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
Washington, DC 20585

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)).

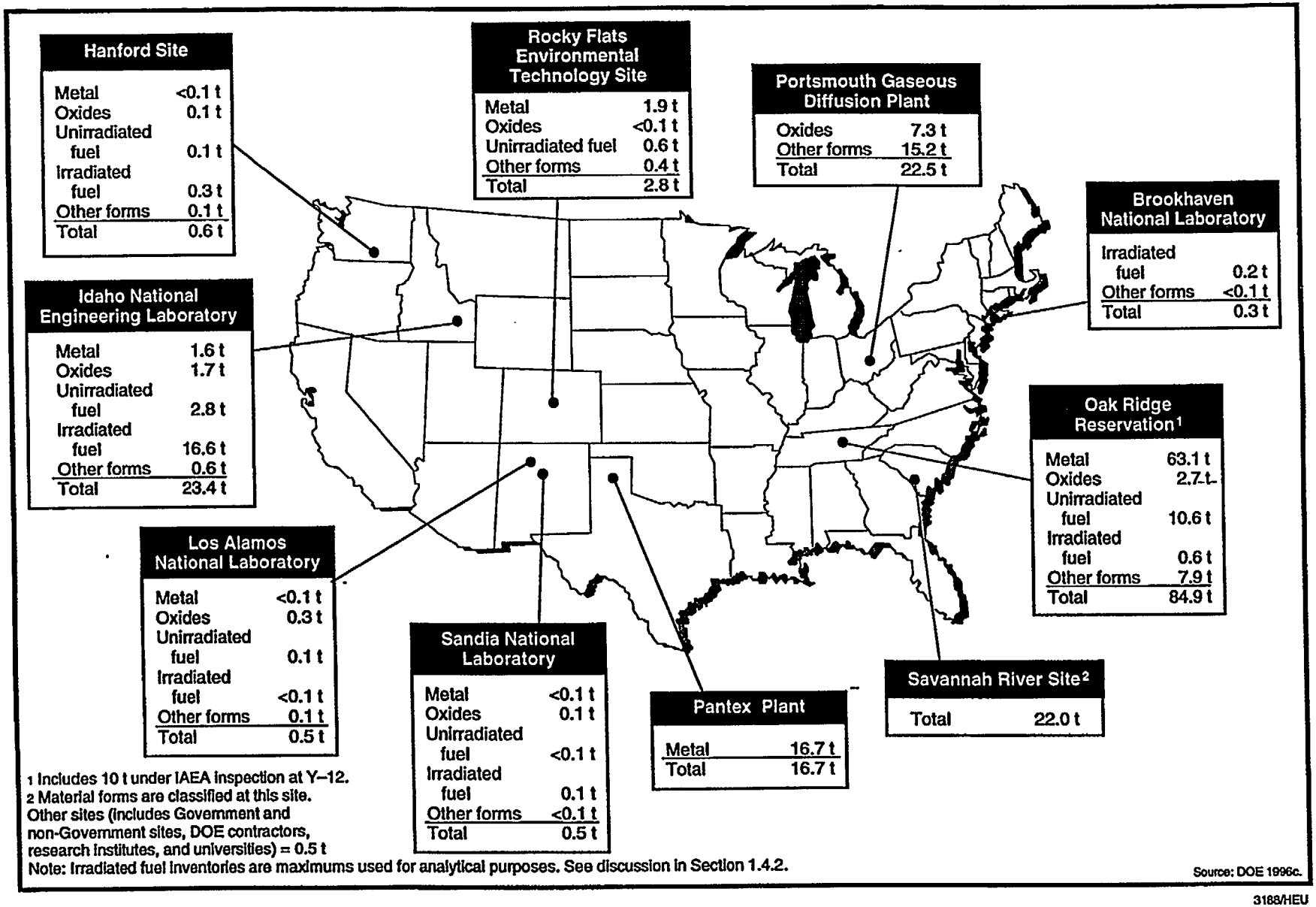

Figure 1.3–1. Locations, Forms, and Amounts of Surplus Highly Enriched Uranium, as of February 6, 1996.

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 r ɔrmal 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.]

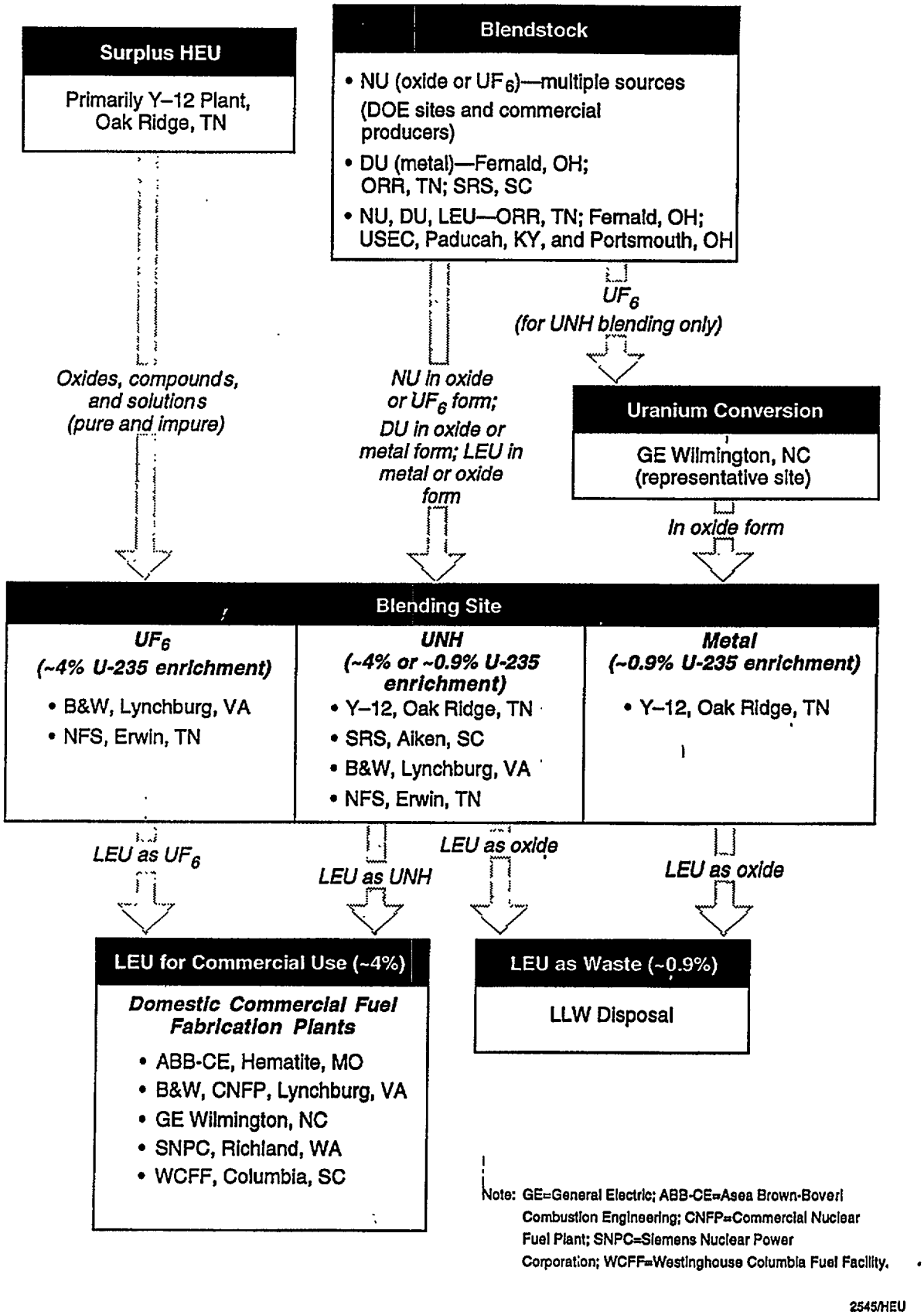

Figure 2.1.1–1. Material Flow Diagram for Surplus Highly Enriched Uranium Disposition.

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.

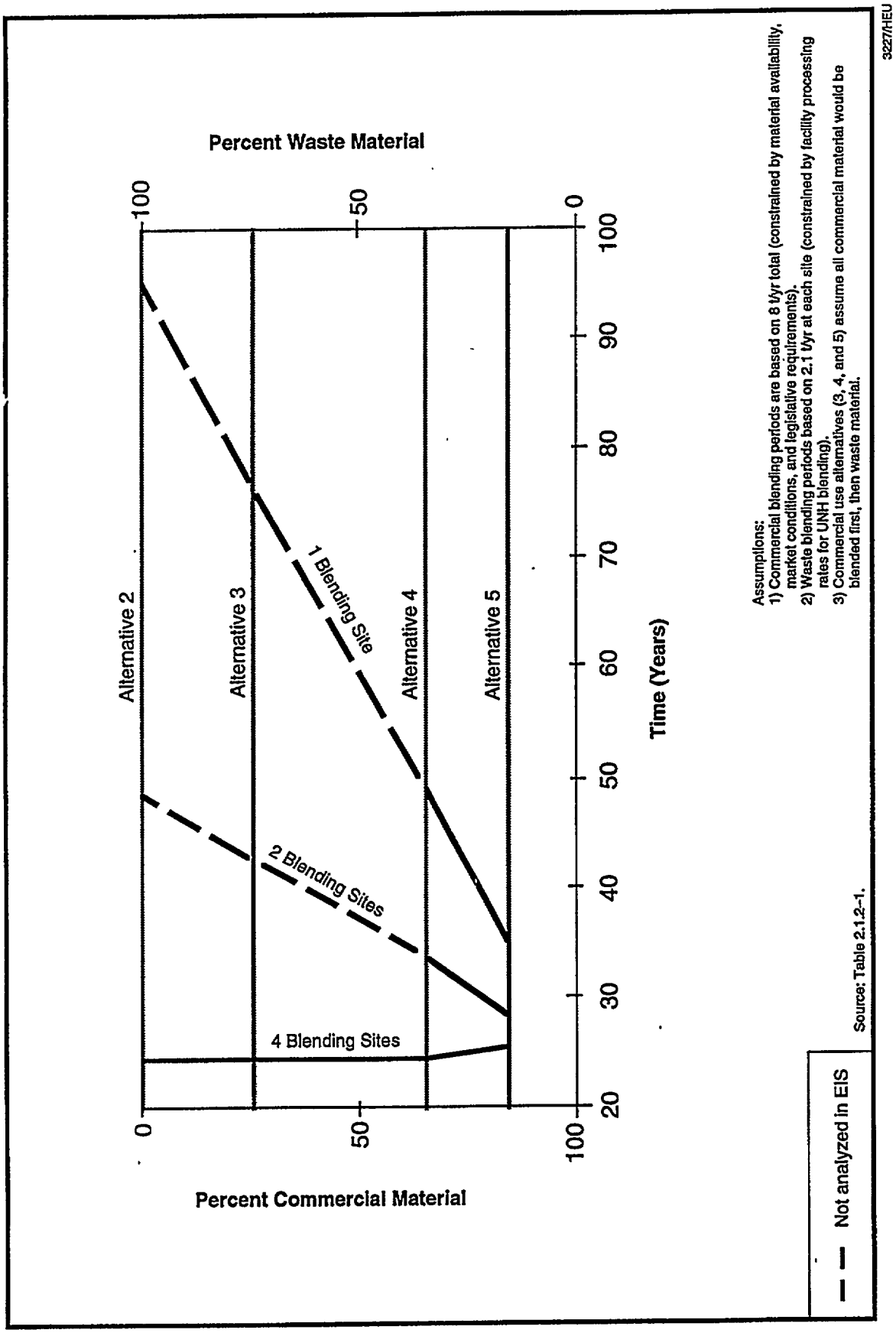

Figure 2.1.2–1. Time Required to Complete Various Alternatives Based on Number of Blending Sites Used.

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.

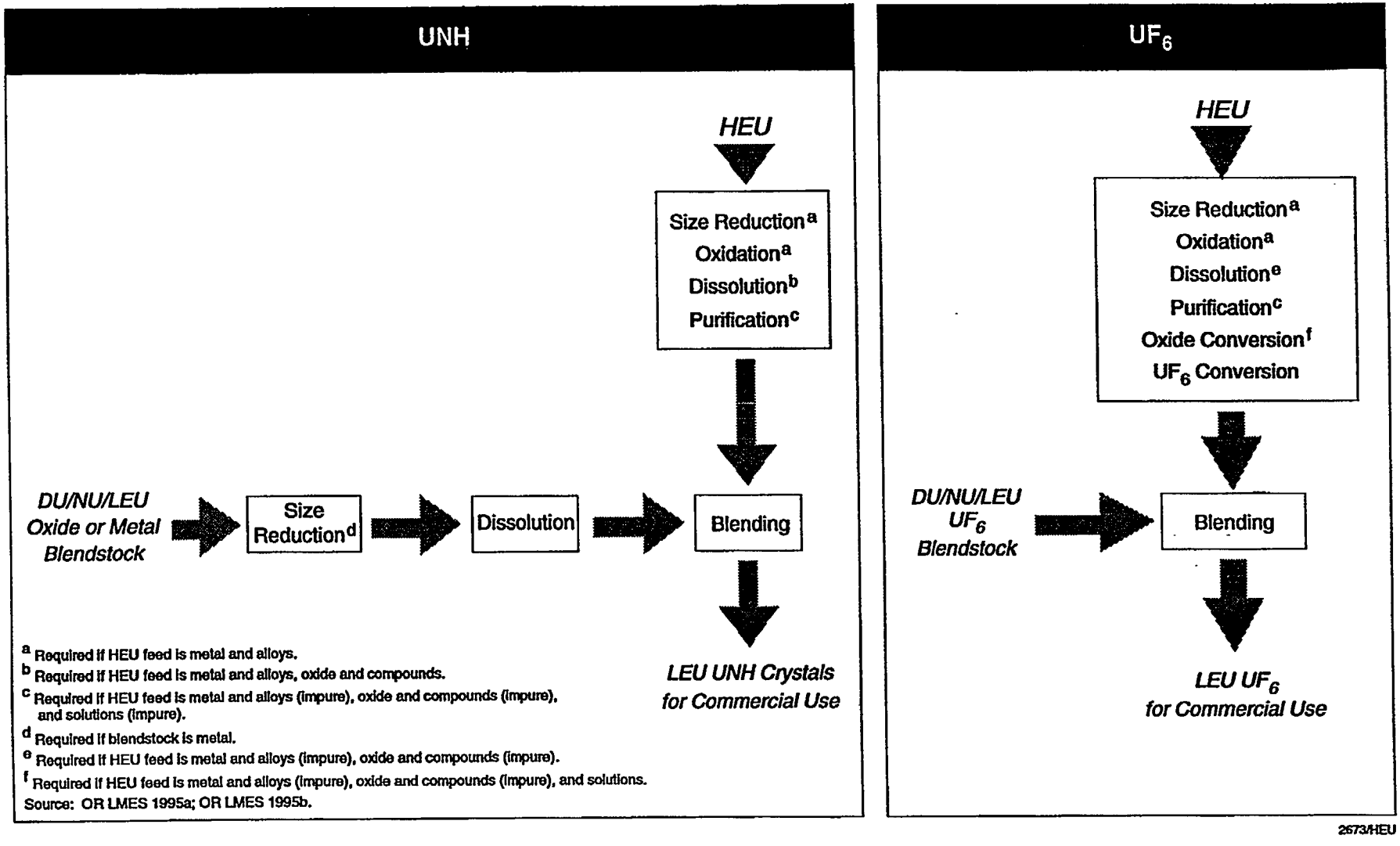


Figure 2.2.2–1. Process Flow Diagram for Commercial Material (applies to off-spec material that would be blended for commercial use).

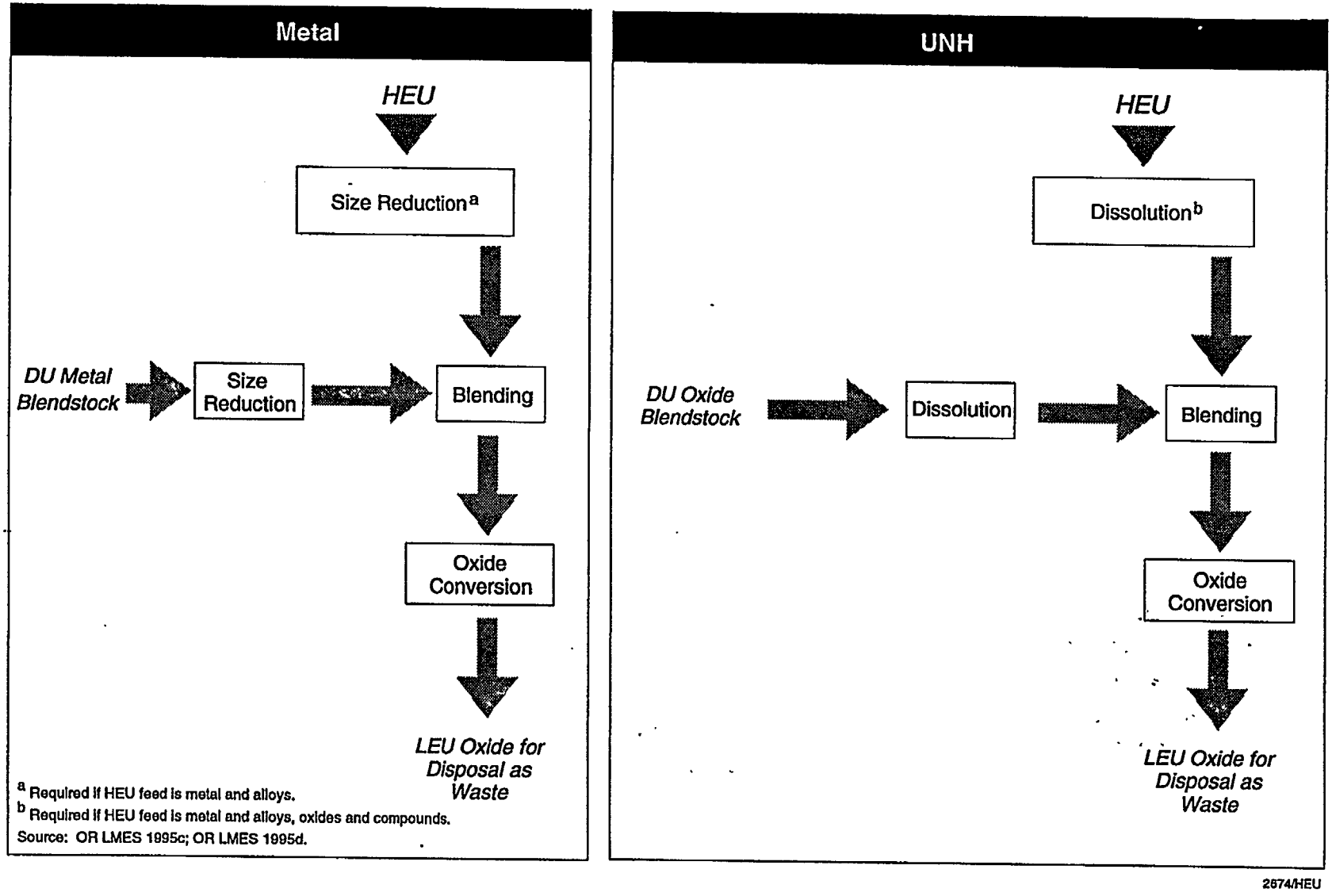


Figure 2.2.2–2. Process Flow Diagram for Non-Commercial Material (applies to off-spec material that would be blended to waste).

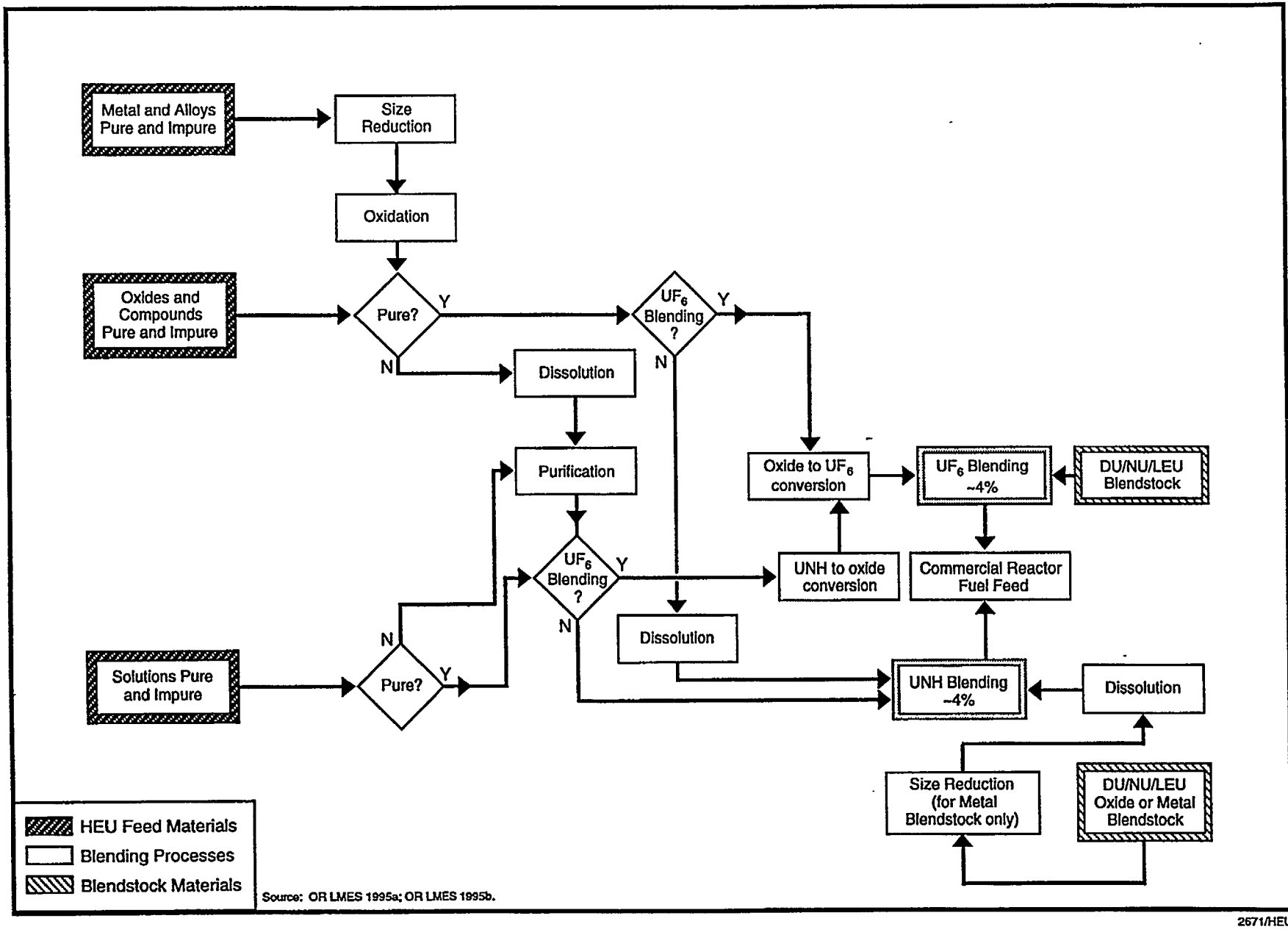


Figure 2.2.2–3. Blending Logic: Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Commercial Fuel (applies to off-spec material that would be blended for commercial use).

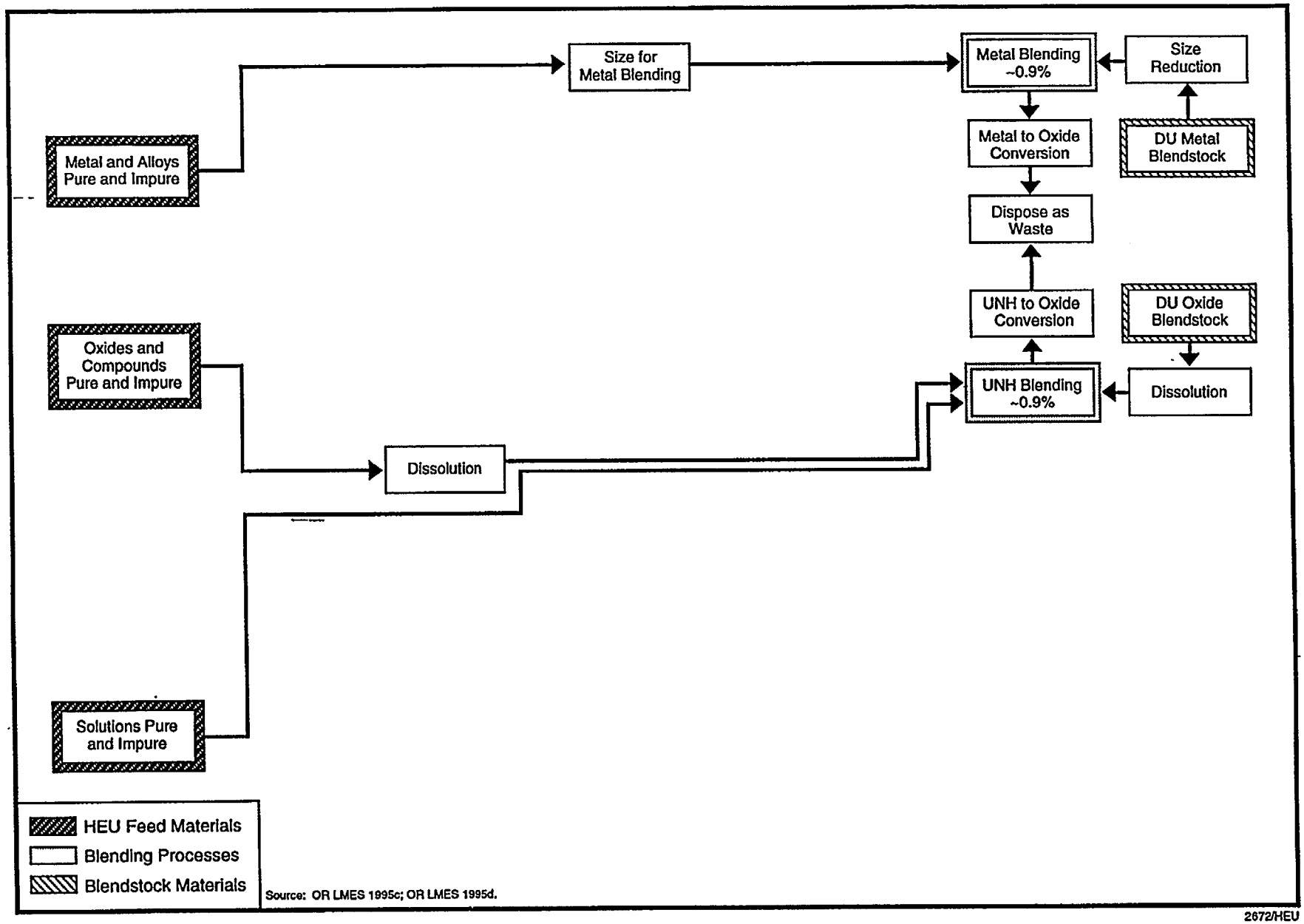


Figure 2.2.2–4. Blending Logic: Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Waste (applies to off-spec material that would be blended to waste).

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

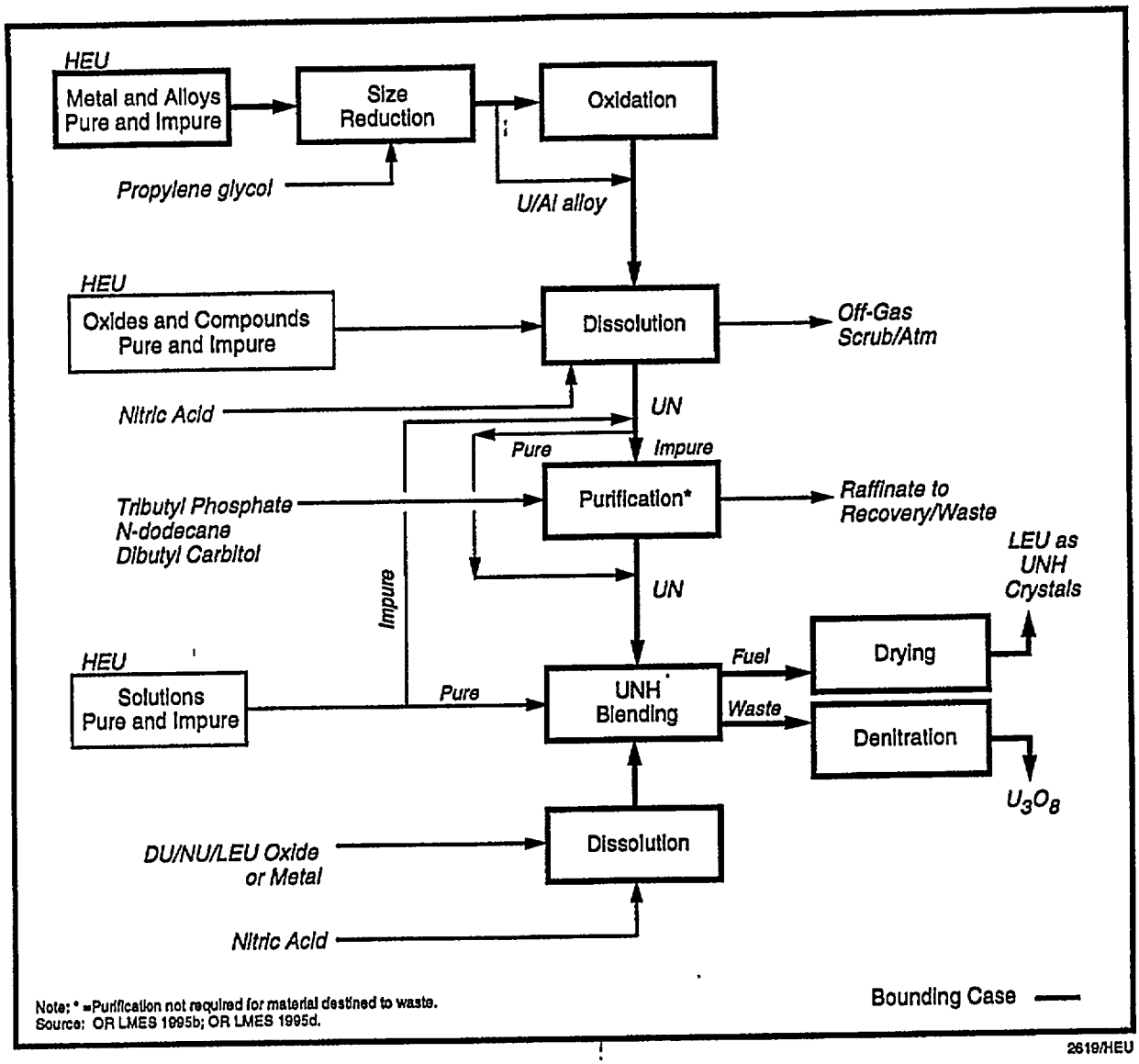


Figure 2.2.2.1–1. Blending Highly Enriched Uranium as Uranyl Nitrate Hexahydrate.

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.)

	4-Percent LEU		0.9-Percent LEU	
Waste Category	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	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)	6.9×10^{-5}	6.9×10^{-5}	6.9×10^{-5}	6.9×10^{-5}
U-238 (Ci/yr)	3.2×10^{-4}	3.2×10^{-4}	3.2×10^{-4}	3.2×10^{-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

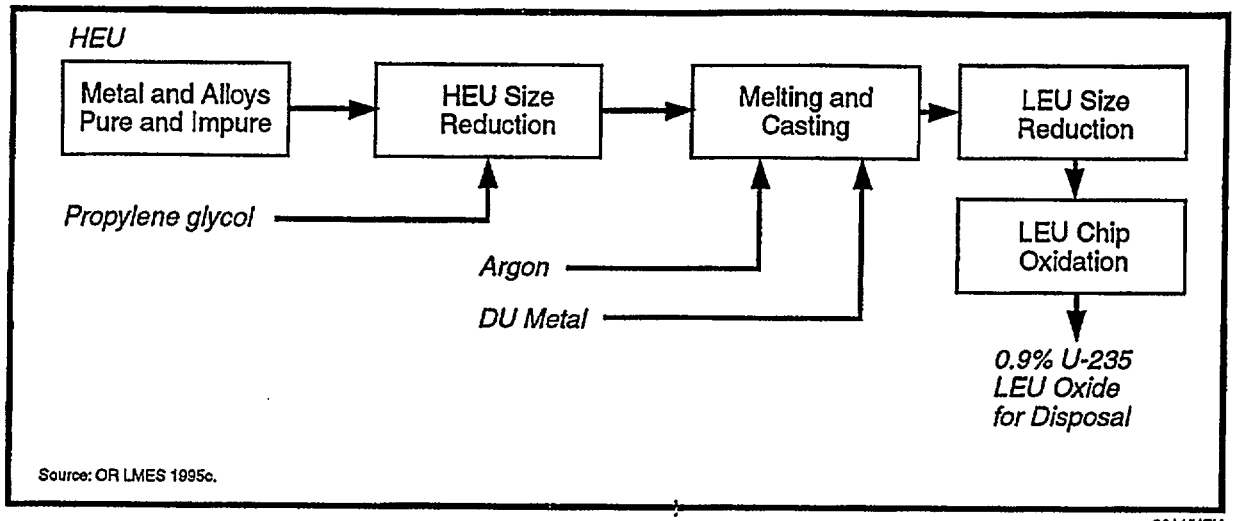


Figure 2.2.2.2–1. Blending Highly Enriched Uranium as Metal.

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

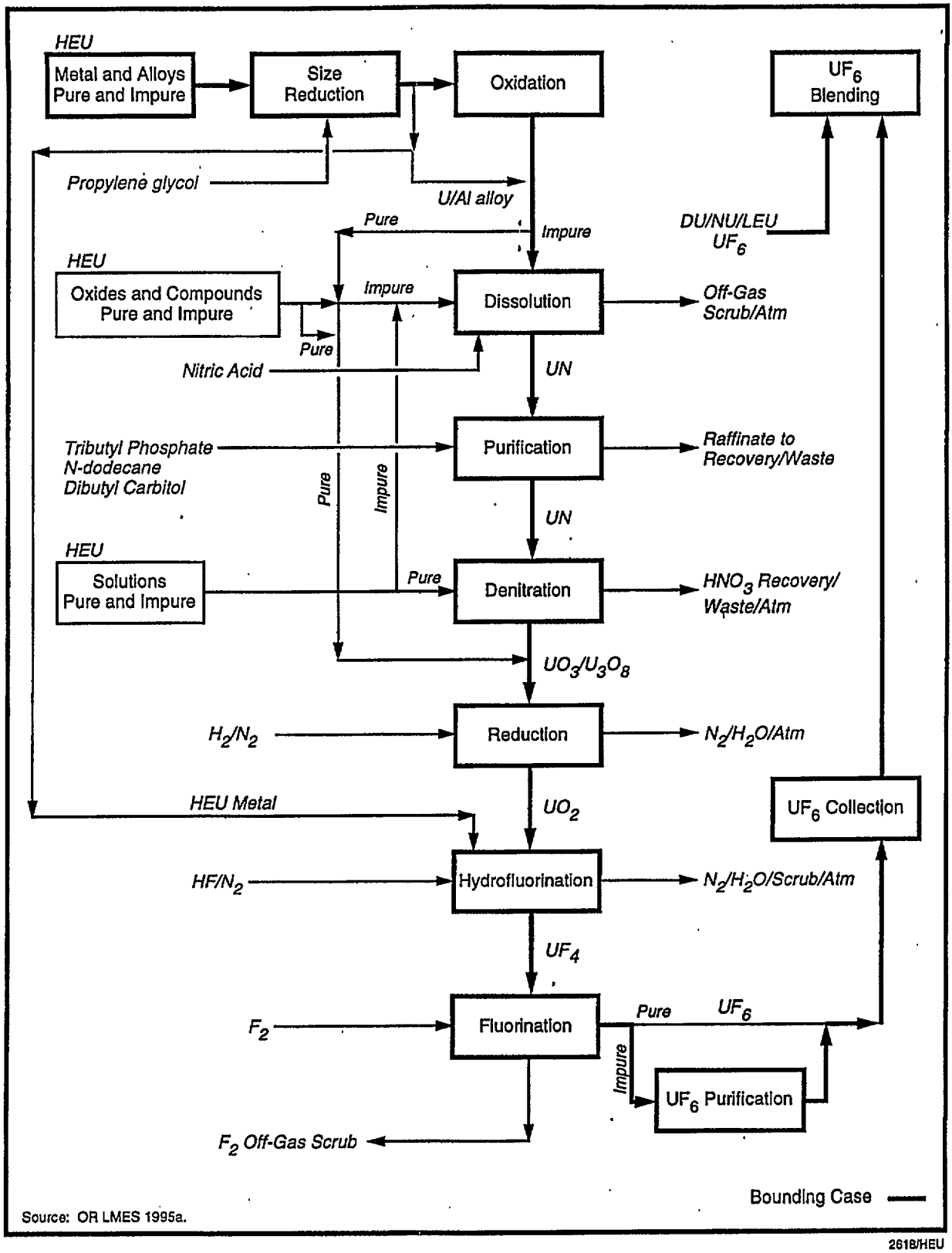


Figure 2.2.2.3–1. Blending Highly Enriched Uranium as Uranium Hexafluoride.

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 (μg/m³)	Y–12 (μg/m³)	SRS (μg/m³)	B&W (μg/m³)	NFS (μg/m³)
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[a]	2.9[c]	[b]	[b]
	12 hours	3.7[c]	[b]	[b]
	8 hours	250[c]	[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

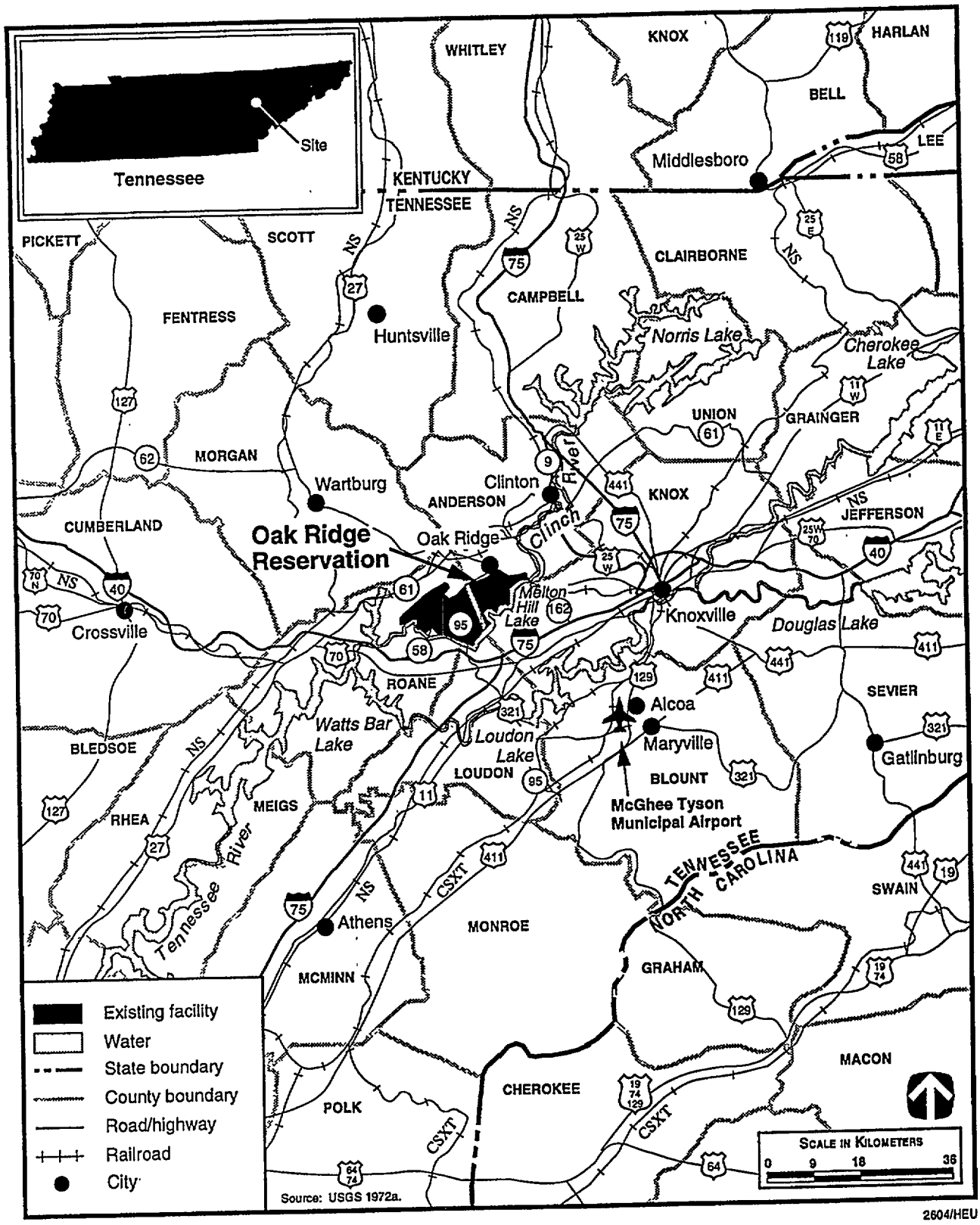


Figure 3.3–1. Oak Ridge Reservation, Tennessee, and Region.

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

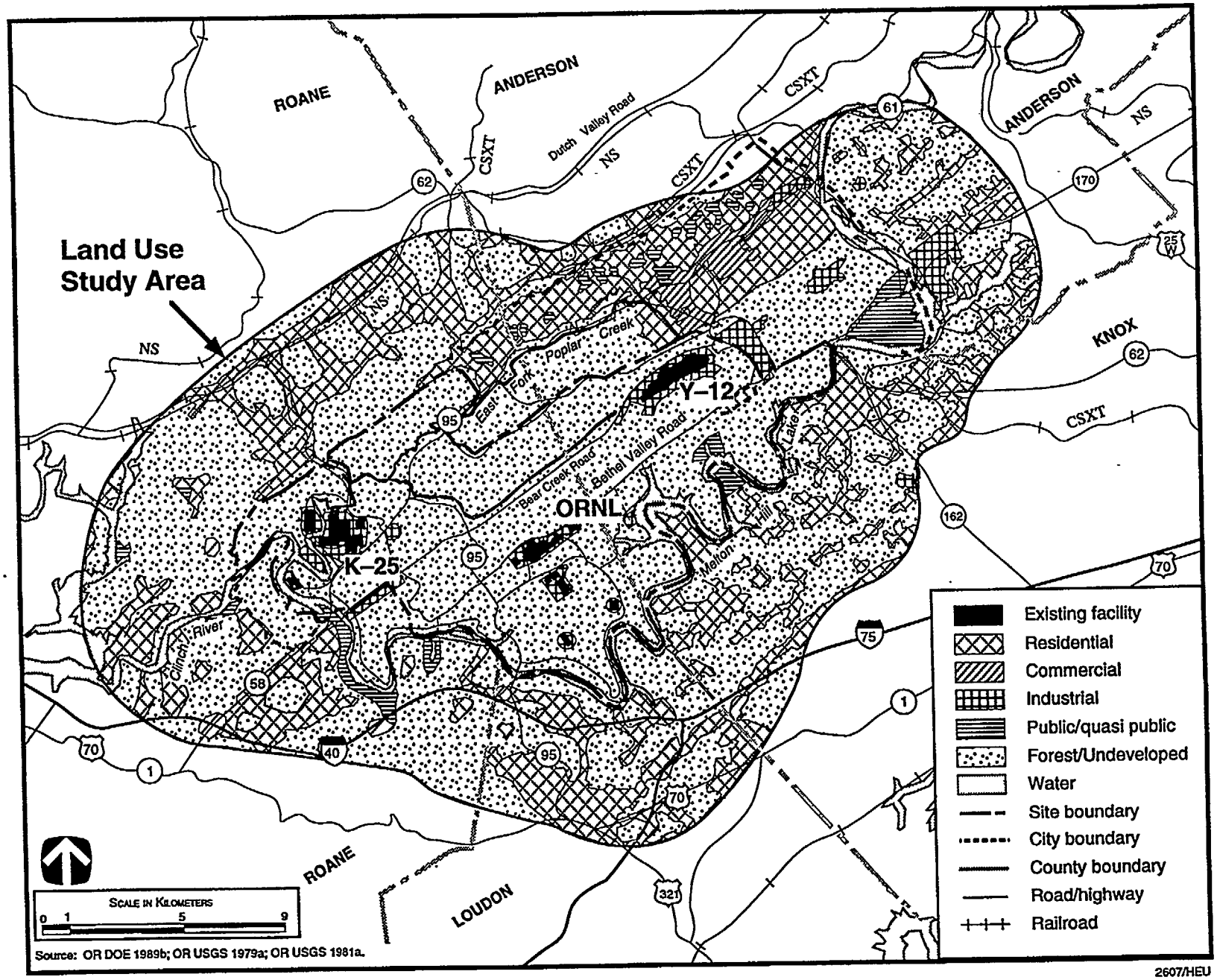


Figure 3.3.1–1. Generalized Land Use at Oak Ridge Reservation and Vicinity.

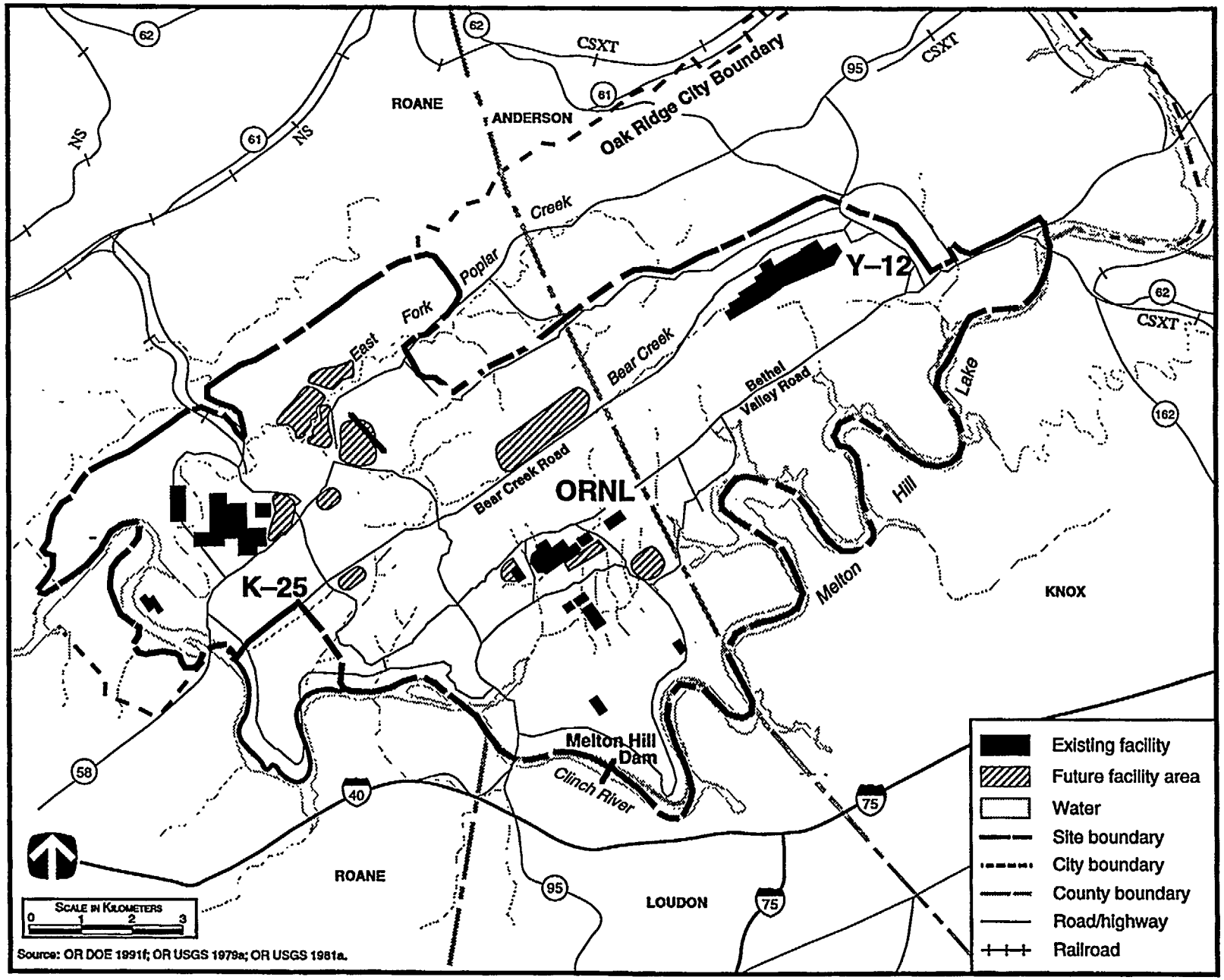


Figure 3.3.1–2. Primary Existing and Potential Future Facility Areas at Oak Ridge Reservation.

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

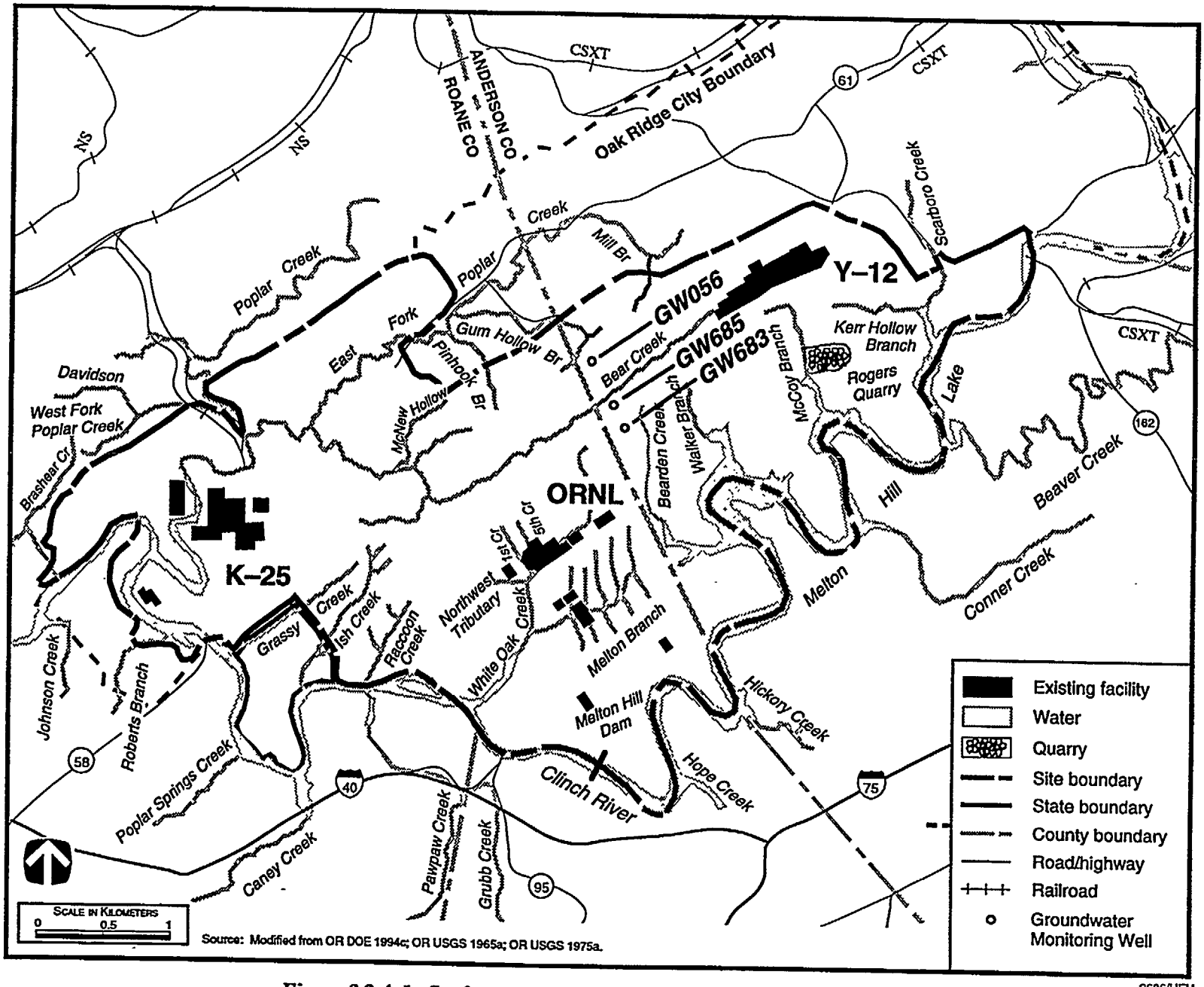


Figure 3.3.4–1. Surface Water Features at Oak Ridge Reservation.

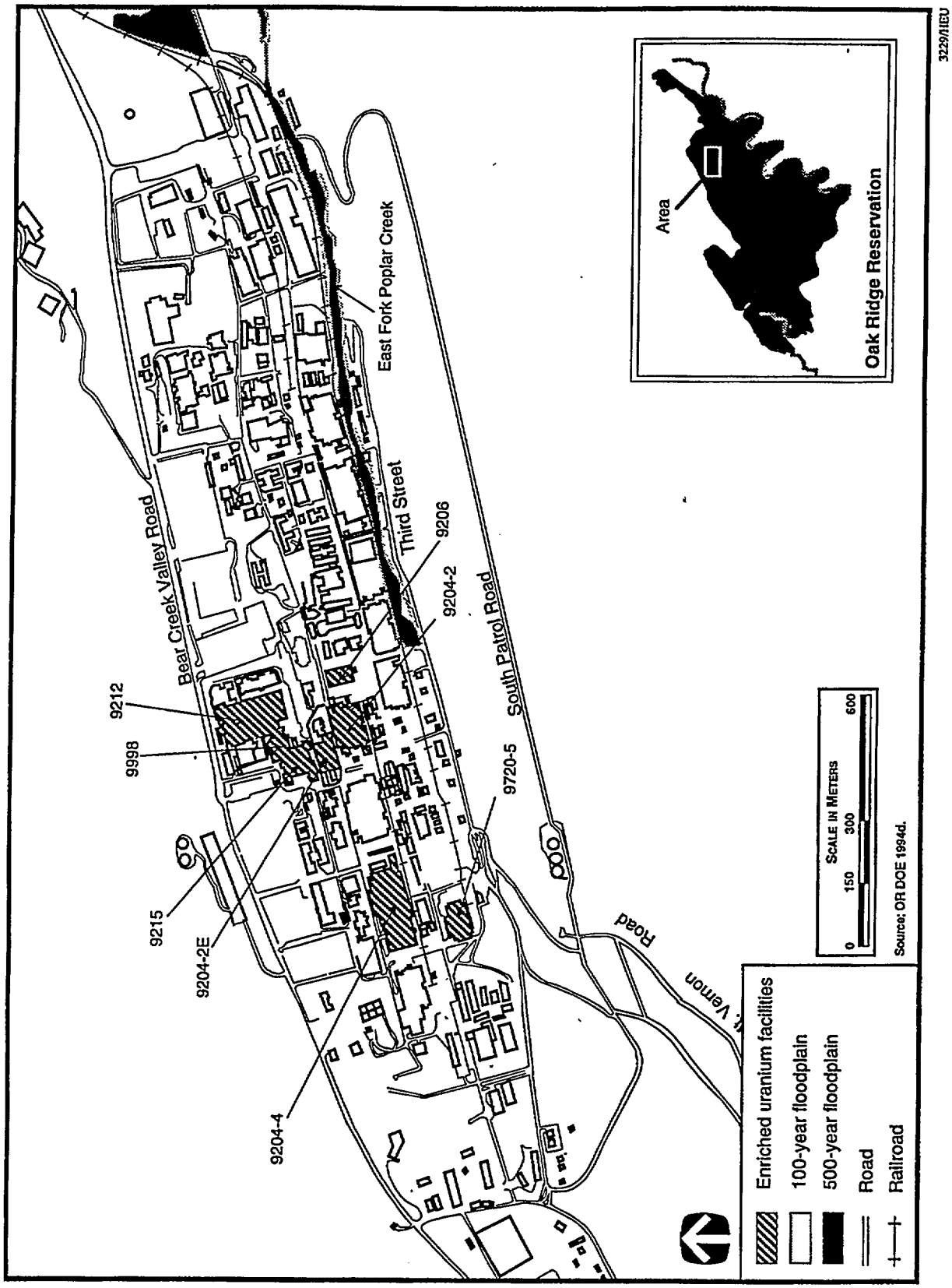


Figure 3.3.4–2. Location of 100- and 500-Year Floodplains at Y–12 Plant.

(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

			Average Water Body Concentration	
Parameter	Unit of Measure	Water Quality Criteria[a]	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.

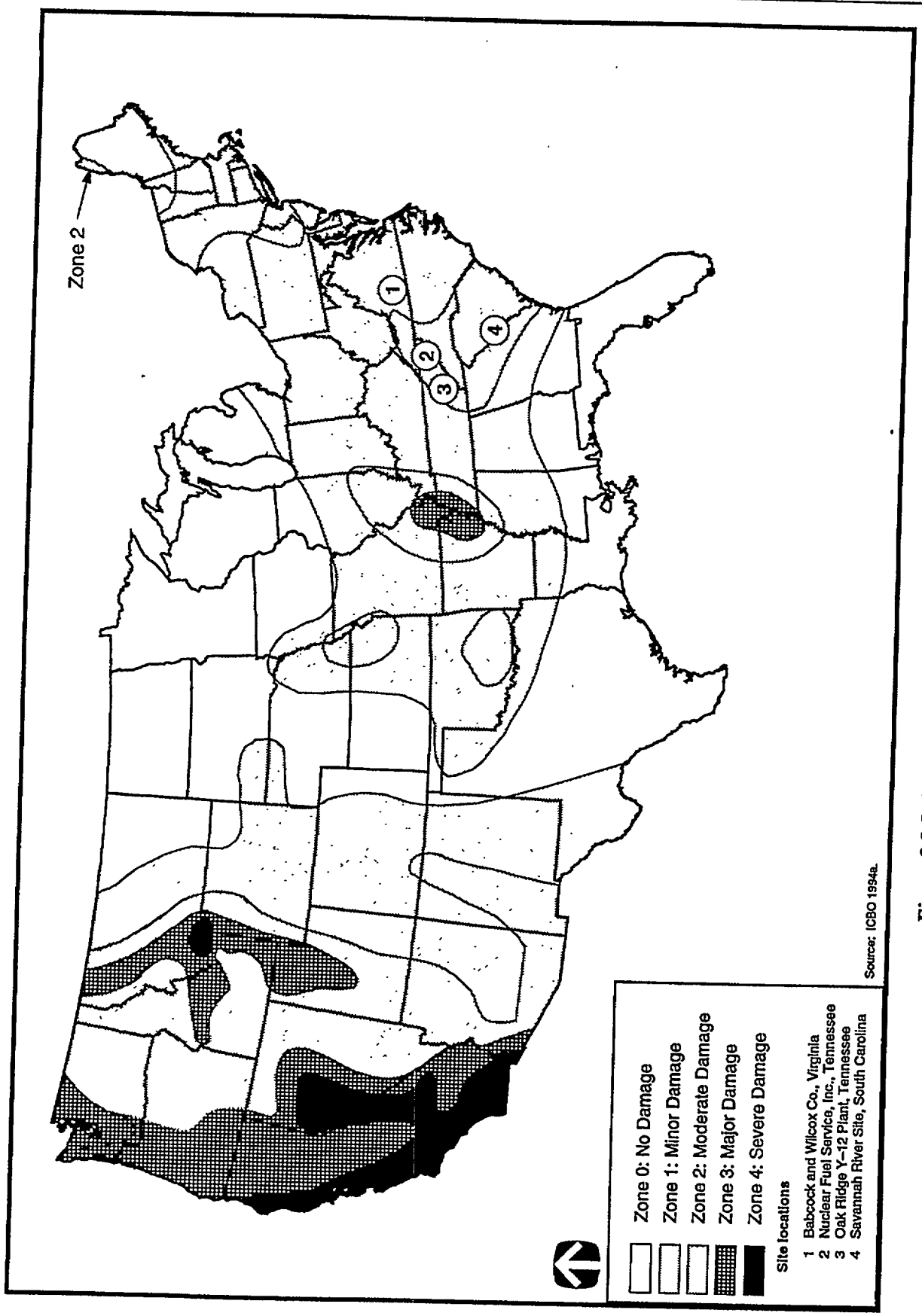


Figure 3.3.5–1. Seismic Zone Map of the United States.

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.

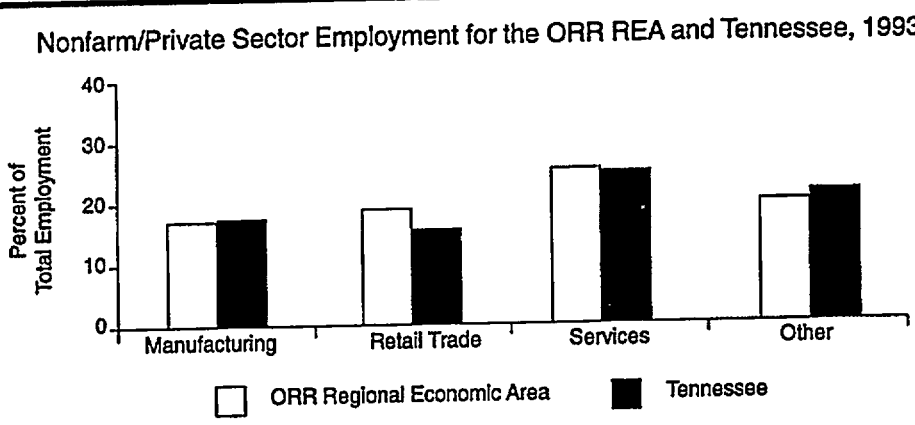
[Text deleted.]

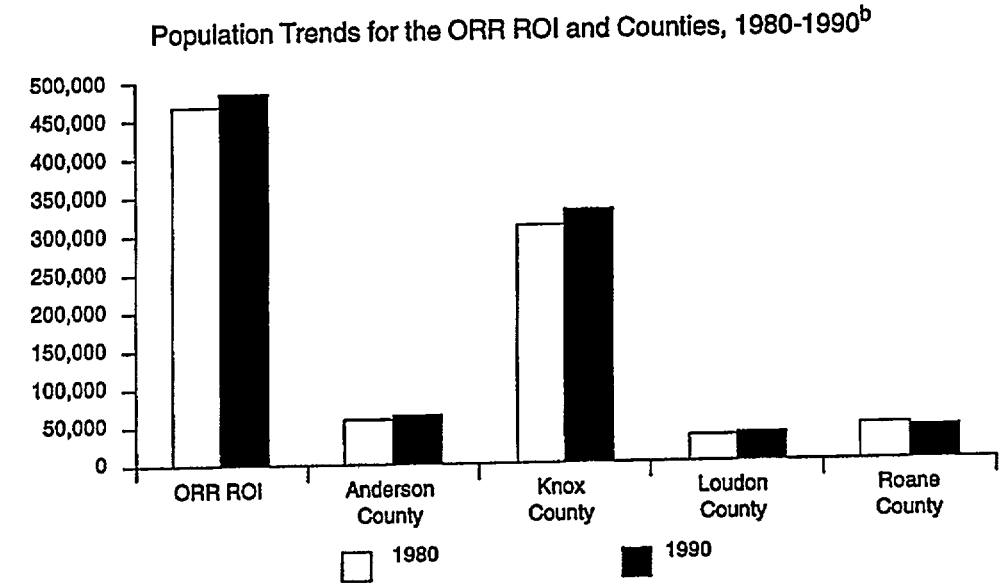
Population and Housing. In 1992, the ROI population totaled 499,444. From 1980 to 1990, the ROI population increased by 4 percent, compared to 6.2 percent for Tennessee. Within the ROI, Loudon County experienced the greatest population increase, 9.5 percent, while Roane County's population decreased by 2.5 percent. Population trends are summarized in Figure 3.3.8–1. [Text deleted.]

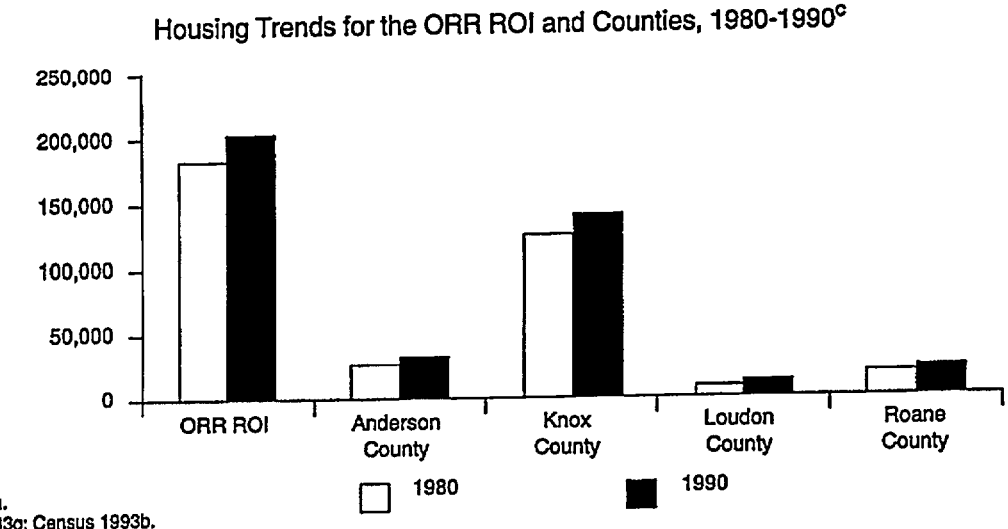
The number of total housing units in the ROI increased 13.8 percent between 1980 and 1990, reaching 206,234 in 1990. In comparison, the number of housing units in the State increased by almost 16 percent during the same period. The 1990 ROI homeowner and rental vacancy rates were 1.7 and 8.5 percent, 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

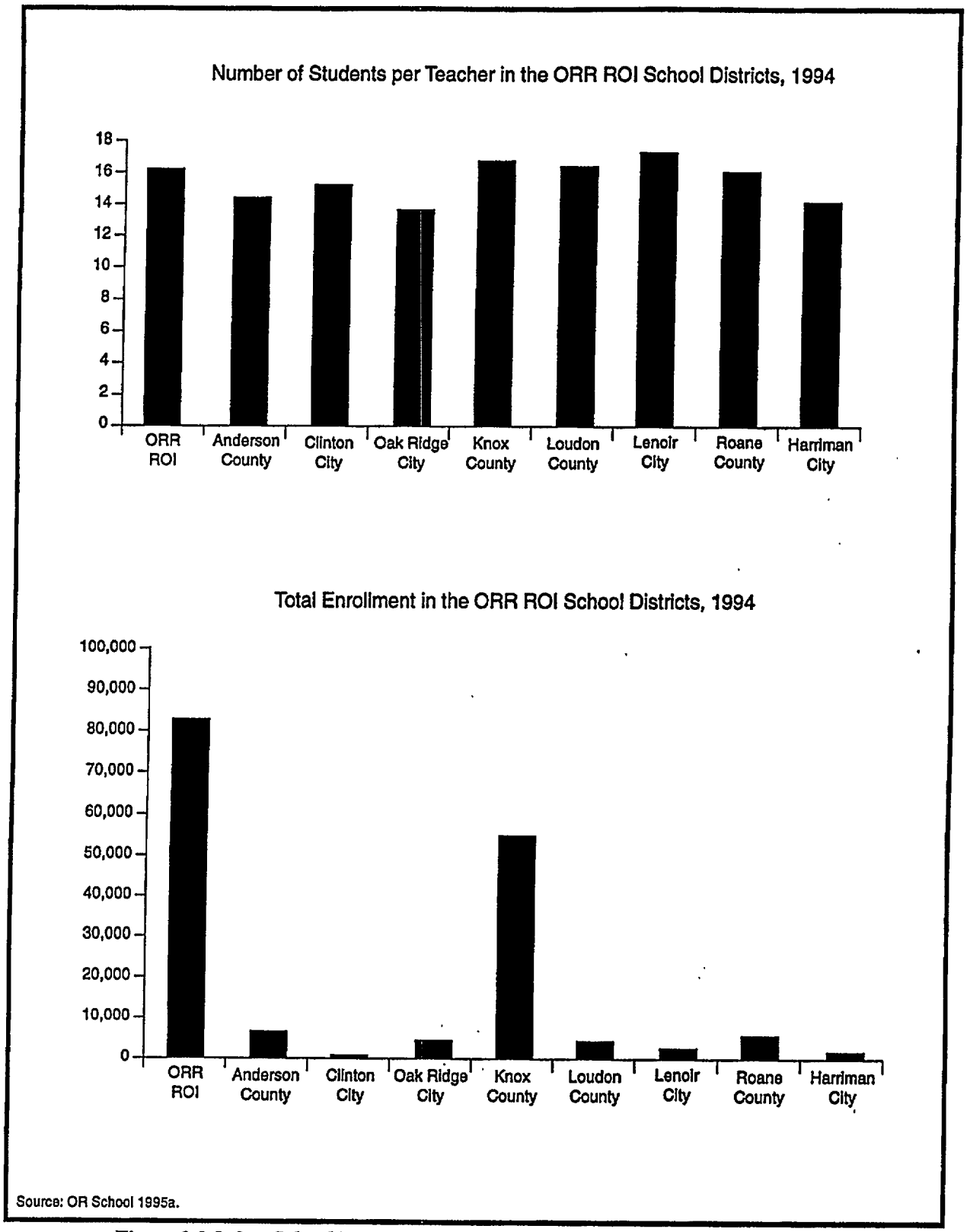






[a] DOC 1995a.
[b] Census 1983q; Census 1993b.
[c] Census 1982d; Census 1991c.

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.

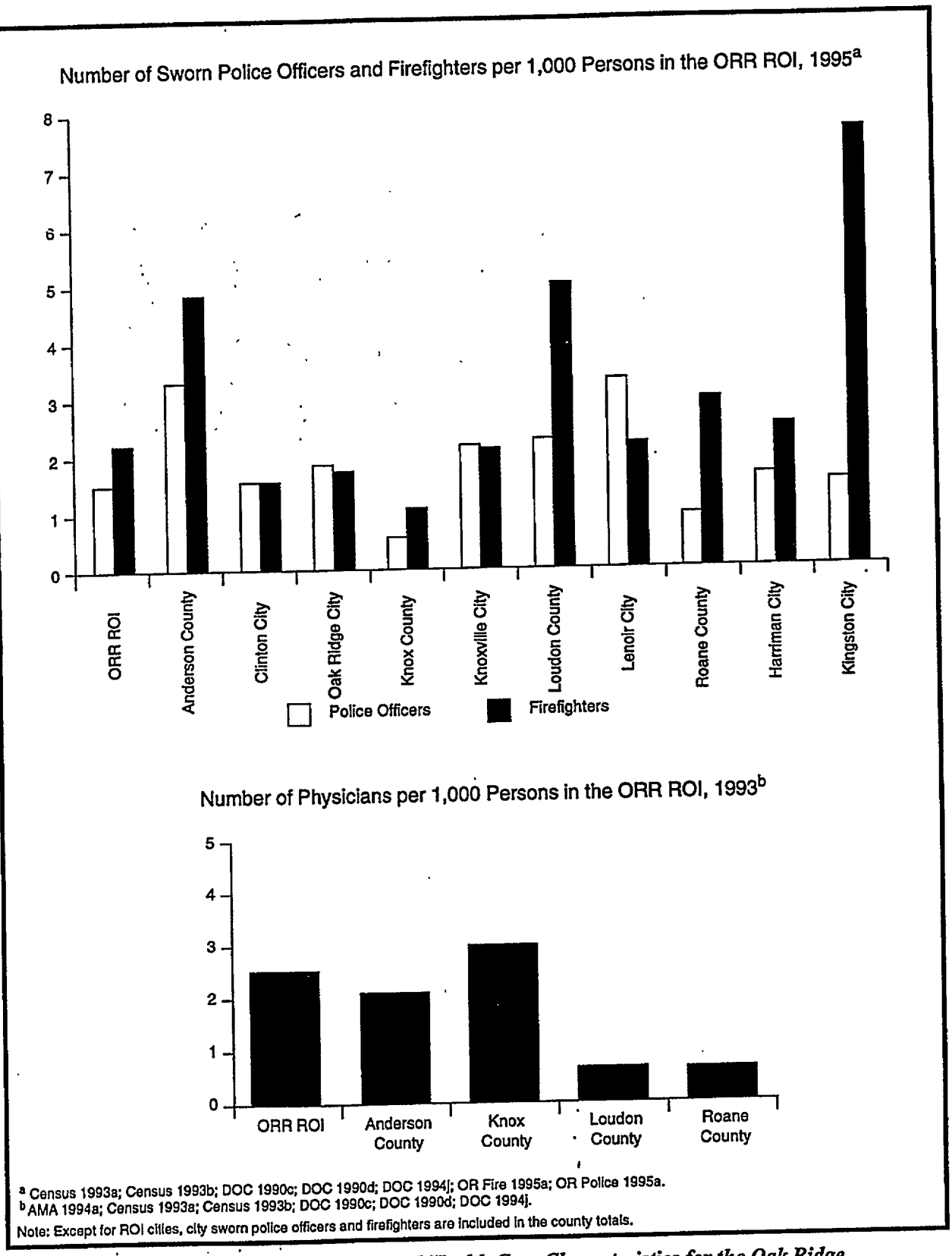


Figure 3.3.8–3. Public Safety and Health Care Characteristics for the Oak Ridge Reservation Region of Influence.

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		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	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.

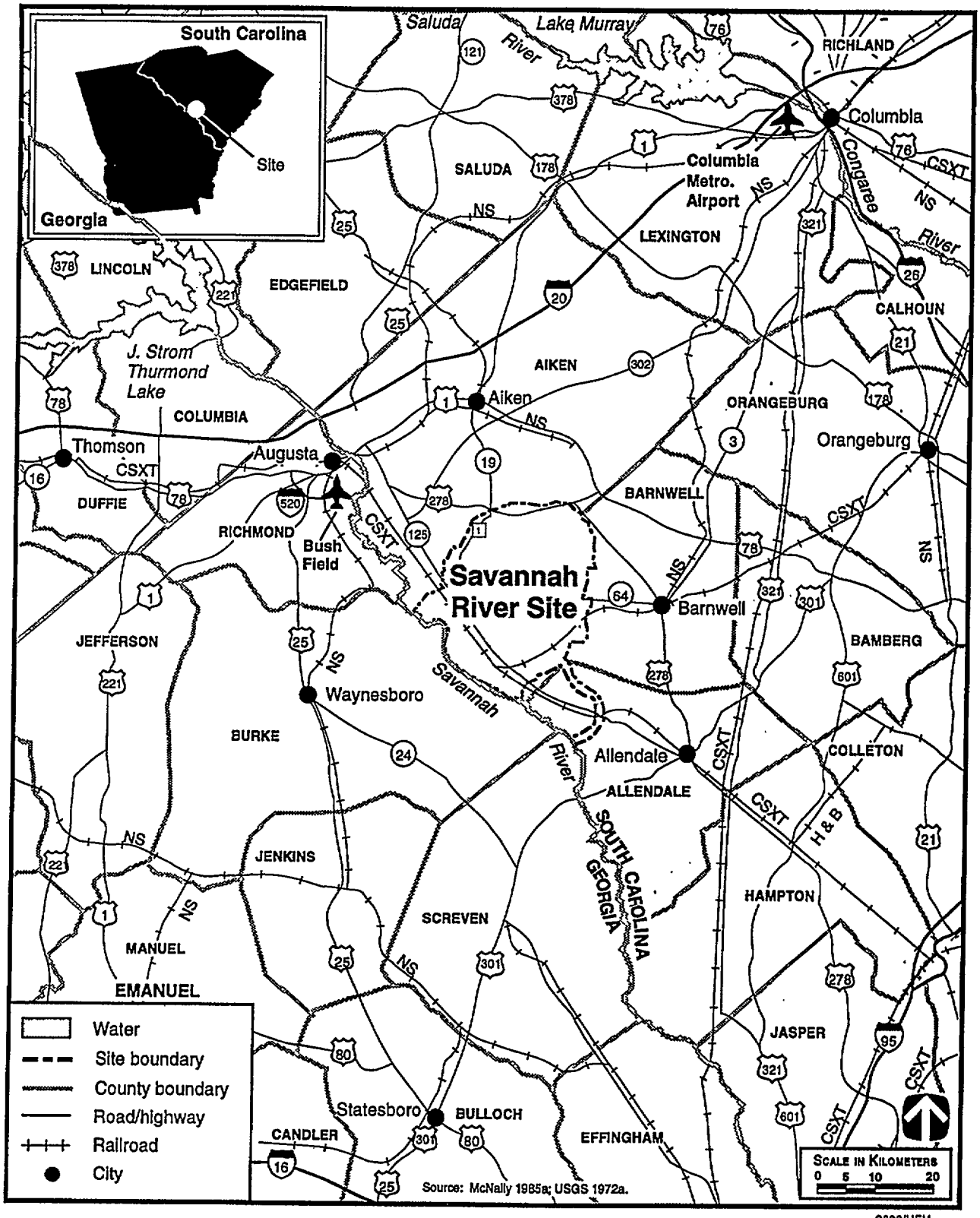


Figure 3.4–1. Savannah River Site, South Carolina, and Region.

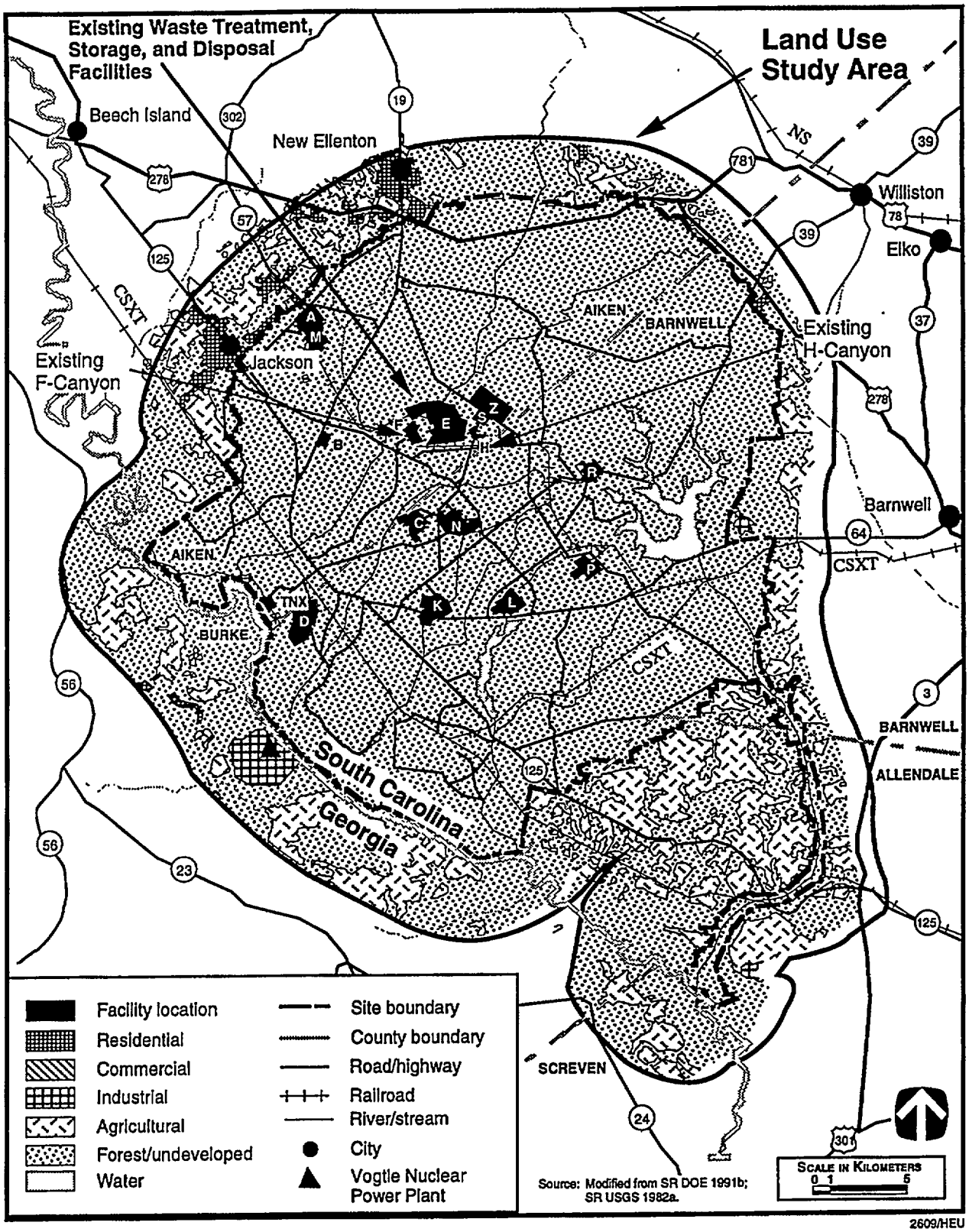


Figure 3.4.1–1. Generalized Land Use at Savannah River Site and Vicinity.

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

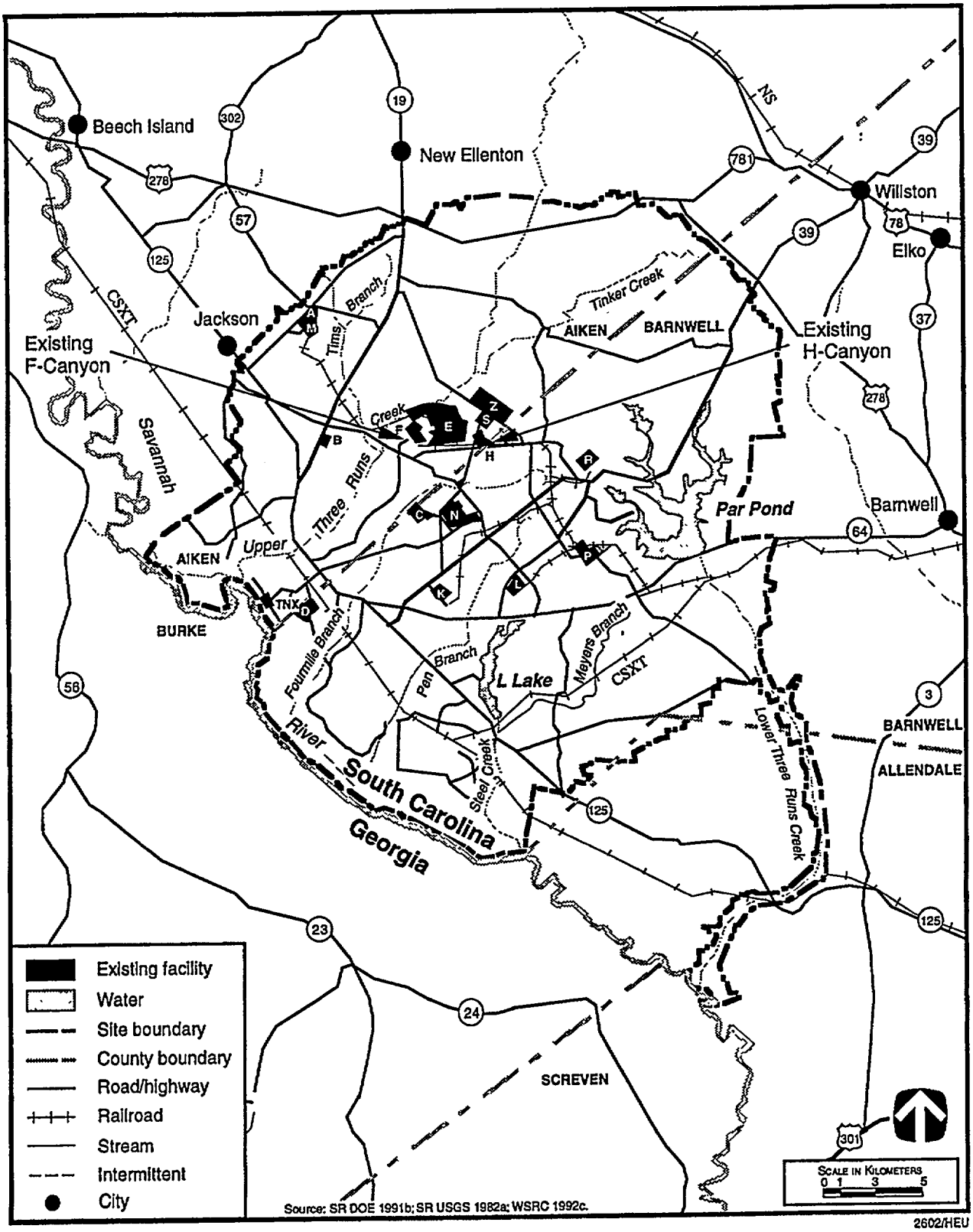


Figure 3.4.2–1. Primary Facilities at Savannah River Site.

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.

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.

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.

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.