulatory requirements, as indicated by regulatory checks incorporated in RADTRAN. These regulatory checks limit the product of the number of packages and the transport index (of each package) to a value of about 16. The quantity of material per package, number of packages per truckload, and number of truckloads per year were estimated.

The transportation accident model in RADTRAN assigns accident probabilities to a set of accident categories. For the truck analysis, the eight accident-severity categories defined in Nuclear Regulatory Commission's (NRC) *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes* (NUREG-0170, December 1977) were used. The least severe accident category (Category I) represents low magnitudes of crush force, accident-impact velocity, fire duration, or puncture-impact speed. The most severe category (Category VIII) represents a large crush force, high-impact velocity, high puncture-impact speed, an 88-kilometer per hour (km/hr) (54.6-mi/hr) collision into the side of the vehicle, and a 982 Celsius (°C) (1,800 Fahrenheit [°F]) fire lasting 1.5 hrs to produce a release of HEU. The release fractions for Category VIII accidents were conservatively estimated to be 0.1 for the strictly controlled SST shipments of HEU and 1 for other shipments.

Unit risk factors for radiological exposure from transportation were calculated in terms of fatal cancers for each type of material to be shipped a distance of 1 km (0.62 mi) in rural, suburban, and urban population zones. These unit risk factors are presented in Table G.1–3. The RADTRAN code was used to estimate population and occupational doses (unit dose factors) for transportation of each material over 1 km (0.62 mi) in each population zone. The unit dose factors were converted to unit risk factors by multiplying the occupational accident-free unit dose factors by 4.0×10^{-4} cancers per person-rem and the public accident-free and accident unit dose factors by 5.0×10^{-4} cancers per person-rem (ICRP 1991a:22).

Radiological exposures from handling of uranium materials during loading and unloading of trucks were estimated per shipment (truckload) as shown in Table G.1–4. It was estimated that there would be two cargo handlers and 35 other workers within 50 m (165 ft) of the loading/unloading operations. Accident-free risks to cargo handlers and other workers were summed for determining total health impacts.

Table G.1–5 presents the computed health risks per year from the transport of HEU to blending sites for each alternative; Table G.1–6 presents the risks from the transport of blendstock materials; and Table G.1–7 presents the risks from transporting commercial reactor fuel feed material and LLW from blending sites to either a fuel fabrication plant or LLW disposal site.

For these calculations, distances and the fractions for rural, suburban, and urban populations for each intersite route were estimated using the INTERSTAT routing code. Among the routes considered, the average population distribution for rural, suburban, and urban were 78, 20, and 2 percent, respectively. Annual radiological transportation impacts were calculated by multiplying route distance by the number of shipments and then multiplying by the sum of the products of the rural distance fraction and rural unit risk factor, the suburban distance fraction and suburban unit risk factor, and the urban distance fraction and urban unit risk factor. Tables G.1–5, G.1–6, and G.1–7 also include estimates of nonradiological impacts due to air pollution and highway accidents. Fatalities from potential air pollution were estimated using 1.0×10^{-7} cancer fatalities per urban kilometer. Highway accident fatalities were estimated from national statistics using 1.5×10^{-8} rural, 3.7×10^{-9} suburban, and 2.1×10^{-9} urban for occupational risks per kilometer, and 5.3×10^{-8} rural, 1.3×10^{-8} suburban, and 7.5×10^{-9} urban for nonoccupational risks per kilometer.

Table G.1–8 presents a summary of the cumulative annual transportation health impacts for all blending options.

Table G.1–3. Unit Dose and Risk Factors for Radiological Health Risks

Distance (1 km)	Material	Form	Material Weight per Package (kilogram)	Pkgs per Shipment	Unit Dose Factors (person-rem)						Unit Risk Factors (fatal cancers)		
					Accident	Accident-Free					Accident	Accident-Free	
						Transport Crew	Public Off-Link[a]	On-Link[b]	Stops[c]	Total	Public	Public	Crew
Rural	HEU-93	Metal, UF_6	2	48	$9.7x10^{-10}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$4.8x10^{-13}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	HEU-93	Metal, UF_6	2	48	$1.3x10^{-7}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$6.0x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$6.7x10^{-11}$	$3.1x10^{-8}$	$7.2x10^{-9}$
Urban	HEU-93	Metal, UF_6	2	48	$3.9x10^{-7}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.2x10^{-5}$	$1.9x10^{-10}$	$3.6x10^{-8}$	$1.2x10^{-8}$
Rural	HEU-93	UNH	35	48	$1.7x10^{-8}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$8.7x10^{-12}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	HEU-93	UNH	35	48	$2.4x10^{-6}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$6.0x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$1.2x10^{-9}$	$3.1x10^{-8}$	$7.2x10^{-9}$
Urban	HEU-93	UNH	35	48	$6.9x10^{-6}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.2x10^{-5}$	$3.5x10^{-9}$	$3.6x10^{-8}$	$1.2x10^{-8}$
Rural	DU-0.2	Metal	2,200	5	$8.9x10^{-8}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$4.4x10^{-11}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	DU-0.2	Metal	2,200	5	$1.2x10^{-5}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$5.9x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$6.1x10^{-9}$	$3.1x10^{-8}$	$7.2x10^{-9}$
Urban	DU-0.2	Metal	2,200	5	$3.6x10^{-5}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.1x10^{-5}$	$1.8x10^{-8}$	$3.6x10^{-8}$	$1.2x10^{-8}$
Rural	NU-0.7	UNH	2,200	5	$9.1x10^{-8}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$4.6x10^{-11}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	NU-0.7	UNH	2,200	5	$1.3x10^{-5}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$5.9x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$6.3x10^{-9}$	$3.1x10^{-8}$	$7.2x10^{-9}$
Urban	NU-0.7	UNH	2,200	5	$3.6x10^{-5}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.1x10^{-5}$	$1.8x10^{-8}$	$3.6x10^{-9}$	$1.2x10^{-8}$
Rural	NU-0.7	UF_6	6,133	1	$5.1x10^{-8}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$2.5x10^{-11}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	NU-0.7	UF_6	6,133	1	$7.0x10^{-6}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$5.9x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$3.5x10^{-9}$	$3.1x10^{-8}$	$7.2x10^{-9}$
Urban	NU-0.7	UF_6	6,133	1	$2.0x10^{-5}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.1x10^{-5}$	$1.0x10^{-8}$	$3.6x10^{-8}$	$1.2x10^{-8}$
Rural	LEU-1	Metal	93	48	$4.0x10^{-8}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$2.0x10^{-11}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	LEU-1	Metal	93	48	$5.5x10^{-6}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$6.0x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$2.8x10^{-9}$	$3.1x10^{-8}$	$7.2x10^{-9}$
Urban	LEU-1	Metal	93	48	$1.6x10^{-5}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.2x10^{-5}$	$8.0x10^{-9}$	$3.6x10^{-8}$	$1.2x10^{-8}$
Rural	LEU-4	UNH	43	50	$5.0x10^{-8}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$2.5x10^{-11}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	LEU-4	UNH	43	50	$6.9x10^{-6}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$5.9x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$3.4x10^{-9}$	$3.1x10^{-8}$	$7.2x10^{-9}$
Urban	LEU-4	UNH	43	50	$2.0x10^{-5}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.1x10^{-5}$	$1.0x10^{-8}$	$3.6x10^{-8}$	$1.2x10^{-8}$
Rural	LEU-4	UF_6	1,516	4	$6.8x10^{-8}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$3.4x10^{-11}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	LEU-4	UF_6	1,516	4	$9.4x10^{-6}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$5.9x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$4.7x10^{-9}$	$3.1x10^{-8}$	$7.2x10^{-9}$

Table G.1–3. Unit Dose and Risk Factors for Radiological Health Risks—Continued

					Unit Dose Factors (person-rem)						Unit Risk Factors (fatal cancers)		
					Accident	Accident-Free					Accident	Accident-Free	
Distance (1 km)	Material	Form	Material Weight per Package (kilogram)	Pkgs per Shipment		Transport Crew	Public Off-Link[a]	On-Link[b]	Stops[c]	Total	Public	Public	Crew
Urban	LEU-4	UF_6	1,516	4	$2.7x10^{-5}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.1x10^{-5}$	$1.4x10^{-8}$	$3.6x10^{-8}$	$1.2x10^{-8}$
Rural	LEU-1	UNH	87	50	$4.0x10^{-8}$	$8.2x10^{-6}$	$5.1x10^{-8}$	$2.1x10^{-6}$	$5.0x10^{-5}$	$5.2x10^{-5}$	$2.0x10^{-11}$	$2.6x10^{-8}$	$3.3x10^{-9}$
Suburban	LEU-1	UNH	87	50	$5.5x10^{-6}$	$1.8x10^{-5}$	$5.8x10^{-6}$	$6.0x10^{-6}$	$5.0x10^{-5}$	$6.1x10^{-5}$	$2.8x10^{-9}$	$3.1x10^{-8}$	$7.2x10^{-9}$
Urban	LEU-1	UNH	87	50	$1.6x10^{-5}$	$3.0x10^{-5}$	$6.5x10^{-7}$	$2.1x10^{-5}$	$5.0x10^{-5}$	$7.2x10^{-5}$	$8.0x10^{-9}$	$3.6x10^{-8}$	$1.2x10^{-8}$
Handling (Each Loading or Unloading)						$6.0x10^{-2}$	$4.0x10^{-3}$					$1.6x10^{-6}$	$2.4x10^{-5}$
Handling (One Loading Plus One Unloading)						$1.2x10^{-1}$	$8.1x10^{-3}$					$3.2x10^{-6}$	$4.8x10^{-5}$

[a] Off-link is population within 500 m (1,640 ft) of the highway.

[b] On-link is population sharing the highway.

[c] Truck stop en route (for example, gas).

Source: RADTRAN model results.

Table G.1–4. Accident-Free Radiological Exposure From Transferring Materials Between Storage and a Truck

Types of Population[a]	Population Size	Dose	Later Cancer Fatality
Cargo Handlers			
Collective population	2	$6.0x10^{-2}$ person-rem	$2.4x10^{-5}$
Average individual dose	1	$3.0x10^{-2}$ rem	$1.2x10^{-5}$
Other Workers			
Collective population	35	$4.0x10^{-3}$ person-rem	$1.6x10^{-6}$
Average individual dose	1	$1.2x10^{-4}$ rem	$4.8x10^{-8}$

[a] Under normal (accident-free) conditions the public does not receive a measurable dose.

Source: RADTRAN model results.

Table G.1–5. Annual Health Effects From Transportation of Highly Enriched Uranium (93-Percent U-235) From Y–12 Plant to Blending Plants

Destination	Shipments[c] (per year)	Distance (km)	Population			Radiological[a]			Nonradiological[b]			Total Health Effect[d]
			Rural (%)	Suburban (%)	Urban (%)	Accident	Accident-Free		Accident		Air Pollution	
							Public	Crew	Public	Crew		
UNH Blending to Fuel Feed Material												
B&W	6	526	68	31	1	$1.3x10^{-6}$	$1.1x10^{-4}$	$3.0x10^{-4}$	$2.5x10^{-4}$	$7.2x10^{-5}$	$6.9x10^{-6}$	$7.4x10^{-4}$
NFS	6	247	68	31	1	$6.2x10^{-7}$	$6.0x10^{-5}$	$3.0x10^{-4}$	$1.2x10^{-4}$	$3.4x10^{-5}$	$3.3x10^{-6}$	$5.1x10^{-4}$
SRS	6	479	71	27	2	$1.2x10^{-6}$	$9.8x10^{-5}$	$3.0x10^{-4}$	$2.4x10^{-4}$	$6.7x10^{-5}$	$1.1x10^{-5}$	$7.2x10^{-4}$
Y–12	6	0	0	0	0	0	$1.9x10^{-5}$	$2.9x10^{-4}$	0	0	0	$3.1x10^{-4}$
UNH Blending to LLW												
B&W	22	526	68	31	1	$2.7x10^{-7}$	$3.9x10^{-4}$	$1.1x10^{-3}$	$9.3x10^{-4}$	$2.6x10^{-4}$	$2.6x10^{-5}$	$2.7x10^{-3}$
NFS	22	247	68	31	1	$1.3x10^{-7}$	$2.2x10^{-4}$	$1.1x10^{-3}$	$4.4x10^{-4}$	$1.2x10^{-4}$	$1.2x10^{-6}$	$1.9x10^{-3}$
SRS	22	479	71	27	2	$2.3x10^{-7}$	$3.6x10^{-4}$	$1.1x10^{-3}$	$8.7x10^{-4}$	$2.5x10^{-4}$	$4.1x10^{-5}$	$2.6x10^{-3}$
Y–12	22	0	0	0	0	0	$7.1x10^{-5}$	$1.1x10^{-3}$	0	0	0	$1.1x10^{-3}$
UF_6 Blending to Fuel Feed Material												
B&W	105	526	68	31	1	$1.3x10^{-6}$	$1.9x10^{-3}$	$5.3x10^{-3}$	$4.4x10^{-3}$	$1.3x10^{-3}$	$1.2x10^{-4}$	$1.3x10^{-2}$
NFS	105	247	68	31	1	$6.0x10^{-7}$	$1.1x10^{-3}$	$5.2x10^{-3}$	$2.1x10^{-3}$	$5.9x10^{-4}$	$5.7x10^{-5}$	$8.9x10^{-3}$
Metal Blending to LLW												
[Text deleted.]												
Y–12	33	0	0	0	0	0	$1.1x10^{-4}$	$1.6x10^{-3}$	0	0	0	$1.7x10^{-3}$

[a] Cancer fatalities.

[b] Fatalities.

[c] A shipment is a truckload.

[d] Estimated fatalities per year.

Source: RADTRAN model results.

Table G.1–6. Annual Health Effects From Transportation of Uranium Hexafluoride, Uranium Oxide, and Metal Blendstock

Origin	Destination	Material	Shipments[c] (per year)	Distance (km)	Radiological[a]			Nonradiological[b]			Total Health Effect[d]
					Accident	Accident-Free		Accident		Air Pollution	
						Public	Crew	Public	Crew		
Uranium Hexafluoride (UF_6)											
Paducah	GE	DU-0.2	23	1,278	$3.5x10^{-5}$	$8.8x10^{-4}$	$1.2x10^{-3}$	$2.4x10^{-3}$	$6.8x10^{-4}$	$1.0x10^{-4}$	$5.3x10^{-3}$
Piketon	GE	DU-0.2	23	1,323	$3.8x10^{-5}$	$9.1x10^{-4}$	$1.3x10^{-3}$	$2.5x10^{-3}$	$7.0x10^{-4}$	$1.2x10^{-4}$	$5.5x10^{-3}$
Paducah	GE	NU-0.7	22	1,278	$2.1x10^{-5}$	$8.4x10^{-4}$	$1.2x10^{-3}$	$2.3x10^{-3}$	$6.5x10^{-4}$	$9.6x10^{-5}$	$5.1x10^{-3}$
Piketon	GE	NU-0.7	22	1,323	$2.2x10^{-5}$	$8.7x10^{-4}$	$1.2x10^{-3}$	$2.4x10^{-3}$	$6.7x10^{-4}$	$1.1x10^{-4}$	$5.2x10^{-3}$
Paducah	B&W	NU-0.7	22	1,013	$2.7x10^{-5}$	$6.8x10^{-4}$	$1.2x10^{-3}$	$1.8x10^{-3}$	$5.1x10^{-4}$	$4.9x10^{-5}$	$4.2x10^{-3}$
Paducah	NFS	NU-0.7	22	734	$2.0x10^{-5}$	$5.1x10^{-4}$	$1.1x10^{-3}$	$1.3x10^{-3}$	$3.7x10^{-4}$	$3.6x10^{-5}$	$3.4x10^{-3}$
Piketon	B&W	NU-0.7	22	858	$2.5x10^{-5}$	$5.9x10^{-4}$	$1.2x10^{-3}$	$1.5x10^{-3}$	$4.2x10^{-4}$	$5.7x10^{-5}$	$3.7x10^{-3}$
Piketon	NFS	NU-0.7	22	916	$2.6x10^{-5}$	$6.3x10^{-4}$	$1.2x10^{-3}$	$1.6x10^{-3}$	$4.5x10^{-4}$	$6.5x10^{-5}$	$3.9x10^{-3}$
Uranium Oxide (U_3O_8)											
Hanford	SRS	NU-0.7	15	4,442	$1.1x10^{-4}$	$1.8x10^{-3}$	$1.0x10^{-3}$	$5.9x10^{-3}$	$1.7x10^{-3}$	$2.0x10^{-4}$	$1.1x10^{-2}$
Hanford	Y–12	NU-0.7	15	3,969	$9.3x10^{-5}$	$1.7x10^{-3}$	$9.7x10^{-4}$	$5.3x10^{-3}$	$1.5x10^{-3}$	$1.7x10^{-4}$	$9.7x10^{-3}$
Hanford	B&W	NU-0.7	15	4,422	$1.1x10^{-4}$	$1.8x10^{-3}$	$1.0x10^{-3}$	$5.8x10^{-3}$	$1.6x10^{-3}$	$1.9x10^{-4}$	$1.1x10^{-2}$
Hanford	NFS	NU-0.7	15	4,216	$9.9x10^{-5}$	$1.8x10^{-3}$	$9.9x10^{-4}$	$5.6x10^{-3}$	$1.6x10^{-3}$	$1.8x10^{-4}$	$1.0x10^{-2}$
Hanford	SRS	DU-0.2	16	4,442	$1.1x10^{-4}$	$2.0x10^{-3}$	$1.1x10^{-3}$	$6.3x10^{-3}$	$1.8x10^{-3}$	$2.1x10^{-4}$	$1.1x10^{-2}$
Hanford	Y–12	DU-0.2	16	3,969	$9.6x10^{-5}$	$1.8x10^{-3}$	$1.0x10^{-3}$	$5.6x10^{-3}$	$1.6x10^{-3}$	$1.8x10^{-4}$	$1.0x10^{-2}$
Hanford	B&W	DU-0.2	16	4,422	$1.1x10^{-4}$	$2.0x10^{-3}$	$1.1x10^{-3}$	$6.2x10^{-3}$	$1.8x10^{-3}$	$2.0x10^{-4}$	$1.1x10^{-2}$
Hanford	NFS	DU-0.2	16	4,216	$1.0x10^{-4}$	$1.9x10^{-3}$	$1.1x10^{-3}$	$6.0x10^{-3}$	$1.7x10^{-3}$	$2.0x10^{-4}$	$1.1x10^{-2}$
GE	B&W	NU-0.7	15	801	$2.5x10^{-5}$	$3.8x10^{-4}$	$7.8x10^{-4}$	$1.0x10^{-3}$	$2.8x10^{-4}$	$4.6x10^{-5}$	$2.5x10^{-3}$
GE	NFS	NU-0.7	15	860	$2.7x10^{-5}$	$4.0x10^{-4}$	$7.8x10^{-4}$	$1.1x10^{-3}$	$3.0x10^{-4}$	$5.7x10^{-5}$	$2.6x10^{-3}$
GE	SRS	NU-0.7	15	596	$1.8x10^{-5}$	$2.9x10^{-4}$	$7.6x10^{-4}$	$7.5x10^{-4}$	$2.1x10^{-4}$	$4.1x10^{-5}$	$2.1x10^{-3}$
GE	Y–12	NU-0.7	15	791	$2.5x10^{-5}$	$3.7x10^{-4}$	$7.8x10^{-4}$	$9.8x10^{-4}$	$2.8x10^{-4}$	$5.0x10^{-5}$	$2.5x10^{-3}$
GE	B&W	DU-0.2	16	801	$2.6x10^{-5}$	$4.0x10^{-4}$	$8.3x10^{-4}$	$1.1x10^{-3}$	$3.0x10^{-4}$	$5.0x10^{-5}$	$2.7x10^{-3}$
GE	NFS	DU-0.2	16	860	$2.8x10^{-5}$	$4.3x10^{-4}$	$8.3x10^{-4}$	$1.1x10^{-3}$	$3.2x10^{-4}$	$6.1x10^{-5}$	$2.8x10^{-3}$
GE	SRS	DU-0.2	16	596	$1.9x10^{-5}$	$3.1x10^{-4}$	$8.1x10^{-4}$	$8.0x10^{-4}$	$2.3x10^{-4}$	$4.4x10^{-5}$	$2.2x10^{-3}$
GE	Y–12	DU-0.2	16	791	$2.6x10^{-5}$	$4.0x10^{-4}$	$8.3x10^{-4}$	$1.1x10^{-3}$	$3.0x10^{-4}$	$5.3x10^{-5}$	$2.7x10^{-3}$

Table G.1–6. Annual Health Effects From Transportation of Uranium Hexafluoride, Uranium Oxide, and Metal Blendstock—Continued

Origin	Destination	Material	Shipments[c] (per year)	Distance (km)	Radiological[a] Accident	Radiological[a] Accident-Free Public	Radiological[a] Accident-Free Crew	Nonradiological[b] Accident Public	Nonradiological[b] Accident Crew	Nonradiological[b] Air Pollution	Total Health Effect[d]
Metal											
Fernald	Y–12	DU-0.2	20	466	2.0×10^{-5}	3.2×10^{-4}	1.0×10^{-3}	7.4×10^{-4}	2.1×10^{-4}	2.2×10^{-5}	2.3×10^{-3}
[Text deleted.]											

[a] Cancer fatalities.

[b] Fatalities.

[c] A shipment is a truckload.

[d] Estimated fatalities per year.

Note: GE=General Electric Wilmington.

Source: RADTRAN model results.

Table G.1–7. Annual Health Effects From Transportation of Fuel Feed Material and Low-Level Waste From the Blending Plant to Destination

Origin	Destination	Distance (km)	Radiological[a] Accident	Radiological[a] Accident-Free Public	Radiological[a] Accident-Free Crew	Nonradiological[b] Accident Public	Nonradiological[b] Accident Crew	Nonradiological[b] Air Pollution	Total Health Effect[c]
Uranyl Nitrate Hexahydrate[d] (4-Percent Enrichment)									
B&W	ABB-CE	1,301	1.2×10^{-4}	2.7×10^{-3}	3.8×10^{-3}	7.1×10^{-3}	2.0×10^{-3}	3.1×10^{-4}	1.6×10^{-2}
B&W	B&W	0	0	2.3×10^{-4}	3.4×10^{-3}	0	0	0	3.6×10^{-3}
B&W	GE	801	6.4×10^{-5}	1.8×10^{-3}	3.6×10^{-3}	4.6×10^{-3}	1.3×10^{-3}	2.1×10^{-4}	1.2×10^{-2}
B&W	SNPC	4,422	2.8×10^{-4}	8.6×10^{-3}	4.7×10^{-3}	2.7×10^{-2}	7.7×10^{-3}	8.7×10^{-4}	4.9×10^{-2}
B&W	WCFF	607	4.9×10^{-5}	1.4×10^{-3}	3.6×10^{-3}	3.5×10^{-3}	9.9×10^{-4}	1.5×10^{-4}	9.6×10^{-3}
NFS	ABB-CE	1,095	9.7×10^{-5}	2.3×10^{-3}	3.7×10^{-3}	6.0×10^{-3}	1.7×10^{-3}	2.3×10^{-4}	1.4×10^{-2}
NFS	B&W	595	5.0×10^{-5}	1.4×10^{-3}	3.6×10^{-3}	3.3×10^{-3}	9.4×10^{-4}	9.2×10^{-5}	9.3×10^{-3}
NFS	GE	860	6.8×10^{-5}	1.9×10^{-3}	3.6×10^{-3}	5.1×10^{-3}	1.4×10^{-3}	2.7×10^{-4}	1.2×10^{-2}
NFS	SNPC	4,216	2.5×10^{-4}	8.2×10^{-3}	4.6×10^{-3}	2.6×10^{-2}	7.4×10^{-3}	8.3×10^{-4}	4.7×10^{-2}
NFS	WCFF	519	4.1×10^{-5}	1.2×10^{-3}	3.5×10^{-3}	3.0×10^{-3}	8.5×10^{-4}	1.5×10^{-4}	8.8×10^{-3}

Table G.1–7. Annual Health Effects From Transportation of Fuel Feed Material and Low-Level Waste From the Blending Plant to Destination—Continued

Origin	Destination	Distance (km)	Radiological[a] Accident	Radiological[a] Accident-Free Public	Radiological[a] Accident-Free Crew	Nonradiological[b] Accident Public	Nonradiological[b] Accident Crew	Nonradiological[b] Air Pollution	Total Health Effect[c]
SRS	ABB-CE	1,321	1.1×10^{-4}	2.7×10^{-3}	3.8×10^{-3}	7.4×10^{-3}	2.1×10^{-3}	3.5×10^{-4}	1.7×10^{-2}
SRS	B&W	705	5.7×10^{-5}	1.6×10^{-3}	3.6×10^{-3}	4.1×10^{-3}	1.2×10^{-3}	1.9×10^{-4}	1.1×10^{-2}
SRS	GE	596	4.7×10^{-5}	1.4×10^{-3}	3.6×10^{-3}	3.5×10^{-3}	1.0×10^{-3}	1.9×10^{-4}	9.6×10^{-3}
SRS	SNPC	4,442	2.7×10^{-4}	8.6×10^{-3}	4.6×10^{-3}	2.7×10^{-2}	7.8×10^{-3}	9.3×10^{-4}	5.0×10^{-2}
SRS	WCFF	98	7.7×10^{-6}	4.1×10^{-4}	3.4×10^{-3}	5.7×10^{-4}	1.6×10^{-4}	3.2×10^{-5}	4.6×10^{-3}
Y–12	ABB-CE	848	7.6×10^{-5}	1.9×10^{-3}	3.6×10^{-3}	4.7×10^{-3}	1.3×10^{-3}	1.9×10^{-4}	1.2×10^{-2}
Y–12	B&W	526	4.4×10^{-5}	1.2×10^{-3}	3.5×10^{-3}	3.0×10^{-3}	8.3×10^{-4}	8.1×10^{-5}	8.7×10^{-3}
Y–12	GE	791	6.3×10^{-5}	1.7×10^{-3}	3.6×10^{-3}	4.6×10^{-3}	1.3×10^{-3}	2.3×10^{-4}	1.2×10^{-2}
Y–12	SNPC	3,969	2.4×10^{-4}	7.7×10^{-3}	4.5×10^{-3}	2.5×10^{-2}	7.0×10^{-3}	7.8×10^{-4}	4.5×10^{-2}
Y–12	WCFF	450	3.6×10^{-5}	1.1×10^{-3}	3.5×10^{-3}	2.6×10^{-3}	7.3×10^{-4}	1.2×10^{-4}	8.1×10^{-3}
Uranyl Nitrate Hexahydrate[e] (0.9-Percent Enrichment)									
Y–12	NTS	3,181	7.9×10^{-5}	3.6×10^{-3}	2.5×10^{-3}	1.1×10^{-2}	3.2×10^{-3}	2.8×10^{-4}	2.1×10^{-2}
SRS	NTS	3,654	9.6×10^{-5}	4.1×10^{-3}	2.5×10^{-3}	1.3×10^{-2}	3.7×10^{-3}	3.5×10^{-4}	2.4×10^{-2}
B&W	NTS	3,715	1.0×10^{-4}	4.2×10^{-3}	2.6×10^{-3}	1.3×10^{-2}	3.8×10^{-3}	5.1×10^{-4}	2.4×10^{-2}
NFS	NTS	3,428	9.2×10^{-5}	3.8×10^{-3}	2.5×10^{-3}	1.2×10^{-2}	3.4×10^{-3}	3.0×10^{-4}	2.2×10^{-2}
Uranium Hexafluoride[f] (4-Percent Enrichment)									
B&W	ABB-CE	1,301	4.7×10^{-5}	7.8×10^{-4}	1.0×10^{-3}	2.0×10^{-3}	5.8×10^{-4}	8.9×10^{-5}	4.6×10^{-3}
B&W	B&W	0	0	6.5×10^{-5}	9.6×10^{-4}	0	0	0	1.0×10^{-3}
B&W	GE	801	2.5×10^{-5}	4.9×10^{-4}	1.0×10^{-3}	1.3×10^{-3}	3.7×10^{-4}	6.1×10^{-5}	3.3×10^{-3}
B&W	SNPC	4,422	1.1×10^{-4}	2.5×10^{-3}	1.3×10^{-3}	7.7×10^{-3}	2.2×10^{-3}	2.5×10^{-4}	1.4×10^{-2}
B&W	WCFF	607	1.9×10^{-5}	4.0×10^{-4}	1.0×10^{-3}	1.0×10^{-3}	2.8×10^{-4}	4.4×10^{-5}	2.8×10^{-3}
NFS	ABB-CE	1,095	3.8×10^{-5}	6.7×10^{-4}	1.1×10^{-3}	1.7×10^{-3}	4.9×10^{-4}	6.6×10^{-5}	4.1×10^{-3}
NFS	B&W	595	2.0×10^{-5}	3.9×10^{-4}	1.0×10^{-3}	9.5×10^{-4}	2.7×10^{-4}	2.6×10^{-5}	2.7×10^{-3}
NFS	GE	860	2.7×10^{-5}	5.3×10^{-4}	1.0×10^{-3}	1.4×10^{-3}	4.1×10^{-4}	7.6×10^{-5}	3.5×10^{-3}
NFS	SNPC	4,216	9.9×10^{-5}	2.3×10^{-3}	1.3×10^{-3}	7.5×10^{-3}	2.1×10^{-3}	2.4×10^{-4}	1.4×10^{-2}
NFS	WCFF	519	1.6×10^{-5}	3.5×10^{-4}	1.0×10^{-3}	8.6×10^{-4}	2.4×10^{-4}	4.4×10^{-5}	2.5×10^{-3}

Table G.1–7. Annual Health Effects From Transportation of Fuel Feed Material and Low-Level Waste From the Blending Plant to Destination—Continued

Origin	Destination	Distance (km)	Radiological[a] Accident	Radiological[a] Accident-Free Public	Radiological[a] Accident-Free Crew	Nonradiological[b] Accident Public	Nonradiological[b] Accident Crew	Nonradiological[b] Air Pollution	Total Health Effect[c]
Metal[g] (0.9-Percent Enrichment)									
Y–12	NTS	3,181	$1.2x10^{-4}$	$5.2x10^{-3}$	$3.6x10^{-3}$	$1.7x10^{-2}$	$4.8x10^{-3}$	$4.1x10^{-4}$	$3.1x10^{-2}$
[Text deleted.]									

[a] Cancer fatalities.

[b] Fatalities.

[c] Estimated fatalities per year.

[d] There would be 70 shipments (truckloads) per year.

[e] There would be 40 shipments per year.

[f] There would be 20 shipments per year.

[g] There would be 59 shipments per year.

Note: ABB-CE=Asea Brown-Boveri Combustion Engineering; GE=General Electric Wilmington; SNPC=Siemans Nuclear Power Corporation; WCFF=Westinghouse Columbia Fuel Facility.

Source: RADTRAN model results.

Table G.1–8. Cumulative Annual Health Impacts From Transportation of Highly Enriched Uranium and Other Materials for Each Blending Option

Origin of Blending Material	Conversion Site	Blending Site	Destination[c]	Radiological[a] Accident	Radiological[a] Accident-Free Public	Radiological[a] Accident-Free Crew	Nonradiological[b] Accident Public	Nonradiological[b] Accident Crew	Nonradiological[b] Air Pollution	Total Health Effect[d]
UNH Blending to Fuel Feed Material										
Paducah	GE	B&W	ABB-CE	$1.7x10^{-4}$	$4.1x10^{-3}$	$6.1x10^{-3}$	$1.1x10^{-2}$	$3.0x10^{-3}$	$4.6x10^{-4}$	$2.4x10^{-2}$
Paducah	GE	B&W	B&W	$4.7x10^{-5}$	$1.6x10^{-3}$	$5.6x10^{-3}$	$3.5x10^{-3}$	$1.0x10^{-3}$	$1.5x10^{-4}$	$1.2x10^{-2}$
Paducah	GE	B&W	GE	$1.1x10^{-4}$	$3.1x10^{-3}$	$5.9x10^{-3}$	$8.2x10^{-3}$	$2.3x10^{-3}$	$3.6x10^{-4}$	$2.0x10^{-2}$
Paducah	GE	B&W	SNPC	$3.2x10^{-4}$	$9.9x10^{-3}$	$6.9x10^{-3}$	$3.1x10^{-2}$	$8.7x10^{-3}$	$1.0x10^{-3}$	$5.8x10^{-2}$
Paducah	GE	B&W	WCFF	$9.6x10^{-5}$	$2.7x10^{-3}$	$5.8x10^{-3}$	$7.0x10^{-3}$	$2.0x10^{-3}$	$3.0x10^{-4}$	$1.8x10^{-2}$

Table G.1–8. Cumulative Annual Health Impacts From Transportation of Highly Enriched Uranium and Other Materials for Each Blending Option—Continued

Origin of Blending Material	Conversion Site	Blending Site	Destination[c]	Radiological[a]			Nonradiological[b]			Total Health Effect[d]
				Accident	Accident-Free		Accident		Air Pollution	
					Public	Crew	Public	Crew		
UNH Blending to Fuel Feed Material (Continued)										
Paducah	GE	B&W	WCFF	9.6×10^{-5}	2.7×10^{-3}	5.8×10^{-3}	7.0×10^{-3}	2.0×10^{-3}	3.0×10^{-4}	1.8×10^{-2}
Paducah	GE	NFS	ABB-CE	1.5×10^{-4}	3.6×10^{-3}	6.0×10^{-3}	9.5×10^{-3}	2.7×10^{-3}	3.9×10^{-4}	2.2×10^{-2}
Paducah	GE	NFS	B&W	9.8×10^{-5}	2.7×10^{-3}	5.8×10^{-3}	6.8×10^{-3}	1.9×10^{-3}	2.5×10^{-4}	1.8×10^{-2}
Paducah	GE	NFS	GE	1.2×10^{-4}	3.2×10^{-3}	5.9×10^{-3}	8.5×10^{-3}	2.4×10^{-3}	4.2×10^{-4}	2.1×10^{-2}
Paducah	GE	NFS	SNPC	3.0×10^{-4}	9.5×10^{-3}	6.9×10^{-3}	3.0×10^{-2}	8.4×10^{-3}	9.8×10^{-4}	5.6×10^{-2}
Paducah	GE	NFS	WCFF	8.9×10^{-5}	2.5×10^{-3}	5.8×10^{-3}	6.5×10^{-3}	1.8×10^{-3}	3.1×10^{-4}	1.7×10^{-2}
Paducah	GE	SRS	ABB-CE	1.5×10^{-4}	4.0×10^{-3}	6.0×10^{-3}	1.1×10^{-2}	3.0×10^{-3}	5.0×10^{-4}	2.5×10^{-2}
Paducah	GE	SRS	B&W	9.7×10^{-5}	2.8×10^{-3}	5.8×10^{-3}	7.3×10^{-3}	2.1×10^{-3}	3.4×10^{-4}	1.9×10^{-2}
Paducah	GE	SRS	GE	8.7×10^{-5}	2.6×10^{-3}	5.8×10^{-3}	6.7×10^{-3}	1.9×10^{-3}	3.4×10^{-4}	1.8×10^{-2}
Paducah	GE	SRS	SNPC	3.1×10^{-4}	9.8×10^{-3}	6.9×10^{-3}	3.1×10^{-2}	8.7×10^{-3}	1.1×10^{-3}	5.8×10^{-2}
Paducah	GE	SRS	WCFF	4.8×10^{-5}	1.6×10^{-3}	5.6×10^{-3}	3.9×10^{-3}	1.1×10^{-3}	1.8×10^{-4}	1.3×10^{-2}
Paducah	GE	Y–12	ABB-CE	1.2×10^{-4}	3.1×10^{-3}	5.9×10^{-3}	8.0×10^{-3}	2.3×10^{-3}	3.4×10^{-4}	2.0×10^{-2}
Paducah	GE	Y–12	B&W	8.9×10^{-5}	2.5×10^{-3}	5.8×10^{-3}	6.2×10^{-3}	1.8×10^{-3}	2.3×10^{-4}	1.7×10^{-2}
Paducah	GE	Y–12	GE	1.1×10^{-4}	3.0×10^{-3}	5.9×10^{-3}	7.9×10^{-3}	2.2×10^{-3}	3.8×10^{-4}	1.9×10^{-2}
Paducah	GE	Y–12	SNPC	2.8×10^{-4}	8.9×10^{-3}	6.8×10^{-3}	2.8×10^{-2}	7.9×10^{-3}	9.2×10^{-4}	5.3×10^{-2}
Paducah	GE	Y–12	WCFF	8.1×10^{-5}	2.3×10^{-3}	5.8×10^{-3}	5.9×10^{-3}	1.7×10^{-3}	2.7×10^{-4}	1.6×10^{-2}
Piketon	GE	B&W	ABB-CE	1.7×10^{-4}	4.1×10^{-3}	6.1×10^{-3}	1.1×10^{-2}	3.0×10^{-3}	4.7×10^{-4}	2.5×10^{-2}
Piketon	GE	B&W	B&W	4.9×10^{-5}	1.6×10^{-3}	5.6×10^{-3}	3.6×10^{-3}	1.0×10^{-3}	1.6×10^{-4}	1.2×10^{-2}
Piketon	GE	B&W	GE	1.1×10^{-4}	3.1×10^{-3}	5.9×10^{-3}	8.2×10^{-3}	2.3×10^{-3}	3.8×10^{-4}	2.0×10^{-2}
Piketon	GE	B&W	SNPC	3.3×10^{-4}	9.9×10^{-3}	7.0×10^{-3}	3.1×10^{-2}	8.7×10^{-3}	1.0×10^{-3}	5.8×10^{-2}
Piketon	GE	B&W	WCFF	9.8×10^{-5}	2.7×10^{-3}	5.8×10^{-3}	7.1×10^{-3}	2.0×10^{-3}	3.1×10^{-4}	1.8×10^{-2}
Piketon	GE	NFS	ABB-CE	1.5×10^{-4}	3.7×10^{-3}	6.0×10^{-3}	9.6×10^{-3}	2.7×10^{-3}	4.0×10^{-4}	2.3×10^{-2}

Table G.1–8. Cumulative Annual Health Impacts From Transportation of Highly Enriched Uranium and Other Materials for Each Blending Option—Continued

Origin of Blending Material	Conversion Site	Blending Site	Destination[c]	Radiological[a]			Nonradiological[b]			Total Health Effect[d]
				Accident	Accident-Free		Accident		Air Pollution	
					Public	Crew	Public	Crew		
UNH Blending to Fuel Feed Material (Continued)										
Piketon	GE	NFS	B&W	9.9×10^{-5}	2.7×10^{-3}	5.8×10^{-3}	6.9×10^{-3}	2.0×10^{-3}	2.6×10^{-4}	1.8×10^{-2}
Piketon	GE	NFS	GE	1.2×10^{-4}	3.2×10^{-3}	5.9×10^{-3}	8.6×10^{-3}	2.4×10^{-3}	4.4×10^{-4}	2.1×10^{-2}
Piketon	GE	NFS	SNPC	3.0×10^{-4}	9.5×10^{-3}	6.9×10^{-3}	3.0×10^{-2}	8.4×10^{-3}	1.0×10^{-3}	5.6×10^{-2}
Piketon	GE	NFS	WCFF	9.1×10^{-5}	2.6×10^{-3}	5.8×10^{-3}	6.6×10^{-3}	1.9×10^{-3}	3.2×10^{-4}	1.7×10^{-2}
Piketon	GE	SRS	ABB-CE	1.6×10^{-4}	4.0×10^{-3}	6.1×10^{-3}	1.1×10^{-2}	3.1×10^{-3}	5.1×10^{-4}	2.5×10^{-2}
Piketon	GE	SRS	B&W	9.9×10^{-5}	2.8×10^{-3}	5.8×10^{-3}	7.4×10^{-3}	2.1×10^{-3}	3.5×10^{-4}	1.9×10^{-2}
Piketon	GE	SRS	GE	8.9×10^{-5}	2.6×10^{-3}	5.8×10^{-3}	6.8×10^{-3}	1.9×10^{-3}	3.6×10^{-4}	1.8×10^{-2}
Piketon	GE	SRS	SNPC	3.2×10^{-4}	9.9×10^{-3}	6.9×10^{-3}	3.1×10^{-2}	8.7×10^{-3}	1.1×10^{-3}	5.8×10^{-2}
Piketon	GE	SRS	WCFF	4.9×10^{-5}	1.7×10^{-3}	5.7×10^{-3}	3.9×10^{-3}	1.1×10^{-3}	1.9×10^{-4}	1.3×10^{-2}
Piketon	GE	Y–12	ABB-CE	1.2×10^{-4}	3.1×10^{-3}	5.9×10^{-3}	8.0×10^{-3}	2.3×10^{-3}	3.5×10^{-4}	2.0×10^{-2}
Piketon	GE	Y–12	B&W	9.1×10^{-5}	2.5×10^{-3}	5.8×10^{-3}	6.3×10^{-3}	1.8×10^{-3}	2.4×10^{-4}	1.7×10^{-2}
Piketon	GE	Y–12	GE	1.1×10^{-4}	3.0×10^{-3}	5.9×10^{-3}	7.9×10^{-3}	2.2×10^{-3}	3.9×10^{-4}	2.0×10^{-2}
Piketon	GE	Y–12	SNPC	2.8×10^{-4}	9.0×10^{-3}	6.8×10^{-3}	2.8×10^{-2}	7.9×10^{-3}	9.4×10^{-4}	5.3×10^{-2}
Piketon	GE	Y–12	WCFF	8.3×10^{-5}	2.4×10^{-3}	5.7×10^{-3}	5.9×10^{-3}	1.7×10^{-3}	2.8×10^{-4}	1.6×10^{-2}
Hanford	-	B&W	ABB-CE	2.3×10^{-4}	4.7×10^{-3}	5.1×10^{-3}	1.3×10^{-2}	3.7×10^{-3}	5.0×10^{-4}	2.7×10^{-2}
Hanford	-	B&W	B&W	1.1×10^{-4}	2.2×10^{-3}	4.7×10^{-3}	6.1×10^{-3}	1.7×10^{-3}	1.9×10^{-4}	1.5×10^{-2}
Hanford	-	B&W	GE	1.7×10^{-4}	3.7×10^{-3}	4.9×10^{-3}	1.1×10^{-2}	3.0×10^{-3}	4.1×10^{-4}	2.3×10^{-2}
Hanford	-	B&W	SNPC	3.9×10^{-4}	1.1×10^{-2}	6.0×10^{-3}	3.3×10^{-2}	9.4×10^{-3}	1.1×10^{-3}	6.1×10^{-2}
Hanford	-	B&W	WCFF	1.6×10^{-4}	3.3×10^{-3}	4.9×10^{-3}	9.5×10^{-3}	2.7×10^{-3}	3.5×10^{-4}	2.1×10^{-2}
Hanford	-	NFS	ABB-CE	2.0×10^{-4}	4.1×10^{-3}	5.0×10^{-3}	1.2×10^{-2}	3.3×10^{-3}	4.1×10^{-4}	2.5×10^{-2}
Hanford	-	NFS	B&W	1.5×10^{-4}	3.2×10^{-3}	4.8×10^{-3}	9.0×10^{-3}	2.6×10^{-3}	2.7×10^{-4}	2.0×10^{-2}
Hanford	-	NFS	GE	1.7×10^{-4}	3.7×10^{-3}	4.9×10^{-3}	1.1×10^{-2}	3.0×10^{-3}	4.5×10^{-4}	2.3×10^{-2}
Hanford	-	NFS	SNPC	3.5×10^{-4}	1.0×10^{-2}	5.9×10^{-3}	3.2×10^{-2}	9.0×10^{-3}	1.0×10^{-3}	5.8×10^{-2}
Hanford	-	NFS	WCFF	1.4×10^{-4}	3.0×10^{-3}	4.8×10^{-3}	8.7×10^{-3}	2.5×10^{-3}	3.3×10^{-4}	2.0×10^{-2}
Hanford	-	SRS	ABB-CE	2.2×10^{-4}	4.7×10^{-3}	5.1×10^{-3}	1.4×10^{-2}	3.8×10^{-3}	5.6×10^{-4}	2.8×10^{-2}
Hanford	-	SRS	B&W	1.7×10^{-4}	3.5×10^{-3}	4.9×10^{-3}	1.0×10^{-2}	2.9×10^{-3}	4.0×10^{-4}	2.2×10^{-2}

Table G.1–8. Cumulative Annual Health Impacts From Transportation of Highly Enriched Uranium and Other Materials for Each Blending Option—Continued

Origin of Blending Material	Conversion Site	Blending Site	Destination[c]	Radiological[a]			Nonradiological[b]			Total Health Effect[d]
				Accident	Accident-Free		Accident		Air Pollution	
					Public	Crew	Public	Crew		
UNH Blending to Fuel Feed Material (Continued)										
Hanford	-	SRS	GE	1.6×10^{-4}	3.3×10^{-3}	4.9×10^{-3}	9.6×10^{-3}	2.7×10^{-3}	4.0×10^{-4}	2.1×10^{-2}
Hanford	-	SRS	SNPC	3.8×10^{-4}	1.1×10^{-2}	6.0×10^{-3}	3.4×10^{-2}	9.5×10^{-3}	1.1×10^{-3}	6.1×10^{-2}
Hanford	-	SRS	WCFF	1.2×10^{-4}	2.4×10^{-3}	4.7×10^{-3}	6.7×10^{-3}	1.9×10^{-3}	2.4×10^{-4}	1.6×10^{-2}
Hanford	-	Y–12	ABB-CE	1.7×10^{-4}	3.5×10^{-3}	4.9×10^{-3}	9.9×10^{-3}	2.8×10^{-3}	3.6×10^{-4}	2.2×10^{-2}
Hanford	-	Y–12	B&W	1.4×10^{-4}	2.9×10^{-3}	4.8×10^{-3}	8.2×10^{-3}	2.3×10^{-3}	2.5×10^{-4}	1.9×10^{-2}
Hanford	-	Y–12	GE	1.6×10^{-4}	3.4×10^{-3}	4.9×10^{-3}	9.9×10^{-3}	2.8×10^{-3}	4.0×10^{-4}	2.2×10^{-2}
Hanford	-	Y–12	SNPC	3.3×10^{-4}	9.4×10^{-3}	5.8×10^{-3}	3.0×10^{-2}	8.5×10^{-3}	9.5×10^{-4}	5.5×10^{-2}
Hanford	-	Y–12	WCFF	1.3×10^{-4}	2.8×10^{-3}	4.8×10^{-3}	7.9×10^{-3}	2.2×10^{-3}	2.9×10^{-4}	1.8×10^{-2}
UNH Blending to LLW										
Paducah	GE	Y–12	NTS	1.4×10^{-4}	4.9×10^{-3}	5.6×10^{-3}	1.5×10^{-2}	4.2×10^{-3}	4.3×10^{-4}	3.0×10^{-2}
Paducah	GE	SRS	NTS	1.5×10^{-4}	5.6×10^{-3}	5.7×10^{-3}	1.7×10^{-2}	4.8×10^{-3}	5.4×10^{-4}	3.4×10^{-2}
Paducah	GE	B&W	NTS	1.6×10^{-4}	5.8×10^{-3}	5.7×10^{-3}	1.8×10^{-2}	5.0×10^{-3}	6.8×10^{-4}	3.5×10^{-2}
Paducah	GE	NFS	NTS	1.6×10^{-4}	5.4×10^{-3}	5.7×10^{-3}	1.6×10^{-2}	4.6×10^{-3}	4.7×10^{-4}	3.2×10^{-2}
Piketon	GE	Y–12	NTS	1.4×10^{-4}	4.9×10^{-3}	5.6×10^{-3}	1.5×10^{-2}	4.2×10^{-3}	4.5×10^{-4}	3.0×10^{-2}
Piketon	GE	SRS	NTS	1.5×10^{-4}	5.7×10^{-3}	5.7×10^{-3}	1.7×10^{-2}	4.9×10^{-3}	5.5×10^{-4}	3.4×10^{-2}
Piketon	GE	B&W	NTS	1.7×10^{-4}	5.9×10^{-3}	5.7×10^{-3}	1.8×10^{-2}	5.0×10^{-3}	7.0×10^{-4}	3.5×10^{-2}
Piketon	GE	NFS	NTS	1.6×10^{-4}	5.4×10^{-3}	5.7×10^{-3}	1.6×10^{-2}	4.6×10^{-3}	4.9×10^{-4}	3.2×10^{-2}
Hanford	-	Y–12	NTS	1.8×10^{-4}	5.4×10^{-3}	4.5×10^{-3}	1.7×10^{-2}	4.8×10^{-3}	4.6×10^{-4}	3.2×10^{-2}
Hanford	-	SRS	NTS	2.0×10^{-4}	6.4×10^{-3}	4.7×10^{-3}	2.0×10^{-2}	5.7×10^{-3}	6.1×10^{-4}	3.8×10^{-2}
Hanford	-	B&W	NTS	2.1×10^{-4}	6.5×10^{-3}	4.7×10^{-3}	2.1×10^{-2}	5.8×10^{-3}	7.3×10^{-4}	3.8×10^{-2}
Hanford	-	NFS	NTS	2.0×10^{-4}	5.9×10^{-3}	4.6×10^{-3}	1.9×10^{-2}	5.2×10^{-3}	5.0×10^{-4}	3.5×10^{-2}

Table G.1–8. Cumulative Annual Health Impacts From Transportation of Highly Enriched Uranium and Other Materials for Each Blending Option—Continued

Origin of Blending Material	Conversion Site	Blending Site	Destination[c]	Radiological[a]			Nonradiological[b]			Total Health Effect[d]
				Accident	Accident-Free		Accident		Air Pollution	
					Public	Crew	Public	Crew		
UF_6 Blending to Fuel Feed Material										
Paducah	-	B&W	ABB-CE	$7.5x10^{-5}$	$3.3x10^{-3}$	$7.6x10^{-3}$	$8.2x10^{-3}$	$2.3x10^{-3}$	$2.6x10^{-4}$	$2.2x10^{-2}$
Paducah	-	B&W	B&W	$2.8x10^{-5}$	$2.6x10^{-3}$	$7.4x10^{-3}$	$6.2x10^{-3}$	$1.8x10^{-3}$	$1.7x10^{-4}$	$1.8x10^{-2}$
Paducah	-	B&W	GE	$5.4x10^{-5}$	$3.0x10^{-3}$	$7.5x10^{-3}$	$7.5x10^{-3}$	$2.1x10^{-3}$	$2.3x10^{-4}$	$2.1x10^{-2}$
Paducah	-	B&W	SNPC	$1.4x10^{-4}$	$5.0x10^{-3}$	$7.8x10^{-3}$	$1.4x10^{-2}$	$4.0x10^{-3}$	$4.2x10^{-4}$	$3.1x10^{-2}$
Paducah	-	B&W	WCFF	$4.8x10^{-5}$	$2.9x10^{-3}$	$7.5x10^{-3}$	$7.2x10^{-3}$	$2.0x10^{-3}$	$2.1x10^{-4}$	$2.0x10^{-2}$
Paducah	-	NFS	ABB-CE	$5.9x10^{-5}$	$2.2x10^{-3}$	$7.4x10^{-3}$	$5.1x10^{-3}$	$1.4x10^{-3}$	$1.6x10^{-4}$	$1.6x10^{-2}$
Paducah	-	NFS	B&W	$4.0x10^{-5}$	$2.0x10^{-3}$	$7.3x10^{-3}$	$4.3x10^{-3}$	$1.2x10^{-3}$	$1.2x10^{-4}$	$1.5x10^{-2}$
Paducah	-	NFS	GE	$4.7x10^{-5}$	$2.1x10^{-3}$	$7.3x10^{-3}$	$4.8x10^{-3}$	$1.4x10^{-3}$	$1.7x10^{-4}$	$1.6x10^{-2}$
Paducah	-	NFS	SNPC	$1.2x10^{-4}$	$3.9x10^{-3}$	$7.6x10^{-3}$	$1.1x10^{-2}$	$3.1x10^{-3}$	$3.3x10^{-4}$	$2.6x10^{-2}$
Paducah	-	NFS	WCFF	$3.6x10^{-5}$	$1.9x10^{-3}$	$7.3x10^{-3}$	$4.2x10^{-3}$	$1.2x10^{-3}$	$1.4x10^{-4}$	$1.5x10^{-2}$
Piketon	-	B&W	ABB-CE	$7.2x10^{-5}$	$3.2x10^{-3}$	$7.5x10^{-3}$	$8.0x10^{-3}$	$2.3x10^{-3}$	$2.7x10^{-4}$	$2.1x10^{-2}$
Piketon	-	B&W	B&W	$2.6x10^{-5}$	$2.5x10^{-3}$	$7.4x10^{-3}$	$5.9x10^{-3}$	$1.7x10^{-3}$	$1.8x10^{-4}$	$1.8x10^{-2}$
Piketon	-	B&W	GE	$5.1x10^{-5}$	$2.9x10^{-3}$	$7.5x10^{-3}$	$7.2x10^{-3}$	$2.1x10^{-3}$	$2.4x10^{-4}$	$2.0x10^{-2}$
Piketon	-	B&W	SNPC	$1.4x10^{-5}$	$4.9x10^{-3}$	$7.8x10^{-3}$	$1.4x10^{-2}$	$3.9x10^{-3}$	$4.3x10^{-4}$	$3.1x10^{-2}$
Piketon	-	B&W	WCFF	$4.5x10^{-5}$	$2.8x10^{-3}$	$7.5x10^{-3}$	$6.9x10^{-3}$	$2.0x10^{-3}$	$2.2x10^{-4}$	$1.9x10^{-2}$
Piketon	-	NFS	ABB-CE	$6.5x10^{-5}$	$2.3x10^{-3}$	$7.4x10^{-3}$	$5.4x10^{-3}$	$1.5x10^{-3}$	$1.9x10^{-4}$	$1.7x10^{-2}$
Piketon	-	NFS	B&W	$4.7x10^{-5}$	$2.1x10^{-3}$	$7.3x10^{-3}$	$4.6x10^{-3}$	$1.3x10^{-3}$	$1.5x10^{-4}$	$1.6x10^{-2}$
Piketon	-	NFS	GE	$5.4x10^{-5}$	$2.2x10^{-3}$	$7.4x10^{-3}$	$5.1x10^{-3}$	$1.4x10^{-3}$	$2.0x10^{-4}$	$1.6x10^{-2}$
Piketon	-	NFS	SNPC	$1.3x10^{-5}$	$4.0x10^{-3}$	$7.6x10^{-3}$	$1.1x10^{-2}$	$3.2x10^{-3}$	$3.6x10^{-4}$	$2.6x10^{-2}$
Piketon	-	NFS	WCFF	$4.3x10^{-5}$	$2.0x10^{-3}$	$7.3x10^{-3}$	$4.5x10^{-3}$	$1.3x10^{-3}$	$1.7x10^{-4}$	$1.5x10^{-2}$
Metal Blending to LLW										
Fernald	-	Y–12	NTS	$1.4x10^{-4}$	$5.7x10^{-3}$	$6.2x10^{-3}$	$1.8x10^{-2}$	$5.0x10^{-3}$	$4.4x10^{-4}$	$3.5x10^{-2}$
[Text deleted.]										

[a] Cancer fatalities.

[b] Fatalities.

[c] Destination is either a fuel fabrication site or NTS for LLW.

G.2 6M, TYPE B RADIOACTIVE MATERIALS SHIPMENT PACKAGING TEST SEQUENCE

In addition to meeting standards demonstrating it can withstand normal conditions of transport without loss or dispersal of its radioactive contents, the model 6M, Type B packaging used for Department of Energy (DOE) shipments must survive certain severe hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and water submersion. Test conditions do not duplicate accident environments but, rather, produce damage equivalent to extreme and unlikely accidents. The 6M, Type B packaging is judged as surviving extreme sequential testing if it retains all its contents except for minuscule allowable releases, and the dose rate outside the packaging does not exceed 1 rem/hr at a distance of 1 m from the package surface. Drum sizes (outer package) can vary from 38 to 416 liters (10 to 110 gallons).

The complete sequence of tests is listed below:

- **Drop Test.** A 9-m (30-ft) drop onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected.

- **Puncture Test.** A 1-m (40-inch) drop onto the upper end of a 15-centimeter (6-inch) diameter solid, vertical, cylindrical, mild steel bar mounted on an essentially unyielding, horizontal surface.

- **Thermal Test.** An exposure for not less than 30 minutes to a heat flux not less than that of a radiation environment of 800 °C (1,475 °F) with an emissivity coefficient of at least 0.9.

- **Water-Immersion Test.** A subjection to water pressure equivalent to immersion under a head of water of at least 15 m (50 ft) for not less than 8 hours.

The regulatory test conditions for the 6M, Type B packaging and other similar packaging are much more demanding than they might appear. For example, an impact on a very hard surface (desert caliche) at over 322 km/hr (200 mph) is not as likely to deform the packaging as would a drop of 9 m (30 ft) onto an unyielding target.

A typical 6M, Type B packaging approved for use by DOE is covered by Certificate of Compliance Number 9965, dated February 16, 1996.

The 6M, Type B packaging is made up of several component parts each playing an integral engineered role in containment and confinement of the radioactive material being shipped. The applicable DOE Safety Analysis Report for Packaging provides additional detail that shows that the package provides a high level of public safety regardless of the accidental conditions it might encounter during transportation. Although 6M, Type B packagings have been involved in severe accidents, the integrity of the packaging has never been compromised.

Appendix H
Federal, State, and Local Agencies/Organizations/Individuals Contacted

This appendix identifies the various agencies contacted during the preparation of the *Disposition of Surplus Highly Enriched Uranium Environmental Impact Statement* (HEU EIS). The various agencies were contacted to actively solicit site-specific data; regulatory compliance requirements; Federal, State, and local laws; or Executive Orders that may be applicable to the proposed alternatives considered in this EIS.

The Department of Energy has also requested certain agencies and organizations to cooperate during the preparation of the HEU EIS. The Environmental Protection Agency and the United States Enrichment Corporation have agreed to cooperate with the Department of Energy and signed memorandums of understanding, which are included in this appendix.

Babcock & Wilcox
Naval Nuclear Fuels Division

Babcock & Wilcox Fuel Company
Commercial Nuclear Fuel Plant

Campbell County, Virginia
Office of County Administrator

City of Greenville, Tennessee
Water Department

City of Jonesborough, Tennessee
Water Department

Commonwealth of Virginia
Department of Environmental Quality
Water Regional Office

Commonwealth of Virginia
Department of Health
Office of Water Programs

Commonwealth of Virginia
Department of Historic Resources

Commonwealth of Virginia
Department of Transportation

Commonwealth of Virginia
Game and Inland Fisheries

Department of Environment and Conservation
Regional Office
Environmental Epidemiological Program

Erwin Chamber of Commerce
Erwin, Tennessee

Erwin Utilities
Erwin, Tennessee

Flood Distribution Center
National Flood Insurance Program

Dr. Kerry Gatlie, M.D.
Tennessee State Health Department, Epidemiology

Health Hazard Control

Lynchburg Airport
Airport Director

Lynchburg Chamber of Commerce
Lynchburg, Virginia

National Climatic Data Center

Nuclear Fuel Services
Erwin, Tennessee

Patrick A. Turri, Epidemiologist
Environmental Epidemiology
Nashville, Tennessee

State of South Carolina
Department of Health and Environmental
Protection Division
Bureau of Air Quality

State of Tennessee
Attorney General's Office
Environmental Protection Division

State of Tennessee
Department of Health and Environment

State of Tennessee
Division of Underground Storage Tanks

State of Tennessee
Department of Transportation
Map Sales Department

State of Tennessee
State Wildlife Division

Tri-Cities Airport
FAA Airport Director

Unicoi County, Tennessee
County Executive, Paul Monk

Unicoi County, Tennessee
Department of Health

U.S. Department of Agriculture
National Resources Conservation Service

U.S. Department of Agriculture
Soil Conservation Service

U.S. Department of Commerce
Federal Emergency Management Agency

U.S. Department of the Interior
Geological Survey
Nashville, Tennessee

U.S. Department of the Interior
Geological Survey
Reston, Virginia

U.S. Department of the Interior
Geological Survey
Richmond, Virginia

U.S. Department of the Interior
National Park Service

U.S. Department of Transportation
Federal Aviation Administration

Virginia Game and Inland Fisheries

Virginia Polytechnic Institute and State University
Department of Crop and Soil Environmental Sciences

Virginia Polytechnic Institute and State University
Virginia Water Resources Research Center

Wayne Scott
Scott's Farm
Erwin, Tennessee

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 21 1995

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

Mr. J. David Nulton, Director
NEPA Compliance and Outreach
Office of Fissile Materials Disposition
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Mr. Nulton:

Thank you for your letter dated May 2, 1995, inviting our participation as a potential cooperating agency in the preparation of the Environmental Impact Statement (EIS) for the Disposition of Surplus Highly Enriched Uranium (HEU). We would be pleased to be a cooperating agency.

In order to define our specific involvement, we have enclosed a Memorandum of Understanding (MOU) to be signed by both agencies. This MOU has been coordinated by the staffs at EPA and DOE. After signature, we request that the MOU be sent to the EPA point of contact. EPA Office of Federal Activities will distribute copies of the MOU internally to the appropriate program offices.

In response to the questions posed in your May 2, 1995, memorandum, we offer the following response. We were asked to comment on the issues identified for analysis and if there were any additional issues. Concerning the EIS alternatives, we suggest that DOE discuss: the form of the material, the location for treatment and storage of the material, any uses of the blended down material, and if applicable, how and where it will be disposed. Through the Clean Water Act Section 102, and the Safe Drinking Water Act Section 1428, states have developed comprehensive state groundwater protection programs and state wellhead protection programs to protect priority areas for future water supplies. We recommend that DOE work with the appropriate state agencies to ensure that adequate groundwater protection approaches are developed in determining the disposal and storage locations for the material.

We appreciate the opportunity to work along with DOE on this project. If you have any questions, please call me at (202) 260-5053. Our staff contact on the issue is Susan Offerdal at (202) 260-5059.

Sincerely,

Richard E. Sanderson
Director
Office of Federal Activities

Enclosure

MEMORANDUM OF UNDERSTANDING BETWEEN THE DEPARTMENT OF ENERGY AND THE ENVIRONMENTAL PROTECTION AGENCY AS A COOPERATING AGENCY ON THE ENVIRONMENTAL IMPACT STATEMENT FOR THE DISPOSITION OF SURPLUS HIGHLY ENRICHED URANIUM

The purpose of this document is to establish a framework for technical cooperation between the Department of Energy (DOE) and the Environmental Protection Agency (EPA) concerning the development of the Environmental Impact Statement (EIS) for the Disposition of Surplus Highly Enriched Uranium (HEU). DOE is the lead agency and EPA is a cooperating agency. When countersigned by both parties, the following paragraphs will provide the basis for the roles between the two agencies as they conduct technical coordination on issues of mutual concern.

This memorandum of understanding (MOU) pertains to the exchange of information on technical issues. It does not abrogate, alter, or in any way modify existing or future environmental compliance or cleanup agreements, other enforceable agreements, any permitting or regulatory requirement, or enforcement actions. Further, it will not alter EPA's responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act to provide scoping comments and conduct an official review of the draft and final EIS. This MOU will in no way affect state actions or policy with respect to specific DOE sites. Funds and other resources will not be exchanged as a result of this MOU.

The DOE has responsibility for compliance with the requirements of NEPA and preparation of the draft and final EIS. Accordingly, DOE agrees:

- to provide EPA with EIS information on areas for which DOE would like EPA technical review and comments. These areas include but are not limited to radiation, mixed waste, risk management, transportation, ground water, and NEPA implementation;

- to invite EPA to participate in internal and external meetings concerning areas that DOE would like EPA technical review and comments. These areas include, but are not limited to, radiation, mixed waste, risk management, transportation, ground water, and NEPA implementation;

- to provide copies of the draft and final EIS as soon as practical to allow EPA sufficient time to review and comment on these documents;

Enclosure

NOTE:. The meetings mentioned above will: assist EPA's understanding of the HEU EIS and related issues, assist DOE in early identification and resolution of EPA issues, and thereby expedite review of the draft and final EIS.

to consult with EPA regarding mitigative measures to be included in the EIS;

- to indicate in the draft and final EIS cover page that EPA is a cooperating agency. Also, the draft and final EIS will include, in the introductory section, a statement that describes EPA's role as a cooperating agency, and EPA's NEPA and Section 309 CAA authorities.

The EPA agrees:

- to assist DOE in defining issues and concerns to be addressed in the EIS. This will be done as part of EPA's participation in document review meetings.

- to provide information in those areas that EPA has regulatory authority and/or technical expertise, that include, but are not limited to, radiation, mixed waste, risk management, transportation, ground water, and NEPA implementation.

- to review and comment, in a timely manner, on those sections of the draft and final EIS document where EPA has specific technical expertise and/or regulatory authority.

The Agency points of contact for this MOU are:

EPA	DOE
Mr. Richard E. Sanderson Director Office of Federal Activities Environmental Protection Agency 401 M Street, SW Washington, D.C. 20460	Mr. J. David Nulton Director Office of NEPA Compliance and Outreach Office of Fissile Materials Disposition Department of Energy 1000 Independence Avenue, SW Washington, D.C. 20585
202-260-5053	202-586-4513

This agreement will be effective upon signature by both EPA and DOE. It can be modified by mutual agreement only and in writing. It can be terminated either when the NEPA process is completed (issuance of DOE's record of decision), or when written notice is given by either agency.

EPA Approval:

7/31/95

Richard E. Sanderson
Director
Office of Federal Activities
Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

DOE Approval:

8/4/95

J. David Nulton
Director
Office of NEPA Compliance and Outreach
Office of Fissile Materials Disposition
Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

USEC
United States
Enrichment Corporation

United States
Enrichment Corporation

2 Democracy Center
6903 Rockledge Drive
Bethesda, MD 20817

Tel: (301) 564-3200
Fax: (301) 564-3201

July 21, 1995

Mr. J. David Nulton
Office of Fissile Materials Disposition (MD-1)
Forrestal Building
U. S. Department of Energy
1000 Independence Avenue S.W.
Washington, D.C. 20585

Dear Mr. Nulton:

Enclosed is the signed Memorandum of Understanding concerning cooperation on the Environmental Impact Statement for *Disposition of Highly Enriched Uranium.* We look forward to working with your agency in this important endeavor.

Please contact me at (301) 564-3409 or Patrick Gorman at 564-3412, to discuss matters related to the addressed above.

Sincerely,

T. Michael Taimi
Environmental Policies and Assurances Manager

Enclosure

MEMORANDUM OF UNDERSTANDING BETWEEN THE DEPARTMENT OF ENERGY AND THE UNITED STATES ENRICHMENT CORPORATION FOR COOPERATION ON THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT FOR THE DISPOSITION OF SURPLUS HIGHLY ENRICHED URANIUM

July 7, 1995

The purpose of this document is to establish a framework for technical cooperation between the Department of Energy (DOE) and the United States Enrichment Corporation (USEC) concerning the development of the Environmental Impact Statement (EIS) on the disposition of surplus highly enriched uranium described in DOE's Notice of Intent published in the *Federal Register*. DOE is the lead agency in the preparation of this EIS, with USEC cooperating on relevant portions. When signed by both parties, the following paragraphs will govern the coordination between the two agencies as they conduct technical coordination on issues of mutual concern.

This memorandum of understanding (MOU) pertains to the exchange of information on technical issues. It does not abrogate, alter, or in any way modify existing or future agreements between DOE and USEC or in any way alter their rights or responsibilities. DOE and USEC will each fund their own activities under this MOU and no funds and other resources will be exchanged as a result of this MOU.

The Department has responsibility for compliance with the requirements of NEPA and preparation of the draft and final EIS. Therefore, DOE agrees:

- To provide USEC with information on areas for which DOE would like USEC technical review and comments.
- To invite USEC to participate in internal and external meetings concerning scheduling and in areas for which DOE would like USEC technical review and comments. These technical areas include, but are not limited to, uranium materials, blending services, and transportation.
- To provide copies of all drafts as soon as practical to help allow USEC sufficient time to review and comment on these documents.
- To consult with USEC regarding mitigative measures to be included in the EIS.

The USEC agrees:

- To assist DOE in defining issues and concerns to be addressed in the EIS. This will be done as part of USEC's participation in document review meetings.
- To provide information in those areas that USEC has responsibility and/or technical expertise.
- To review and comment, in a timely manner, on all drafts of the EIS document.

The agency points of contact for this MOU are:

USEC

Mr. T. Michael Taimi
Environmental Assurance and Policies Manager
United States Enrichment Corporation
Two Democracy Center
6903 Rockledge Drive
Bethesda, Maryland 20817

(301) 564-3409

DOE

Mr. J. David Nulton
Director, NEPA Compliance & Outreach
Office of Fissile Materials Disposition
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

(202) 586-4513

This agreement will be effective upon Signature of both USEC and DOE. It can be modified by mutual agreement only and in writing. It can be terminated either when the NEPA process is completed (issuance of DOE's record of decision) or when written notice is give by either agency.

USEC Approval:

Mr. T. Michael Taimi
United States Enrichment Corporation

DOE Approval:

Mr. J. David Nulton
Department of Energy

Appendix I
Applicable Laws, Regulations, and Other Requirements

I.1 INTRODUCTION

This appendix identifies and presents the environmental standards and statutory requirements that may apply to the disposition of surplus highly enriched uranium (HEU). These statutes and regulations provide the standard against which to evaluate the ability of potential blending sites to meet environmental, safety, and health requirements.

Table I.1–1 lists applicable Federal environmental statutes, regulations, and Executive Orders for the proposed action. The table also identifies the associated permit, approval, and consultation requirements generally required to implement any alternative. Table I.1–2 lists applicable State environmental, safety, and health statutes and regulations for Tennessee, South Carolina, Virginia, North Carolina, Ohio, and Kentucky, and Table I.1–3 provides a list of selected Department of Energy (DOE) environment, safety, and health orders.

Table I.1–1. Federal Environmental Statutes, Regulations, and Orders

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	EIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Air Resources	*Clean Air Act*, as amended	42 USC 7401 et seq.	Environmental Protection Agency (EPA)	Requires sources to meet standards and obtain permits to satisfy: National Ambient Air Quality Standards, State Implementation Plans, Standards of Performance for New Stationary Sources, (NESHAP), and Prevention of Significant Deterioration (PSD).
	National Ambient Air Quality Standards (NAAQS/State Implementation Plans	42 USC 7409 et seq.	EPA	Requires compliance with primary and secondary ambient air quality standards governing SO_2, NO_x, CO, O_3, Pb, and PM_{10} and emission limits/reduction measures as designated in each state's State Implementation Plan.
	Standards of Performance for New Stationary Sources	42 USC 7411	EPA	Establishes control/emission standards and recordkeeping requirements for new or modified sources specifically addressed by a standard.
	National Emission Standards for Hazardous Air Pollutants (NESHAP)	42 USC 7412	EPA	Requires sources to comply with emission levels of carcinogenic or mutagenic pollutants; may require a preconstruction approval, depending on the process being considered and the level of emissions that will result from the new or modified source.
	Prevention of Significant Deterioration (PSD)	42 USC 7470 et seq.	EPA	Applies to areas that are in compliance with National Ambient Air Quality Standards (NAAQS). Requires comprehensive preconstruction review and the application of Best Available Control Technology to major stationary sources (emissions of 100 tons/year) and major modifications; requires a preconstruction review of air quality impacts and the issuance of a construction permit from the responsible State agency setting forth emission limitations to protect the PSD increment.
	Noise Control Act of 1972	42 USC 4901 et seq.	EPA	Requires facilities to maintain noise levels that do not jeopardize the health and safety of the public.
Water Resources	*Clean Water Act*	33 USC 1251 et seq.	EPA	Requires EPA or State-issued permits and compliance with provisions of permits regarding discharge of effluents to surface waters.
	National Pollutant Discharge Elimination System (NPDES) (Section 402 of *Clean Water Act*)	33 USC 1342	EPA	Requires permit to discharge effluents (pollutants) to surface waters and stormwaters; permit modifications are required if discharge effluents are altered.
	Dredged or Fill Material - (Section 404 of *Clean Water Act*/*Rivers and Harbors Appropriations Act* of 1899)	33 USC 1344 33 USC 401 et seq.	U.S. Army Corps of Engineers	Requires permits to authorize the discharge of dredged or fill material into navigable waters or wetlands and to authorize certain structures or work in or affecting navigable waters.

Table I.1–1. Federal Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	EIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Water Resources (continued)	*Wild and Scenic Rivers Act*	16 USC 1271 et seq.	Fish and Wildlife Service (USFWS), Bureau of Land Management, Forest Service, National Park Service	Consultation required before construction of any new Federal project associated with a river designated as wild and scenic or under study in order to minimize and mitigate any adverse effects on the physical and biological properties of the river.
	Safe Drinking Water Act	42 USC 300f et seq.	EPA	Requires permits for construction/operation of underground injection wells and subsequent discharging of effluents to ground aquifers.
	Executive Order 11988: Floodplain Management	3 CFR, 1977 Comp., p. 117	Water Resources Council, Federal Emergency Management Agency, Council on Environmental Quality (CEQ)	Requires consultation if project impacts a floodplain.
	Executive Order 11990: Protection of Wetlands	3 CFR, 1977 Comp., p. 121	U.S. Army Corps of Engineers/USFWS	Requires Federal agencies to avoid the long- and short-term adverse impacts associated with the destruction or modification of wetlands.
	Compliance with Floodplain/ Wetlands Environmental Review Requirements	10 CFR 1022	DOE	Requires DOE to comply with all applicable floodplain/wetlands environmental review requirements.
Hazardous Wastes and Soil Resources	*Resource Conservation and Recovery Act* (RCRA)/ Hazardous and Solid Waste Amendments of 1984	42 USC 6901 et seq./PL 98-616	EPA	Requires notification and permits for operations involving hazardous waste treatment, storage, or disposal facilities; changes to site hazardous waste operations could require amendments to RCRA hazardous waste permits involving public hearings.
	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)/*Superfund Amendments and Reauthorization Act* of 1986 (SARA)	42 USC 9601 et seq./PL 99-499	EPA	Requires cleanup and notification if there is a release or threatened release of a hazardous substance; requires DOE to enter into Interagency Agreements with EPA and state to control the cleanup of each DOE site on the National Priorities List (NPL).

Table I.1–1. Federal Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	EIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Hazardous Wastes and Soil Resources (continued)	*Community Environmental Response Facilitation Act*	PL 102-426	EPA	Amends CERCLA (40 CFR 300) to establish a process for identifying, prior to the termination of Federal activities, property that does not contain contamination. Requires prompt identification of parcels that will not require remediation to facilitate the transfer of such property for economic redevelopment purposes.
	Farmland Protection Policy Act of 1981	7 USC 4201 et seq.	Soil Conservation Service	DOE shall avoid any adverse effects to prime and unique farmlands.
	Federal Facility Compliance Act of 1992	42 USC 6961	States	Waives sovereign immunity for Federal facilities under RCRA and requires DOE to develop plans and enter into agreements with states as to specific management actions for specific mixed waste streams.
	Federal Land Policy and Management Act	43 USC 1701	Federal and State land planning agencies	Requires Federal and/or State land-planning agencies to retain Federal ownership of public lands unless it is determined that disposal of such parcel will serve the national interest.
Biotic Resources	*Fish and Wildlife Coordination Act*	16 USC 661 et seq.	USFWS	Requires consultation on the possible effects on wildlife if there is construction, modification, or control of bodies of water in excess of 10 acres in surface area.
	Bald and Golden Eagle Protection Act	16 USC 668 et seq.	USFWS	Consultations should be conducted to determine if any protected birds are found to inhabit the area. If so, DOE must obtain a permit prior to moving any nests due to construction or operation of tritium supply and recycling facilities.
	Migratory Bird Treaty Act	16 USC 703 et seq.	USFWS	Requires consultation to determine if there are any impacts on migrating bird populations due to construction or operation of tritium supply and recycling facilities. If so, DOE will develop mitigation measures to avoid adverse effects.
	Wilderness Act of 1964	16 USC 1131 et seq.	Department of Commerce (DOC) and Department of Interior (DOI)	DOE shall consult with DOC/DOI and minimize impact.
	Wild Free-Roaming Horses and Burros Act of 1971	16 USC 1331 et seq.	DOI	DOE shall consult with DOI and minimize impact.

Table I.1–1. Federal Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	EIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Biotic Resources (continued)	*Endangered Species Act* of 1973	16 USC 1531 et seq.	USFWS/National Marine Fisheries Service	Requires consultation to identify endangered or threatened species and their habitats, assess DOE impacts thereon, obtain necessary biological opinions and, if necessary, develop mitigation measures to reduce or eliminate adverse effects of construction or operation.
Cultural Resources	*National Historic Preservation Act* of 1966, as amended	16 USC 470 et seq.	President's Advisory Council on Historic Preservation	DOE shall consult with the State Historic Preservation Officer (SHPO) prior to construction to ensure that no historical properties will be affected.
	Archaeological and Historical Preservation Act of 1974	16 USC 469 et seq.	DOI	DOE shall obtain authorization for any disturbance of archaeological resources.
	Archaeological Resources Protection Act of 1979	16 USC 470aa et seq.	DOI	DOE shall obtain authorization for any excavation or removal of archaeological resources.
	American Indian Religious Freedom Act of 1978	42 USC 1996	DOI	DOE shall consult with local Native American tribes prior to construction to ensure that their religious customs, traditions, and freedoms are preserved.
	Native American Graves Protection and Repatriation Act of 1990	25 USC 3001	DOI	DOE shall consult with local Native American tribes prior to construction to guarantee that no Native American graves are disturbed.
	Executive Order 11593: Protection and Enhancement of the Cultural Environment	3 CFR 154, 1971-1975 Comp., p. 559	DOI	DOE shall aid in the preservation of historic and archaeological data that may otherwise be lost during construction activities.
Worker Safety and Health	*Occupational Safety and Health Act* (OSHA)	5 USC 5108	OSHA	Agencies shall comply with all applicable worker safety and health legislation (including guidelines of 29 CFR 1960) and prepare, or have available, Material Safety Data Sheets.
	OSHA Guidelines	29 USC 660	OSHA	Agencies shall comply with all applicable worker safety and health legislation (including guidelines of 29 CFR 1960) and prepare, or have available, Material Safety Data Sheets.
	Hazard Communication Standard	29 CFR 1910.1200	OSHA	DOE shall ensure that workers are informed of, and trained to handle, all chemical hazards in the DOE workplace.
Other	*Atomic Energy Act* of 1954	42 USC 2011	DOE	DOE shall follow its own standards and procedures to ensure the safe operation of its facilities.
	National Environmental Policy Act (NEPA)	42 USC 4321 et seq.	CEQ	DOE shall comply with NEPA implementing procedures in accordance with 10 CFR 1021.

Table I.1–1. Federal Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	EIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Other (continued)	*Toxic Substances Control Act* (TSCA)	15 USC 2601 et seq.	EPA	DOE shall comply with inventory reporting requirements and chemical control provisions of TSCA to protect the public from the risks of exposure to chemicals; TSCA imposes strict limitations on use and disposal of PCB-contaminated equipment.
	Hazardous Materials Transport Action Act	49 USC 1801 et seq.	Department of Transportation (DOT)	DOE shall comply with the requirements governing hazardous materials and waste transportation.
	Hazardous Materials Transportation Uniform Safety Act of 1990	49 USC 1801	DOT	Restricts shippers of highway route-controlled quantities of radioactive materials to use only permitted carriers.
	Emergency Planning and Community Right-To-Know Act of 1986	42 USC 11001 et seq.	EPA	Requires the development of emergency response plans and reporting requirements for chemical spills and other emergency release, and imposes right-to-know reporting requirements covering storage and use of chemicals which are reported in toxic chemical release forms.
	Executive Order 12088: Federal Compliance with Pollution Control Standards	3 CFR, 1978 Comp., p. 243	Office of Management and Budget	Requires Federal agency landlords to submit to OMB an annual plan for the control of environmental pollution and to consult with EPA and State agencies regarding the best techniques and methods.
	Executive Order 11514: Protection and Enhancement of Environmental Quality	3 CFR, 1966-1970 Comp., p. 902	CEQ	Requires Federal agencies to demonstrate leadership in achieving the environmental quality goals of NEPA; provides for DOE consultation with appropriate Federal, State, and local agencies in carrying out their activities as they affect the environment.
	Pollution Prevention Act of 1990	42 USC 11001-11050	EPA	Establishes a national policy that pollution should be reduced at the source and requires a toxic chemical source reduction and recycling report for an owner or operator of a facility required to file an annual toxic chemical release form under Section 313 of SARA.
	Executive Order 12114: Environmental Effects Abroad Major Federal Actions	January 4, 1979	Department of State CEQ	Enable responsible officials of Federal agencies having ultimate responsibility for authorizing and approving actions encompassed by this order to be informed of pertinent environmental considerations and to take such considerations into account, with other pertinent considerations of national policy, in making decisions regarding such actions.
	Executive Order 12843: Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances	April 21, 1993	EPA	Requires Federal agencies to minimize procurement of ozone depleting substances and conform their practices to comply with Title VI of *Clean Air Act* Amendments reference stratospheric ozone protection and to recognize the increasingly limited availability of Class I substances until final phaseout.

Table I.1–1. Federal Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	EIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Other (continued)	Executive Order 12856: Federal Compliance with Right-To-Know Laws and Pollution Prevention Requirements	August 3, 1993	EPA	Requires Federal agencies to achieve 50 percent reduction of agency's total releases of toxic chemicals to the environment and offsite transfers, to prepare a written facility pollution prevention plan not later than 1995, and to publicly report toxic chemicals entering any waste stream from Federal facilities, including any releases to the environment, and to improve local emergency planning, response, and accident notification.
	Executive Order 12873: Federal Acquisition, Recycling, and Waste Prevention	October 20, 1993	EPA	Requires Federal agencies to develop affirmative procurement policies and establishes a shared responsibility between the system program manager and the recycling community to effect use of recycled items for procurement.
	Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	February 11, 1994	EPA	Requires Federal agencies to identify and address as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.
	Nuclear Waste Policy Act of 1982	42 USC 10101 et seq.	EPA	DOE shall dispose of radioactive waste per standards of 40 CFR 191.
	Executive Order 10480: Further Providing For the Administration of the Defense Mobilization Program	August 1953	Federal Emergency Management Agency (FEMA)	Delegates to the Director, FEMA, with authority to redelegate, the priorities and allocation functions conferred on the President by Title I of the *Defense Production Act* of 1950, as amended.
	Executive Order 12148: Floodplain Management	July 20, 1979	FEMA	Transferred functions and responsibilities associated with Federal emergency management to the Director, FEMA. The order assigns the director, FEMA, the responsibility to establish Federal policies for and to coordinate all civil defense and civil emergency planning, management, mitigation, and assistance functions of Executive Agencies.
	Executive Order 12472: Assignment of National Security and Emergency Preparedness Telecommunications Functions	April 3, 1984	National Communication System (NCS)	Establishes the NCS. The NCS consists of the telecommunications assets of the entities represented on the NCS of Principals and an administrative structure consisting of the Executive Agent, the NCS Committee of Principals, and the Manager.

Table I.1–1. Federal Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	EIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Other (continued)	Executive Order 12656: Assignment of Emergency Preparedness Responsibilities	May 24, 1977	Var. Agencies	This order assigns emergency preparedness responsibilities to Federal departments and agencies.
	Executive Order 11988: Floodplain Management	3CFR, 1977 Comp., p. 117	Var. Agencies EPA	Directs Federal agencies to establish procedures to ensure that the potential effects of flood hoards and floodplain management are considered for any action undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable.
	Executive Order 12580: Superfund Implementation	January 23, 1987	Var. Agencies	Delegates to the heads of executive departments and agencies the responsibility for undertaking remedial actions for releases, or threatened releases that are not on the National Priority List and removal actions other than emergencies where the release is from any facility under the jurisdiction or control of executive departments and agencies.

Table I.1–2. State Environmental Statutes, Regulations, and Orders

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
Oak Ridge Reservation, and Nuclear Fuel Services, Tennessee				
Air Resources	Tennessee Air Pollution Control Regulations	TN Rules, Division of Air Pollution	TN Air Pollution Control Board	Permit required to construct, modify, or operate an air contaminant source; sets fugitive dust requirements.
Water Resources	*Tennessee Water Quality Control Act*	TN Code, Title 69, Chapter 3	TN Water Quality Control Board	Authority to issue new or modify existing NPDES permits required for a water discharge source.
Hazardous Wastes and Soil Resources	Tennessee Underground Storage Tank Program Regulations	TN Rules, Chapter 1200-1-15	TN Division of Underground Storage Tank Programs	Permit required prior to construction or modification of an underground storage tank.
	Tennessee Hazardous Waste Management Act	TN Code, Title 68, Chapter 46	TN Division of Solid Waste Management	Permit required to construct, modify, or operate a hazardous waste treatment, storage, or disposal facility.
	Tennessee Solid Waste Processing and Disposal Regulations	TN Rules, Chapter 1200-1-7	TN Division of Solid Waste Management	Permit required to construct or operate a solid waste processing or disposal facility.

Table I.1–2. State Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
Biotic Resources	Tennessee State Executive Order on Wetlands	TN State Executive Order	TN Division of Water Quality Control	Consultation with responsible agency.
	Tennessee Threatened Wildlife Species Conservation Act of 1974	TN Code, Title 70, Chapter 8	TN Wildlife Resources Agency	Consultation with responsible agency.
	Tennessee Rare Plant Protection and Conservation Act of 1985	TN Code, Title 70, Chapter 8-301 et seq.	TN Wildlife Resources Agency	Consultation with responsible agency.
	Tennessee Water Quality Control Act	TN Code, Title 69, Chapter 3	TN Division of Water Quality Control	Permit required prior to alteration of a wetland.
Cultural Resources	Tennessee Desecration of Venerated Objects	TN Code, Title 39, Chapter 17-311	TN Historical Commission	Forbids a person to offend or intentionally desecrate venerated objects including a place of worship or burial.
	Tennessee Abuse of Corpse	TN Code, Title 39, Chapter 17-312	TN Historical Commission	Forbids a person from disinterring a corpse that has been buried or otherwise interred.
	Native American Indian Cemetery Removal and Reburial	TN Comp. Rules and Regulations, Chapter 400-9-1	TN Historical Commission	Requires notification if Native American remains are uncovered.
	Tennessee Protective Easements	TN Code, Title 11, Chapter 15-101	TN State Government	Grants power to the state to restrict construction on land deemed as a "protective" easement.
Worker Safety and Health	No State-level legislation identified			
Savannah River Site, South Carolina				
Air Resources	*South Carolina Pollution Control Act*/ South Carolina Air Pollution Control Regulations and Standards	SC Code, Title 48, Chapter 1	SC Department of Health and Environmental Control (SCDHEC)	Permit required prior to construction or modification of an air contaminant source.
	Augusta-Aiken Air Quality Control Region	40 CFR 81.114	SC and GA	Requires Savannah River Site and surrounding communities in the 2-state region to attain NAAQS.
	South Carolina Atomic Energy and Radiation Control Act	SC Code, Title 13, Chapter 7	SCDHEC	Establishes standards for radioactive air emissions.

Table I.1–2. State Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
Water Resources	*South Carolina Pollution Control Act*	SC Code, Title 48, Chapter 1	SCDHEC	Permit required prior to construction or modification of a water discharge source.
	South Carolina Water Quality Standards	SC Code, Title 61, Chapter 68	SCDHEC	Permit required prior to construction or modification of a water discharge source.
	South Carolina Safe Drinking Water Act	SC Code, Title 44, Chapter 55	SCDHEC	Establishes drinking water standards.
Hazardous Wastes and Soil Resources	*South Carolina Underground Storage Tanks Act*	SC Code, Title 44, Chapter 2	SCDHEC	Permit required prior to construction or modification of an underground storage tank.
	South Carolina Solid Waste Regulations	SC Code, Title 61, Chapter 60	SCDHEC	Permit required to store, collect, dispose, or transport solid wastes.
	South Carolina Industrial Solid Waste Disposal Site Regulations	SC Code, Title 61, Chapter 66	SC Pollution Control Authority	Permit required for industrial solid waste disposal systems.
	South Carolina Hazardous Waste Management Act	SC Code, Title 44, Chapter 56	SCDHEC	Permit required to operate, construct, or modify a hazardous waste treatment, storage, or disposal facility.
	South Carolina Solid Waste Management Act	SC Code, Title 44, Chapter 96	SCDHEC	Establishes standards to treat, store, or dispose of solid waste.
Biotic Resources	*South Carolina Nongame and Endangered Species Conservation Act*	SC Code, Title 50, Chapter 15	SC Wildlife and Marine Resources Department	Consult with SC Wildlife and Marine Resources Department and minimize impact.
Cultural Resources	South Carolina Institute of Archaeology and Anthropology	SC Code, Title 60, Chapter 13-210	SC State Historic Preservation Office	Consult with SC State Historic Preservation Officer, and minimize impact.
Worker Safety and Health	No State-level legislation identified			
Babcock & Wilcox, Virginia				
Air Resources	Virginia Air Pollution Control Law	VA Code 10.1-1300 et. seq.	VA Department of Air Pollution Control	Permit required for any new source; operating permit required for any non-exempt source; and performance, monitoring, and reporting required for both new and existing sources.

Table I.1–2. State Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
	State Air Pollution Control Regulations	State Air Pollution Control Board Regulations (SAPCBR) 120	VA State Air Pollution Control Board	Permit required for any new source; operating permit required for any non-exempt source; and performance, monitoring, and reporting required for both new and existing sources.
Water Resources	State Water Control Law	VA Code 62.1	VA Department of Environmental Quality	Permits required for any discharges that fall under the VA NPDES program; VA Pollution Abatement program; Pretreatment program; and the VA Water Protection Program.
	Virginia Regulations	VA Code 680	VA Department of Environmental Quality	Permits required for any discharges that fall under the VA NPDES program; VA Pollution Abatement program; Pretreatment program; and the VA Water Protection Program.
Hazardous Wastes and Soil Resources	*Virginia Waste Management Act*	VA Code 10.1	VA Waste Management Board	Required to identify and properly store, transport, and dispose of hazardous wastes as identified by regulations.
	Virginia Waste Management Regulations	VR 672	VA Department of Waste Management	Required to identify and properly store, transport, and dispose of hazardous wastes as identified by regulations.
	Virginia Erosion and Sediment Act	VA Code 10.1-580-571	VA Department of Conservation and Recreation	Consultation with responsible agency.
Biotic Resources	*Virginia Endangered Species Act*	VA Code 29.1-563-570	VA Department of Game and Inland Fisheries	Adoption of Federal list of threatened and endangered species. Consultation with responsible agency.
	Virginia Endangered Plant and Insect Species Act	VA Code 3.1-1020-1030	VA Department of Agriculture and Consumer Services	Requires contact with endangered species coordinator.
	Virginia Environmental Quality Act	VA Code 10.1-1200-1221	VA Department of Environmental Quality	Consultation with responsible agency.
Worker Safety and Health	State plan state; administers OSHA regulations	NA	VA Department of Labor and Industry	

Table I.1–2. State Environmental Statutes, Regulations, and Orders—Continued

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
Cultural Resources	*Virginia Antiquities Act*	Section 2305	VA Department of Historic Resources	Makes it a felony to remove human remains from a grave without a court order or appropriate permit.
	Cave Protections Act		VA Department of Conservation and Recreation, Natural Heritage Division	Protects all geological, biological, and historical features in caves from vandalism.
North Carolina				
Other Transportation	Complies with Federal laws		VA Division of Solid Waste Management	
Ohio				
Other Transportation	Transportation of Hazardous Waste	Ohio Administrative Code	EPA	Required to properly manage hazardous waste transportation through use of registered haulers, manifests, and recordkeeping.
Kentucky				
Other Transportation	Transportation of Hazardous Waste	401 KAR; Chapter 33	Department of Environmental Protection Division of Waste Management	Required to properly manage hazardous waste transportation through use of registered haulers, manifests, and recordkeeping.

Table I.1–3. Selected Department of Energy Environment, Safety, and Health Orders

DOE Order	Order Title
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
5480.19	Conduct of Operations Requirements for DOE Facilities
5480.20A	Personnel Selection, Qualification, and Training, Requirements for DOE Nuclear Facilities
5480.21	Unreviewed Safety Questions
5480.22	Technical Safety Requirements
5480.23	Nuclear Safety Analysis Reports
5482.1B	Environment, Safety, and Health Appraisal Program
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5530.1A	Accident Response Group
5530.3	Radiological Assistance Program
5530.4	Aerial Measuring System
5530.5	Federal Radiological Monitoring and Assessment Center
5630.12A	Safeguards and Security Inspection and Assessment Program
5632.1C	Protection and Control of Safeguards and Security Interests
5700.6C	Quality Assurance
5820.2A	Radioactive Waste Management
O 151.1	Comprehensive Emergency Management System [Text deleted.]
O 225.1	Accident Investigations
O 231.1	Environment, Safety, and Health Reporting
O 232.1	Occurrence Reporting and Processing of Operations Information
O 420.1	Facility Safety
O 425.1	Startup and Restart of Nuclear Facilities
O 440.1	Worker Protection Management for DOE Federal and Contractor Employees [Text deleted.]
O 451.1	National Environmental Policy Act Compliance Program
O 460.1	Packaging and Transportation Safety
O 460.2	Departmental Materials Transportation and Packaging Management
O 470.1	Safeguards and Security Program

Appendix J
United States Enrichment Corporation Privatization Act

[provisions pertaining to transfers and sales of Russian and Department of Energy uranium]

H.R. 3019, BALANCED BUDGET DOWN PAYMENT ACT (Public Law 104-134, signed April 26, 1996)

TITLE III—RESCISSIONS AND OFFSETS

CHAPTER 1—ENERGY AND WATER DEVELOPMENT

Subchapter A—United States Enrichment Corporation Privatization

SEC. 3101. SHORT TITLE.

This subchapter may be cited as the *USEC Privatization Act.*

SEC. 3112. URANIUM TRANSFERS AND SALES.

(a) Transfers and Sales by the Secretary: The Secretary shall not provide enrichment services or transfer or sell any uranium (including natural uranium concentrates, natural uranium hexafluoride, or enriched uranium in any form) to any person except as consistent with this section.

(b) Russian HEU:

(1) On or before December 31, 1996, the United States Executive Agent under the Russian HEU Agreement shall transfer to the Secretary without charge title to an amount of uranium hexafluoride equivalent to the natural uranium component of low-enriched uranium derived from at least 18 metric tons of highly enriched uranium purchased from the Russian Executive Agent under the Russian HEU Agreement. The quantity of such uranium hexafluoride delivered to the Secretary shall be based on a tails assay of 0.30 [percent] U-235. Uranium hexafluoride transferred to the Secretary pursuant to this paragraph shall be deemed under United States law for all purposes to be of Russian origin.

(2) Within 7 years of the date of enactment of this Act, the Secretary shall sell, and receive payment for, the uranium hexafluoride transferred to the Secretary pursuant to paragraph (1). Such uranium hexafluoride shall be sold—

(A) at any time for use in the United States for the purpose of overfeeding;

(B) at any time for end use outside the United States;

(C) in 1995 and 1996 to the Russian Executive Agent at the purchase price for use in matched sales pursuant to the Suspension Agreement; or,

(D) in calendar year 2001 for consumption by end users in the United States not prior to January 1, 2002, in volumes not to exceed 3,000,000 pounds U_3O_8 equivalent per year.

(3) With respect to all enriched uranium delivered to the United States Executive Agent under the Russian HEU Agreement on or after January 1, 1997, the United States Executive Agent shall, upon request of the Russian Executive Agent, enter into an agreement to deliver concurrently to the Russian Executive Agent an amount of uranium hexafluoride equivalent to the natural uranium component of such uranium. An agreement executed pursuant to a request of the Russian Executive Agent, as contemplated in this paragraph, may pertain to any deliveries due during any period remaining under the Russian HEU Agreement. The quantity of such uranium hexafluoride delivered to the Russian Executive Agent shall be based on a tails assay of 0.30 U-235.

Title to uranium hexafluoride delivered to the Russian Executive Agent pursuant to this paragraph shall transfer to the Russian Executive Agent upon delivery of such material to the Russian Executive Agent, with such delivery to take place at a North American facility designated by the Russian Executive Agent. Uranium hexafluoride delivered to the Russian Executive Agent pursuant to this paragraph shall be deemed under U.S. law for all purposes to be of Russian origin. Such uranium hexafluoride may be sold to any person or entity for delivery and use in the United States only as permitted in subsections (b)(5), (b)(6) and (b)(7) of this section.

(4) In the event that the Russian Executive Agent does not exercise its right to enter into an agreement to take delivery of the natural uranium component of any low-enriched uranium, as contemplated in paragraph (3), within 90 days of the date such low-enriched uranium is delivered to the United States Executive Agent, or upon request of the Russian Executive Agent, then the United States Executive Agent shall engage an independent entity through a competitive selection process to auction an amount of uranium hexafluoride or U_3O_8 (in the event that the conversion component of such hexafluoride has previously been sold) equivalent to the natural uranium component of such low-enriched uranium. An agreement executed pursuant to a request of the Russian Executive Agent, as contemplated in this paragraph, may pertain to any deliveries due during any period remaining under the Russian HEU Agreement. Such independent entity shall sell such uranium hexafluoride in one or more lots to any person or entity to maximize the proceeds from such sales, for disposition consistent with the limitations set forth in this subsection. The independent entity shall pay to the Russian Executive Agent the proceeds of any such auction less all reasonable transaction and other administrative costs. The quantity of such uranium hexafluoride auctioned shall be based on a tails assay of 0.30 U-235. Title to uranium hexafluoride auctioned pursuant to this paragraph shall transfer to the buyer of such material upon delivery of such material to the buyer. Uranium hexafluoride auctioned pursuant to this paragraph shall be deemed under United States law for all purposes to be of Russian origin.

(5) Except as provided in paragraphs (6) and (7), uranium hexafluoride delivered to the Russian Executive Agent under paragraph (3) or auctioned pursuant to paragraph (4), may not be delivered for consumption by end users in the United States either directly or indirectly prior to January 1, 1998, and thereafter only in accordance with the following schedule:

Annual Maximum Deliveries to End Users

Year	(millions of lb U_3O_8 equivalent)
1998	2
1999	4
2000	6
2001	8
2002	10
2003	12
2004	14
2005	16
2006	17
2007	18
2008	19
2009 and each year thereafter	20

(6) Uranium hexafluoride delivered to the Russian Executive Agent under paragraph (3) or auctioned pursuant to paragraph (4) may be sold at any time as Russian-origin natural uranium in a matched sale pursuant to the Suspension Agreement, and in such case shall not be counted against the annual maximum deliveries set forth in paragraph (5).

(7) Uranium hexafluoride delivered to the Russian Executive Agent under paragraph (3) or auctioned pursuant to paragraph (4) may be sold at any time for use in the United States for the purpose of overfeeding in the operations of enrichment facilities.

(8) Nothing in this subsection (b) shall restrict the sale of the conversion component of such uranium hexafluoride.

(9) The Secretary of Commerce shall have responsibility for the administration and enforcement of the limitations set forth in this subsection. The Secretary of Commerce may require any person to

provide any certifications, information, or take any action that may be necessary to enforce these limitations. The United States Customs Service shall maintain and provide any information required by the Secretary of Commerce and shall take any action requested by the Secretary of Commerce which is necessary for the administration and enforcement of the uranium delivery limitations set forth in this section.

(10) The President shall monitor the actions of the United States Executive Agent under the Russian HEU Agreement and shall report to the Congress not later than December 31 of each year on the effect the low-enriched uranium delivered under the Russian HEU Agreement is having on the domestic uranium mining, conversion, and enrichment industries, and the operation of the gaseous diffusion plants. Such report shall include a description of actions taken or proposed to be taken by the President to prevent or mitigate any material adverse impact on such industries or any loss of employment at the gaseous diffusion plants as a result of the Russian HEU Agreement.

(c) Transfers to the Corporation:

(1) The Secretary shall transfer to the Corporation without charge up to 50 metric tons of enriched uranium and up to 7,000 metric tons of natural uranium from the Department of Energy's stockpile, subject to the restrictions in subsection (c)(2).

(2) The Corporation shall not deliver for commercial end use in the United States—

(A) any of the uranium transferred under this subsection before January 1, 1998;

(B) more than 10 percent of the uranium (by uranium hexafluoride equivalent content) transferred under this subsection or more than 4,000,000 pounds, whichever is less, in any calendar year after 1997; or

(C) more than 800,000 separative work units contained in low-enriched uranium transferred under this subsection in any calendar year.

(d) Inventory Sales:

(1) In addition to the transfers authorized under subsections (c) and (e), the Secretary may, from time to time, sell natural and low-enriched uranium (including low-enriched uranium derived from highly enriched uranium) from the Department of Energy's stockpile.

(2) Except as provided in subsections (b), (c), and (e), no sale or transfer of natural or low-enriched uranium shall be made unless—

(A) the President determines that the material is not necessary for national security needs,

(B) the Secretary determines that the sale of the material will not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industry, taking into account the sales of uranium under the Russian HEU Agreement and the Suspension Agreement, and

(C) the price paid to the Secretary will not be less than the fair market value of the material.

(e) Government Transfers: Notwithstanding subsection (d)(2), the Secretary may transfer or sell enriched uranium—

(1) to a Federal agency if the material is transferred for the use of the receiving agency without any resale or transfer to another entity and the material does not meet commercial specifications;

(2) to any person for national security purposes, as determined by the Secretary; or

(3) to any State or local agency or nonprofit, charitable, or educational institution for use other than the generation of electricity for commercial use.

(f) Savings Provision: Nothing in this subchapter shall be read to modify the terms of the Russian HEU Agreement.

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Office of Fissile Materials Disposition, MD-4
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Washington, D.C. 20585

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