DOE/EIS-0359

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR CONSTRUCTION AND OPERATION OF A DEPLETED URANIUM HEXAFLUORIDE CONVERSION FACILITY AT THE PADUCAH, KENTUCKY, SITE

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TITLE: Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site (DOE/EIS-0359)

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ABSTRACT: The U.S. Department of Energy (DOE) proposes, via a contract awarded at the direction of Congress (Public Law 107-206), to design, construct, and operate two conversion facilities for converting depleted uranium hexafluoride (commonly referred to as DUF_6): one at Portsmouth, Ohio, and one at Paducah, Kentucky. DOE intends to use the proposed facilities to convert its inventory of DUF_6 to a more stable chemical form suitable for beneficial use or disposal. This site-specific EIS considers the construction, operation, maintenance, and decontamination and decommissioning (D&D) of the proposed DUF_6 conversion facility at three locations within the Paducah site; transportation of depleted uranium conversion products and waste materials to a disposal facility; transportation and sale of the hydrogen fluoride (HF) produced as a conversion co-product; and neutralization of HF to calcium fluoride (CaF_2) and its sale or disposal in the event that the HF product is not sold. This EIS also considers a no action alternative that assumes continued storage of DUF_6 at the Paducah site. A separate EIS has been prepared for the proposed facility at Portsmouth (DOE/EIS-0360). DOE's preferred alternative is to construct and operate the conversion facility at Location A within the Paducah site. DOE plans to decide where to dispose of depleted U_3O_8 conversion product after additional appropriate NEPA review.

* Vertical lines in the right margin of this cover sheet and in the remainder of this EIS document indicate changes that have been added after the public comment period.

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NOTATION

The following is a list of acronyms and abbreviations, chemical names, and units of measure used in this document. Some acronyms used only in tables may be defined only in those tables.

GENERAL ACRONYMS AND ABBREVIATIONS

AEA	Atomic Energy Act of 1954
AEC	U.S. Atomic Energy Commission
AIHA	American Industrial Hygiene Association
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
ANP	Advanced Nuclear Power (Framatone ANP, Inc.)
ANSI	American National Standards Institute
AQCR	Air Quality Control Region
BLS	Bureau of Labor Statistics
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CRMP	cultural resource management plan
CWA	Clean Water Act
D&D	decontamination and decommissioning
DCG	derived concentration guide
DNFSB	Defense Nuclear Facilities Safety Board
DNL	day-night average sound level
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DU	depleted uranium
DUF_6	depleted uranium hexafluoride
EA	environmental assessment
EBE	evaluation basis earthquake
EIS	environmental impact statement
EM	Office of Environmental Management (DOE)
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
ERPG	Emergency Response Planning Guideline
ETTP	East Tennessee Technology Park (formerly K-25 site)

FONSI	Finding of No Significant Impact
FR	*Federal Register*
FTE	full-time equivalent
FY	fiscal year
GDP	gaseous diffusion plant
GIS	geographic information system
HEPA	high-efficiency particulate air
HMMH	Harris Miller Miller & Hanson, Inc.
HMR	hazardous materials regulation
HMTA	Hazardous Materials Transportation Act
ICRP	International Commission on Radiological Protection
IHE	irreversible health effect
ISC	Industrial Source Complex
KPDES	Kentucky Pollutant Discharge Elimination System
KOW	Kentucky Ordnance Works
LCF	latent cancer fatality
L_{eq}	equivalent steady sound level
LLMW	low-level radioactive mixed waste
LLW	low-level radioactive waste
LMES	Lockheed Martin Energy Systems, Inc.
MCL	maximum concentration limit
MEI	maximally exposed individual
MMES	Martin Marietta Energy Systems, Inc.
MOA	memorandum of agreement
NAAQS	National Ambient Air Quality Standard(s)
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act of 1969
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NOI	Notice of Intent
non-DUF_6	non-depleted uranium hexafluoride
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
NRHP	*National Register of Historic Places*
NTS	Nevada Test Site
OEPA	Ohio Environmental Protection Agency
OIG	Office of Inspector General (DOE)

ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
PA	preliminary assessment
PEA	programmatic environmental assessment
PEIS	programmatic environmental impact statement
PEL	permissible exposure limit
P.L.	Public Law
PM	particulate matter
PM_{10}	particulate matter with a mean aerodynamic diameter of 10 μm or less
$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 μm or less
PSD	prevention of significant deterioration
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal(s)
ROD	Record of Decision
ROI	region of influence
SAAQS	State Ambient Air Quality Standard(s)
SAR	safety analysis report
SHPO	State Historic Preservation Officer
SWMU	solid waste management unit
TDEC	Tennessee Department of Environment and Conservation
TEDE	total effective dose equivalent
TLD	thermoluminescence dosimeter
TRU	transuranic(s)
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
UDS	Uranium Disposition Services, LLC
USACE	U.S. Army Corps of Engineers
USC	*United States Code*
USDA	U.S. Department of Agriculture
USEC	United States Enrichment Corporation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
WM PEIS	Waste Management Programmatic Environmental Impact Statement

CHEMICALS

Am	americium
CaF_2	calcium fluoride
Co	cobalt
CO	carbon monoxide
H_2	hydrogen
HF	hydrogen fluoride (slag); hydrofluoric acid
H_2O	water
H_2S	hydrogen sulfide
KF	potassium fluoride
KOH	potassium hydroxide
kPa	kilopascal(s)
NH_3	ammonia
NO	nitrogen oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
Np	neptunium
O_3	ozone
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl
Pu	plutonium
SO_2	sulfur dioxide
SO_x	sulfur oxides
Tc	technetium
TCE	trichloroethylene
U	uranium
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
UO_2	uranium dioxide
UO_3	uranium trioxide
UO_2F_2	uranyl fluoride
U_3O_8	triuranium octaoxide

UNITS OF MEASURE

°C	degree(s) Celsius
Ci	curie(s)
cm	centimeter(s)
d	day(s)
dB	decibel(s)
dB(A)	A-weighted decibel(s)
°F	degree(s) Fahrenheit
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
g	gram(s)
gal	gallon(s)
h	hour(s)
ha	hectare(s)
in.	inch(es)
$in.^2$	square inch(es)
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
kPa	kilopascal(s)
L	liter(s)
lb	pound(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
MeV	million electron volts
mg	milligram(s)
mi	mile(s)
mi^2	square mile(s)
min	minute(s)
mL	milliliter(s)
mph	mile(s) per hour
mR	milliroentgen(s)
mrem	millirem(s)
mSv	millisievert(s)
MVA	megavolt-ampere(s)
MW	megawatt(s)
MWh	megawatt-hour(s)
nCi	nanocurie(s)
oz	ounce(s)
pCi	picocurie(s)
ppb	part(s) per billion
ppm	part(s) per million
psia	pound(s) per square inch absolute
psig	pound(s) per square inch gauge
rem	roentgen equivalent man
s	second(s)
Sv	sievert(s)
t	metric ton(s)
ton(s)	short ton(s)
wt%	percent by weight
yd^3	cubic yard(s)
yr	year(s)
µg	microgram(s)
µm	micrometer(s)

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS

Multiply	By	To Obtain
English/Metric Equivalents		
acres	0.4047	hectares (ha)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
cubic yards (yd^3)	0.7646	cubic meters (m^3)
degrees Fahrenheit (°F) -32	0.5555	degrees Celsius (°C)
feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (L)
gallons (gal)	0.003785	cubic meters (m^3)
inches (in.)	2.540	centimeters (cm)
miles (mi)	1.609	kilometers (km)
pounds (lb)	0.4536	kilograms (kg)
short tons (tons)	907.2	kilograms (kg)
short tons (tons)	0.9072	metric tons (t)
square feet (ft^2)	0.09290	square meters (m^2)
square yards (yd^2)	0.8361	square meters (m^2)
square miles (mi^2)	2.590	square kilometers (km^2)
yards (yd)	0.9144	meters (m)
Metric/English Equivalents		
centimeters (cm)	0.3937	inches (in.)
cubic meters (m^3)	35.31	cubic feet (ft^3)
cubic meters (m^3)	1.308	cubic yards (yd^3)
cubic meters (m^3)	264.2	gallons (gal)
degrees Celsius (°C) +17.78	1.8	degrees Fahrenheit (°F)
hectares (ha)	2.471	acres
kilograms (kg)	2.205	pounds (lb)
kilograms (kg)	0.001102	short tons (tons)
kilometers (km)	0.6214	miles (mi)
liters (L)	0.2642	gallons (gal)
meters (m)	3.281	feet (ft)
meters (m)	1.094	yards (yd)
metric tons (t)	1.102	short tons (tons)
square kilometers (km^2)	0.3861	square miles (mi^2)
square meters (m^2)	10.76	square feet (ft^2)
square meters (m^2)	1.196	square yards (yd^2)

SUMMARY[1]

S.1 INTRODUCTION

This document is a site-specific environmental impact statement (EIS) for construction and operation of a proposed depleted uranium hexafluoride (DUF_6) conversion facility at the U.S. Department of Energy (DOE) Paducah site in northwestern Kentucky (Figure S-1). The proposed facility would convert the DUF_6 stored at Paducah to a more stable chemical form suitable for use or disposal.

In a Notice of Intent (NOI) published in the *Federal Register* (FR) on September 18, 2001 (*Federal Register*, Volume 66, page 48123 [66 FR 48123]), DOE announced its intention to prepare a single EIS for a proposal to construct, operate, maintain, and decontaminate and decommission two DUF_6 conversion facilities at Portsmouth, Ohio, and Paducah, Kentucky, in accordance with the National Environmental Policy Act of 1969 (NEPA) (*United States Code*, Title 42, Section 4321 et seq. [42 USC 4321 et seq.]) and DOE's NEPA implementing procedures (*Code of Federal Regulation*s, Title 10, Part 1021 [10 CFR Part 1021]). Subsequent to award of a contract on August 29, 2002, to Uranium Disposition Services, LLC (hereafter referred to as UDS), Oak Ridge, Tennessee, for design, construction, and operation of DUF_6 conversion facilities at Portsmouth and Paducah, DOE reevaluated its approach to the NEPA process and decided to prepare separate site-specific EISs. This change was announced in a *Federal Register* Notice of Change in NEPA Compliance Approach published on April 28, 2003 (68 FR 22368); the Notice is included as Attachment B to Appendix C of this EIS.

This EIS addresses the potential environmental impacts from the construction, operation, maintenance, and decontamination and decommissioning (D&D) of the proposed conversion facility at three alternative locations within the Paducah site; from the transportation of depleted uranium conversion products to a disposal facility; and from the transportation, sale, use, or disposal of the fluoride-containing conversion products (hydrogen fluoride [HF] or calcium fluoride [CaF_2]). Although not part of the proposed action, an option of shipping all cylinders (DUF_6, normal and enriched UF_6, and empty) stored at the East Tennessee Technology Park (ETTP) near Oak Ridge, Tennessee, to Paducah rather than to Portsmouth is also considered, as is an option of expanding operations. In addition, this EIS evaluates a no action alternative, which assumes continued storage of DUF_6 in cylinders at the Paducah site. A separate EIS (DOE/EIS-0360) evaluates the potential environmental impacts for the proposed Portsmouth conversion facility.

S.1.1 Background Information

The current DUF_6 conversion facility project is the culmination of a long history of DUF_6 management activities and events. To put the current project into context and provide

[1] Vertical lines in the right margin of this summary and the remainder of this EIS document indicate changes that have been added after the public comment period.

perspective, this section briefly discusses the origin and size of the DOE cylinder inventory considered in this EIS and then summarizes the management history.

Uranium enrichment in the United States began as part of the atomic bomb development by the Manhattan Project during World War II. Enrichment for both civilian and military uses continued after the war under the auspices of the U.S. Atomic Energy Commission and its successor agencies, including DOE. Three large gaseous diffusion plants (GDPs) were constructed to produce enriched uranium, first at the K-25 site (now called ETTP) and subsequently at Paducah and Portsmouth. The K-25 plant ceased operations in 1985, and the Portsmouth plant ceased operations in 2001. The Paducah GDP continues to operate.

The DUF_6 produced during enrichment has been stored in large steel cylinders at all three gaseous diffusion plant sites since the 1950s. The cylinders are typically stacked two high and are stored outdoors on concrete or gravel yards. Figure S-2 shows typical arrangements for storing cylinders.

DOE is currently responsible for the management of approximately 700,000 metric tons (t) (770,000 short tons [tons])[2] of DUF_6 stored in about 60,000 cylinders at three storage sites. The cylinder inventory considered in this EIS is provided in Table S-1. This EIS considers the conversion of the approximately 440,000 t (484,000 tons) of DUF_6 stored in about 36,200 cylinders at Paducah. Also in storage at Paducah are approximately 1,940 cylinders of various sizes that contain enriched UF_6 or normal UF_6 (collectively called "non-DUF_6" cylinders in this EIS) or are

DUF_6 Management Time Line

1950–1993	DOE generates DUF_6 stored in cylinders at the ETTP, Portsmouth, and Paducah sites.
1985	K-25 (ETTP) GDP ceases operations.
1992	Ohio EPA issues Notice of Violation (NOV) to Portsmouth.
1993	USEC is created by P.L. 102-186.
1994	DOE initiates DUF_6 PEIS.
1995	DNFSB issues Recommendation 95-1, Safety of Cylinders Containing Depleted Uranium. DOE initiates UF_6 Cylinder Project Management Plan.
1996	USEC Privatization Act (P.L. 104-134) is enacted.
1997	DOE issues Draft DUF_6 PEIS.
1998	DOE and Ohio EPA reach agreement on NOV. Two DOE-USEC MOAs transfer 11,400 DUF_6 cylinders to DOE. P.L. 105-204 is enacted.
1999	DOE and TDEC enter consent order. DOE issues Final DUF_6 PEIS and Record of Decision. DOE issues conversion plan in response to P.L. 105-204. DNFSB closes Recommendation 95-1. DOE issues Draft RFP for conversion services.
2000	DOE issues Final RFP for conversion services.
2001	DOE receives five proposals in response to RFP. DOE identifies three proposals in competitive range. DOE publishes NOI for site-specific DUF_6 Conversion EIS. DOE prepares environmental critique to support conversion services procurement process. Portsmouth GDP ceases operations. DOE holds public scoping meetings for the site-specific DUF_6 Conversion EIS.
2002	DOE-USEC agreement transfers 23,000 t (25,684 tons) of DUF_6 to DOE. P.L. 107-206 is enacted. DOE awards conversion services contract to UDS. DOE prepares environmental synopsis to support conversion services procurement process.
2003	DOE announces Notice of Change in NEPA Compliance Approach and issues the draft EIS. DOE issues draft site-specific conversion facility EISs.
2004	Final site-specific conversion facility EISs issued.

2 In general, in this EIS, values in English units are presented first, followed by metric units in parentheses. However, when values are routinely reported in metric units, the metric units are presented first, followed by English units in parentheses.

a

b

FIGURE S-2 Storage of DUF_6 Cylinders: (a) New cylinder storage yard at the Paducah site. (b) Overview of cylinder yards at the Paducah site.

TABLE S-1 Inventory of DOE UF_6 Cylinders Considered in This EIS[a]

Location	No. of Cylinders	Weight of UF_6 (t)
Paducah – DUF_6	36,191	436,400
Non-DUF_6		
Enriched UF_6	182	1,600
Normal UF_6	1,485	16,000
Empty	275	0
ETTP[b] – DUF_6	4,822	54,300
Non-DUF_6		
Enriched UF_6	881	7
Normal UF_6	221	19
Empty	20	0
Total		
DUF_6	41,013	490,700
Non-DUF_6	2,769	17,625
Empty	295	0

[a] As of January 26, 2004.

[b] The proposed action calls for shipment of the ETTP cylinders to Portsmouth.

empty. The management of the DOE non-DUF_6 cylinders at Paducah is considered in the EIS; however, the non-DUF_6 cylinders would not be processed in the conversion facility. In addition, in storage at ETTP are approximately 4,800 DUF_6 cylinders and approximately 1,100 non-DUF_6 cylinders. Although not part of the proposed action, this EIS considers as an option the shipment of all ETTP cylinders to Paducah and conversion of the DUF_6 cylinders.

S.1.1.1 Creation of USEC

In 1993, the U.S. government began the process of privatizing uranium enrichment services by creating the United States Enrichment Corporation (USEC), a wholly owned government corporation, pursuant to the *Energy Policy Act of 1992* (Public Law [P.L.] 102-186). The Paducah and Portsmouth GDPs were leased to USEC, but DOE retained responsibility for storage, maintenance, and disposition of 46,422 DUF_6 cylinders produced before 1993 and located at the three gaseous diffusion plant sites (28,351 at Paducah, 13,388 at Portsmouth, and 4,683 at K-25). In 1996, the *USEC Privatization Act* (P.L. 104-134) transferred ownership of USEC from the government to private investors. This act provided for the allocation of USEC's liabilities between the U.S. government (including DOE) and the new private corporation, including liabilities for DUF_6 cylinders generated by USEC before privatization.

In May and June of 1998, USEC and DOE signed two memoranda of agreement (MOAs) regarding the allocation of responsibilities for depleted uranium generated by USEC after 1993. The two MOAs transferred ownership of a total of 11,400 DUF_6 cylinders from USEC to DOE.

On June 17, 2002, DOE and USEC signed a third agreement to transfer up to 23,300 t (25,684 tons) of DUF_6 from USEC to DOE between 2002 and 2006. The exact number of cylinders was not specified. Transfer of ownership of all the material will take place at Paducah. While title to the DUF_6 is transferred to DOE under this agreement, custody and cylinder management responsibility remains with USEC until DOE requests the USEC deliver the cylinders for processing in the conversion facility.

Cylinder-Related Terms Used in This EIS

Types of UF_6

UF_6	A chemical composed of one atom of uranium combined with six atoms of fluorine. UF_6 is a volatile white crystalline solid at ambient conditions.
Normal UF_6	UF_6 made with uranium that contains the isotope uranium-235 at a concentration equal to that found in nature, that is, 0.7% uranium-235.
DUF_6	UF_6 made with uranium that contains the isotope uranium-235 in concentrations less than the 0.7% found in nature. In general, the DOE DUF_6 contains between 0.2% and 0.4% uranium-235.
Enriched UF_6	UF_6 made with uranium containing more than 0.7% uranium-235. In general, DOE enriched UF_6 considered in this EIS contains less than 5% uranium-235.
Reprocessed UF_6	UF_6 made with uranium that was previously irradiated in a nuclear reactor and chemically separated during reprocessing.

Types of Cylinders

Full DUF_6	Cylinders filled to 62% of their volume with DUF_6 (some cylinders are slightly overfilled).
Partially Full	Cylinders that contain more than 50 lb (23 kg) of DUF_6 but less than 62% of their volume.
Heel	Cylinders that contain less than 50 lb (23 kg) of residual nonvolatile material left after the DUF_6 has been removed.
Empty	Cylinders that have had the DUF_6 and heel material removed and contain essentially no residual material.
Feed	Cylinders used to supply UF_6 into the enrichment process. Most feed cylinders contain natural UF_6, although some historically contained reprocessed UF_6.
Non-DUF_6	A term used in this EIS to refer to cylinders that contain enriched UF_6 or normal UF_6.

S.1.1.2 Growing Concern over the DUF_6 Inventory

In May 1995, the Defense Nuclear Facilities Safety Board (DNFSB), an independent DOE oversight organization within the Executive Branch, issued Recommendation 95-1 regarding storage of the DUF_6 cylinders. This document advised that DOE should take three actions: (1) start an early program to renew the protective coating on cylinders containing DUF_6 from the historical production of enriched uranium, (2) explore the possibility of additional measures to protect the cylinders from the damaging effects of exposure to the elements as well as any additional handling that might be called for, and (3) institute a study to determine whether a more suitable chemical form should be selected for long-term storage of depleted uranium.

In response to Recommendation 95-1, DOE began an aggressive effort to better manage its DUF_6 cylinders, known as the *UF_6 Cylinder Project Management Plan*. This plan incorporated more rigorous and more frequent inspections, a multiyear schedule for painting and refurbishing cylinders, and construction of concrete-pad cylinder yards. In December 1999, the DNFSB determined that DOE's implementation of the *UF_6 Cylinder Project Management Plan* was successful, and, as a result, on December 16, 1999, it closed Recommendation 95-1.

Several affected states also expressed concern over the DOE DUF_6 inventory. In October 1992, the Ohio Environmental Protection Agency (OEPA) issued a Notice of Violation (NOV) alleging that DUF_6 stored at the Portsmouth facility is subject to regulation under state hazardous waste laws. The NOV stated that the OEPA had determined DUF_6 to be a solid waste and that DOE had violated Ohio laws and regulations by not evaluating whether such waste was hazardous. DOE disagreed with this assessment and entered into discussions with the OEPA that continued through February 1998, when an agreement was reached. Ultimately, in February 1998, DOE and the OEPA agreed to set aside the issue of whether the DUF_6 is subject to state hazardous waste regulation and instituted a negotiated management plan governing the storage of the Portsmouth DUF_6. The agreement also requires DOE to continue its efforts to evaluate the potential use or reuse of the material. The agreement expires in 2008.

Similarly, in February 1999, DOE and the Tennessee Department of Environment and Conservation (TDEC) entered into a consent order that included a requirement for the performance of two environmentally beneficial projects: the implementation of a negotiated management plan governing the storage of the small inventory (relative to other sites) of all UF_6 (depleted, enriched, and natural) cylinders stored at the ETTP site and the removal of the DUF_6 from the ETTP site or the conversion of the material by December 31, 2009. The consent order further requires DOE to submit a plan, within 60 days of completing NEPA review of its long-term DUF_6 management strategy, that contains schedules for activities related to removal of cylinders from the ETTP site.

In Kentucky, a final Agreed Order between DOE and the Kentucky Natural Resources and Environmental Protection Cabinet concerning DUF_6 cylinder management was entered in October 2003. This Agreed Order requires that DOE provide the Kentucky Department of Environmental Protection with an inventory of all DUF_6 cylinders for which DOE has management responsibility at the Paducah site and, with regard to that inventory, that DOE implement the DUF_6 Cylinder Management Plan, which is Attachment 1 to the Agreed Order.

S.1.1.3 Programmatic NEPA Review and Congressional Interest

In 1994, DOE began work on a *Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DUF_6 PEIS) (DOE/EIS-0269) to evaluate potential broad management options for DOE's DUF_6 inventory. Alternatives considered included continued storage of DUF_6 in cylinders at the gaseous diffusion plant sites or at a consolidated site, and the use of technologies for converting the DUF_6 to a more stable chemical form for long-term storage, use, or disposal. DOE issued the draft DUF_6 PEIS for public review and comment in December 1997 and held hearings near each of the three sites where DUF_6 is currently stored (Paducah, Kentucky; Oak Ridge, Tennessee; and Portsmouth, Ohio) and in Washington, D.C. In response to its efforts, DOE received some 600 comments.

In July 1998, while the PEIS was being prepared, the President signed into law P.L. 105-204. The text of P.L. 105-204 pertinent to the management of DUF_6 is as follows:

> *(a) PLAN. – The Secretary of Energy shall prepare, and the President shall include in the budget request for fiscal year 2000, a Plan and proposed legislation to ensure that all amounts accrued on the books of the United States Enrichment Corporation for the disposition of depleted uranium hexafluoride will be used to commence construction of, not later than January 31, 2004, and to operate, an onsite facility at each of the gaseous diffusion plants at Paducah, Kentucky, and Portsmouth, Ohio, to treat and recycle depleted uranium hexafluoride consistent with the National Environmental Policy Act.*

DOE began, therefore, to prepare a responsive plan while it proceeded with the PEIS.

On March 12, 1999, DOE submitted the plan to Congress; no legislation was proposed. In April 1999, DOE issued the final DUF_6 PEIS. The PEIS identified conversion of DUF_6 to another chemical form for use or long-term storage as part of the preferred management alternative. In the Record of Decision (ROD) (64 FR 43358, August 10, 1999), DOE decided to promptly convert the DUF_6 inventory to a more stable uranium oxide form. DOE also stated that it would use the depleted uranium oxide as much as possible and store the remaining depleted uranium oxide for potential future uses or disposal, as necessary. In addition, DUF_6 would be converted to depleted uranium metal only if uses for metal were available. DOE did not select a specific site or sites for the conversion facilities but reserved that decision for subsequent NEPA review. (This EIS is that site-specific review.)

Then, in July 1999, DOE issued the *Final Plan for the Conversion of Depleted Uranium Hexafluoride as Required by Public Law 105-204*. The Conversion Plan describes the steps that would allow DOE to convert the DUF_6 inventory to a more stable chemical form. It incorporates information received from the private sector in response to a DOE request for expressions of interest; ideas from members of the affected communities, Congress, and other interested stakeholders; and the results of the analyses for the final DUF_6 PEIS. The Conversion Plan describes DOE's intent to chemically process the DUF_6 to create products that would present a lower long-term storage hazard and provide a material suitable for use or disposal.

S.1.1.4 DOE Request for Contractor Proposals and Site-Specific NEPA Review

DOE initiated the final Conversion Plan on July 30, 1999, and announced the availability of a draft Request for Proposals (RFP) for a contractor to design, construct, and operate DUF_6 conversion facilities at the Paducah and Portsmouth sites.

In early 2000, the RFP was modified to allow for a wider range of potential conversion product forms and process technologies than had been previously reviewed in the DUF_6 PEIS (the PEIS considered conversion to triuranium octaoxide [U_3O_8] and uranium dioxide [UO_2] for disposal and conversion to uranium metal for use). DOE stated that if the selected conversion technology would generate a previously unconsidered product (e.g., depleted uranium tetrafluoride [UF_4]), DOE would review the potential environmental impacts as part of the site-specific NEPA review.

On October 31, 2000, DOE issued a final RFP to procure a contractor to design, construct, and operate DUF_6 conversion facilities at the Paducah and Portsmouth sites. The RFP stated that any conversion facilities that would be built would have to convert the DUF_6 within a 25-year period to a more stable chemical form that would be suitable for either beneficial use or disposal. The selected contractor would use its proposed technology to design, construct, and operate the conversion facilities for an initial 5-year period. Operation would include (1) maintaining the DUF_6 inventories and conversion product inventories; (2) transporting all UF_6 storage cylinders currently located at ETTP to a conversion facility at the Portsmouth site, as appropriate; and (3) transporting to an appropriate disposal site any conversion product for which no use was found. The selected contractor would also be responsible for preparing such excess material for disposal.

In March 2001, DOE announced the receipt of five proposals in response to the RFP, three of which proposed conversion to U_3O_8 and two of which proposed conversion to UF_4. In August 2001, DOE deemed three of these proposals to be within the competitive range; two conversion to U_3O_8 proposals and one conversion to UF_4 proposal.

On September 18, 2001, DOE published the NOI in the *Federal Register* (66 FR 48123), announcing its intention to prepare an EIS for the proposed action to construct, operate, maintain, and decontaminate and decommission two DUF_6 conversion facilities at Portsmouth, Ohio, and Paducah, Kentucky. DOE held three scoping meetings to provide the public with an opportunity to present comments on the scope of the EIS and to ask questions and discuss concerns with DOE officials regarding the EIS. The scoping meetings were held in Piketon, Ohio, on November 28, 2001; in Oak Ridge, Tennessee, on December 4, 2001; and in Paducah, Kentucky, on December 6, 2001.

The alternatives identified in the NOI included a two-plant alternative (one at the Paducah site and another at the Portsmouth site), a one-plant alternative (only one plant would be built, at either the Paducah or the Portsmouth site), an alternative using existing UF_6 conversion capacity at commercial nuclear fuel fabrication facilities, and a no action alternative. For alternatives that involved constructing one or two new plants, DOE planned to consider alternative conversion technologies, local siting alternatives within the Paducah and Portsmouth site boundaries, and the shipment of DUF_6 cylinders stored at ETTP to either the Portsmouth site or to the Paducah site. The technologies to be considered in the EIS were those submitted in response to the October 2000 RFP, plus any other technologies that DOE believed must be considered.

S.1.1.5 Public Law 107-206 Passed by Congress

During the site-specific NEPA review process, Congress acted again regarding DUF_6 management, and on August 2, 2002, the President signed the *2002 Supplemental Appropriations Act for Further Recovery from and Response to Terrorist Attacks on the United States* (P.L. 107-206). The pertinent part of P.L. 107-206 had several requirements: that no later than 30 days after enactment, DOE must select for award of a contract for the scope of work described in the October 2000 RFP, including design, construction, and operation of a DUF_6 conversion facility at each of the Department's Paducah, Kentucky, and Portsmouth, Ohio, gasous diffusion sites; that the contract require groundbreaking for construction to occur no later than July 31, 2004; that the contract require construction to proceed expeditiously thereafter; that the contract include as an item of performance the transportation, conversion, and disposition of DU contained in cylinders located at ETTP, consistent with environmental agreements between the State of Tennessee and the Secretary of Energy; and that no later than 5 days after the date of groundbreaking for each facility, the Secretary of Energy shall submit to Congress a certification that groundbreaking has occurred. The relevant portions of the Appropriations Act are set forth in Appendix A of this EIS.

In response to P.L. 107-206, on August 29, 2002, DOE awarded a contract to UDS for construction and operation of two conversion facilities. DOE also reevaluated the appropriate scope of its site-specific NEPA review and decided to prepare two separate EISs, one for the plant proposed for the Paducah site and a second for the Portsmouth site. This change in approach was announced in the *Federal Register* on April 28, 2003 (68 FR 22368).

The two draft site-specific conversion facility EISs were mailed to stakeholders in late November 2003, and a notice of availability was published by the U.S. Environmental Protection Agency (EPA) in the *Federal Register* on November 28, 2003 (68 FR 66824). Comments on the draft EISs were accepted during a 67-day review period, from November 28, 2003, until February 2, 2004. Public hearings on the draft EISs were held near Portsmouth, Ohio, on January 7, 2004; Paducah, Kentucky, on January 13, 2004; and Oak Ridge, Tennessee, on January 15, 2004.

S.1.1.6 Characteristics of DUF_6

The gaseous diffusion process uses uranium in the form of UF_6, primarily because UF_6 can conveniently be used in gaseous form for processing, in liquid form for filling or emptying containers, and in solid form for storage. Solid UF_6 is a white, dense, crystalline material that resembles rock salt. Depleted uranium is uranium that, through the enrichment process, has been stripped of a portion of the uranium-235 that it once contained so that its proportion is lower than the 0.7 percent by weight (wt%) found in nature. The uranium in most of DOE's DUF_6 has between 0.2 wt% and 0.4 wt% uranium-235.

The chemical and physical characteristics of DUF_6 pose potential health risks, and the material is handled accordingly. Uranium and its decay products in DUF_6 emit low levels of alpha, beta, gamma, and neutron radiation. If DUF_6 is released to the atmosphere, it reacts with water vapor in the air to form HF and a uranium oxyfluoride compound called uranyl fluoride (UO_2F_2), which can be harmful to human health if inhaled or ingested in sufficient quantities. Uranium is a heavy metal that, in addition to being radioactive, can have toxic chemical effects (primarily on the kidneys) if it enters the bloodstream by means of ingestion or inhalation. HF is an extremely corrosive gas that can damage the lungs and cause death if inhaled at high enough concentrations. In light of such characteristics, DOE stores DUF_6 in a manner designed to minimize the risk to workers, the public, and the environment.

As the inventory of DUF_6 cylinders ages, some cylinders have begun to show evidence of external corrosion. At Paducah, a total of three cylinder breaches have occurred (see text box on next page). However, since DUF_6 is solid at ambient temperatures and pressures, it is not readily released after a cylinder leak or breach due to corrosion. When a hole develops in a cylinder, moist air reacts with the exposed solid DUF_6 and iron, forming a dense plug of solid uranium and iron compounds and a small amount of HF gas. The plug limits the amount of material released from a breached cylinder. When a hole in a cylinder is identified, the cylinder is typically repaired or its contents are transferred to a new cylinder. Following a large release of solid UF_6 (generally possible only if a cylinder is involved in a fire), the UF_6 would slowly react with moisture in the air, forming UO_2F_2 and HF, which would be dispersed downwind. The presence of a fire can result in a more rapid reaction and a larger release of UO_2F_2 and HF.

Because reprocessed uranium was enriched in the early years of gaseous diffusion, some of the DUF_6 inventory is contaminated with small amounts of technetium (Tc) and the transuranic (TRU) elements plutonium (Pu), neptunium (Np), and americium (Am). The final RFP for conversion services concluded that any DUF_6 contaminated with TRU elements and Tc at the concentrations expected could be safely handled in a conversion facility. As discussed in this EIS, the risk associated with potential contamination would be relatively small, and those cylinders would be processed in the same manner as cylinders not containing TRU and Tc contamination.

Some of the cylinders manufactured before 1978 were painted with coatings containing polychlorinated biphenyls (PCBs). (Although PCBs are no longer in production in the United States, from the 1950s to the late 1970s, PCBs were added to some paints as fungicides and to increase durability and flexibility.) The long persistence of PCBs in the environment and the tendency for bioaccumulation in the foodchain has resulted in regulations to prevent their release and distribution in the environment. Potential issues associated with PCB-containing cylinder coatings are addressed in more detail in Appendix B of the EIS. As discussed in Appendix B, the presence of PCBs in the coatings of some cylinders is not expected to result in health and safety risks to workers or the public.

Summary Data for Breached Cylinders at the Storage Sites through 2003

Paducah Site, three breached cylinders: One identified in 1992 was initiated by mechanical damage during stacking. The breached area was about 0.06 in. × 2 in. (0.16 cm × 5.1 cm). Estimated material loss was 0. The other two cylinder breaches were identified as breached because of missing cylinder plugs; they were identified between 1998 and 2002. Material loss from these cylinders was not estimated.

ETTP Site, five breached cylinders: Four were identified in 1991 and 1992. Two of these were initiated by mechanical damage during stacking, and two were caused by external corrosion due to prolonged ground contact. The breach areas for these four cylinders were about 2 in. (5.1 cm), 6 in. (15 cm), and 10 in. (25 cm) in diameter for three circular breaches, and 17 in. × 12 in. for a rectangular-shaped breach. The mass of material loss from the cylinders could not be estimated because equipment to weigh the cylinders was not available at the ETTP site. The fifth breach occurred in 1998 and was caused by steel grit blasting, which resulted in a breach at the location of an as-fabricated weld defect (immediately repaired without loss of DUF_6).

Portsmouth Site, three breached cylinders: Two identified in 1990 were initiated by mechanical damage during stacking; the damage was not noticed immediately, and subsequent corrosion occurred at the point of damage. The largest breach size was about 9 in. × 18 in. (23 cm × 46 cm); the estimated mass of DUF_6 lost was between 17 and 109 lb (7.7 and 49 kg). The next largest cylinder breach had an area of about 2 in. (5.1 cm) in diameter; the estimated DUF_6 lost was less than 4 lb (1.8 kg). The third breached cylinder occurred in 1996 and was the result of handling equipment knocking off a cylinder plug.

S.1.2 Purpose and Need

DOE needs to convert its inventory of DUF_6 to a more stable chemical form for use or disposal. This need follows directly from (1) the decision presented in the August 1999 ROD for the PEIS, namely, to begin conversion of the DUF_6 inventory as soon as possible, and (2) P.L. 107-206, which directs DOE to award a contract for construction and operation of conversion facilities at both the Paducah site and the Portsmouth site.

S.1.3 Proposed Action

The proposed action evaluated in this EIS is to construct and operate a conversion facility at the Paducah site for converting the Paducah DUF_6 inventory into depleted uranium oxide (primarily U_3O_8) and other conversion products. The action includes construction, operation, maintenance, and D&D of the proposed DUF_6 conversion facility at the Paducah site; transportation of depleted uranium conversion products and waste materials to a disposal facility; transportation and sale of the HF produced as a conversion co-product; and neutralization of HF to CaF_2 and its sale or disposal in the event that the HF product is not sold. Although not part of the proposed action, this EIS considers an option of shipping the cylinders stored at ETTP to Paducah rather than to Portsmouth (under this option, DUF_6 cylinders would be converted and non-DUF_6 cylinders would be stored for ultimate use) and an option of expanding facility operations.

S.1.4 Scope

The scope of an EIS refers to the range of actions, alternatives, and impacts it considers. As noted in Section S.1.1.4, on September 18, 2001, DOE published a NOI in the *Federal Register* (66 FR 48123) announcing its intention to prepare an EIS for a proposal to construct, operate, maintain, and decontaminate and decommission two DUF_6 conversion facilities at Portsmouth, Ohio, and Paducah, Kentucky. The NOI announced that the scoping period for the EIS would be open until November 26, 2001. The scoping period was later extended to January 11, 2002. During the scoping process, the public was given six ways to submit comments on the DUF_6 proposal to DOE, including public meetings, mail, facsimile transmission, voice messages, electronic mail, and through a dedicated Web site. DOE held public scoping meetings near Paducah, Kentucky, Portsmouth, Ohio, and Oak Ridge, Tennessee, to give the public an opportunity to present comments on the scope of the EIS and to ask questions and discuss concerns regarding the EIS with DOE officials. The scoping meeting in Paducah, Kentucky, was held on December 6, 2001. Approximately 140 comments were received from about 30 individuals and organizations during the scoping period via all media. These comments were examined to determine the proposed scope of this EIS. Comments were related primarily to five major issues: (1) DOE policy; (2) alternatives; (3) cylinder inventory, maintenance, and surveillance; (4) transportation; and (5) general environmental concerns. Comments received in response to the April 28, 2003, Notice of Change in NEPA Compliance Approach were similar to those made during the public scoping period and were also considered.

The alternatives that are evaluated and compared in this EIS represent reasonable alternatives for converting DUF_6. Three alternative locations within the Paducah site are evaluated in detail in this EIS for the proposed action as well as a no action alternative. In addition, this EIS considers an option of shipping the cylinders at ETTP to Paducah, although current proposals call for these cylinders to be shipped to Portsmouth, and an option of expanding the conversion facility operations. These alternatives and options, as well as alternatives considered but not evaluated in detail, are described in more detail in Chapter 2.

S.1.5 Public Review of the Draft EIS

The two draft site-specific conversion facility EISs were mailed to stakeholders in late November 2003, and a notice of availability was published by the EPA in the *Federal Register* on November 28, 2003 (68 FR 66824). In addition, each EIS was also made available in its entirety on the Internet at the same time, and e-mail notification was sent to those on the project Web site mailing list. Stakeholders were encouraged to provide comments on the draft EISs during a 67-day review period, from November 28, 2003, until February 2, 2004. Comments could be submitted by calling a toll-free number, by fax, by letter, by e-mail, or through the project Web site. Comments could also be submitted at public hearings held near Portsmouth, Ohio, on January 7, 2004; Paducah, Kentucky, on January 13, 2004; and Oak Ridge, Tennessee, on January 15, 2004. The public hearings were announced on the project Web site and in local newspapers prior to the meetings.

A total of about 210 comments was received during the comment period. The comments received and DOE's responses to those comments are presented in Volume 2 of this EIS. Because of the similarities in the proposed actions and the general applicability of many of the comments to both the Portsmouth and the Paducah site-specific conversion facility EISs, all comments received on both EISs are included in Volume 2. In addition, all comments received were considered in the preparation of both final EISs.

The most common issues raised by reviewers were related to support for the proposed action and preferred alternative, transportation of cylinders, removal of cylinders from the ETTP site, the potential for DOE to accept additional DUF_6 cylinders from other sources, the recently announced USEC American Centrifuge Facility, and general health and safety concerns. Several revisions were made to the two site-specific conversion facility draft EISs on the basis of the comments received (changes are indicated by vertical lines in the right margin of the document). The vast majority of the changes were made to provide clarification and additional detail. Specific responses to each comment received on the draft EISs are presented in Volume 2 of this EIS.

S.1.6 Relationship to Other NEPA Reviews

This DUF_6 Conversion EIS, along with the Portsmouth conversion facility EIS (DOE/EIS-0360), represent the second level of a tiered environmental review process being used to evaluate and implement DOE's DUF_6 Management Program. The project-level review in these conversion facility EISs incorporates, by reference, the programmatic analysis, as appropriate, from the DUF_6 PEIS published by DOE in 1999.

In addition to the Portsmouth conversion facility EIS, which is directly related to this EIS, DOE has prepared (or is preparing) other NEPA reviews that are related to the management of DUF_6 or to the current DUF_6 storage sites. These reviews were evaluated and their results taken into consideration in the preparation of this EIS. The related reviews included continued waste management activities at Paducah, demonstration of a mixed waste vitrification process at Paducah, and long-term management for DOE's inventory of potentially reusable uranium.

In addition, DOE prepared a Supplement Analysis for the shipment of up to 1,700 DUF_6 cylinders that meet transportation requirements from ETTP to Portsmouth in fiscal years (FYs) 2003 through 2005. Based on the Supplement Analysis, DOE issued an amended ROD to the PEIS concluding that the estimated impacts for the proposed transport of up to 1,700 cylinders were less than or equal to those considered in the PEIS and that no further NEPA documentation was required (68 FR 53603). Nonetheless, this EIS considers shipment of all DUF_6 and non-DUF_6 at ETTP to Paducah by truck and rail.

S.1.7 Organization of This Environmental Impact Statement

This DUF_6 Conversion EIS consists of two volumes. Volume 1 contains 10 chapters and 8 appendixes. Chapter 1 describes background information, the purpose and need for the DOE action, the scope of the assessment, and related NEPA reviews and other studies. Chapter 2 defines the alternatives and options considered in this EIS. Chapter 3 discusses the environmental setting at the Paducah and ETTP sites. Chapter 4 addresses the assumptions, approach, and methods used in the impact analyses. Chapter 5 discusses the potential environmental impacts of the alternatives, and Chapter 6 identifies the major laws, regulations, and other requirements applicable to implementing the alternatives. Chapter 7 lists the cited references used in preparing this EIS, and Chapter 8 lists the names of those who prepared this EIS. Chapter 9 is a glossary of technical terms used in this EIS, and Chapter 10 is a subject matter index.

The eight appendixes in Volume 1 include a summary of the pertinent text from P.L. 107-206 (Appendix A), a discussion of issues associated with potential TRU and Tc contamination (Appendix B), comments received during public scoping and from the Notice of Change in NEPA Compliance Approach (Appendix C), the environmental synopsis prepared to support the DUF_6 conversion procurement process (Appendix D), the potential sale of HF and CaF_2 and estimated health and socioeconomic impacts associated with their use (Appendix E), a description of discipline-specific assessment methodologies (Appendix F), letters of consultation (Appendix G), and the contractor disclosure statement (Appendix H).

Volume 2 of the EIS is the comment response document prepared after the public review of the draft EIS. Volume 2 contains an overview of the public review process, copies of the letters or other documents that contained comments to DOE, and the responses to all comments received.

S.2 ALTERNATIVES

The alternatives considered in this EIS are summarized in Table S-2 and described below.

S.2.1 No Action Alternative

Under the no action alternative, it is assumed that DUF_6 cylinder storage would continue indefinitely at the Paducah site. The no action alternative assumes that DOE would continue surveillance and maintenance activities to ensure the continued safe storage of cylinders. Potential environmental impacts are estimated through the year 2039. The year 2039 was selected to be consistent with the PEIS, which evaluated a 40-year cylinder storage period (1999–2039). In addition, long-term impacts (i.e., occurring after 2039) from potential cylinder breaches are assessed.

Specifically, the activities assumed to occur under no action include routine cylinder inspections, ultrasonic testing of the wall thicknesses of selected cylinders, painting of cylinders to prevent corrosion, cylinder yard surveillance and maintenance, reconstruction of several storage yards, and relocation of some cylinders to the new or improved yards. It was assumed that cylinders would be painted every 10 years. On the basis of these activities, an assessment of the potential impacts on workers, members of the general public, and the environment was conducted.

For assessment purposes in this EIS, two cylinder breach cases were evaluated. In the first case, it was assumed that the planned cylinder maintenance and painting program would maintain the cylinders in a protected condition and control further corrosion. For this case, it was assumed that after initial painting, some breaches would occur from handling damage; a total of 36 future breaches were estimated to occur through 2039. In the second case, it was assumed that external corrosion would not be halted by improved storage conditions, cylinder maintenance, and painting. This case was considered in order to account for uncertainties with regard to how effective painting would be in controlling cylinder corrosion and uncertainties in the future painting schedule. In this case, the number of future breaches estimated through 2039 was 444 for the Paducah site (i.e., 11 per year).

Alternatives Considered in This EIS

No Action: NEPA regulations require evaluation of a no action alternative as a basis for comparing alternatives. In this EIS, the no action alternative is storage of DUF_6 and non-DUF_6 cylinders indefinitely in yards at the Paducah site, with continued cylinder surveillance and maintenance activities.

Proposed Action: Construction and operation of a conversion facility at the Paducah site for conversion of the Paducah DUF_6 inventory into depleted uranium oxide (primarily U_3O_8) and other conversion products.

Action Alternatives: Three action alternatives focus on where to construct the conversion facility within the Paducah site (Alternative Locations A, B, and C). The preferred alternative is Location A.

The estimated number of future breaches at the Paducah site was used to estimate potential impacts that might occur during the repair of breached cylinders and impacts from releases that might occur during continued cylinder storage.

S.2.2 Proposed Action Alternatives

Proposed Action

The proposed action in this EIS is construction and operation of a conversion facility at the Paducah site for conversion of the Paducah DUF_6 inventory into depleted uranium oxide (primarily U_3O_8) and other conversion products. Three alternative locations within the Paducah site are evaluated (Locations A, B, and C).

The proposed action evaluated in this EIS is to construct and operate a conversion facility at the Paducah site for converting the DUF_6 inventory stored at Paducah into depleted uranium oxide (primarily U_3O_8) and other conversion products. Three alternative locations within the Paducah site are evaluated (Table S-2). The conversion facility would convert DUF_6 into a stable chemical form for beneficial use/reuse and/or disposal. The off-gas from the conversion process would yield aqueous HF, which would be processed and marketed or converted to a solid for sale or disposal. To support the conversion operations, the emptied DUF_6 cylinders would be stored, handled, and processed for reuse as uranium oxide disposal containers to the extent practicable. The time period considered is a construction period of approximately 2 years, an operational period of 25 years, and a 3-year period for the D&D of the facility. Current plans call for construction to begin in the summer of 2004. The assessment is based on the conceptual conversion facility design proposed by UDS, the selected contractor (see text box).

The action alternatives focus on where to site the conversion facility within the Paducah site. The Paducah site was evaluated to identify alternative locations for a conversion facility. The three alternative locations identified at the Paducah site, denoted Locations A, B, and C, are shown in Figure S-3.

> **Conversion Facility Design**
>
> This EIS is based on the conversion facility design being developed by UDS, the selected conversion contractor. At the time the draft EIS was prepared, the UDS design was in the 30% conceptual stage, with several facility design options being considered.
>
> Following the public comment period, the draft EIS was revised on the basis of comments received and on the basis of UDS 100% conceptual facility design. This final EIS identifies and evaluates design options where possible.

S.2.2.1 Alternative Location A (Preferred Alternative)

Location A is the preferred location for the conversion facility. It is located south of the administration building and its parking lot, immediately west of and next to the primary location of the DOE cylinder yards and east of the main plant access road. This location is an L-shaped tract consisting mostly of grassy field. However, the southeastern section is a wooded area. A drainage ditch crosses the northern part of the site, giving the cylinder yard storm water access to the Kentucky Pollution Discharge Elimination System (KPDES) Outfall 017. This location is about 35 acres (14 ha) in size. This location was identified in the RFP for conversion services as the site for which bidders were to design their proposed facilities.

S.2.2.2 Alternative Location B

Location B is directly south of the Paducah maintenance building and west of the main plant access road. The northern part of this location is mowed grass and has a slightly rolling topography. The southern part has a dense covering of trees and brush, and some high-voltage power lines cross it, limiting its use. This location has an area of about 59 acres (23 ha).

S.2.2.3 Alternative Location C

Location C is east of the Paducah pump house and cooling towers. It has an area of about 53 acres (21 ha). Dykes Road runs through the center of this location from north to south. Use of the eastern half of this location could be somewhat limited because several high-voltage power lines run through this area.

S.2.2.4 Conversion Process Description

The proposed conversion system is based on a proven commercial process in operation at the Framatome Advanced Nuclear Power fuel fabrication facility in Richland, Washington. The UDS dry conversion is a continuous process in which DUF_6 is vaporized and converted to a mixture of uranium oxides (primarily U_3O_8) by reaction with steam and hydrogen in a fluidized-bed conversion unit. The hydrogen is generated using anhydrous ammonia (NH_3). Nitrogen is also used as an inert purging gas and is released to the atmosphere through the building stack as part of the clean off-gas stream. The depleted U_3O_8 powder is collected and packaged for disposition. The process equipment would be arranged in parallel lines. Each line would consist of two autoclaves, two conversion units, a HF recovery system, and process off-gas scrubbers. The Paducah facility would have four parallel conversion lines. Equipment would also be installed to collect the HF co-product and process it into any combination of several marketable products. A backup HF acid neutralization system would be provided to convert up to 100% of the HF acid to CaF_2 for storage, sale, or disposal in the future, if necessary. Figure S-4 is an overall material flow diagram for the conversion facility; Figure S-5 is a conceptual facility site plan. A summary of key facility characteristics is presented in Table S-3.

The conversion facility will be designed to convert 18,000 t (20,000 tons) of DUF_6 per year, requiring 25 years to convert the Paducah inventory. The Paducah processing facility would be approximately 148 ft × 271 ft (45 m × 83 m). The conversion facility would occupy a total of approximately 10 acres (4 ha), with up to 45 acres (18 ha) of land disturbed during construction (including temporary construction lay-down areas and utility access). Some of the disturbed areas would be areas cleared for railroad or utility access, not adjacent to the construction area.

The conversion process would generate four conversion products that have a potential use or reuse: depleted U_3O_8, HF, CaF_2, and steel from emptied DUF_6 cylinders (if not used as disposal containers). DOE has been working with industrial and academic researchers for several years to identify potential uses for these products. Some potential uses for depleted uranium exist or are being developed, and DOE believes that a viable market exists for the HF generated during conversion. To take advantage of these to the extent possible, DOE requested in the RFP that the bidders for conversion services investigate and propose viable uses. Table S-4 summarizes the probable disposition paths identified by UDS for each of the conversion products.

S.2.2.5 Option of Shipping ETTP Cylinders to Paducah

DOE proposes to ship the DUF_6 and non-DUF_6 cylinders at ETTP to Portsmouth. However, this EIS considers an option of sending the ETTP cylinders to Paducah. All shipments of ETTP cylinders would have to be made consistent with U.S. Department of Transportation (DOT) regulations for the shipment of radioactive materials as specified in Title 49 of the CFR (see text box on page S-24). A large number of the ETTP DUF_6 cylinders do not meet the DOT requirements intended to maintain the safety of shipments during both routine and accident conditions. Some cylinders have physically deteriorated such that they no longer meet the DOT requirements. Currently, it is estimated that 1,700 cylinders are DOT compliant.

Before shipment, each cylinder would be inspected to determine if it met DOT requirements. This inspection would include a record review to determine if the cylinder was overfilled; a visual inspection for damage or defects; a pressure check to determine if the cylinder was overpressurized; and an ultrasonic wall thickness measurement (based on a visual inspection, if necessary). If a cylinder passed the inspection, the appropriate documentation would be prepared, and the cylinder would be loaded directly for shipment.

This EIS considers three options for shipping noncompliant cylinders from ETTP: obtaining an exemption from the DOT to ship the cylinders "as-is" or following repairs, use of cylinder overpacks, and use of a cylinder transfer facility. For an exemption to be granted, DOE would have to demonstrate that the proposed shipments would achieve a level of safety that would be at least equal to the level required by the regulations, likely requiring some type of compensatory measures. An overpack (the second option) is a container into which a cylinder is placed for shipment. The overpack would be designed, tested, and certified to meet all DOT shipping requirements. It would be suitable for containing, transporting, and storing the cylinder contents regardless of cylinder condition. The third option considers the transfer of the DUF_6 from substandard cylinders to new or used cylinders that would meet all DOT requirements. This option could require the construction of a new cylinder transfer facility at ETTP, for which there are no current plans. If a decision were made to construct such a facility, additional NEPA review would be conducted. Transportation impacts are estimated for shipment by both truck and rail after cylinder preparation.

S.2.2.6 Option of Expanding Conversion Facility Operations

The conversion facility at Paducah is currently being designed to process the DOE DUF_6 cylinder inventory at the site over 25 years by using four process lines (see Sections S.2.2.4 and 2.2.2). There are no current plans to operate the conversion facility beyond this time period or to increase the throughput of the facility by adding an additional process line. However, a future decision to extend conversion facility operations or increase throughput at the site could be made for several reasons. Consequently, this EIS includes an evaluation of the environmental impacts associated with expanding conversion facility operations at the site in order to provide future planning flexibility. (Impacts are discussed in Section S.5.22 and presented in detail in Section 5.2.6.) The possible reasons for expanding operations in the future are discussed below.

The DOE Office of Inspector General (OIG) issued a final audit report in March 2004 reviewing the proposed depleted uranium hexafluoride conversion project. The OIG report recommends that the Office of Environmental Management (EM) conduct a cost benefit analysis to determine the optimum size of the Portsmouth conversion facility and, on the basis of the results of that review, implement the most cost-effective approach. The report states that by adding an additional process line to the Portsmouth facility, the time to process the Portsmouth and ETTP inventories of DUF_6 could be shortened by 5 years at a substantial cost savings of 55 million dollars.

In contrast to the findings at Portsmouth, the OIG report notes that it would not be feasible to add an additional conversion line to the Paducah facility. Consequently, this EIS evaluates the potential environmental impacts associated with increasing the Paducah plant throughput by implementing process improvements (see Section S.5.22). On the basis of experience with other projects, DOE believes that higher throughput rates can be achieved by improving the efficiency of the planned equipment.

A future decision to extend operations or expand throughput might also result from the fact that DOE could assume management responsibility for DUF_6 in addition to the current inventory. Possible reasons include future DOE management responsibility for DUF_6 due to regulatory changes or possible MOAs between USEC and DOE; development of an advanced enrichment technology by USEC (currently proposed for the Portsmouth site); and new commercial uranium enrichment facilities that may be built and operated in the United States by commercial companies other than USEC. In addition, because the Portsmouth facility would conclude operations approximately 7 years before the current Paducah inventory would be converted at the Paducah site, it is possible that some DUF_6 cylinders could be transferred from Paducah to Portsmouth, particularly if DOE assumes responsibility for additional DUF_6 at Paducah. These possibilities are discussed and evaluated in this EIS in order to provide future planning flexibility.

Transportation Requirements
for DUF_6 Cylinders

All shipments of UF_6 cylinders have to be made in accordance with applicable DOT regulations for the shipment of radioactive materials; specifically, the provisions of 49 CFR Part 173, Subpart I. The DOT regulations require that each UF_6 cylinder be designed, fabricated, inspected, tested, and marked in accordance with the various engineering standards that were in effect at the time the cylinder was manufactured. The DOT requirements are intended to maintain the safety of shipments during both routine and accident conditions. The following provisions are particularly important relative to DUF_6 cylinder shipments:

1. A cylinder must be filled to less than 62% of the certified volumetric capacity (the fill limit was reduced from 64% to 62% in about 1987).

2. The pressure within a cylinder must be less than 14.8 psia (subatmospheric pressure).

3. A cylinder must be free of cracks, excessive distortion, bent or broken valves or plugs, and broken or torn stiffening rings or skirts, and it must not have a shell thickness that has decreased below a specified minimum value. (Shell thicknesses are assessed visually by a code vessel inspector, and ultrasonic testing may be specified at the discretion of the inspector to verify wall thickness, when and in areas the inspector deems necessary.)

4. A cylinder must be designed so that it will withstand (1) a hydraulic test at an internal pressure of at least 1.4 megapascals (200 psi) without leakage; (2) a free drop test onto a flat, horizontal surface from a height of 1 ft (0.3 m) to 4 ft (1.2 m), depending on the cylinder's mass, without loss or dispersal; and (3) a 30-minute thermal test equivalent to being engulfed in a hydrocarbon fuel/air fire having an average temperature of at least 800°C (1,475°F) without rupture of the containment system.

S.2.3 Alternatives Considered but Not Analyzed in Detail

S.2.3.1 Use of Commercial Conversion Capacity

An alternative examined was using existing UF_6 conversion capacity at commercial nuclear fuel fabrication facilities that convert natural or enriched UF_6 to UO_2 in lieu of constructing new conversion capacity for DUF_6. This alternative was not analyzed in detail because the small capacity possibly available to DOE, coupled with the low interest level expressed by facility owners, indicates that the feasibility of this suggested alternative is low, and the duration of the conversion period is long (more than 125 years).

S.2.3.2 Sites Other Than Paducah

The consideration of alternative sites was limited to alternative locations within the Paducah site in response to Congressional direction. As discussed in detail in Section 1.1, Congress has acted twice regarding the construction and operation of DUF_6 conversion facilities at Portsmouth and Paducah. Both P.L. 105-204 and P.L. 107-206 directed DOE to construct and operate conversion facilities at these two sites.

S.2.3.3 Alternative Conversion Processes

Potential environmental impacts associated with alternative conversion processes were considered during the procurement process, including the preparation of an environmental critique and environmental synopsis (Appendix D of this EIS), which were prepared in accordance with the requirements of 10 CFR 1021.216. The environmental synopsis concluded that, on the basis of assessment of potential environmental impacts presented in the critique, no proposal received by DOE was clearly environmentally preferable. The potential environmental impacts associated with the proposals were found to be similar to, and generally less than, those presented in the DUF_6 PEIS for representative conversion technologies.

S.2.3.4 Long-Term Storage and Disposal Alternatives

There are no current plans for long-term storage of conversion products; long-term storage alternatives were analyzed in the PEIS, including storage as DUF_6 and storage as an oxide (either U_3O_8 or UO_2). The potential environmental impacts from long-term storage were evaluated in the PEIS for representative and generic sites. Therefore, long-term storage alternatives were not evaluated in this EIS.

With respect to disposal, this EIS evaluates the impacts from packaging, handling, and transporting depleted uranium conversion products from the conversion facility to a LLW disposal facility that would be (1) selected in a manner consistent with DOE policies and orders, and (2) authorized or licensed to receive the conversion products by DOE (in conformance with

DOE orders), the U.S. Nuclear Regulatory Commission (NRC) (in conformance with NRC regulations), or an NRC Agreement State agency (in conformance with state laws and regulations determined to be equivalent to NRC regulations). Assessment of the impacts and risks from on-site handling and disposal at the LLW disposal facility is deferred to the disposal site's site-specific NEPA or licensing documents. However, this EIS covers the impacts from transporting the DUF_6 conversion products to both the Envirocare of Utah, Inc., facility and the NTS. DOE plans to decide the specific disposal location(s) for the depleted U_3O_8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

S.2.3.5 Other Transportation Modes

Transportation by air and barge were considered but not analyzed in detail. Transportation by air was deemed to not be reasonable for the types and quantities of materials that would be transported to and from the conversion site. Transportation by barge was also considered and deemed to be unreasonable. ETTP is the only site with a nearby barge facility. Paducah would either have to build new facilities at a distance of at least 6 mi (10 km) or use existing facilities located 20 to 30 mi (32 to 48 km) from the site, and an additional loading/unloading step and on-land transport by truck or rail over this distance would be required. If barge shipment was proposed in the future and considered to be reasonable, an additional NEPA review would be conducted.

S.2.3.6 One Conversion Plant for Two Sites

In the NOI published in the *Federal Register* on September 18, 2001, construction and operation of one conversion plant was identified as a preliminary alternative that would be considered in the conversion EIS. However, with the passage of P.L. 107-206, which mandates the award of a contract for the construction and operation of conversion facilities at both Paducah and Portsmouth, the one conversion plant alternative was considered but not analyzed in this EIS.

S.3 AFFECTED ENVIRONMENT

This EIS considers the proposed action at the Paducah site for conversion of the Paducah DUF_6 inventory, including the option of shipping cylinders from the ETTP site to the Paducah site. Chapter 3 presents a detailed description of the affected environment at and around the Paducah and ETTP sites. Environmental resources and values that could potentially be affected include the following:

- Cylinder yards,
- Site infrastructure,
- Air quality,
- Noise,
- Soils,
- Surface and groundwater,
- Vegetation,
- Wildlife,
- Wetlands,
- Threatened and endangered species,
- Public and occupational safety and health,
- Socioeconomics,
- Waste management,
- Land use,
- Cultural resources, and
- Environmental justice.

S.4 ENVIRONMENTAL IMPACT ASSESSMENT APPROACH, ASSUMPTIONS, AND METHODOLOGY

Potential environmental impacts were assessed by examining all of the activities required to implement each alternative, including construction of the required facility, operation of the facility, and transportation of materials between sites (Figure S-6). For continued cylinder storage under the no action alternative, potential long-term impacts were also estimated. For each alternative, potential impacts to workers, members of the general public, and the environment were estimated for both normal operations and for potential accidents.

The analysis for this EIS considered all potential areas of impact and emphasized those that might have a significant impact on human health or the environment, would be different under different alternatives, or would be of special interest to the public (such as potential radiation effects). The estimates of potential environmental impacts for the action alternatives were based on characteristics of the proposed UDS conversion facility.

The process of estimating environmental impacts from the conversion of DUF_6 is subject to some uncertainty because final facility designs are not yet available. In addition, the methods used to estimate impacts have uncertainties associated with their results. This EIS impact assessment was designed to ensure — through selection of assumptions, models, and input parameters — that impacts would not be underestimated and that relative comparisons among the alternatives would be valid and meaningful. Although uncertainty may characterize estimates of the absolute magnitude of impacts, a uniform approach to impact assessment enhances the ability to make valid comparisons among alternatives. This uniform approach was implemented in the analyses conducted for this EIS to the extent practicable.

Table S-5 summarizes the major assumptions and parameters that formed the basis of the analyses in this EIS.

S.5 CONSEQUENCES AND COMPARISON OF ALTERNATIVES

This EIS analyzes potential impacts at the Paducah site under the no action alternative and the proposed action alternatives. Under the no action alternative, potential impacts associated with the continued storage of DUF_6 cylinders in yards are evaluated through 2039; in addition, the long-term impacts that could result from releases of DUF_6 and HF from future cylinder breaches are evaluated. For the proposed action, potential impacts are evaluated at three alternative locations for a construction period of 2 years and an operational period of 25 years.

The potential environmental impacts at Paducah under the proposed action alternatives and the no action alternative are presented in Table S-6 (placed at the end of this summary). To supplement the information in Table S-6, each area of impact evaluated in this EIS is discussed below. Major similarities and differences among the alternatives are highlighted. Additional details and discussion are provided in Chapter 5 for each alternative.

S.5.1 Human Health and Safety — Construction and Normal Facility Operations

Under the no action alternative and the action alternatives, it is estimated that potential exposures of workers and members of the general public to radiation and chemicals would be well within applicable public health standards and regulations during normal facility operations (including 10 CFR 835, 40 CFR 61 Subpart H, and DOE Order 5400.5). The estimated doses and risks from radiation and/or chemical exposures of the general public and noninvolved workers would be very low, with zero latent cancer fatalities (LCFs) expected among these groups over the time periods considered, and with minimal adverse health impacts from chemical exposures expected. (Dose and risk estimates are shown in Table S-6.) In general, the location of a conversion facility within the Paducah site would not significantly affect potential impacts (i.e., no significant differences in impacts from Location A, B, or C were identified) to workers or the general public during normal facility operations. Construction workers at Locations A and C and cylinder yard reconstruction workers under the no action alternative would receive low doses (i.e., up to 40 mrem/yr for the action alternatives and up to 230 mrem/yr for the no action alternative) because of the proximity of the construction sites to the cylinder yards.

Key Concepts in Estimating Risks from Radiation

The health effect of concern from exposure to radiation at levels typical of environmental and occupational exposures is the inducement of cancer. Radiation-induced cancers may take years to develop following exposure and are generally indistinguishable from cancers caused by other sources. Current radiation protection standards and practices are based on the premise that any radiation dose, no matter how small, can result in detrimental health effects (cancer) and that the number of effects produced is in direct proportion to the radiation dose. Therefore, doubling the radiation dose is assumed to result in doubling the number of induced cancers. This approach is called the “linear-no-threshold hypothesis” and is generally considered to result in conservative estimates (i.e., over-estimates) of the health effects from low doses of radiation.

Involved workers (persons directly involved in the handling of radioactive or hazardous materials) could be exposed to low-level radiation emitted by uranium during the normal course of their work activities, and this exposure could result in a slight increase in the risk for radiation-induced LCFs to individual involved workers. (The possible presence of TRU and Tc contamination in the cylinder inventory would not contribute to exposures during normal operations.) The annual number of workers exposed could range from about 40 (under the no action alternative) to 172 under the action alternatives. Under the no action alternative, it is estimated that radiation exposure of involved workers would result in a 1-in-2 chance of one additional LCF among the entire involved worker population over the life of the project. Under the action alternatives, a 1-in-7 chance of one additional LCF among involved workers over the life of the project was estimated.

Possible radiological exposures from using groundwater potentially contaminated as a result of releases from breached cylinders or facility releases were also evaluated. In general, these exposures would be at very low levels and within applicable public health standards and regulations. However, the uranium concentration in groundwater could exceed 20 μg/L (the drinking water guideline used for comparison in this EIS) at some time in the future under the no action alternative if cylinder corrosion was not controlled. This scenario is highly unlikely because ongoing cylinder inspections and maintenance would prevent significant releases from occurring.

S.5.2 Human Health and Safety — Facility Accidents

S.5.2.1 Physical Hazards

Under all alternatives, workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. On the basis of accident statistics for similar industries, it is estimated that under the no action alternative, zero fatalities and about 84 injuries might occur through 2039 at the Paducah site (about 2 injuries per year). Under the action alternatives, the risk of physical hazards would not depend on the location of the conversion facility. No fatalities are predicted, but about 11 injuries during construction and about 200 injuries during operations could occur at the conversion facility (about 6 injuries per year during a 2-year construction period and 8 injuries per year during operations). Accidental injuries and deaths are not unusual in industries that use heavy equipment to manipulate heavy objects and bulk materials.

S.5.2.2 Facility Accidents Involving Radiation or Chemical Releases

Under all alternatives, it is possible that accidents could release radiation or chemicals to the environment, potentially affecting workers and members of the general public. Of all the accidents considered, those involving DUF_6 cylinders and those involving chemicals at the conversion facility would have the largest potential effects.

Health Effects from Accidental Chemical Releases

The impacts from accidental chemical releases were estimated by determining the numbers of people downwind who might experience adverse effects and irreversible adverse effects:

Adverse Effects: Any adverse health effects from exposure to a chemical release, ranging from mild and transient effects, such as respiratory irritation or skin rash (associated with lower chemical concentrations), to irreversible (permanent) effects, including death or impaired organ function (associated with higher chemical concentrations).

Irreversible Adverse Effects: A subset of adverse effects, irreversible adverse effects are those that generally occur at higher concentrations and are permanent in nature. Irreversible effects may include death, impaired organ function (such as central nervous system or lung damage), and other effects that may impair everyday functions.

The cylinder management plan (Commonwealth of Kentucky and DOE 2003) outlines required cylinder maintenance activities and procedures to be undertaken in the event of a cylinder breach and/or release of DUF_6 from one or more cylinders. Under all alternatives, there is a low probability that accidents involving DUF_6 cylinders could occur at the current storage locations. If an accident occurred, DUF_6 could be released to the environment. If a release occurred, the DUF_6 would combine with moisture in the air, forming gaseous HF and UO_2F_2, a soluble solid in the form of small particles. The depleted uranium and HF could be dispersed downwind, potentially exposing workers and members of the general public to radiation and chemical effects. The amount released would depend on the severity of the accident and the number of cylinders involved. The probability of cylinder accidents would decrease under the action alternatives as the DUF_6 was converted and the number of cylinders in storage decreased as a result.

For releases involving DUF_6 and other uranium compounds, both chemical and radiological effects could occur if the material was ingested or inhaled. The chemical effect of most concern associated with internal uranium exposure is kidney damage, and the radiological effect of concern is an increase in the probability of developing cancer. With regard to uranium, chemical effects occur at lower exposure levels than do radiological effects. Exposure to HF from accidental releases could result in a range of health effects, from eye and respiratory irritation to death, depending on the exposure level. Large anhydrous NH_3 releases could also cause severe respiratory irritation and death (NH_3 is used to generate hydrogen, which is required for the conversion process).

Chemical and radiological exposures to involved workers under accident conditions would depend on how rapidly the accident developed, the exact location and response of the workers, the direction and amount of the release, the physical forces causing or caused by the accident, meteorological conditions, and the characteristics of the room or building if the accident occurred indoors. Impacts to involved workers under accident conditions would likely be dominated by physical forces from the accident itself; thus, quantitative dose/effect estimates would not be meaningful. For these reasons, the impacts to involved workers during accidents are not quantified in this EIS. However, it is recognized that injuries and fatalities among involved workers would be possible if an accident did occur.

Under the no action alternative, for accidents involving cylinders that might happen at least once in 100 years (i.e., likely accidents [see text box]), it is estimated that the off-site concentrations of HF and uranium would be considerably below levels that would cause adverse chemical effects among members of the general public from exposure to these chemicals. However, up to 10 noninvolved workers might experience potential adverse effects from exposure to HF and uranium (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function). It is estimated that one noninvolved worker might experience potential irreversible adverse effects that are permanent in nature (such as lung damage or kidney damage), with no fatalities expected. Radiation exposures would be unlikely to result in additional LCFs among noninvolved workers or members of the general public for these types of accidents.

Cylinder accidents that are less likely to occur could be more severe, having greater consequences that could potentially affect off-site members of the general public. These types of accidents are considered extremely unlikely, expected to occur with a frequency of between once in 10,000 years and once in 1 million years of operations. Based on the expected frequency, through 2039, the probability of this type of accident was estimated to be about 1 chance in 2,500. Among all the cylinder accidents analyzed, the postulated accident that would result in the largest number of people with adverse effects (including mild and temporary as well as permanent effects) would be an accident that involves rupture of cylinders in a fire. If this type of accident occurred at the Paducah site, it is estimated that up to 2,000 members of the general public and 910 noninvolved workers might experience adverse chemical effects from HF and uranium exposure (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function). It is estimated that more adverse effects would occur among the general public than among noninvolved workers because of the buoyancy effects from the fire on contaminant plume spread (i.e., the concentrations that would occur would be higher at points farther from the release than at closer locations).

The postulated cylinder accident that would result in the largest number of persons with irreversible adverse health effects is a corroded cylinder spill under wet conditions, with an estimated frequency of between once in 10,000 years and once in 1 million years of operations. If this accident occurred, it is estimated that 1 member of the general public and 300 noninvolved workers might experience irreversible adverse effects (such as lung damage or kidney damage). No fatalities are expected among the members of the general public; there would be a potential for 3 fatalities among noninvolved workers from chemical effects. Radiation exposures would be unlikely to result in additional LCFs among noninvolved workers (1 chance in 170) or the general public (1 chance in 70).

Accident Categories and Frequency Ranges

Likely: Accidents estimated to occur one or more times in 100 years of facility operations (frequency $\geq 1 \times 10^{-2}$/yr).

Unlikely: Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency = from 1×10^{-2}/yr to 1×10^{-4}/yr).

Extremely Unlikely: Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency = from 1×10^{-4}/yr to 1×10^{-6}/yr).

Incredible: Accidents estimated to occur less than one time in 1 million years of facility operations (frequency < 1×10^{-6}/yr).

In addition to the cylinder accidents discussed above is a certain class of accidents that the DOE investigated; however, because of security concerns, information about such accidents is not available for public review but is presented in a classified appendix to the EIS. All classified information will be presented to state and local officials, as appropriate.

The number of persons actually experiencing adverse or irreversible adverse effects from cylinder accidents would likely be considerably fewer than those estimated for this analysis and would depend on the actual circumstances of the accident and the individual chemical sensitivities of the affected persons. For example, although exposures to releases from cylinder accidents could be life-threatening (especially with respect to immediate effects from inhalation of HF at high concentrations), the guideline exposure level of 20 parts per million (ppm) of HF used to estimate the potential for irreversible adverse effects from HF exposure is likely to result in overestimates. This is because no animal or human deaths have been known to occur as a result of acute exposures (i.e., 1 hour or less) at concentrations of less than 50 ppm; generally, if death does not occur quickly after HF exposure, recovery is complete.

Similarly, the guideline intake level of 30 mg used to estimate the potential for irreversible adverse effects from the intake of uranium in this EIS is the level suggested in NRC guidance. This level is somewhat conservative; that is, it is intended to overestimate rather than underestimate the potential number of irreversible adverse effects in the exposed population following uranium exposure. In more than 40 years of cylinder handling activities, no accidents involving releases from cylinders containing *solid* UF_6 have occurred that have caused diagnosable irreversible adverse effects among workers. In previous accidental exposure incidents involving *liquid* UF_6 in gaseous diffusion plants, some worker fatalities occurred immediately after the accident as a result of inhalation of HF generated from the UF_6. However, no fatalities occurred as a result of the toxicity of the uranium exposure. A few workers were exposed to amounts of uranium estimated to be about three times the guideline level (30 mg) used for assessing irreversible adverse effects; none of these workers, however, actually experienced such effects.

Under the action alternatives, low-probability accidents involving chemicals at the conversion facility could have large potential consequences for noninvolved workers and members of the general public. At a conversion site, accidents involving chemical releases, such as NH_3 and HF, could occur. NH_3 is used to generate hydrogen for conversion, and HF can be produced as a co-product of converting DUF_6. Although the UDS proposal uses NH_3 to generate hydrogen, hydrogen can be produced using natural gas. In that case, the accident impacts would be less than those discussed in this section for NH_3 accidents. (Further details are provided about potential NH_3 and other accidents in Section 5.2.2.2 for the conversion facility and in Section 5.2.3 for transportation.)

The conversion accident estimated to have the largest potential consequences is an accident involving the rupture of an anhydrous NH_3 tank. Such an accident could be caused by a large earthquake and is expected to occur with a frequency of less than once in 1 million years per year of operations. The probability of this type of accident occurring during the operation of a conversion facility is a function of the period of operation; over 25 years of operations, the accident probability would be less than 1 chance in 40,000.

If an NH_3 tank ruptured at the conversion facility, a maximum of up to about 6,700 members of the general public might experience adverse effects (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function) as a result of chemical exposure. A maximum of about 370 people might experience irreversible adverse effects (such as lung damage or kidney damage), with the potential for about 7 fatalities. With regard to noninvolved workers, up to about 1,600 workers might experience adverse effects (mild and temporary) as a result of chemical exposures. A maximum of about 1,600 noninvolved workers might experience irreversible adverse effects, with the potential for about 30 fatalities.

The location of the conversion facility within the Paducah site would affect the number of noninvolved workers who might experience adverse or irreversible adverse effects from an HF or NH_3 tank rupture accident. However, the accident analyses indicate that the impacts would not be consistently higher or lower at any of the alternative locations.

Although such high-consequence accidents at a conversion facility are possible, they are expected to be extremely rare. The risk (defined as consequence × probability) for these accidents would be less than 1 fatality and less than 1 irreversible adverse health effect for noninvolved workers and members of the public combined. NH_3 and HF are commonly used for industrial applications in the United States, and there are well-established accident prevention and mitigative measures for HF and NH_3 storage tanks. These include storage tank siting principles, design recommendations, spill detection measures, and containment measures. These measures would be implemented, as appropriate.

Under the action alternatives, the highest consequence radiological accident is estimated to be an earthquake damaging the depleted U_3O_8 product storage building. If this accident occurred, it is estimated that about 180 lb (82 kg) of depleted U_3O_8 would be released to the atmosphere outside of the building. The maximum collective dose received by the general public and the noninvolved workers would be about 70 person-rem and 1,300 person-rem, respectively. There would be about a 1-in-40 chance of an LCF among the general public and a 1-in-5 chance of an LCF among the noninvolved workers. Because the accident has a probability of occurrence that is about 1 chance in 4,000, the risk posed by the accident would be essentially zero LCFs among both the public and the workers.

S.5.3 Human Health and Safety — Transportation

Under the no action alternative, only small amounts of the LLW and low-level radioactive mixed waste (LLMW) that would be generated during routine cylinder maintenance activities would require transportation (about one shipment per year). Only negligible impacts are expected from such shipments. No DUF_6 or non-DUF_6 cylinders would be transported between sites.

Under the action alternatives, the number of shipments would include the following:

1. If U_3O_8 was disposed of in emptied cylinders, there would be approximately 7,240 railcar shipments of depleted U_3O_8 from the conversion facility to Envirocare (proposed) or NTS (option), or up to 36,200 truck shipments

(alternative) to either Envirocare or NTS. The numbers of shipments would be about 16,400 for trucks or 4,100 for railcars if bulk bags were used as disposal containers.

2. About 15,300 truck or 3,060 railcar shipments of aqueous (70% and 49%) HF could occur; alternatively, the aqueous HF could be neutralized to CaF_2, requiring a total of about 25,000 truck or 6,300 railcar shipments. Currently, the destination for these shipments is not known.

3. About 1,300 truck or 650 railcar shipments of anhydrous NH_3 from a supplier to the site. Currently, the origin of these shipments is not known.

4. Emptied heel cylinders to Envirocare or NTS, if bulk bags were used to dispose of the depleted U_3O_8.

5. For the option of shipping ETTP cylinders to Paducah, approximately 5,400 truck or 1,400 railcar shipments of cylinders from ETTP.

During normal transportation operations, radioactive material and chemicals would be contained within their transport packages. Health impacts to crew members (i.e., workers) and members of the general public along the routes could occur if they were exposed to low-level external radiation in the vicinity of uranium material shipments. In addition, exposure to vehicle emissions (engine exhaust and fugitive dust) could potentially cause latent fatalities from inhalation.

The risk estimates for emissions are based on epidemiological data that associate mortality rates with particulate concentrations in ambient air. (Increased latent mortality rates resulting from cardiovascular and pulmonary diseases have been linked to incremental increases in particulate concentrations.) Thus, the increase in ambient air particulate concentrations caused by a transport vehicle, with its associated fugitive dust and diesel exhaust emissions, is related to such premature latent fatalities in the form of risk factors. Because of the conservatism of the assumptions made to reconcile results among independent epidemiological studies and associated uncertainties, the latent fatality risks estimated for normal vehicle emissions should be considered to be an upper bound.[3] For the transport of conversion products and co-products (depleted U_3O_8, aqueous HF, and emptied cylinders, if not used as disposal containers), it is conservatively estimated that a total of up to 20 fatalities from vehicle emissions could occur if shipments were only by truck and if aqueous HF product was sold and transported 620 mi (1,000 km) from the site (about 30 fatalities are estimated if HF was neutralized to CaF_2 and transported 620 mi [1,000 km]). The number of fatalities occurring from exhaust emissions if shipments were only by rail would be less than 1 if HF was sold and about 1 if the HF was neutralized to CaF_2.

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3 For perspective, in a recently published EIS for a geologic repository at Yucca Mountain, Nevada, the same risk factors were used for vehicle emissions; however, they were adjusted to reduce the amount of conservatism in the estimated health impacts. As reported in the Yucca Mountain EIS, the adjustments resulted in a reduction in the emission risks by a factor of about 30.

Exposure to external radiation during normal transportation operations is estimated to cause less than 1 LCF under both truck and rail options. Members of the general public living along truck and rail transportation routes would receive extremely small doses of radiation from shipments, about 0.1 mrem or less over the duration of the program. This would be true even if a single person was exposed to every shipment of radioactive material during the program.

Traffic accidents could occur during the transportation of radioactive materials and chemicals. These accidents could potentially affect the health of workers (i.e., crew members) and members of the general public, either from the accident itself or from accidental releases of radioactive materials or chemicals.

The total number of traffic fatalities (unrelated to the type of cargo) was estimated on the basis of national traffic statistics for shipments by both truck and rail. If the aqueous HF was sold to users about 620 mi (1,000 km) from the site, about 2 traffic fatalities under the truck option would be estimated and 1 traffic fatality would be estimated under the rail option. If HF was neutralized to CaF_2, about 4 fatalities would be estimated for the truck option, and 2 fatalities for the rail option.

Severe transportation accidents could also result in a release of radioactive material or chemicals from a shipment. The consequences of such a release would depend on the material released, location of the accident, and atmospheric conditions at the time. Potential consequences would be greatest in urban areas because more people could be exposed. Accidents that occurred when atmospheric conditions were very stable (typical of nighttime) would have higher potential consequences than accidents that occurred when conditions were unstable (i.e., turbulent, typical of daytime) because the stability would determine how quickly the released material dispersed and diluted to lower concentrations as it moved downwind.

For the action alternatives, the highest potential accident consequences during transportation activities would be caused by a rail accident involving anhydrous NH_3. Although anhydrous NH_3 is a hazardous gas, it has many industrial applications and is commonly safely transported by industry as a pressurized liquid in trucks and rail tank cars.

The occurrence of a severe anhydrous NH_3 railcar accident in a highly populated urban area under stable atmospheric conditions is extremely rare. The probability of such an accident occurring if all the anhydrous NH_3 needed was transported 620 mi (1,000 km) is estimated to be less than 1 chance in 200,000. Nonetheless, if such an accident (i.e., release of anhydrous NH_3 from a railcar in a densely populated urban area under stable atmospheric conditions) occurred, up to 5,000 persons might experience irreversible adverse effects (such as lung damage), with the potential for about 100 fatalities. If the same type of NH_3 rail accident occurred in a typical rural area, which would have a smaller population density than an urban area, potential impacts would be considerably less. It is estimated that in a rural area, approximately 20 persons might experience irreversible adverse effects, with no expected fatalities. The atmospheric conditions at the time of an accident would also significantly affect the consequences of a severe NH_3 accident. The consequences of an NH_3 accident would be less severe under unstable conditions, the most likely conditions in the daytime. Unstable conditions would result in more rapid dispersion of the airborne NH_3 plume and lower downwind concentrations. Under unstable conditions in an urban area, approximately 400 persons could experience irreversible adverse effects, with the potential for about 8 fatalities. If the accident occurred in a rural area under unstable conditions, one person would be expected to experience an irreversible adverse effect, with zero fatalities expected. When the probability of an NH_3 accident occurring is taken into account, it is expected that no irreversible adverse effects and no fatalities would occur over the shipment period.

For perspective, anhydrous NH_3 is routinely shipped commercially in the United States for industrial and agricultural applications. On the basis of information provided in the DOT *Hazardous Material Incident System (HMIS) Database*, for 1990 through 2002, 2 fatalities and 19 major injuries to the public or to transportation or emergency response personnel have occurred as a result of anhydrous NH_3 releases during nationwide commercial truck and rail operations. These fatalities and injuries occurred during transportation or loading and unloading operations. Over that period, truck and rail NH_3 spills resulted in more than 1,000 and 6,000 evacuations, respectively. Five very large spills, more than 10,000 gal (38,000 L), have occurred; however, these spills were all en route derailments from large rail tank cars. The two largest spills, both around 20,000 gal (76,000 L), occurred in rural or lightly populated areas and resulted in 1 major injury. Over the past 30 years, the safety record for transporting anhydrous NH_3 has significantly improved. Safety measures contributing to this improved safety record include the installation of protective devices on railcars, fewer derailments, closer manufacturer supervision of container inspections, and participation of shippers in the Chemical Transportation Emergency Center.

After anhydrous NH_3, the types of accidents that are estimated to result in the second highest consequences are those involving shipment of 70% aqueous HF produced during the conversion process. The estimated numbers of irreversible adverse effects for 70% HF rail accidents are about one-third of those from the anhydrous NH_3 accidents. However, the number of estimated fatalities is about one-sixth of those from NH_3 accidents, because the percent of fatalities among the individuals experiencing irreversible adverse effects is 1% as opposed to 2% for NH_3 exposures. For perspective, since 1971, the period covered by DOT records, no fatal or serious injuries to the public or to transportation or emergency response personnel have occurred as a result of anhydrous HF releases during transportation. (Most of the HF transported in the United States is anhydrous HF, which is more hazardous than aqueous HF.) Over that period, 11 releases from railcars were reported to have no evacuations or injuries associated with them. The only major release (estimated at 6,400 lb [29,000 kg] of HF) occurred in 1985 and resulted in approximately 100 minor injuries. Another minor HF release during transportation occurred in 1990. The safety record for transporting HF has improved in the past 10 years for the same reasons as those discussed above for NH_3. Transportation accidents involving the shipment of DUF_6 cylinders were also evaluated, with the estimated consequences being less than those discussed above for NH_3 and HF (see Section 5.2.5.3).

S.5.4 Air Quality and Noise

Under the no action alternative, air quality from construction and operations would be within national and state ambient air quality standards. However, estimated concentrations of particulate matter (PM) that could be generated during yard reconstruction activities at Paducah would be close to air quality standards; these temporary emissions could be controlled by good construction practices. Continued cylinder maintenance and painting are expected to be effective in controlling corrosion, and concentrations of HF would be kept within regulatory standards at the Paducah site.

Under the action alternatives, air quality impacts during construction were found to be similar for all three alternative locations. The total (modeled plus the measured background value representative of the site) concentrations due to emissions of most criteria pollutants — such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO) — would be well within applicable air quality standards. As is often the case for construction, the primary concern would be PM released from near-ground-level sources. Total concentrations of PM_{10} and $PM_{2.5}$ (PM with an aerodynamic diameter of 10 μm or less and 2.5 μm or less, respectively) at the construction site boundary would be close to or above the standards because of the high background concentrations and the proposed facility's proximity to potentially publicly accessible areas. Accordingly, construction activities should be conducted so as to minimize further impacts on ambient air quality. To mitigate impacts, water could be sprayed on disturbed areas more often, and dust suppressant or pavement could be applied to roads with frequent traffic.

During operations, it is estimated that total concentrations for all criteria pollutants (except for $PM_{2.5}$) would be well within standards. The background level of annual average $PM_{2.5}$ in the area of the Paducah site approaches the standard. Again, impacts during operations were found to be similar for all three alternative locations.

Noise impacts are expected to be negligible under the no action alternative. Under the action alternatives, estimated noise levels at the nearest residence (located 1.3 km [0.8 mi] from the construction location) would be below the U.S. Environmental Protection Agency (EPA) guideline of 55 dB(A)[4] as day-night average sound level (DNL)[5] for residential zones during construction and operations.

S.5.5 Water and Soil

Under the no action alternative, uranium concentrations in surface water, groundwater, and soil would remain below guidelines throughout the project duration. However, if cylinder maintenance and painting were not effective in reducing cylinder corrosion rates, the uranium concentration in groundwater could be greater than the guideline at some time in the future (no earlier than about 2100). If continued cylinder maintenance and painting were effective in

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4 dB(A) is a unit of weighted sound-pressure level, measured by the use of the metering characteristics and the A-weighting specified in the *American National Standard Specification for Sound Level Meters*, ANSI S1.4-1983, and in Amendment S1.4A-1985.

5 DNL is the 24-hour average sound level, expressed in dB(A), with a 10-dB penalty artificially added to the nighttime (10 p.m.–7 a.m.) sound level to account for noise-sensitive activities (e.g., sleep) during these hours.

controlling corrosion, as expected, groundwater uranium concentrations would remain less than the guideline.

During construction of the conversion facility, construction material spills could contaminate surface water, groundwater, or soil. However, by implementing storm water management, sediment and erosion control (e.g., temporary and permanent seeding; mulching and matting; sediment barriers, traps, and basins; silt fences; runoff and earth diversion dikes), and good construction practices (e.g., covering chemicals with tarps to prevent interaction with rain, promptly cleaning up any spills), concentrations in soil and wastewater (and therefore surface water and groundwater) could be kept well within applicable standards or guidelines.

During operations, no appreciable impacts on surface water or groundwater would result from the conversion facility because no contaminated liquid effluents are anticipated, and because airborne emissions would be at very low levels (e.g., <0.25 g/yr of uranium). Impacts among the three alternative locations would be similar.

Contaminated soil associated with solid waste management unit (SWMU) 194 could be excavated during construction at Locations A and C; these soils would be managed as described in Section S.5.8.

S.5.6 Socioeconomics

The socioeconomic analysis evaluates the effects of construction and operation on population, employment, income, regional growth, housing, and community resources in the region of influence (ROI) around the site. In general, socioeconomic impacts tend to be positive, creating jobs and income, with only minor impacts on housing, public finances, and employment in local public services.

The no action alternative would result in a small socioeconomic impact, creating 110 jobs during cylinder yard reconstruction (over 2 construction years) and 130 jobs during operations (direct and indirect jobs) and generating $3.2 million in personal income during construction and $3.8 million in personal income per operational year. No significant impacts on regional growth and housing, local finances, and public service employment in the ROI are expected.

Under the action alternatives, jobs and direct income would be generated during both construction and operation. Construction of the conversion facility would create 290 jobs and generate almost $10 million in personal income in the peak construction year (construction occurs over a 2-year period). Operation of the conversion facility would create 330 jobs and generate $13 million in personal income each year. Only minor impacts on regional growth and housing, local finances, and public service employment in the ROI are expected. The socioeconomic impacts are not dependent on the location of the conversion facility; therefore, the impacts would be the same for alternative Locations A, B, and C.

S.5.7 Ecology

Under the no action alternative, continued cylinder maintenance and surveillance activities would have negligible impacts on ecological resources (i.e., vegetation, wildlife, threatened and endangered species). Only a small amount of yard reconstruction, in a previously disturbed area, would occur at the Paducah site. It is estimated that potential concentrations of contaminants in the environment from future cylinder breaches would be below levels harmful to biota. However, there is a potential for impacts to aquatic biota from cylinder yard runoff during painting activities.

For the action alternatives, the total area disturbed during conversion facility construction would be 45 acres (18 ha). Vegetation communities would be impacted in this area with a loss of habitat. However, for all three alternative locations, impacts could be minimized depending on exactly where the facility was placed within each location. These habitat losses would constitute less than 1% of available land at the site. It was found that concentrations of contaminants in the environment during operations would be below harmful levels. Negligible impacts to vegetation and wildlife are expected at all locations.

Wetlands at or near Locations A, B, and C could be adversely affected at the Paducah site. Impacts to wetlands could be minimized depending on where exactly the facility was placed within each location. Mitigation for unavoidable impacts may be developed in coordination with the appropriate regulatory agencies. Unavoidable impacts to wetlands that are within the jurisdiction of the U.S. Army Corps of Engineers may require a Clean Water Act (CWA) Section 404 Permit, which would trigger the requirement for a CWA Section 401 water quality certification from the Commonwealth of Kentucky. A mitigation plan might be required prior to the initiation of construction.

Construction of the conversion facility in the eastern portion of Location C could impact potential habitat for cream wild indigo (state-listed as a species of special concern) and compass plant (state-listed as threatened). For construction at all three locations, impacts on deciduous forest might occur. Impacts to forested areas could be avoided if temporary construction areas were placed in previously disturbed locations. Trees with exfoliating bark, such as shagbark hickory or dead trees with loose bark, can be used by the Indiana bat (federal- and state-listed as endangered) as roosting trees during the summer. If either live or dead trees with exfoliating bark are encountered on construction areas, they should be saved if possible. If necessary, the trees should be cut before March 31 or after October 15.

S.5.8 Waste Management

Under the no action alternative, LLW, LLMW, and PCB-containing waste could be generated from cylinder scraping and painting activities. The amount of LLMW generated could represent an increase of less than 1% in the site's LLMW load, representing a negligible impact on site waste management operations.

Under the action alternatives, waste management impacts would not depend on the location of the conversion facility within the site and would be the same for alternative Locations A, B, and C. Waste generated during construction and operations would have negligible impacts on the Paducah site waste management operations, with the exception of possible impacts from disposal of CaF_2. Industrial experience indicates that HF, if produced, would contain only trace amounts of depleted uranium (less than 1 ppm). It is expected that HF would be sold for use. If sold for use, the sale would be subject to review and approval by DOE in coordination with the NRC, depending on the specific use (as discussed in Appendix E of this EIS).

The U_3O_8 produced during conversion would generate about 7,850 yd^3 (6,000 m^3) per year of LLW. This is 83% of Paducah's annual projected LLW volume and could have potentially large impacts on site LLW management. However, plans for off-site disposal of this LLW are included in the proposed action.

If the HF was not sold but instead neutralized to CaF_2, it is currently unknown whether (1) the CaF_2 could be sold, (2) the low uranium content would allow the CaF_2 to be disposed of as nonhazardous solid waste, or (3) disposal as LLW would be required. The low level of uranium contamination expected (i.e., less than 1 ppm) suggests that sale or disposal as nonhazardous solid waste would be most likely. If sold for use, the sale would be subject to review and approval by DOE in coordination with the NRC, depending on the specific use. Waste management for disposal as nonhazardous waste could be handled through appropriate planning and design of the facilities. If the CaF_2 had to be disposed of as LLW, it could represent a potentially large impact on waste management operations.

A small quantity of TRU could be entrained in the gaseous DUF_6 during the cylinder emptying operations. These contaminants would be captured in the filters between the cylinders and the conversion equipment. The filters would be monitored and replaced routinely to maintain concentrations below regulatory limits for TRU waste. The spent filters would be disposed of as LLW, generating up to 25 drums of LLW waste over the life of the project.

Current UDS plans are to leave the heels in the emptied cylinders, add a stabilizer, and use the cylinders as disposal containers for the U_3O_8 product, to the extent practicable. An alternative is to process the emptied cylinders and dispose of them directly as LLW. Either one of these approaches is expected to meet the waste acceptance criteria of the disposal facilities and minimize the potential for generating TRU waste through washing of the cylinders to remove the heels. Although cylinder washing is not considered a foreseeable option at this time, for completeness, an analysis of the maximum potential quantities of TRU waste that could be generated from cylinder washing is included in Appendix B of this EIS, as is a discussion of PCBs contained in some cylinder coatings.

In addition, potentially contaminated soil associated with SWMU 194 could be excavated during construction at Locations A and B. The excavated soil would be managed consistent with Resource Conservation and Recovery Act (RCRA) regulations and coordinated between the Commonwealth of Kentucky (Division of Waste Management) and DOE.

S.5.9 Resource Requirements

Resource requirements include construction materials, fuel, electricity, process chemicals, and containers. In general, all alternatives would have a negligible effect on the local or national availability of these resources.

S.5.10 Land Use

Under the no action alternative, all activities would occur in areas previously used for conducting similar activities; therefore, no land use impacts are expected. Under the action alternatives, a total of 45 acres (18 ha) could be disturbed, with some areas cleared for railroad or utility access and not adjacent to the site. All three alternative locations are within an already-industrialized facility, and impacts to land use would be similar for the three alternative locations. The permanently altered areas represent less than 1% of available land already developed for industrial purposes. Negligible impacts on land use are thus expected.

S.5.11 Cultural Resources

Under the no action alternative, impacts on cultural resources at the current storage locations would be unlikely because all activities would occur in areas already dedicated to cylinder storage. Under the action alternatives, impacts on cultural resources could be possible. Archaeological and architectural surveys have not been completed for the candidate locations and must be undertaken prior to initiation of the action alternatives. However, if archaeological resources were encountered, or historical or traditional cultural properties were identified, a mitigation plan would be required.

S.5.12 Environmental Justice

No disproportionately high and adverse human health or environmental impacts are expected to minority or low-income populations during normal facility operations under the action alternatives. Although the consequences of facility accidents could be high if severe accidents occurred, the risk of irreversible adverse effects (including fatalities) among members of the general public from these accidents (taking into account the consequences and probability of the accidents) would be less than 1. Furthermore, transportation accidents with high and adverse impacts are unlikely; their locations cannot be projected, and the types of persons who would be involved cannot be reliably predicted. Thus, there is no reason to expect that minority and low-income populations would be affected disproportionately by high and adverse impacts.

S.5.13 Option of Shipping ETTP Cylinders to Paducah

If cylinders from ETTP were transported to Paducah, the cylinders would have to be prepared to be shipped by either truck or rail. Approximately 4,800 DUF_6 cylinders for conversion and about 1,100 non-DUF_6 cylinders would require preparation for shipment at ETTP. Three cylinder preparation options are considered for the shipment of noncompliant cylinders.

In general, the use of cylinder overpacks would result in small potential impacts. Overpacking operations would be similar to current cylinder handling operations, and impacts would be limited to involved workers. No LCFs among involved workers from radiation exposure are expected. Impacts would be similar if noncompliant cylinders were shipped "as-is" or following repairs under a DOT exemption, assuming appropriate compensatory measures.

The use of a cylinder transfer facility would likely require the construction of a new facility at ETTP; there are no current plans to build such a facility. Operational impacts would generally be small and limited primarily to external radiation exposure of involved workers, with no LCFs expected. Transfer facility operations would generate a large number of emptied cylinders requiring disposition. If a decision were made to construct and operate a transfer facility at ETTP, additional NEPA review would be conducted.

Impacts from extended operations of the conversion plant from 25 to 28 years would not be expected to significantly increase overall impacts.

S.5.14 Impacts Associated with Conversion Product Sale and Use

The conversion of the DUF_6 inventory produces products having some potential for reuse (no large-scale market exists for depleted U_3O_8). These products include HF and CaF_2, which are commonly used as commercial materials. An investigation of the potential reuse of HF and CaF_2 has been included as part of this EIS. Areas examined include the characteristics of these materials as produced within the conversion process, the current markets for these products, and the potential socioeconomic impacts should these products be provided to the commercial sector. Because there would be some residual radioactivity associated with these materials, the DOE process for authorizing release of materials for unrestricted use (referred to as "free release") and an estimate of the potential human health effects of such free release have also been included in this investigation. The results of the analysis of HF and CaF_2 use are included in Table S-6.

If the products were to be released for restricted use (e.g., in the nuclear industry for the manufacture of nuclear fuel), the impacts would be less than those for unrestricted release.

Conservative estimates of the amount of uranium and technetium that might transfer into the HF and CaF_2 were used to evaluate the maximum expected dose to workers using the material if it was released for commercial use. On the basis of very conservative assumptions concerning use, the maximum dose to workers was estimated to be less than 1 mrem/yr, much less than the regulatory limit of 100 mrem/yr specified for members of the general public. Doses to the general public would be even lower.

Socioeconomic impact analyses were conducted to evaluate the impacts of the introduction of the conversion-produced HF or CaF_2 into the commercial marketplace. A potential market for the aqueous HF has been identified as the current aqueous HF acid producers. The impact of HF sales on the local economy in which the existing producers are located and on the U.S. economy as a whole is likely to be minimal. No market for the CaF_2 that might be produced in the conversion facility has been identified. Should such a market be found, the impact of CaF_2 sales on the U.S. economy is also predicted to be minimal.

S.5.15 Impacts from D&D Activities

D&D would involve the disassembly and removal of all radioactive and hazardous components, equipment, and structures. For the purposes of analysis in this EIS, it was also assumed that the various buildings would be dismantled and "greenfield" (unrestricted use) conditions would be achieved. The "clean" waste will be sent to a landfill that accepts construction debris. LLW will be sent to a licensed or DOE disposal facility, where it will likely be buried in accordance with the waste acceptance criteria and other requirements in effect at that time. Hazardous and mixed waste will be disposed of in a licensed facility in accordance with regulatory requirements. D&D impacts to involved workers would be primarily from external radiation; expected exposures would be a small fraction of operational doses; no LCFs would be expected. It is estimated that no fatalities and up to five injuries would result from occupational accidents. Impacts from waste management would include a total generation of about 275 yd^3 (210 m^3) of LLW, 157 yd^3 (120 m^3) of LLMW, and 157 yd^3 (120 m^3) of hazardous waste; these volumes would result in low impacts compared with projected site annual generation volumes.

S.5.16 Cumulative Impacts

The Council on Environmental Quality (CEQ) guidelines for implementing NEPA define cumulative effects as the impacts on the environment resulting from the incremental impact of an action under consideration when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7) Activities considered for cumulative analysis include those in the vicinity of the site.

Actions planned at the Paducah site include the continuation of uranium enrichment operations (by USEC), waste management activities, waste disposal activities, environmental restoration activities, and DUF_6 management activities considered in this EIS. Although Portsmouth was identified by USEC in January 2004 as the site of the American Centrifuge Facility, construction and operation of such a facility at Paducah has been included in the cumulative impacts analysis.

Actions occurring near the Paducah site that, because of their diffuse nature, could contribute to existing or future impacts on the site include continued operation of the Tennessee Valley Authority's Shawnee power plant; the Joppa, Illinois, power plant; and the Honeywell International uranium conversion plant in Metropolis, Illinois. Cumulative impacts of these actions at Paducah would be as follows for the no action alternative and the proposed action alternatives:

- The cumulative collective radiological exposure to the off-site population would be well below the maximum DOE dose limit of 100 mrem per year to the off-site maximally exposed individual (MEI) and below the limit of 25 mrem/yr specified in 40 CFR 190 for uranium fuel cycle facilities. Annual individual doses to involved workers would be monitored to maintain exposure below the regulatory limit of 5 rem per year.

- Under the no action alternative cumulative impacts assessment, although less than 1 shipment per year of radioactive wastes is expected from cylinder management activities, up to 14,400 truck shipments could be associated with existing and planned actions (no rail shipments are expected). Under the action alternatives, up to 6,000 rail shipments and 18,600 truck shipments of radioactive material could occur. The cumulative maximum dose to the MEI along the transportation route near the site entrance would be less than 1 mrem per year under all alternatives and for all transportation modes.

- The Paducah site is located in an attainment region. However, the background annual-average $PM_{2.5}$ concentration is near the regulatory standard. Cumulative impacts would not affect attainment status.

- Data from the 2000 annual groundwater monitoring showed that four pollutants exceeded primary drinking water regulation levels in groundwater at the Paducah site. Good engineering and construction practices should ensure that indirect cumulative impacts on groundwater associated with the conversion facility would be minimal.

- Cumulative ecological impacts on habitats and biotic communities, including wetlands, would be negligible to minor for all alternatives. Construction of a conversion facility might remove a type of tree preferred by the Indiana bat; however, this federal- and state-listed endangered species is not known to utilize these areas.

- No cumulative land use impacts are anticipated for any of the alternatives.

- It is unlikely that any noteworthy cumulative impacts on cultural resources would occur under any alternative, and any such impacts would be adequately mitigated before activities for the chosen action would begin.

- Given the absence of high and adverse cumulative impacts for any impact area considered in this EIS, no environmental justice cumulative impacts are anticipated for the Paducah site, despite the presence of disproportionately high percentages of low-income populations in the vicinity.

- Socioeconomic impacts under all alternatives considered are anticipated to be generally positive, often temporary, and relatively small.

S.5.17 Mitigation

On the basis of the analyses conducted for this EIS, the following recommendations can be made to reduce the impacts of the proposed action:

- Current cylinder management activities, including inspecting cylinders, carrying out cylinder maintenance activities (such as painting), and promptly cleaning up releases from any breached DUF_6 cylinders, should be continued to avoid potential future impacts on site air and groundwater. In addition, runoff from cylinder yards should be collected and sampled so that contaminants can be detected and their release to surface water or groundwater can be avoided. If future cylinder painting results in KPDES Permit violations, treating cylinder yard runoff prior to release may be required.

- Temporary impacts on air quality from fugitive dust emissions during reconstruction of cylinder yards or construction of any new facility should be controlled by the best available practices to avoid temporary exceedances of the PM_{10} and $PM_{2.5}$ standard. Technologies that will be used to mitigate air quality impacts during construction include using water sprays on dirt roadways and on bare soils in work areas for dust control; covering open-bodied trucks transporting materials likely to become airborne when full and at all times when in motion; water spraying and covering bunkered or staged excavated and replacement soils; maintaining paved roadways in good repair and in a clean condition; using barriers and windbreaks around construction areas such as soil banks, temporary screening, and/or vegetative cover; mulching or covering exposed bare soil areas until vegetation has time to recover or paving has been installed; and prohibiting any open burning.

- During construction, impacts to water quality and soil can be minimized through implementing storm water management, sediment and erosion controls (e.g., temporary and permanent seeding; mulching and matting; sediment barriers, traps, and basins; silt fences; runoff and earth diversion dikes), and good construction practices (e.g., covering chemicals with tarps to prevent interaction with rain, promptly cleaning up any spills).

- Potential impacts to wetlands at the Paducah site could be minimized or eliminated by maintaining a buffer near adjacent wetlands during construction. Mitigation for unavoidable impacts may be developed in coordination with the appropriate regulatory agencies.

- If trees (either live or dead) with exfoliating bark are encountered on construction areas, they should be saved if possible to avoid destroying potential habitat for the Indiana bat. If necessary, the trees should be cut before March 31 or after October 15.

- The quantity of radioactive and hazardous materials stored on site, including the products of the conversion process, should be minimized.

- The construction of a DUF_6 conversion facility at Paducah would have the potential to impact cultural resources. Neither an archaeological nor an architectural survey has been completed for the Paducah site as a whole or for any of the alternative locations, although an archaeological sensitivity study has been conducted. In accordance with Section 106 of the National Historic Preservation Act, the adverse effects of this undertaking must be evaluated once a location is chosen.

- Testing should be conducted either prior to or during the conversion facility startup operations to determine if the air vented from the autoclaves should be monitored or if any alternative measures would need to be taken to ensure that worker exposures to PCBs above allowable Occupational Safety and Health Administration limits do not occur.

- The nuclear properties of DUF_6 are such that the occurrence of a nuclear criticality is not a concern, regardless of the amount of DUF_6 present. However, criticality is a concern for the handling, packaging, and shipping of enriched UF_6. For enriched UF_6, criticality control is accomplished by employing, individually or collectively, specific limits on uranium-235 enrichment, mass, volume, geometry, moderation, and spacing for each type of cylinder. The amount of enriched UF_6 that may be contained in an individual cylinder and the total number of cylinders that may be transported together are determined by the nuclear properties of enriched UF_6. Spacing of enriched UF_6 cylinders in transit during routine and accident conditions is ensured by use of regulatory approval packages that provide protection against impact and fire.

- Because of the relatively high consequences estimated for some accidents, special attention will be given to the design and operational procedures for components that may be involved in such accidents. For example, the tanks holding hazardous chemicals, such as anhydrous NH_3 and aqueous HF, on site would be designed to meet all applicable codes and standards, and special procedures would be in place for gaining access to the tanks and for filling the tanks. In addition, although the probabilities of occurrence for a high-consequence accident are extremely low, emergency response plans and procedures would be in place to respond to any emergencies should an accident occur.

S.5.18 Unavoidable Adverse Impacts

Unavoidable adverse impacts are those impacts that cannot be mitigated by choices associated with siting and facility design options. Such impacts would be unavoidable, no matter which options were selected, and would include the following:

- Exposure of workers to radiation in the storage yards and the conversion facility that would be below applicable standards;

- Generation of vehicle exhaust and particulate air emissions during construction (emissions that would exceed air quality standards would be mitigated);

- Disturbance of up to 45 acres (18 ha) of land during construction, with approximately 10 acres (4 ha) required for the facility footprint;

- Loss of terrestrial and aquatic habitats from construction and disturbance of wildlife during operations; and
- Generation of vehicle exhaust and particulate air emissions during transportation.

S.5.19 Irreversible and Irretrievable Commitment of Resources

A commitment of a resource is considered *irreversible* when the primary or secondary impacts from its use limit the future options for its use. An *irretrievable* commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for later use by future generations. The major irreversible and irretrievable commitments of natural and man-made resources related to the alternatives analyzed in this EIS include the land used to dispose of any conversion products, energy usage, and materials used for construction of the facility that could not be recovered or recycled.

S.5.20 Relationship between Short-Term Use of the Environment and Long-Term Productivity

Disposal of solid nonhazardous waste resulting from new facility construction, operations, and D&D would require additional land at a sanitary landfill site, which would be unavailable for other uses in the long term. Any radioactive or hazardous waste generated by the various alternatives would involve the commitment of associated land, transportation, and disposal resources, and resources associated with the processing facilities for waste management. For the construction and operation of the conversion facility, the associated construction activities would result in both short-term and long-term losses of terrestrial and aquatic habitats from natural productivity. After closure of the new facility, it would be decommissioned and could be reused, recycled, or remediated.

S.5.21 Pollution Prevention and Waste Minimization

Implementation of the EIS alternatives would be conducted in accordance with all applicable pollution prevention and waste minimization guidelines. A consideration of opportunities for reducing waste generation at the source, as well as for recycling and reusing material, will be incorporated to the extent possible into the engineering and design process for the conversion facility. Pollution prevention and waste minimization will be major factors in determining the final design of any facility to be constructed. Specific pollution prevention and waste minimization measures will be considered in designing and operating the final conversion facility.

S.5.22 Potential Impacts Associated with the Option of Expanding Conversion Facility Operations

As discussed in Sections S.2.2.6 and 2.2.5, several reasonably foreseeable activities could result in a future decision to increase the conversion facility throughput or extend the operational period at one or both of the conversion facility sites. Although there are no current plans to do so, to account for these future possibilities and provide future planning flexibility, Section 5.2.6 includes an evaluation of the environmental impacts associated with expanding conversion facility operations at Paducah, either by increasing throughput (by process improvements) or by extending operations.

As described in Section 5.2.6, a throughput increase through process improvements would not be expected to significantly change the overall environmental impacts when compared with those of the current plant design. Efficiency improvements are generally on the order of 10%, which is within the uncertainty that is inherent in the impact estimate calculations. Slight variations in plant throughput are not unusual from year to year because of operational factors (e.g., equipment maintenance or replacement) and are generally accounted for by the conservative nature of the impact calculations.

The conversion facility operations could also be expanded by operating the facility longer than the currently anticipated 25 years. There are no current plans to operate the conversion facility beyond this period. However, with routine facility and equipment maintenance and periodic equipment replacements or upgrades, it is believed that the conversion facility could be operated safely beyond this time period to process any additional DUF_6 for which DOE might assume responsibility. As discussed in Section 5.2.6, if operations were extended beyond 25 years and if the operational characteristics (e.g., estimated releases of contaminants to air and water) of the facility remained unchanged, it is expected that the annual impacts would be essentially the same as those presented above and summarized in Table S-6. The overall cumulative impacts from the operation of the facility would increase proportionately with the increased life of the facility.

S.6 ENVIRONMENTAL AND OCCUPATIONAL SAFETY AND HEALTH PERMITS AND COMPLIANCE REQUIREMENTS

DUF_6 cylinder management as well as construction and operation of the proposed DUF_6 conversion facility would be subject to many federal, state, local, and other legal requirements. In accordance with such legal requirements, a variety of permits, licenses, and other consents must be obtained. Chapter 6 of this EIS contains a detailed listing of applicable requirements.

S.7 PREFERRED ALTERNATIVE

The preferred alternative is to construct and operate the proposed DUF_6 conversion facility at alternative Location A, which is south of the administration building and its parking lot and east of the main Paducah GDP access road.

1 INTRODUCTION

Over the last five decades, the U.S. Department of Energy (DOE) has enriched large quantities of uranium for nuclear applications by means of gaseous diffusion. This enrichment has taken place at three DOE sites located at Paducah, Kentucky; Portsmouth, Ohio; and the East Tennessee Technology Park (ETTP, formerly known as the K-25 site) in Oak Ridge, Tennessee (Figure 1-1). "Depleted" uranium hexafluoride (commonly referred to as DUF_6) is a product of this process. It is being stored at the three sites. The total DUF_6 inventory at the three sites weighs approximately 700,000 metric tons (t) (770,000 short tons [tons])[1] and is stored in about 60,000 steel cylinders.

This document is a site-specific environmental impact statement (EIS) for construction and operation of a proposed DUF_6 conversion facility at the Paducah site. The proposed facility would convert the DUF_6 stored at Paducah to a more stable chemical form suitable for use or disposal. A separate EIS (DOE 2004a) evaluates potential impacts for a proposed conversion facility to be constructed at the Portsmouth site. The EISs have been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA) (*United States Code*, Title 42, Section 4321 et seq. [42 USC 4321 et seq.]), Council on Environmental Quality (CEQ) NEPA regulations (*Code of Federal Regulations*, Title 40, Parts 1500–1508 [40 CFR Parts 1500–1508]), and DOE's NEPA implementing procedures (10 CFR Part 1021).

National Environmental Policy Act (NEPA) Regulations

For major federal actions with the potential for significant environmental impacts, NEPA regulations require federal agencies to discuss a proposed action and all reasonable alternatives in an environmental impact statement (EIS). The information in the EIS must be sufficient for reviewers to evaluate the relative merits of each alternative.

The agency must briefly discuss any alternatives that were eliminated from further analysis. The agency should identify its preferred alternatives, if one or more exist, in the draft EIS and must identify its preferred alternative in the final EIS unless another law prohibits naming a preference. After completing the final EIS and in order to implement an alternative, the federal agency must issue a Record of Decision that announces the decision that was made and identifies the alternatives that were considered.

This EIS addresses the potential environmental impacts at the Paducah site from the construction, operation, maintenance, and decontamination and decommissioning (D&D) of the proposed conversion facility; from the transportation of depleted uranium conversion products to a disposal facility; and from the transportation, sale, use, or disposal of the fluoride-containing conversion products (hydrogen fluoride [HF] or calcium fluoride [CaF_2]). Three alternative locations within the Paducah site are evaluated for the conversion facility. Although not part of the proposed action, an option of

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1 In general, in this EIS, values in English units are presented first, followed by metric units in parentheses. However, when values are routinely reported in metric units, the metric units are presented first, followed by English units in parentheses.

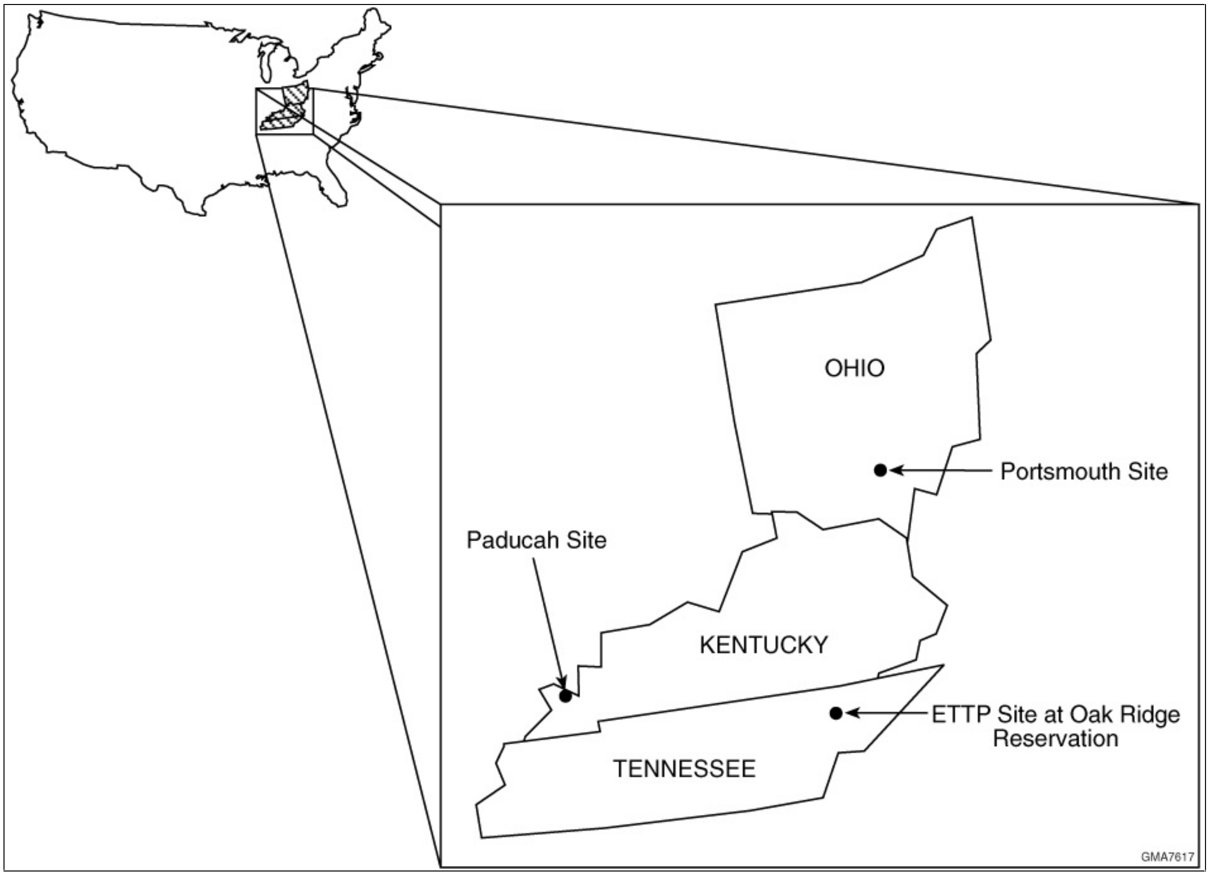

FIGURE 1-1 DUF_6 Storage Locations

shipping the ETTP cylinders to Paducah rather than to Portsmouth is also considered, as is an option of expanding conversion facility operations. In addition, this EIS evaluates a no action alternative, which assumes continued storage of DUF_6 in cylinders at the Paducah site.

1.1 BACKGROUND INFORMATION

The current DUF_6 conversion facility project is the culmination of a long history of DUF_6 management activities and events. To put the current project into context and provide perspective, this section provides a brief summary of this history. Additional background information on the storage and characteristics of DUF_6 and the DUF_6 cylinder inventory is provided in Section 1.2.

Uranium enrichment in the United States began as part of the atomic bomb development by the Manhattan Project during World War II. Enrichment for both civilian and military uses continued after the war under the auspices of the U.S. Atomic Energy Commission (AEC) and its successor agencies, including DOE. Three large gaseous diffusion plants (GDPs) were constructed to produce enriched uranium, first at the K-25 site (now called ETTP) and subsequently at Paducah and Portsmouth. The K-25 plant ceased operations in 1985, and the

Portsmouth plant ceased operations in 2001. The Paducah GDP continues to operate (see Section 1.1.1).

The DUF_6 produced during enrichment has been stored in large steel cylinders at all three gaseous diffusion plant sites since the 1950s. The cylinders are typically stacked two high and are stored outdoors on concrete or gravel yards. Figure 1.1-1 shows typical arrangements for storing cylinders.

1.1.1 Creation of USEC

In 1993, the U.S. government began the process of privatizing uranium enrichment services by creating the United States Enrichment Corporation (USEC), a wholly owned government corporation, pursuant to the *Energy Policy Act of 1992* (Public Law [P.L.] 102-186). The Paducah and Portsmouth GDPs were leased to USEC, but DOE retained responsibility for storage, maintenance, and disposition of about 46,422 DUF_6 cylinders produced before 1993 and located at the three gaseous diffusion plant sites (28,351 at Paducah, 13,388 at Portsmouth, and 4,683 at K-25). In 1996, the *USEC Privatization Act* (P.L. 104-134) transferred ownership of USEC from the government to private investors. This act provided for the allocation of USEC's liabilities between the U.S. government (including DOE) and the new private corporation, including liabilities for DUF_6 cylinders generated by USEC before privatization.

In May and June of 1998, USEC and DOE signed two memoranda of agreement (MOAs) regarding the allocation of responsibilities for depleted uranium generated by USEC after 1993 (DOE and USEC 1998a,b). The two MOAs transferred ownership of a total of 11,400 DUF_6 cylinders from USEC to DOE.

DUF_6 Management Time Line

1950–1993	DOE generates DUF_6 stored in cylinders at the ETTP, Portsmouth, and Paducah sites.
1985	K-25 (ETTP) GDP ceases operations.
1992	Ohio EPA issues Notice of Violation (NOV) to Portsmouth.
1993	USEC is created by P.L. 102-186.
1994	DOE initiates DUF_6 PEIS.
1995	DNFSB issues Recommendation 95-1, Safety of Cylinders Containing Depleted Uranium. DOE initiates UF_6 Cylinder Project Management Plan.
1996	USEC Privatization Act (P.L. 104-134) is enacted.
1997	DOE issues Draft DUF_6 PEIS.
1998	DOE and Ohio EPA reach agreement on NOV. Two DOE-USEC MOAs transfer 11,400 DUF_6 cylinders to DOE. P.L. 105-204 is enacted.
1999	DOE and TDEC enter consent order. DOE issues Final DUF_6 PEIS. DOE issues conversion plan in response to P.L. 105-204. DNFSB closes Recommendation 95-1. DOE issues Draft RFP for conversion services.
2000	DOE issues Final RFP for conversion services.
2001	DOE receives five proposals in response to RFP. DOE identifies three proposals in competitive range. DOE publishes NOI for site-specific DUF_6 Conversion EIS. DOE prepares environmental critique to support conversion services procurement process. Portsmouth GDP ceases operations. DOE holds public scoping meetings for the site-specific DUF_6 Conversion EIS.
2002	DOE-USEC agreement transfers 23,000 t (25,684 tons) of DUF_6 to DOE. P.L. 107-206 is enacted. DOE awards conversion services contract to UDS. DOE prepares environmental synopsis to support conversion services procurement process.
2003	DOE announces Notice of Change in NEPA Compliance Approach and issues the draft EIS. DOE issues draft site-specific conversion facility EISs.
2004	Final site-specific conversion facility EISs issued.

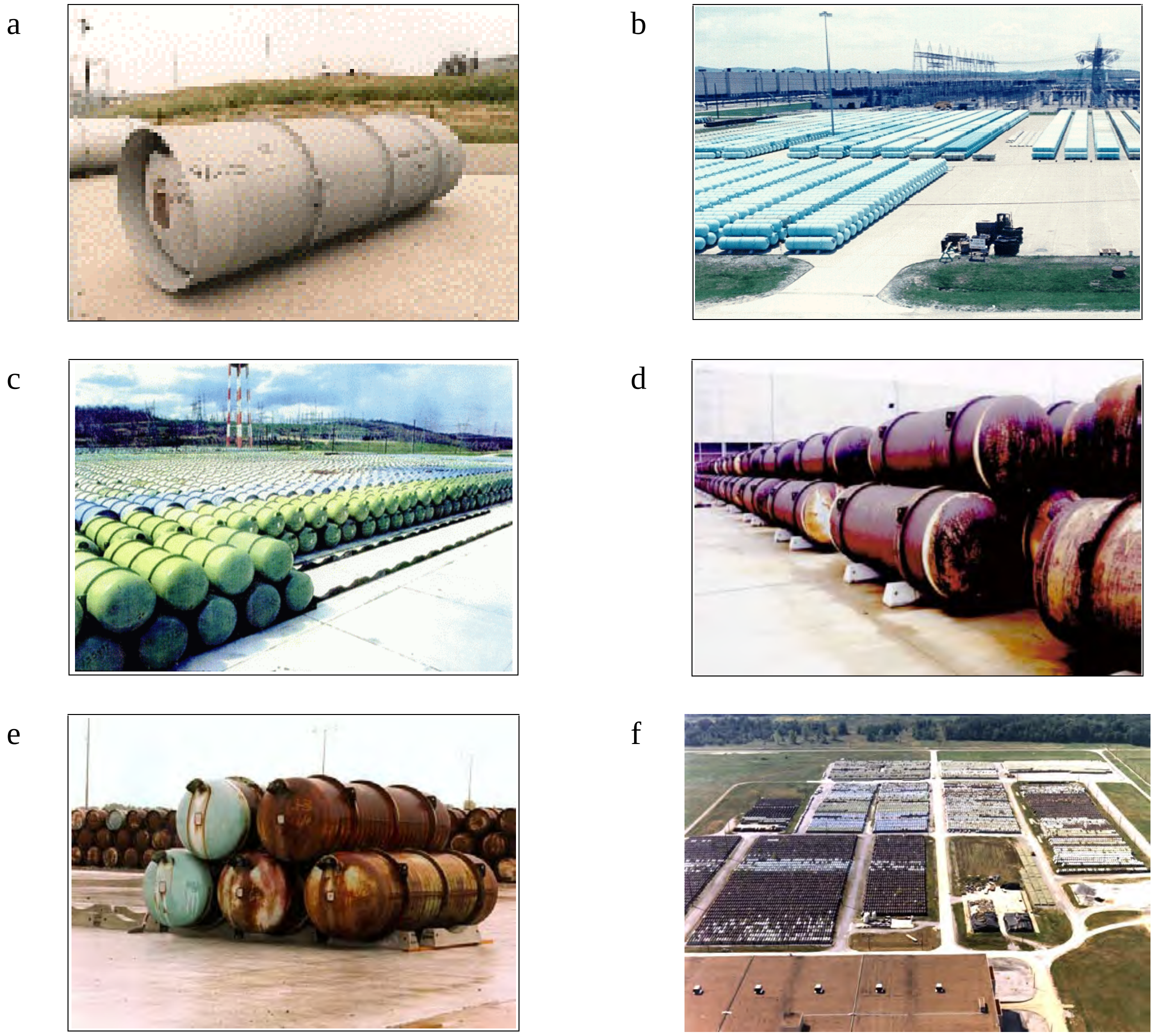

FIGURE 1.1-1 Storage of DUF_6 Cylinders: (a) Typical 14-ton (12-t) skirted cylinder. (b) New cylinder storage yard at the Paducah site. (c, d, e) Cylinders stacked two high on concrete chocks. (f) Cylinder yards at the Paducah site.

On June 17, 2002, DOE and USEC signed a third agreement (DOE and USEC 2002) to transfer up to 23,300 t (25,684 tons) of DUF_6 from USEC to DOE between 2002 and 2006. The exact number of cylinders was not specified. Transfer of ownership of all the material will take place at Paducah. While title to the DUF_6 is transferred to DOE under this agreement, custody and cylinder management responsibility remains with USEC until DOE requests that USEC deliver the cylinders for processing in the conversion facility.

1.1.2 Growing Concern over the DUF_6 Inventory

In May 1995, the Defense Nuclear Facilities Safety Board (DNFSB), an independent DOE oversight organization within the Executive Branch, issued Recommendation 95-1 regarding storage of the DUF_6 cylinders. This document advised that DOE should take three actions: (1) start an early program to renew the protective coating on cylinders containing DUF_6 from the historical production of enriched uranium, (2) explore the possibility of additional measures to protect the cylinders from the damaging effects of exposure to the elements as well as any additional handling that might be called for, and (3) institute a study to determine whether a more suitable chemical form should be selected for long-term storage of depleted uranium.

In response to Recommendation 95-1, DOE began an aggressive effort to better manage its DUF_6 cylinders, known as the *UF_6 Cylinder Project Management Plan* (Lockheed Martin Energy Systems, Inc. [LMES] 1997d). This plan incorporated more rigorous and more frequent inspections, a multiyear schedule for painting and refurbishing cylinders, and construction of concrete-pad cylinder yards. In December 1999, the DNFSB determined that DOE's implementation of the *UF_6 Cylinder Project Management Plan* was successful, and, as a result, on December 16, 1999, it closed Recommendation 95-1.

Several affected states also expressed concern over the DOE DUF_6 inventory. In October 1992, the Ohio Environmental Protection Agency (OEPA) issued a Notice of Violation (NOV) alleging that DUF_6 stored at the Portsmouth facility is subject to regulation under state hazardous waste laws. The NOV stated that the OEPA had determined DUF_6 to be a solid waste and that DOE had violated Ohio laws and regulations by not evaluating whether such waste was hazardous. DOE disagreed with this assessment and entered into discussions with the OEPA that continued through February 1998, when an agreement was reached. Ultimately, in February 1998, DOE and the OEPA agreed to set aside the issue of whether the DUF_6 is subject to state hazardous waste regulation and instituted a negotiated management plan governing the storage of the Portsmouth DUF_6. The agreement also requires DOE to continue its efforts to evaluate the potential use or reuse of the material. The agreement expires in 2008.

Similarly, in February 1999, DOE and the Tennessee Department of Environment and Conservation (TDEC) entered into a consent order that included a requirement for the performance of two environmentally beneficial projects: the implementation of a negotiated management plan governing the storage of the small inventory (relative to other sites) of all UF_6 (depleted, enriched, and natural) cylinders stored at the ETTP site and the removal of the DUF_6 from the ETTP site or the conversion of the material by December 31, 2009. The consent order further requires DOE to submit a plan, within 60 days of completing NEPA review of its long-term DUF_6 management strategy, that contains schedules for activities related to removal of cylinders from the ETTP site.

In Kentucky, a final Agreed Order between DOE and the Kentucky Natural Resources and Environmental Protection Cabinet concerning DUF_6 cylinder management was entered in October 2003. This Agreed Order requires that DOE provide the Kentucky Department of Environmental Protection with an inventory of all DUF_6 cylinders for which DOE has management responsibility at the Paducah site and, with regard to that inventory, that DOE implement the DUF_6 Cylinder Management Plan, which is Attachment 1 to the Agreed Order.

1.1.3 Programmatic NEPA Review and Congressional Interest

In 1994, DOE began work on a *Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DUF_6 PEIS) (DOE/EIS-0269) (DOE 1999a) to evaluate potential broad management options for DOE's DUF_6 inventory. Alternatives considered included continued storage of DUF_6 in cylinders at the gaseous diffusion plant sites or at a consolidated site, and the use of technologies for converting the DUF_6 to a more stable chemical form for long-term storage, use, or disposal. DOE issued the draft DUF_6 PEIS for public review and comment in December 1997 and held hearings near each of the three sites where DUF_6 is currently stored (Paducah, Kentucky; Oak Ridge, Tennessee; and Portsmouth, Ohio) and in Washington, D.C. In response to its efforts, DOE received some 600 comments.

In July 1998, while the PEIS was being prepared, the President signed into law P.L. 105-204. The text of P.L. 105-204 pertinent to the management of DUF_6 is as follows:

> *(a) PLAN. – The Secretary of Energy shall prepare, and the President shall include in the budget request for fiscal year 2000, a Plan and proposed legislation to ensure that all amounts accrued on the books of the United States Enrichment Corporation for the disposition of depleted uranium hexafluoride will be used to commence construction of, not later than January 31, 2004, and to operate, an onsite facility at each of the gaseous diffusion plants at Paducah, Kentucky, and Portsmouth, Ohio, to treat and recycle depleted uranium hexafluoride consistent with the National Environmental Policy Act.*

DOE began, therefore, to prepare a responsive plan while it proceeded with the PEIS.

On March 12, 1999, DOE submitted the plan to Congress; no legislation was proposed. In April 1999, DOE issued the final DUF_6 PEIS. The PEIS identified conversion of DUF_6 to another chemical form for use or long-term storage as part of the preferred management alternative. In the Record of Decision (ROD; *Federal Register*, Volume 64, page 43358 [64 FR 43358]), DOE decided to promptly convert the DUF_6 inventory to a more stable uranium oxide form (DOE 1999b). DOE also stated that it would use the depleted uranium oxide as much as possible and store the remaining depleted uranium oxide for potential future uses or disposal, as necessary. In addition, DUF_6 would be converted to depleted uranium metal only if uses for metal were available. DOE did not select a specific site or sites for the conversion facilities but reserved that decision for subsequent NEPA review. (This EIS is that site-specific review.)

Then, in July 1999, DOE issued the *Final Plan for the Conversion of Depleted Uranium Hexafluoride as Required by Public Law 105-204* (DOE 1999c). The Conversion Plan describes the steps that would allow DOE to convert the DUF_6 inventory to a more stable chemical form. It incorporates information received from the private sector in response to a DOE request for expressions of interest; ideas from members of the affected communities, Congress, and other interested stakeholders; and the results of the analyses for the final DUF_6 PEIS. The Conversion

Plan describes DOE's intent to chemically process the DUF_6 to create products that would present a lower long-term storage hazard and provide a material suitable for use or disposal.

1.1.4 DOE Request for Contractor Proposals and Site-Specific NEPA Review

DOE initiated the final Conversion Plan on July 30, 1999, and announced the availability of a draft Request for Proposals (RFP) for a contractor to design, construct, and operate DUF_6 conversion facilities at the Paducah and Portsmouth sites.

In early 2000, the RFP was modified to allow for a wider range of potential conversion product forms and process technologies than had been previously reviewed in the DUF_6 PEIS (the PEIS considered conversion to triuranium octaoxide [U_3O_8] and uranium dioxide [UO_2] for disposal and conversion to uranium metal for use). DOE stated that, if the selected conversion technology would generate a previously unconsidered product (e.g., depleted uranium tetrafluoride [UF_4]), DOE would review the potential environmental impacts as part of the site-specific NEPA review.

On October 31, 2000, DOE issued a final RFP to procure a contractor to design, construct, and operate DUF_6 conversion facilities at the Paducah and Portsmouth sites. The RFP stated that any conversion facilities that would be built would have to convert the DUF_6 within a 25-year period to a more stable chemical form that would be suitable for either beneficial use or disposal. The selected contractor would use its proposed technology to design, construct, and operate the conversion facilities for an initial 5-year period. Operation would include (1) maintaining the DUF_6 inventories and conversion product inventories; (2) transporting all UF_6 storage cylinders currently located at ETTP to a conversion facility at the Portsmouth site, as appropriate; and (3) transporting to an appropriate disposal site any conversion product for which no use was found. The selected contractor would also be responsible for preparing such excess material for disposal.

In March 2001, DOE announced the receipt of five proposals in response to the RFP, three of which proposed conversion to U_3O_8 and two of which proposed conversion to UF_4. In August 2001, DOE deemed three of these proposals to be within the competitive range; two conversion to U_3O_8 proposals and one conversion to UF_4 proposal.

On September 18, 2001, DOE published a Notice of Intent (NOI) in the *Federal Register* (66 FR 48123) announcing its intention to prepare an EIS for the proposed action to construct, operate, maintain, and decontaminate and decommission two DUF_6 conversion facilities at Portsmouth, Ohio, and Paducah, Kentucky. DOE held three scoping meetings to provide the public with an opportunity to present comments on the scope of the EIS and to ask questions and discuss concerns with DOE officials regarding the EIS. The scoping meetings were held in Piketon, Ohio, on November 28, 2001; in Oak Ridge, Tennessee, on December 4, 2001; and in Paducah, Kentucky, on December 6, 2001.

The alternatives identified in the NOI included a two-plant alternative (one at the Paducah site and another at the Portsmouth site), a one-plant alternative (only one plant would be built, at either the Paducah or the Portsmouth site), an alternative using existing UF_6 conversion capacity at commercial nuclear fuel fabrication facilities, and a no action alternative. For alternatives that involved constructing one or two new plants, DOE planned to consider alternative conversion technologies, local siting alternatives within the Paducah and Portsmouth site boundaries, and the shipment of DUF_6 cylinders stored at ETTP to either the Portsmouth site or to the Paducah site. The technologies to be considered in the EIS were those submitted in response to the October 2000 RFP, plus any other technologies that DOE believed must be considered.

1.1.5 Public Law 107-206 Passed by Congress

During the site-specific NEPA review process, Congress acted again regarding DUF_6 management, and on August 2, 2002, the President signed the *2002 Supplemental Appropriations Act for Further Recovery from and Response to Terrorist Attacks on the United States* (P.L. 107-206). The pertinent part of P.L. 107-206 had several requirements: that no later than 30 days after enactment, DOE must select for award of a contract for the scope of work described in the October 2000 RFP, including design, construction, and operation of a DUF_6 conversion facility at each of the Department's Paducah, Kentucky, and Portsmouth, Ohio, gaseous diffusion sites; that the contract require groundbreaking for construction to occur no later than July 31, 2004; that the contract require construction proceed expeditiously thereafter; that the contract include as an item of performance the transportation, conversion, and disposition of DU contained in cylinders located at ETTP, consistent with environmental agreements between the State of Tennessee and the Secretary of Energy; and that no later than 5 days after the date of groundbreaking for each facility, the Secretary of Energy shall submit to Congress a certification that groundbreaking has occurred. The relevant portions of the Appropriations Act are set forth in Appendix A of this EIS. The relevant portions of the Appropriations Act are set forth in Appendix A.

In response to P.L. 107-206, on August 29, 2002, DOE awarded a contract to Uranium Disposition Services, LLC (hereafter referred to as UDS) for construction and operation of two conversion facilities. DOE also reevaluated the appropriate scope of its site-specific NEPA review and decided to prepare two separate EISs, one for the plant proposed for the Paducah site and a second for the Portsmouth site. This change was announced in the *Federal Register* Notice of Change in NEPA Compliance Approach on April 28, 2003 (68 FR 22368).

The two draft site-specific conversion facility EISs were mailed to stakeholders in late November 2003, and a notice of availability was published by the EPA in the *Federal Register* on November 28, 2003 (68 FR 66824). Comments on the draft EISs were accepted during a 67-day review period, from November 28, 2003, until February 2, 2004. Public hearings on the draft EISs were held near Portsmouth, Ohio, on January 7, 2004; Paducah, Kentucky, on January 13, 2004; and Oak Ridge, Tennessee, on January 15, 2004. (Section 1.6.3 provides additional information on the public review of the draft EISs).

1.2 CHARACTERISTICS OF DUF_6

DUF_6 results from the process of making uranium suitable for use as fuel in nuclear reactors or for military applications. The use of uranium in these applications requires that the proportion of the uranium-235 isotope found in natural uranium, which is approximately 0.7% by weight (wt%), be increased through an isotopic separation process. To achieve this increase, a uranium-235 enrichment process called gaseous diffusion is used in the United States. The gaseous diffusion process uses uranium in the form of UF_6, primarily because UF_6 can conveniently be used in gaseous form for processing, in liquid form for filling or emptying containers, and in solid form for storage. Solid UF_6 is a white, dense, crystalline material that resembles rock salt.

Depleted uranium is uranium that, through the enrichment process, has been stripped of a portion of the uranium-235 that it once contained so that its proportion is lower than the 0.7 wt% found in nature. The uranium in most of DOE's DUF_6 has between 0.2 wt% and 0.4 wt% uranium-235.

The chemical and physical characteristics of DUF_6 pose potential health risks, and the material is handled accordingly. Uranium and its decay products in DUF_6 emit low levels of alpha, beta, gamma, and neutron radiation. The radiation levels measured on the outside surface of filled DUF_6 storage cylinders are typically about 2 to 3 millirem per hour (mrem/h), decreasing to about 1 mrem/h at a distance of 1 ft (0.3 m). If DUF_6 is released to the atmosphere, it reacts with water vapor in air to form HF and a uranium oxyfluoride compound called uranyl fluoride (UO_2F_2), which can be harmful to human health if inhaled or ingested in sufficient quantities. Uranium is a heavy metal that, in addition to being radioactive, can have harmful chemical effects (primarily on the kidneys) if it enters the bloodstream by means of ingestion or

Cylinder-Related Terms Used in This EIS

Types of UF_6

UF_6	A chemical composed of one atom of uranium combined with six atoms of fluorine. UF_6 is a volatile white crystalline solid at ambient conditions.
Normal UF_6	UF_6 made with uranium that contains the isotope uranium-235 at a concentration equal to that found in nature, that is, 0.7% uranium-235.
DUF_6	UF_6 made with uranium that contains the isotope uranium-235 in concentrations less than the 0.7% found in nature. In general, the DOE DUF_6 contains between 0.2% and 0.4% uranium-235.
Enriched UF_6	UF_6 made with uranium containing more than 0.7% uranium-235. In general, DOE enriched UF_6 considered in this EIS contains less than 5% uranium-235.
Reprocessed UF_6	UF_6 made with uranium that was previously irradiated in a nuclear reactor and chemically separated during reprocessing.

Types of Cylinders

Full DUF_6	Cylinders filled to 62% of their volume with DUF_6 (some cylinders are slightly overfilled).
Partially Full	Cylinders that contain more than 50 lb (23 kg) of DUF_6 but less than 62% of their volume.
Heel	Cylinders that contain less than 50 lb (23 kg) of residual nonvolatile material left after the DUF_6 has been removed.
Empty	Cylinders that have had the DUF_6 and heel material removed and contain essentially no residual material.
Feed	Cylinders used to supply UF_6 into the enrichment process. Most feed cylinders contain natural UF_6, although some historically contained reprocessed UF_6.
Non-DUF_6	A term used in this EIS to refer to cylinders that contain enriched UF_6 or normal UF_6.

inhalation. HF is an extremely corrosive gas that can damage the lungs and cause death if inhaled at high enough concentrations. In light of such characteristics, DOE stores DUF_6 in a manner designed to minimize the risk to workers, the public, and the environment.

DUF_6 has been stored in large steel cylinders at all three storage sites since the 1950s. Several different cylinder types are in use, although the vast majority of cylinders have a 14-ton (12-t) capacity. (Typical cylinders in storage are shown in Figure 1.1-1.) The cylinders with a 14-ton (12-t) capacity are 12 ft (3.7 m) long by 4 ft (1.2 m) in diameter; most have a steel wall that is 5/16 in. (0.79 cm) thick. The cylinders have external stiffening rings that provide support. Lifting lugs for handling are attached to the stiffening rings. A small percentage of the cylinders have skirted ends (extensions of the cylinder walls past the rounded ends of the cylinder), as shown in Figure 1.1-1. Each cylinder has a single valve for filling and emptying located on one end at the 12 o'clock position. Similar but slightly smaller cylinders with a capacity of 10 tons (9 t) are also in use. Most of the cylinders were manufactured in accordance with an American National Standards Institute standard (ANSI N14.1, *American National Standard for Nuclear Materials — Uranium Hexafluoride — Packaging for Transport*) as specified in 49 CFR 173.420, the federal regulations governing transport of DUF_6.

1.2.1 Cylinder Inventory

This EIS considers conversion of the DUF_6 inventory stored at the Paducah site for which DOE has responsibility. Statistics on the DUF_6 cylinders managed by DOE at the Paducah site as of January 26, 2004, are summarized in Table 1.1-1. Approximately 36,200 cylinders containing almost 440,000 t (484,000 tons) of DUF_6 are managed at Paducah. In addition to the DUF_6 cylinders, included in the Paducah inventory are approximately 1,940 DOE cylinders that contain enriched UF_6 or normal UF_6 (collectively called "non-DUF_6" cylinders in this EIS) or are empty. The management of these non-DUF_6 cylinders is included in the EIS; however, they would not be processed in the conversion facility.

The conversion facility proposed for Paducah is designed to convert 18,000 t (20,000 tons) of DUF_6 per year (approximately 1,400 cylinders per year). At that rate of throughput, it will take approximately 25 years to convert the Paducah cylinder inventory.

The cylinder inventory at the ETTP site is also listed in Table 1.1-1. Approximately 4,800 DUF_6 and 1,100 non-DUF_6 cylinders are stored at ETTP. The non-DUF_6 cylinders contain a total of approximately 26 t (29 tons) of UF_6 (7 t [8 tons] of enriched UF_6 plus 19 t [21 tons] of normal UF_6) (Hightower 2004). 100% of the Paducah enriched UF_6 and over 98% of the ETTP enriched UF_6 contain less than 5% uranium-235.

In addition to the Paducah and ETTP inventories, approximately 16,000 cylinders are managed at the Portsmouth site. Construction and operation of a conversion facility at the Portsmouth site for conversion of the Portsmouth and ETTP inventories is the subject of a separate EIS (DOE 2004a).

TABLE 1.1-1 Inventory of DOE UF_6 Cylinders Considered in This EIS[a]

Location	No. of Cylinders	Weight of UF_6 (t)
Paducah – DUF_6	36,191	436,400
Non-DUF_6		
Enriched UF_6	182	1,600
Normal UF_6	1,485	16,000
Empty	275	0
ETTP[b] – DUF_6	4,822	54,300
Non-DUF_6		
Enriched UF_6	881	7
Normal UF_6	221	19
Empty	20	0
Total		
DUF_6	41,013	490,700
Non-DUF_6	2,769	17,625
Empty	295	0

[a] As of January 26, 2004 (Hightower 2004).

[b] The proposed action calls for shipment of the ETTP cylinders to Portsmouth.

DOE proposes to ship all ETTP cylinders to Portsmouth. However, this EIS does consider an option of shipping the ETTP cylinders to Paducah. If the ETTP cylinders were shipped to Paducah, the Paducah conversion facility would operate for approximately 28 rather than 25 years to convert the DUF_6 cylinders. The shipment of the non-DUF_6 cylinders to Paducah is also included. It is assumed that the normal UF_6 and enriched UF_6 cylinders from both Paducah and ETTP would be put to beneficial uses; therefore, conversion of the contents of the non-DUF_6 cylinders is not considered.

The evaluation of the no action alternative in this EIS is based on the assessment conducted for the PEIS, which was revised to reflect updated information. To account for uncertainties related to the amount of USEC-generated DUF_6 to be managed in the future, the PEIS analysis used for this EIS assumed that a total of approximately 40,400 DUF_6 cylinders at the Paducah site would need to be managed.

Several reasonably foreseeable activities could potentially result in a future increase in the number of DUF_6 cylinders for which DOE has management responsibility. These include potential transfers of DUF_6 to DOE from continued USEC gaseous diffusion plant operations at Paducah; from a future USEC advanced enrichment technology plant at Portsmouth, Paducah, or elsewhere; and from some unspecified future commercial uranium enrichment facility licensed and operated in the United States. Such an inventory increase could result in a future decision to extend conversion facility operations or expand throughput at one or both of the conversion facility sites. An option of expanding operations at the conversion facility is considered in this EIS, as discussed in more detail in Section 2.2.5 and in the assessment of impacts presented in Chapter 5.

1.2.2 Cylinder Condition and Potential Contamination

As the inventory of DUF_6 cylinders ages, some cylinders have begun to show evidence of external corrosion. As of August 2002, at all three storage sites combined, 11 cylinders had developed holes (breaches) (see text box). The majority of these breaches were the result of handling damage during stacking or handling damage followed by corrosion. Only 2 of the 11 breaches are believed to have resulted from corrosion alone. At Paducah, a total of 3 cylinder breaches have occurred. However, since DUF_6 is solid at ambient temperatures and pressures, it is not readily released after a cylinder leak or breach. When a cylinder is breached, moist air reacts with the exposed solid DUF_6 and iron, forming a dense plug of solid uranium and iron compounds and a small amount of HF gas. The plug limits the amount of material released from a breached cylinder. When a cylinder breach is identified, the cylinder is typically repaired or its contents are transferred to a new cylinder.

Because reprocessed uranium was enriched in the early years of gaseous diffusion, some of the DUF_6 inventory is contaminated with small amounts of technetium (Tc) and the transuranic (TRU) elements plutonium (Pu), neptunium (Np), and americium (Am). In 2000, DOE, on the basis of existing process knowledge and results from additional sampling of cylinders, characterized the TRU and Tc contamination in the DUF_6 cylinders. As indicated in a report by Oak Ridge National Laboratory (ORNL) (Hightower et al. 2000), nondetectable or very low levels of TRU elements were found to be

Summary Data for Breached Cylinders at the Storage Sites Through 2003

Paducah Site, three breached cylinders: One identified in 1992 was initiated by mechanical damage during stacking. The breached area was about 0.06 in. × 2 in. (0.16 cm × 5.1 cm). Estimated material loss was 0. The other two cylinder breaches were identified as breached because of missing cylinder plugs; they were identified between 1998 and 2002. Material loss from these cylinders was not estimated.

ETTP Site, five breached cylinders: Four were identified in 1991 and 1992. Two of these were initiated by mechanical damage during stacking, and two were caused by external corrosion due to prolonged ground contact. The breach areas for these four cylinders were about 2 in. (5.1 cm), 6 in. (15 cm), and 10 in. (25 cm) in diameter for three circular breaches, and 17 in. × 12 in. for a rectangular-shaped breach. The mass of material loss from the cylinders could not be estimated because equipment to weigh the cylinders was not available at the ETTP site. The fifth breach occurred in 1998 and was caused by steel grit blasting, which resulted in a breach at the location of an as-fabricated weld defect (immediately repaired without loss of DUF_6).

Portsmouth Site, three breached cylinders: Two identified in 1990 were initiated by mechanical damage during stacking; the damage was not noticed immediately, and subsequent corrosion occurred at the point of damage. The largest breach size was about 9 in. × 18 in. (23 cm × 46 cm); the estimated mass of DUF_6 lost was between 17 and 109 lb (7.7 and 49 kg). The next largest cylinder breach had an area of about 2 in. (5.1 cm) in diameter; the estimated DUF_6 lost was less than 4 lb (1.8 kg). The third breached cylinder occurred in 1996 and was the result of handling equipment knocking off a cylinder plug.

dispersed in the DUF_6 stored in the cylinders. However, higher levels of TRU elements, associated with the "heels" remaining in a small number of cylinders formerly used to store reprocessed uranium, are expected to occur. (The term "heel" refers to the residual amount of nonvolatile material left in a cylinder following removal of the DUF_6, typically less than 50 lb [23 kg].) The final RFP for providing conversion services concluded that any DUF_6 contaminated with TRU elements and Tc at the concentrations expected to be encountered could be safely handled in a conversion facility. The data and assumptions used in this EIS to evaluate potential impacts from the DUF_6 contaminated with Tc and TRU elements are described in Appendix B.

Some of the cylinders manufactured before 1978 were painted with coatings containing polychlorinated biphenyls (PCBs). (Although PCBs are no longer in production in the United States, from the 1950s to the late 1970s, PCBs were added to some paints as fungicides and to increase durability and flexibility.) The long persistence of PCBs in the environment and the tendency for bioaccumulation in the foodchain has resulted in regulations to prevent their release and distribution in the environment. As a result, the cylinders with PCB-containing coatings may require special measures during transport, such as bagging, to ensure that PCB-containing paint chips are not released. Additionally, environmental monitoring and maintenance of cylinder storage and process areas may be required to ensure that PCBs are not released during storage or processing. Potential issues associated with PCB-containing cylinder coatings are discussed in Appendix B. As discussed in Appendix B, the presence of PCBs in the coatings of some cylinders is not expected to result in health and safety risks to workers or the public.

1.3 PURPOSE AND NEED

DOE needs to convert its inventory of DUF_6 to a more stable chemical form for use or disposal. This need follows directly from (1) the decision presented in the August 1999 ROD for the PEIS, namely, to begin conversion of the DUF_6 inventory as soon as possible, and (2) P.L. 107-206, which directs DOE to award a contract for construction and operation of conversion facilities at both the Paducah site and the Portsmouth site.

1.4 PROPOSED ACTION

The proposed action evaluated in this EIS is to construct and operate a conversion facility at the Paducah site for converting the Paducah DUF_6 inventory into depleted uranium oxide (primarily U_3O_8) and other conversion products. The time period considered is a construction period of approximately 2 years, an operational period of 25 years, and a 3-year period for D&D of the facility.

This EIS assesses the potential environmental impacts from the following proposed activities:

- Construction, operation, maintenance, and D&D of the proposed DUF_6 conversion facility at the Paducah site;

- Transportation of uranium conversion products and waste materials to a disposal facility;

- Transportation and sale of the HF produced as a co-product of conversion; and

- Neutralization of HF to CaF_2 and its sale or disposal in the event that the HF product is not sold.

Three alternative locations for the conversion facility within the Paducah site are considered. Although not part of the proposed action, this EIS considers an option of transporting the ETTP DUF_6 and non-DUF_6 cylinders to Paducah. In addition, this EIS includes an evaluation of the impacts that would result from a no action alternative (i.e., continued DUF_6 cylinder storage at the Paducah site).

1.5 DOE DUF_6 MANAGEMENT PROGRAM

In fiscal year (FY) 2001, the responsibility for all uranium program activities was transferred from DOE's Office of Nuclear Energy, Science, and Technology (NE) to its Office of Environmental Management (EM). All activities related to this program are managed by the DOE's Lexington Office. The uranium program supports important government activities associated with the federal enrichment program that were not transferred to USEC under the provisions of the National Energy Policy Act of 1992 (P.L. 102-486), including management of highly enriched uranium; management of the facilities at the Paducah and Portsmouth sites; responsibility for preexisting liabilities; management of DOE's inventories of DUF_6 and other surplus uranium; and oversight of the construction of DUF_6 conversion facilities.

Within the uranium program is DOE's DUF_6 management program, whose mission is to safely and efficiently manage DOE's inventory of DUF_6 in a way that protects the health and safety of workers and the public and protects the environment until the DUF_6 is either used or disposed of. In addition to the conversion activities that are the subject of this EIS, the DUF_6 management program involves two other primary activities: (1) surveillance and maintenance of cylinders and (2) development of beneficial uses for depleted uranium.

Since it may take 25 years to convert the DUF_6 in the inventory to a more stable chemical form, DOE intends to ensure the continued surveillance and maintenance of the DUF_6 cylinders currently in storage. Day-to-day management includes actions designed to cost-effectively improve cylinder storage conditions, such as:

- Performing regular inspections and general maintenance of cylinders and storage yards, including:

  - Restacking and respacing the cylinders to improve drainage and allow for more thorough inspections,

  - Repainting cylinder bodies and the ends of skirted cylinders as needed to arrest corrosion, and

    - Constructing new concrete cylinder storage yards and reconditioning existing yards from gravel to concrete to improve storage conditions; and

- Performing routine cylinder valve surveys and maintenance.

DOE is committed to exploring the safe, beneficial use of depleted uranium and other materials that result from the conversion of DUF_6 (e.g., HF and empty carbon steel cylinders) in order to conserve more resources and increase savings over levels achieved through disposal. Accordingly, a DOE research and development (R&D) program on uses for depleted uranium has been initiated. This program is exploring the risks and benefits associated with several uses for depleted uranium, such as a radiation shielding material, a catalyst, and a semiconductor material in electronic devices. More information about DOE's R&D on depleted uranium uses is available on the *Depleted UF_6 Management Information Network* Web site (http://web.ead.anl.gov/uranium). In addition, in the RFP for conversion services, DOE requested that the bidders investigate and propose viable uses for the conversion products.

1.6 SCOPE

The scope of an EIS refers to the range of actions, alternatives, and impacts it considers. An agency generally determines the scope of an EIS through a two-part process: internal scoping and public scoping. Internal scoping refers to the agency's efforts to identify potential alternatives and important issues and to determine which analyses to include in an EIS. Public scoping refers to the agency's request for public comments on the proposed action and on the results from its internal scoping. It involves consultations with federal, state, and local agencies as well as requests for comments from stakeholder organizations and members of the general public. The EIS scoping process provides a means for the public to provide input into the decision-making process. DOE is committed to ensuring that the public has ample opportunity to participate in the review. This section summarizes the public scoping conducted for this EIS (Section 1.6.1), discusses the range of issues and alternatives that resulted from the internal and public scoping process (Section 1.6.2), and summarizes the public review of the draft EIS (Section 1.6.3).

1.6.1 Public Scoping Process for This Environmental Impact Statement

On September 18, 2001, DOE published a NOI in the *Federal Register* (66 FR 48123) announcing its intention to prepare an EIS for a proposal to construct, operate, maintain, and decontaminate and decommission DUF_6 conversion facilities at Portsmouth, Ohio, and/or Paducah, Kentucky. The purpose of the NOI was to encourage early public involvement in the EIS process and to solicit public comments on the proposed scope of the EIS, including the issues and alternatives it would analyze. To facilitate public comments, the NOI included a detailed discussion of the project background, a list of the preliminary alternatives and environmental impacts that DOE proposed to evaluate in the EIS, and a project schedule. The NOI announced that the scoping period for the EIS would be open until November 26, 2001. The scoping period was later extended to January 11, 2002.

During the scoping process, the public was given six ways to submit comments on the DUF_6 proposal to DOE:

1. Attendance at public scoping meetings held in Piketon, Ohio; Oak Ridge, Tennessee; and Paducah, Kentucky;

2. Traditional mail delivery;

3. Toll-free facsimile transmission;

4. Toll-free voice message;

5. Electronic mail; and

6. Directly through the *Depleted UF_6 Management Information Network* Web site on the Internet (http://web.ead.anl.gov/uranium).

Numerous ways to communicate about issues and submit comments were provided to encourage maximum participation. All comments, regardless of how they were submitted, received equal consideration.

A total of approximately 100 individuals attended the three scoping meetings, and 20 of these individuals provided oral comments. Individuals in attendance included federal officials, state regulators, local officials, site oversight committee members, representatives of interested companies, members of local media, and private individuals. In addition, about 20 individuals and organizations provided comments through the other means available (fax, telephone, mail, e-mail, and Web site). Some of the comments received through these other means were duplicates of comments made at the scoping meetings. During the scoping period (September 18, 2001, through January 11, 2002), the *Depleted UF_6 Management Information Network* Web site was used a great deal; a total of 64,366 pages were viewed (averaging 554 per day) during 9,983 user sessions (averaging 85 per day) by 4,784 unique visitors.

Approximately 140 comments were received from about 30 individuals and organizations during the scoping period. Appendix C of this EIS provides a summary of these comments. These comments were examined to finalize the proposed scope of this EIS. Comments were related primarily to five major issues: (1) DOE policy; (2) alternatives; (3) cylinder inventory, maintenance, and surveillance; (4) transportation; and (5) general environmental concerns.

Most of the comments made during the public scoping period were related to issues that DOE was already planning to discuss in this EIS. Such comments helped to clarify the need for addressing those issues. However, a few issues were raised that DOE was not able to address in this EIS. These issues and the reasons why they are not addressed are summarized below.

- One commentor stated that DOE should not consider any alternatives other than the two conversion plants alternative because Congress had mandated that two plants be built: one at Paducah and one at Portsmouth. NEPA requires that the no action alternative be one of the alternatives considered. Therefore, the no action alternative has been included in this EIS.

- A request was made to designate specific routes and perform route-specific risk analyses for transporting the ETTP cylinders. Specific routes will not be known until the selected contractor is ready to ship the cylinders from ETTP. The exact routes will be determined on the basis of the shipment mode selected (truck or rail), applicable regulations, and other factors, as appropriate. Before the shipments occur, a transportation plan will be coordinated with the appropriate regulatory agencies. However, this EIS does present an evaluation of transportation risks for representative routes that were identified by using route prediction models for truck and rail modes.

- Requests were made to analyze the impacts associated with the use of conversion products. As described further below, no large-scale uses of the depleted uranium conversion product have been identified, and current plans assume disposal of the material. The DUF_6 PEIS (DOE 1999a) analyzed the generic impacts associated with the manufacture of waste containers using depleted uranium and depleted UO_2. Impacts associated with actual use of any depleted uranium products will be analyzed if specific uses are identified in the future and any necessary licenses, permits, or exemptions are obtained. This EIS does evaluate impacts associated with the potential sale of fluoride-containing conversion products (i.e., HF and CaF_2).

1.6.2 Scope of This Environmental Impact Statement

In response to the congressional mandate to build conversion plants at the Paducah and Portsmouth sites (P.L. 107-206), DOE reevaluated the appropriate scope of its NEPA review and decided to prepare two separate site-specific EISs in parallel: one EIS for the facility proposed for the Paducah site and a second EIS for the Portsmouth site. This change in approach was announced in a *Federal Register* Notice published on April 28, 2003 (DOE 2003b).

This EIS addresses the potential environmental impacts at Paducah from the construction, operation, maintenance, and D&D of the proposed conversion facility; from the transportation of depleted uranium conversion products to a disposal facility; and from the transportation, sale, or disposal of the fluoride-containing conversion products (HF or CaF_2). Three alternative locations within the Paducah site are evaluated for the conversion facility. An option of shipping the ETTP cylinders to Paducah for conversion is also considered. In addition, this EIS evaluates a no action alternative, which assumes continued storage of DUF_6 in cylinders at the Paducah site. Additional details are provided in the sections below.

1.6.2.1 Alternatives

The alternatives that are evaluated and compared in this EIS include a no action alternative and three action alternatives that focus on where to site the conversion facility within the Paducah site:

1. *No Action Alternative*. Under the no action alternative, conversion would not occur. Current cylinder management activities (handling, inspection, monitoring, and maintenance) would continue; thus, the status quo would be maintained at Paducah indefinitely, consistent with the *UF_6 Cylinder Project Management Plan* (LMES 1997d) and consent orders, which cover actions needed to meet safety and environmental requirements.

2. *Action Alternatives.* The proposed action considers the construction and operation of a conversion facility at the Paducah site. Three alternative locations within the site are evaluated (Locations A [preferred], B, and C, which are defined in Chapter 2). In addition, an option of transporting the ETTP cylinders to Paducah is considered, as well as an option of expanding conversion facility operations.

These alternatives and options, as well as the alternatives that were considered but not evaluated in detail, are described more fully in Chapter 2.

1.6.2.2 Depleted Uranium Conversion Technologies and Products

As noted in Section 1.1.5, DOE awarded a conversion services contract to UDS on August 29, 2002. The proposed UDS facility would convert DUF_6 to a mixture of depleted uranium oxides (primarily U_3O_8), a form suitable for disposal if uses are not identified. In addition to depleted U_3O_8, the UDS conversion facility would produce aqueous HF, which is a product that has commercial value and could potentially be sold for industrial use. The evaluation of the proposed action in this EIS is based on the proposed UDS conversion technology and facility design, which is described in Section 2.2.

The conversion project RFP did not specify the conversion product technology or form. Three proposals submitted in response to the RFP were deemed to be in the competitive range; two of these proposals involved conversion of DUF_6 to U_3O_8 and the third involved conversion to depleted UF_4. Potential environmental impacts associated with these proposals were considered during the procurement process, which involved the preparation of an environmental critique and environmental synopsis that were prepared in accordance with the requirements of 10 CFR 1021.216.

The environmental critique, which contains proprietary information, focuses on environmental issues pertinent to a decision among the proposals within the competitive range and includes a discussion of the purpose of the procurement and each offer, a discussion of the salient characteristics of each offer, and a comparative evaluation of the environmental impacts of the offers. The environmental synopsis is a summary document based on the environmental critique; it does not contain proprietary information. The synopsis documents the evaluation of potential environmental impacts associated with the proposals in the competitive range and does not contain procurement-sensitive information. The environmental synopsis is presented in Appendix D.

The environmental synopsis concludes that, on the basis of the assessment of potential environmental impacts presented in the critique, no proposal was clearly environmentally preferable. Although differences in a number of impact areas were identified, none of the differences were considered to result in one proposal being preferable over the others. In addition, the potential environmental impacts associated with the proposals were found to be similar to, and generally less than, those presented in the DUF_6 PEIS (DOE 1999a) for representative conversion technologies.

1.6.2.3 Transportation Modes

This EIS considers an option of shipping the cylinders at ETTP to Paducah, although current plans call for the shipment of these cylinders to Portsmouth. For this option, this EIS considers several transportation methods for preparing the DUF_6 and non-DUF_6 cylinders and shipping them to the conversion facility. Many of the cylinders currently stored at ETTP do not meet U.S. Department of Transportation (DOT) requirements for shipment without some type of preparation first. The DUF_6 PEIS (DOE 1999a) and a separate transportation impact assessment (Biwer et al. 2001) contain detailed information on cylinder conditions, regulations, and preparation methods. As described in detail in Section 2.2.4, three options for preparing noncompliant cylinders are considered in this EIS: (1) use of overpacks, which are large containers, certified to meet DOT shipping requirements, into which cylinders could be placed; (2) use of a cylinder transfer facility, in which the UF_6 contents could be transferred from noncompliant cylinders to compliant ones; and (3) obtaining an exemption from DOT allowing the cylinders to be shipped “as-is” or following repairs. This EIS also considers the transportation of conversion products to a user or disposal facility. Transportation of DUF_6 cylinders and conversion products by two modes, truck and train, are analyzed in this EIS.

1.6.2.4 Conversion Product Disposition

As noted, the products of the DUF_6 conversion process would consist of depleted U_3O_8 and HF. DOE has been working with industrial and academic researchers for several years to identify potential uses for both products. Some potential uses for depleted uranium exist or are being developed, and DOE believes that a viable market exists for the HF generated during conversion. To take advantage of these to the extent possible, DOE requested in the RFP that the bidders for conversion services investigate and propose viable uses.

Currently, there are several uses for depleted uranium, including (1) reactor fuel in breeder reactors; (2) conventional military applications, such as tank armor and armor-piercing projectiles; (3) biological shielding, which provides protection from x-rays or gamma rays; and

(4) counterweights for use in aircraft applications. One characteristic of all these applications is that the amount of depleted uranium that they require is small, and existing demand can be met by depleted uranium stocks separate from the DUF_6 considered in this EIS; thus, these applications do not and are not expected to have a significant effect on the inventory of depleted uranium contained in the DOE DUF_6 inventory.

In the RFP, DOE acknowledges that uses for much of the depleted uranium may not be found, thus requiring that it be dispositioned as low-level radioactive waste (LLW). In its proposal, UDS confirmed that widescale applications of the depleted U_3O_8 conversion product are not currently available and that the material will likely require disposal. Studies conducted by ORNL for DOE indicate that both the Nevada Test Site (NTS) (a DOE facility) and Envirocare of Utah, Inc. (a commercial facility) are potential disposal facilities for depleted uranium (Croff et al. 2000a,b). These studies included reviews of the LLW acceptance programs and disposal capacities of both NTS and Envirocare of Utah, Inc. It was concluded that either facility would have the capacity needed to dispose of the U_3O_8 product from the proposed DOE DUF_6 conversion program, and that the U_3O_8 material to be sent to these facilities would be likely to meet each site's waste acceptance criteria. In its proposal to design, construct, and operate the DUF_6 conversion facilities, UDS provided evidence that both sites can presently accept the U_3O_8 and identified the Envirocare facility as the primary disposal site and NTS as the secondary disposal site.

Shipments of depleted U_3O_8 to a disposal facility are expected to begin shortly after conversion facility operations commence, currently planned for late 2006. The conversion facilities are being designed with a short-term storage capacity for 6 months' worth of depleted uranium conversion products. This storage capacity is being provided in order to accommodate potential delays in disposal activities without affecting conversion operations. If a delay was to extend beyond 6 months, DOE would evaluate possible options and conduct appropriate NEPA review for those options.

This EIS evaluates the impacts from packaging, handling, and transporting depleted U_3O_8 from the conversion facility to disposal sites that would be (1) selected in a manner consistent with DOE policies and orders and (2) authorized or licensed to receive the conversion products by DOE (in conformance with DOE orders), the U.S. Nuclear Regulatory Commission (NRC; in conformance with NRC regulations), or an NRC Agreement State agency (in conformance with state laws and regulations determined to be equivalent to NRC regulations). Assessment of the impacts and risks from on-site handling and disposal at the LLW disposal facility are deferred to the disposal site's site-specific NEPA or licensing documents. DOE plans to decide the specific disposal location(s) for the depleted U_3O_8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

In addition, UDS believes that aqueous HF generated during conversion is a valuable commercial commodity that could be readily sold for industrial use. Thus, this EIS evaluates impacts associated with HF sale and use. To account for the possibility that uses for HF will not be identified, this EIS also evaluates a contingency for the neutralization of HF to the unreactive solid CaF_2 for sale or disposal.

1.6.2.5 Human Health and Environmental Issues

This EIS evaluates and compares the potential impacts on human health and the environment at the Paducah site under the alternatives and options described above. In general, this EIS emphasizes those impacts that might differ under the various alternatives and those impacts that would be of special interest to the general public (such as potential radiation effects).

This EIS includes assessments of impacts on human health and safety, air, water, soil, biota, socioeconomics, cultural resources, site waste management capabilities, resource requirements, and environmental justice. Impacts judged by DOE to be of the greatest concern or public interest and to receive more detailed analysis include impacts on human health and safety, air and water, waste management capabilities, and socioeconomics. These issues are consequently treated in greater detail in this EIS.

The process of estimating environmental impacts from the conversion of DUF_6 is subject to some uncertainty because final facility designs are not yet available. In addition, the methods used to estimate impacts have uncertainties associated with their results. This EIS impact assessment was designed to ensure — through the selection of assumptions, models, and input parameters — that impacts would not be underestimated and that relative comparisons among the alternatives would be valid and meaningful. This approach was developed by uniformly applying common assumptions to each alternative and by choosing assumptions intended to produce conservative estimates of impacts — that is, assumptions that would lead to overestimates of the expected impacts. Although uncertainty may characterize estimates of the absolute magnitude of impacts, a uniform approach to impact assessment enhances the ability to make valid comparisons among alternatives. This uniform approach was implemented in the analyses conducted for this EIS to the extent practicable.

1.6.3 Public Review of the Draft EIS

The two draft site-specific conversion facility EISs were mailed to stakeholders in late November 2003, and a notice of availability was published by the EPA in the *Federal Register* on November 28, 2003 (68 FR 66824). In addition, each EIS was also made available in its entirety on the Internet at the same time, and e-mail notification was sent to those on the project Web site mailing list. Stakeholders were encouraged to provide comments on the draft EISs during a 67-day review period, from November 28, 2003, until February 2, 2004. Comments could be submitted by calling a toll-free number, by fax, by letter, by e-mail, or through the project Web site. Comments could also be submitted at public hearings held near Portsmouth, Ohio, on January 7, 2004; Paducah, Kentucky, on January 13, 2004; and Oak Ridge, Tennessee, on January 15, 2004. The public hearings were announced on the project Web site and in local newspapers prior to the meetings.

A total of about 210 comments were received during the comment period. The comments received and DOE's responses to those comments are presented in Volume 2 of this EIS. Because of the similarities in the proposed actions and the general applicability of many of the comments to both site-specific conversion facility EISs, all comments received on the Portsmouth and Paducah EISs are included in Volume 2. In addition, all comments received were considered in the preparation of both final EISs.

Several revisions were made to the two site-specific conversion facility draft EISs on the basis of the comments received (changes are indicated by vertical lines in the right margin of the document). The vast majority of the changes were made to provide clarification and additional detail. Specific responses to each comment received on the draft EISs are presented in Volume 2 of this EIS; a summary of the most common issues raised by the reviewers and the general DOE responses to these issues are listed below.

- *Comments related to the proposed action and preferred alternative.*

  Numerous reviewers expressed support for the DOE conversion project in general and agreement with the preferred alternatives identified in the draft EISs. Reviewers stressed the importance of meeting the requirements of P.L. 107-206, as well as the consent orders that DOE has signed with each of the affected states.

  DOE appreciates support for the conversion project and is committed to complying with all applicable regulations, agreements, and orders.

- *Comments related to transportation of cylinders.*

  Several reviewers raised concerns over the safe transportation of cylinders from the ETTP site. Common themes included a preference for the use of overpacks, opposition to transporting noncompliant cylinders "as-is" under a DOT exemption, a general desire that shipments be made in a manner protective of health and safety, and questions concerning the potential use of barge transportation.

  DOE is committed to conducting all transportation activities in a manner protective of human health and safety and in compliance with all applicable regulations. A Transportation Plan will be developed for each shipping program related to the DUF_6 conversion facility project. Each Plan will be developed to address specific issues associated with the commodity being shipped, the origin and destination points, and concerns of jurisdictions transited by the shipments. In all cases, DOE-sponsored shipments will comply with all applicable State and Federal regulations and will be reflected in many of the operational decisions that will be made and presented in the Plan. The transportation regulations are designed to be protective of public health and safety during both accident and routine transportation conditions.

To allow flexibility in planning and future operations, the transportation analysis in each EIS evaluates a range of options for cylinder preparation and transport modes. For example, all three options for shipping noncompliant cylinders, including obtaining a DOT exemption, using overpacks, and transferring the contents from noncompliant to compliant cylinders, are evaluated in the EISs, as are both truck and rail modes. Because barge transport has not been proposed as part of the current conversion facility project and for the reasons discussed in Section 2.3.5, a detailed evaluation has not been included in the final EISs. If barge transportation was proposed in the future and considered to be a reasonable option, additional NEPA review would be conducted.

- *Comments related to removal of cylinders from the ETTP site.*

  Several reviewers stressed the importance of DOE compliance with the 1999 consent order with the TDEC that requires the removal of the DUF_6 cylinders from the ETTP site or the conversion of the material by December 31, 2009.

  DOE is committed to complying with the 1999 consent order. Toward that end, the DOE contract for accelerated cleanup of the ETTP site, including removal of the DUF_6 cylinders, calls for completion of this activity by the end of FY 2008.

- *Comments related to the potential for DOE to receive additional DUF_6 cylinders from other sources.*

  Several reviewers noted that DOE may receive additional DUF_6 cylinders from other sources, including continued USEC operations, the proposed American Centrifuge Facility at the Portsmouth site, and other potential commercial enrichment facilities. Some reviewers requested that DOE design the conversion facilities to accommodate such an increase.

  At the present time, there are no plans or proposals for DOE to accept DUF_6 cylinders for conversion beyond the current inventory for which it has responsibility. However, Section 2.2.7 of the Portsmouth site-specific conversion facility EIS and Section 2.2.5 of the Paducah EIS discuss a number of possible future sources of additional DUF_6 that could require conversion. The potential environmental impacts associated with expanding plant operations (either by extending operations or by increasing the throughput) to accommodate processing of additional cylinders are discussed in Section 5.2.8 of the Portsmouth EIS and Section 5.2.6 of the Paducah EIS. Because of the uncertainty associated with possible future sources of DUF_6 for which DOE could assume responsibility, there is no current proposal to increase the throughputs of the conversion facilities or extend the operational period.

- *Comments related to USEC's American Centrifuge Facility.*

  Several reviewers noted the January 2004 announcement by USEC that the American Centrifuge Facility would be sited at Portsmouth, and stated that the EISs should be revised accordingly, including consideration of the facility under Portsmouth cumulative impacts.

  The two site-specific conversion facility EISs have been revised to reflect that Portsmouth has been selected as the site for the USEC American Centrifuge Facility. Although Location B is the likely site for construction of the centrifuge facility, it has been retained in the final Portsmouth conversion EIS as a siting alternative. The cumulative impacts analysis included in both the draft and final Portsmouth conversion facility EIS assumed that a new USEC centrifuge enrichment facility would be constructed and operated at the Portsmouth site (see Sections S.5.16 and 5.3.2). As stated in Sections S.5.16 and 5.3.2, the analysis assumed that such a plant would be sited at Portsmouth, that the existing DOE gas centrifuge technology would be used, and that the environmental impacts of such a facility would be similar to those outlined in a 1977 EIS for Expansion of the Portsmouth Gaseous Diffusion Plant that considered a similar action that was never completed. It should be noted that the NRC licensing activities for the proposed centrifuge enrichment plant will include preparation of an EIS that must also evaluate cumulative impacts at the Portsmouth site. The centrifuge enrichment facility cumulative impacts analysis will be based on the anticipated USEC enrichment facility design, which does not currently exist, and will benefit from the detailed evaluation of conversion facility impacts presented in this EIS.

- *Comments related to current cylinder management.* Several reviewers raised questions and concerns about the current management of the cylinders at the three DOE storage sites.

  In response to these concerns, it has been emphasized that DOE's current cylinder management program provides for safe storage of the depleted UF_6 cylinders. DOE is committed to the safe storage of the cylinders at each site through the implementation of the decision made in the ROD. DOE has an active cylinder management program designed to ensure the continued safety of cylinders until conversion is accomplished.

1.7 RELATIONSHIP TO OTHER NEPA REVIEWS

This site-specific DUF_6 Conversion EIS, along with the EIS prepared for the Portsmouth conversion facility (DOE/EIS-0360), represents the second level of a tiered environmental review process being used to evaluate and implement DOE's DUF_6 Management Program. A "tiered" process refers to a process of first addressing higher-order decisions in a PEIS and then conducting a more narrowly focused (project-level) environmental review. The project-level review incorporates, by reference, the programmatic analysis, as appropriate, as well as additional site-specific analyses. The DUF_6 PEIS (DOE 1999a), issued in April 1999, represents the first level of this tiered process.

DOE prepared, or is in the process of preparing, other NEPA reviews that are related to the management of DUF_6 or to the current DUF_6 storage sites. The DUF_6 PEIS includes an extensive list of reviews that were prepared before 1999; that list is not repeated here. The following related NEPA reviews were conducted after publication of the DUF_6 PEIS; these reviews are related to this EIS primarily because they evaluate activities occurring at Paducah.

- *Supplement Analysis for Transportation of DOT Compliant Depleted Uranium Hexafluoride Cylinders from the East Tennessee Technology Park to the Portsmouth Gaseous Diffusion Plant in Fiscal Years 2003 through 2005* (DOE 2003d): The purpose of this supplement analysis is to provide a basis for determining whether the existing PEIS NEPA analysis and documentation would be sufficient to allow DOE to transport up to 1,700 full cylinders containing DUF_6 from its ETTP location to the Portsmouth site in FYs 2003 through 2005. All of these cylinders would be compliant with DOT regulatory requirements. Details of the proposed shipment campaign are presented in a transportation plan prepared by Bechtel Jacobs Company LLC (2003). Based on the Supplement Analysis, DOE issued an amended ROD to the PEIS concluding that the estimated impacts for the proposed transport of up to 1,700 cylinders were less than or equal to those considered in the PEIS and that no further NEPA documentation was required (68 FR 53603). However, this EIS considers shipment of all DUF_6 and non-DUF_6 at ETTP to Portsmouth (proposed) and Paducah (option). No shipments were made in FY 2003, and it is expected that the planned shipments would occur in FYs 2004 and 2005.

- *Final Environmental Assessment for Waste Disposition Activities at the Paducah Site, Paducah, Kentucky* (DOE 2002a): DOE proposes disposition activities for polychlorinated biphenyl (PCB) waste, LLW, low-level radioactive mixed waste (LLMW), and TRU waste from the Paducah site. All of the wastes would be transported for disposal at various locations in the United States. This environmental assessment (EA) for the disposition of various DOE wastes stored and/or generated at nonleased portions of the Paducah site was prepared in accordance with CEQ and DOE regulations and DOE orders and guidance regarding these waste types. This EA (1) provides an evaluation of the potential effects from the disposition of accumulated legacy and ongoing operational wastes at the Paducah site; (2) presents the most current volumes of Environmental Management Program wastes at the Paducah site; (3) is tiered under other currently existing NEPA documents; (4) is intended to supplement and update the previous NEPA evaluation of waste disposition activities; and (5) does not include a detailed consideration of impacts from treatment and disposal operations at commercial facilities.

- *Final Environmental Assessment, Proposed Demonstration of the Vortec Vitrification System for Treatment of Mixed Wastes at the Paducah Gaseous Diffusion Plant* (DOE 1999d): DOE prepared this document to evaluate the proposed construction and operation of a demonstration facility at the Paducah site in McCracken County, Kentucky. The objective of the demonstration is to evaluate the Vortec Cyclone Melting System™, a glass-making vitrification process for treating various wastes that resulted from previous operations at the Paducah site. Wastes to be treated include LLW, LLMW, Toxic Substances Control Act (TSCA)-regulated, TSCA-regulated mixed, and Resource Conservation and Recovery Act (RCRA)/TSCA-regulated mixed wastes. On the basis of the analysis in the EA, DOE determined that the demonstration would not constitute a major federal action significantly affecting the quality of the human environment within the meaning of NEPA. DOE concluded that the preparation of an EIS was not required.

- *Final Programmatic Environmental Assessment for the U.S. Department of Energy, Oak Ridge Operations Implementation of a Comprehensive Management Program for the Storage, Transportation, and Disposition of Potentially Re-Usable Uranium Materials* (DOE 2003c): DOE proposes to implement a comprehensive management program to safely, efficiently, and effectively manage its potentially reusable low-enriched uranium, normal uranium, and depleted uranium. Uranium materials presently located at multiple sites are to be consolidated by transporting the materials to one or several locations to facilitate disposition. Management would include the storage, transport, and ultimate disposition of these materials. This programmatic EA (PEA) addresses the proposed action to implement a long-term (more than 20 years) management plan for DOE's inventory of potentially reusable low-enriched, normal, and depleted uranium. A Finding of No Significant Impact (FONSI) was approved on October 16, 2002.

- *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997): This EIS (referred to herein as the WM PEIS) evaluates the impacts of different approaches to the treatment, storage, and disposal of the existing and projected DOE inventory of certain types of waste management program wastes over the next 20 years. The WM PEIS considers radioactive low-level, high-level, TRU, and mixed wastes, as well as toxic and hazardous wastes. The amounts of wastes analyzed for treatment, storage, or disposal range from thousands to millions of cubic meters and include wastes generated at the DOE sites in Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee. The WM PEIS does not evaluate management of DUF_6 because that material is considered a source material, not a waste. The draft WM PEIS was issued in September 1995, and the final was issued in May 1997.

The WM PEIS considers the impacts of waste management at Paducah, Portsmouth, and the Oak Ridge Reservation (ORR) on the basis of existing and projected inventories of waste generated during site operations. The three sites are also considered as candidate sites for regionalized waste management sites, and waste management impacts are evaluated for these scenarios as well. Cumulative impacts of current operations, waste management, and proposed future operations are also assessed for the three sites in the WM PEIS.

1.8 OTHER DOCUMENTS AND STUDIES RELATED TO DUF_6 MANAGEMENT AND CONVERSION ACTIVITIES

In addition to the related NEPA reviews described in Section 1.7, other reports that relate to managing the DUF_6 inventory (covering conversion, transportation, characterization, and disposal activities) that were completed after the DUF_6 PEIS was published were also reviewed in preparing this EIS. A list of the reports reviewed and used as a part of the preparation for this EIS is provided here.

- *Final Plan for the Conversion of Depleted Uranium Hexafluoride as Required by Public Law 105-204* (DOE 1999b): This report is the final plan for converting DOE's DUF_6 inventory, as required by P.L. 105-204. This Conversion Plan describes the steps that would allow DOE to convert the DUF_6 inventory to a more stable chemical form. It incorporates information received from the private sector in response to DOE's request for expressions of interest; ideas from members of the affected communities, Congress, and other interested stakeholders; and the results of the analyses for the final DUF_6 PEIS. The Conversion Plan describes DOE's intent to chemically process the DUF_6 to create products that would present a lower long-term storage hazard and provide a material suitable for use or disposal.

- *U.S. Department of Energy DUF_6 Materials Use Roadmap* (DOE 2000a): This report meets the commitment presented in the Conversion Plan by providing a comprehensive roadmap that DOE will use to guide any future R&D activities for the materials associated with its DUF_6 inventory. It supports the decision presented in the ROD, namely, to begin conversion of the DUF_6 inventory to uranium oxide, uranium metal, or a combination of both as soon as possible, while allowing for future uses for as much of this inventory as possible. This roadmap is intended to explore potential uses for the DUF_6 conversion products and identify areas where further development is needed. Although it focuses on potential governmental uses of DUF_6 conversion products, it also incorporates a limited analysis of private sector uses. This roadmap also addresses other surplus depleted uranium, primarily in the form of depleted uranium trioxide (UO_3) and depleted UF_4.

- *Depleted Uranium Hexafluoride Management Program: Data Compilation for the Paducah Site in Support of Site-Specific NEPA Requirements for Continued Cylinder Storage, Cylinder Preparation, Conversion, and Long-Term Storage Activities* (Hartmann 1999): This report is a compilation of site-specific data and analyses for the Paducah site that were obtained and conducted to prepare the DUF_6 PEIS. The report describes the affected environment at the Paducah site and summarizes potential environmental impacts that could result from conducting the following DUF_6 activities at the site: continued cylinder storage, preparation of cylinders for shipment, conversion, and long-term storage.

- *Evaluation of UF_6-to-UO_2 Conversion Capability at Commercial Nuclear Fuel Fabrication Facilities* (Ranek and Monette 2001): This report examines the capabilities of existing commercial nuclear fuel fabrication facilities to convert DUF_6 to depleted UO_2. For domestic facilities, the information summarized includes currently operating capacity to convert DUF_6 to UO_2; transportation distances from DUF_6 storage locations near Oak Ridge, Portsmouth, and Paducah to the commercial conversion facilities; and regulatory requirements for nuclear fuel fabrication and transportation of DUF_6. The report concludes that current U.S. commercial nuclear fuel fabricators could convert 5,200 t (5,700 tons) of DUF_6 per year to UO_2 (which includes 666 t [734 tons] of DUF_6 per year of capacity that was scheduled for shutdown by the end of 2001). However, only about 300 t (330 tons) of DUF_6 per year of this capacity could be confirmed as being possibly available to DOE. The report also provides some limited descriptions of the capabilities of foreign fuel fabrication plants to convert DUF_6 to UO_2.

- *Assessment of Preferred Depleted Uranium Disposal Forms* (Croff et al. 2000a): This study assesses the acceptability of various potential depleted uranium conversion products for disposal at likely LLW disposal sites. The objective is to help DOE decide the preferred form for the depleted uranium conversion product and determine a path that will ensure reliable and efficient disposal. The study was conducted under the expectation that if worthwhile beneficial uses could not be found for the converted depleted uranium product, it would be sent to an appropriate site for disposal. The depleted uranium products are considered to be LLW under both DOE orders and NRC regulations. A wide range of issues associated with disposal are discussed in the report. The report concludes that, on balance, the four potential forms of depleted uranium (uranium metal, UF_4, UO_2, and U_3O_8) considered in the study should be acceptable, with proper controls, for near-surface disposal at sites such as NTS and Envirocare.

- *Evaluation of the Acceptability of Potential Depleted Uranium Hexafluoride Conversion Products at the Envirocare Disposal Site* (Croff et al. 2000b): With regard to the Envirocare site, the earlier report (Croff et al. 2000a), concluded that “current waste acceptance criteria suggest that the acceptability of depleted uranium hexafluoride conversion material for disposal at Envirocare of Utah is questionable. Further investigation is required before a definitive determination can be made." The purpose of this report is to document the more thorough investigation suggested in the earlier report. It concludes that an amendment to the Envirocare license issued on October 5, 2000, has reduced the uncertainties associated with disposal of the depleted uranium product at Envirocare to the point that they are now comparable with uncertainties associated with the disposal of the depleted uranium product at NTS that were discussed in the earlier report.

- *Transportation Impact Assessment for Shipment of Uranium Hexafluoride (UF_6) Cylinders from the East Tennessee Technology Park to the Portsmouth and Paducah Gaseous Diffusion Plants* (Biwer et al. 2001): This report presents a transportation impact assessment for shipping the 4,683 full cylinders of DUF_6 (containing a total of approximately 56,000 t [62,000 tons]) stored at ETTP to the Portsmouth and Paducah sites for conversion. It also considers the transport of 2,394 cylinders stored at ETTP that contain a total of 25 t (28 tons) of enriched and normal uranium or that are empty. Shipments by both truck and rail are considered, with and without cylinder overpacks. In addition, the report contains an analysis of the current and pending regulatory requirements applicable to packaging UF_6 for transport by truck or rail, and it evaluates regulatory options for meeting the packaging requirements.

- *Strategy for Characterizing Transuranics and Technetium Contamination in Depleted UF_6 Cylinders* (Hightower et al. 2000): This report summarizes the results of a study performed to develop a strategy for characterizing low levels of radioactive contaminants (Pu, Np, Am, and Tc) in DUF_6 cylinders at the ETTP, Portsmouth, and Paducah sites. The principal conclusion from this review and analysis is that even without additional sampling, the current body of knowledge is sufficient to give potential conversion vendors an adequate basis for designing facilities that can operate safely. The report also provides upper-bound estimates of Pu, Np, and Tc concentrations in DUF_6 cylinders.

- *A Peer Review of the Strategy for Characterizing Transuranics and Technetium Contamination in Depleted Uranium Hexafluoride Tails Cylinders* (Brumburgh et al. 2000): This document provides the findings from a peer review of the ORNL study (Hightower et al. 2000) that set forth a strategy for characterizing low levels of radioactive contaminants in DUF_6 cylinders at the ETTP, Portsmouth, and Paducah sites. This peer review evaluates the ORNL study in three main areas: TRU chemistry/radioactivity, statistical approach, and the uranium enrichment process. It provides both general and specific observations about the general characterization strategy and its recommendations.

1.9 ORGANIZATION OF THIS ENVIRONMENTAL IMPACT STATEMENT

This DUF_6 Conversion EIS consists of two volumes. Volume 1 contains 10 chapters and 8 appendixes. Volume 2 contains the comment response document based on the review of the draft EIS. Brief summaries of the main components of the EIS follow:

Volume 1 — Main Text and Appendixes:

- Chapter 1 introduces the EIS, discussing pertinent background information, the purpose of and need for the DOE action, the scope of the assessment, related NEPA reviews, other related reports and studies, and EIS organization.

- Chapter 2 defines the alternatives and implementation options considered in the EIS, defines alternatives considered but not analyzed in detail, and presents a summary comparison of the estimated environmental impacts.

- Chapter 3 discusses the environmental setting at the Paducah and ETTP sites.

- Chapter 4 addresses the assumptions on which this EIS and its analyses are based, defines the approaches to and methods for environmental impact assessment used in developing this EIS, and presents background information on the human health assessment.

- Chapter 5 discusses the potential environmental impacts of the alternatives. This chapter also discusses potential cumulative impacts at the Paducah site; possible mitigation of adverse impacts that are unavoidable; irreversible commitment of resources; the relationship between short-term use of the environment and long-term productivity; pollution prevention and waste minimization; and impacts from D&D activities.

- Chapter 6 identifies the major laws, regulations, and other requirements applicable to implementing the alternatives.

- Chapter 7 is an alphabetical listing of all the references cited in the EIS. All cited references are available to the public.

- Chapter 8 lists the names, education, and experience of persons who helped prepare the EIS. Also included are the subject areas for which each preparer was responsible.

- Chapter 9 presents brief definitions of the technical terminology used in the EIS.

- Chapter 10 is a subject matter index that provides the numbers of pages where important terms and concepts are discussed.

- Appendix A presents the pertinent text of P.L. 107-206, which mandates the construction of conversion facilities at the Portsmouth and Paducah sites.

- Appendix B discusses issues associated with potential TRU and Tc contamination of a portion of the DUF_6 inventory as well as PCBs contained in some cylinder coatings and describes how such contamination was addressed in this EIS.

- Appendix C summarizes the comments received during public scoping.

- Appendix D contains the environmental synopsis prepared to support the DUF_6 conversion procurement process.

- Appendix E discusses potential uses of HF and CaF_2, the DOE-authorized release process, and impacts associated with sale and use.

- Appendix F describes the assessment methodologies used to evaluate the potential environmental impacts.

- Appendix G contains copies of consultation letters regarding the preparation of this EIS that were sent to state agencies and recognized Native American groups.

- Appendix H contains the contractor disclosure statement.

Volume 2 — Responses to Public Comments:

- Chapter 1 provides an overview of the public participation and comment process.

- Chapter 2 provides copies of the actual letters or other documents that contain comments on the draft EIS to DOE.

- Chapter 3 lists DOE responses to all comments received.

2 DESCRIPTION AND COMPARISON OF ALTERNATIVES

Alternatives for building and operating a DUF_6 conversion facility at the Paducah site were evaluated for their potential impacts on the human and natural environment. This EIS considers the proposed action of building and operating a conversion facility and a no action alternative. Under the proposed action, three action alternatives are considered that focus on where to construct the conversion facility within the Paducah site. An option of shipping cylinders currently stored at ETTP to the Paducah facility is also considered. The no action alternative assumes that a conversion facility is not built at Paducah and that the DUF_6 cylinders at Paducah would continue to be stored indefinitely in a manner consistent with current management practices. This chapter defines these alternatives and options in detail and discusses the types of activities that would be required under each. A summary of the alternatives considered in this EIS is presented in Table 2.1-1.

Alternatives Considered in This EIS

No Action: NEPA regulations require evaluation of a no action alternative. In this EIS, the no action alternative is storage of DUF_6 cylinders indefinitely in yards at the Paducah site, with continued cylinder surveillance and maintenance activities.

Proposed Action: Construction and operation of a DUF_6 conversion facility at the Paducah site for conversion of the Paducah DUF_6 inventory into depleted uranium oxide (primarily U_3O_8) and other conversion products.

Action Alternatives: Three action alternatives focus on where to construct the conversion facility within the Paducah site (Alternative Locations A, B, and C). The preferred alternative is Location A.

A separate EIS prepared for construction and operation of a conversion facility at the Portsmouth site (DOE 2004a) also includes a no action alternative. The no action alternative defined in the Portsmouth EIS includes an evaluation of the potential impacts of indefinite long-term storage of cylinders at the Portsmouth site as well as the continued long-term storage of cylinders at the ETTP site.

In addition to describing the alternatives evaluated in this EIS, this chapter includes a discussion of alternatives considered but not analyzed in detail (Section 2.3) and a summary comparison of the potential environmental impacts from the alternatives (Section 2.4). The comparison of alternatives is based on information about the environmental setting provided in Chapter 3, descriptions of the assessment methodologies provided in Chapter 4, and the detailed assessment results presented in Chapter 5.

No Action Alternative

It is assumed that the DUF_6 cylinders would continue to be stored indefinitely at the Paducah site and that cylinder surveillance and maintenance would also continue. Impacts are evaluated through the year 2039; in addition, potential long-term (after 2039) impacts are evaluated.

2.1 NO ACTION ALTERNATIVE

Under the no action alternative, it is assumed that DUF_6 cylinder storage would

TABLE 2.1-1 Summary of Alternatives Considered

Alternative	Description	Options Considered
No Action (Section 2.1)	Continued storage of the DUF_6 cylinders indefinitely at the Paducah site, with continued cylinder surveillance and maintenance.	None.
Proposed Action (Section 2.2)	Construction and operation of a conversion facility at the Paducah site for conversion of the Paducah DUF_6 inventory into depleted uranium oxide (primarily U_3O_8) and other conversion products. This EIS assesses the potential environmental impacts from the following proposed activities: • Construction, operation, maintenance, and D&D of the proposed DUF_6 conversion facility at the Paducah site; • Conversion to depleted U_3O_8 based on the proposed UDS technology; • Transportation of uranium conversion products and waste materials to a disposal facility; • Transportation and sale of the HF conversion product; and • Neutralization of HF to CaF_2 and its sale or disposal in the event that the HF product is not sold.	*ETTP Cylinders:* This EIS considers an option of shipping DUF_6 and non-DUF_6 cylinders at ETTP to Paducah. *Transportation:* This EIS evaluates the shipment of cylinders and conversion products by both truck and rail. *Expanded Operations:* This EIS discusses the impacts associated with potential expansion of plant operations by extending the operational period and by increasing throughput through efficiency improvements.
Alternative Location A (Preferred) (Section 2.2.1.1)	Construction of the conversion facility at Location A, an area that encompasses 35 acres (14 ha) located south of the administration building and its parking lot, immediately west of and next to the primary location of the DOE cylinder yards and east of the main plant access road.	
Alternative Location B (Section 2.2.1.2)	Construction of the conversion facility at Location B, an area that encompasses 59 acres (23 ha) directly south of the Paducah maintenance building and west of the main plant access road.	
Alternative Location C (Section 2.2.1.3)	Construction of the conversion facility at Location C, an area that encompasses 53 acres (21 ha) east of the Paducah pump house and cooling towers.	

continue indefinitely at the Paducah site. The no action alternative assumes that DOE would continue surveillance and maintenance activities to ensure the continued safe storage of cylinders. Potential environmental impacts are estimated through the year 2039. The year 2039 was selected to be consistent with the DUF_6 PEIS (DOE 1999a), which evaluated a 40-year storage period (1999 through 2039). In addition, long-term impacts (i.e., occurring after 2039) from potential cylinder breaches are assessed. A similarly defined no action alternative was also evaluated in the DUF_6 PEIS. The assessment of the no action alternative in this EIS has been updated to reflect changes that have occurred since publication of the DUF_6 PEIS in 1999. Details are provided below.

Specifically, the activities assumed to occur include routine cylinder inspections, ultrasonic testing of the wall thicknesses of selected cylinders, painting of cylinders to prevent corrosion, cylinder yard surveillance and maintenance, reconstruction of several storage yards, and relocation of some cylinders to the new or improved yards. It is assumed that cylinders would be painted every 10 years. On the basis of these activities, an assessment of the potential impacts on workers, members of the public, and the environment was conducted.

Breached cylinders are cylinders that have a hole of any size at some location on the wall. The occurrence of cylinder breaches, caused by either corrosion or handling damage, is an important concern when the potential impacts of continued cylinder storage are evaluated. There is a general concern that the number of cylinder breaches at the site could increase in the future as the cylinder inventory ages.

At the time the PEIS was published (1999), 8 breached cylinders had been identified at the three storage sites; 1 of those breaches was at the Paducah site.[1] Investigation of these breaches indicated that 6 of the 8 were initiated by mechanical damage during stacking; the damage was not noticed immediately, and subsequent corrosion occurred at the damaged point. It was concluded that the other 2 cylinder breaches, both at ETTP, had been caused by external corrosion due to prolonged ground contact.

For assessment purposes in this EIS, two cylinder breach cases are evaluated. In the first case, it is assumed that the planned cylinder maintenance and painting program would maintain the cylinders in a protected condition and control further corrosion. In this case, it is assumed that after initial painting, some cylinder breaches would occur from handling damage; a total of 36 future breaches are estimated to occur through 2039. In the second case, it is assumed that external corrosion would not be halted by improved storage conditions, cylinder maintenance, and painting. This case is considered in order to account for uncertainties with regard to how effective painting would be in controlling cylinder corrosion and uncertainties in the future painting schedule. In this case, the number of future breaches estimated through 2039 is 444 for the Paducah site (i.e., 11 per year). These breach estimates were determined on the basis of historical corrosion rates when cylinders were stored under poor conditions (i.e., cylinders were

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1 An additional breach that occurred at the ETTP site in 1998 was discussed in Section B.2 of the PEIS (DOE 1999a). In the period 1998 through 2002, two additional breaches were discovered at the Paducah site, the result of missing cylinder plugs (Hightower 2002). A total of 11 breaches have been identified at the Portsmouth, ETTP, and Paducah sites.

stacked too close together, were stacked on wooden chocks, or came in contact with the ground). Because storage conditions have improved dramatically over the last several years as a result of cylinder yard upgrades and restacking activities, it is expected that these breach estimates based on the historical corrosion rate provide a worst case for estimating the potential impacts from continued cylinder storage. The results of this assessment were used to provide an estimate of the earliest time when continued cylinder storage could begin to raise regulatory concerns under these worst-case conditions.

The impacts to human health and safety, surface water, groundwater, soil, air quality, and ecology from uranium and HF releases from breached cylinders are assessed in this EIS. For all hypothetical cylinder breaches, it is assumed that the breach would be undetected for 4 years, which is the period between planned inspections for most of the cylinders. In practice, cylinders that show evidence of damage or heavy external corrosion are inspected annually, so it is very unlikely that a breach would be undetected for a 4-year period. For each hypothetical cylinder breach, it is further assumed that 1 lb (0.45 kg) of uranium (as UO_2F_2) and 4.4 lb (2 kg) of HF would be released from the cylinder annually for a period of 4 years.

The estimated number of future breaches at the Paducah site was used to estimate potential impacts that might occur during the repair of breached cylinders and impacts from releases that might occur during continued cylinder storage. Potential radiological exposures of involved workers could result from patching breached cylinders or emptying the cylinder contents into new cylinders. The impacts on groundwater and human health and safety from uranium releases were assessed by estimating the amount of uranium that could be transported from the yards in surface runoff and the amount that could migrate through the soil to the groundwater.

For this EIS, a reassessment of the no action alternative assumptions used in the PEIS was conducted. Recent cylinder surveillance and maintenance plans — including inspections, painting, and reconstruction of cylinder storage areas — were used to update the PEIS no action alternative assessments. The results of this reevaluation, together with a consideration of the changes in the on-site worker and off-site public populations at Paducah, were used to determine the impacts from the no action alternative. Additional discussion and the estimated impacts from the no action alternative are presented in Section 5.1.

2.2 PROPOSED ACTION

The proposed action evaluated in this EIS is to construct and operate a conversion facility at the Paducah site for converting the DUF_6 inventory stored at Paducah into depleted uranium oxide (primarily U_3O_8) and other conversion products. Three locations within the Paducah site are evaluated as alternatives (Section 2.2.1). The conversion facility would convert DUF_6 into a stable

Proposed Action

The proposed action in this EIS is construction and operation of a conversion facility at the Paducah site for conversion of the Paducah DUF_6 inventory into depleted uranium oxide (primarily U_3O_8) and other conversion products. Three alternative locations within the Paducah site are evaluated (Locations A, B, and C).

chemical form for beneficial use/reuse and/or disposal. The off-gas from the conversion process would yield aqueous HF, which would be processed and marketed or converted to a solid for sale or disposal. To support the conversion operations, the emptied DUF_6 cylinders would be stored, handled, and processed for reuse as disposal containers to the extent practicable. The time period considered is a construction period of approximately 2 years, an operational period of 25 years, and a 3-year period for the D&D of the facility. Current plans call for construction to begin in the summer of 2004. The assessment is based on the conceptual conversion facility design proposed by UDS, the selected contractor (see text box).

Conversion Facility Design

The EIS is based on the conversion facility design being developed by UDS, the selected conversion contractor. At the time the draft EIS was prepared, the UDS design was in the 30% conceptual stage, with several facility design options being considered.

Following the public comment period, the draft EIS was revised on the basis of comments received and on the basis of the 100% conceptual facility design. This final EIS identifies and evaluates design options to the extent possible.

This EIS assesses the potential environmental impacts from the following proposed activities:

- Construction, operation, maintenance, and D&D of the proposed DUF_6 conversion facility at the Paducah site;
- Transportation of uranium conversion products and waste materials to a disposal facility;
- Transportation and sale of the HF conversion product; and
- Neutralization of HF to CaF_2 and its sale or disposal in the event that the HF product is not sold.

In addition, an option of expanding operations by extending conversion facility operations or increasing throughput is discussed in this section.

2.2.1 Action Alternatives

The action alternatives focus on where to site the conversion facility within the Paducah site. The Paducah site was evaluated to identify alternative facility locations for a conversion facility (Shaw 2001). Potential locations were evaluated on the basis of the following criteria:

- *Current condition of the land and site preparation required*. This criterion looked at the condition of the land from a constructability viewpoint, considering factors that would increase the construction cost over that needed for a relatively level grassy topography.

- *Legacy environmental concerns*. This criterion looked at environmental factors that would affect construction at the site.

- *Availability of utilities.* This criterion looked at the relative difficulty of bringing services from existing plant utilities to the site.

- *Location*. This criterion looked at the advantages and disadvantages of location in relation to cylinder transport between the yards and the new facility.

- *Effect on current plant operations*. This criterion looked at how the conversion facility's location could affect existing plant operations.

- *Size*. This criterion looked at size to ensure that the required minimum amount of land would be available for construction of the conversion facility (assumed to be about 30 acres [12 ha]).

The three alternative locations identified at the Paducah site, denoted Locations A, B, and C, are shown in Figure 2.2-1.

2.2.1.1 Alternative Location A (Preferred Alternative)

Location A is the preferred location for the conversion facility. It is located south of the administration building and its parking lot, immediately west of and next to the primary location of the DOE cylinder yards and east of the main plant access road. This location is an L-shaped tract consisting mostly of grassy field. However, the southeastern section is a wooded area. A drainage ditch crosses the northern part of the site, giving the cylinder yard storm water access to Kentucky Pollution Discharge Elimination System (KPDES) Outfall 017. This location is about 35 acres (14 ha) in size and was identified in the RFP for conversion services as the site for which bidders were to design their proposed facilities.

2.2.1.2 Alternative Location B

Location B is directly south of the Paducah maintenance building and west of the main plant access road. The northern part of this location is mowed grass and has a slightly rolling topography. The southern part has a dense covering of trees and brush, and some high-voltage power lines cross it, which limits its use. This location has an area of about 59 acres (23 ha).

2.2.1.3 Alternative Location C

Location C is east of the Paducah pump house and cooling towers. It has an area of about 53 acres (21 ha). Dykes Road runs through the center of this location from north to south. Use of the eastern half of this location could be somewhat limited because several high-voltage power lines run through this area.

2.2.2 Conversion Process Description

This section provides a summary description of the proposed UDS conversion process and facility. The proposed UDS conversion system is based on a proven commercial process in operation at the Framatome Advanced Nuclear Power (ANP), Inc., fuel fabrication facility in Richland, Washington. The two primary sources for the information in this section are excerpts from the UDS conversion facility conceptual design report (UDS 2003a) and the UDS NEPA data package prepared for the 100% conceptual facility design (UDS 2003b).

The UDS dry conversion is a continuous process in which DUF_6 is vaporized and converted to a mixture of uranium oxides (primarily U_3O_8) by reaction with steam and hydrogen in a fluidized-bed conversion unit. The resulting depleted U_3O_8 powder is collected and packaged for disposition. The process equipment would be arranged in parallel lines. Each line would consist of two autoclaves, two conversion units, an HF recovery system, and process off-gas scrubbers. The Paducah facility would have four parallel conversion lines. Equipment would also be installed to collect the HF co-product and process it into any combination of several marketable products. A backup HF acid neutralization system would be provided to convert up to 100% of the HF acid to CaF_2 for storage, sale, or disposal in the future, if necessary. Figure 2.2-2 is an overall material flow diagram for the conversion facility; Figure 2.2-3 is a conceptual facility site plan. A summary of key facility characteristics is presented in Table 2.2-1.

The conversion facility will be designed to convert 18,000 t (20,000 tons) of DUF_6 per year, requiring 25 years to convert the Paducah inventory. The Paducah processing facility would be approximately 148 ft × 271 ft (45 m × 83 m). The conversion facility would occupy a total of approximately 10 acres (4 ha), with up to 45 acres (18 ha) of land disturbed during construction (including temporary construction lay-down areas and utility access). Some of the disturbed areas would be areas cleared for railroad or utility access, not adjacent to the construction area.

DUF_6 cylinders would be delivered from long-term storage to the cylinder staging yard at the conversion facility by means of cylinder handling equipment already available at the site. The staging yard would accommodate short-term storage of cylinders. Cylinders in the conversion staging yard would be transferred into the conversion building airlock by using an overhead bridge crane. The cylinders would then be moved into the vaporization room to the autoclaves by an overhead monorail crane and/or rail cart. The cylinders would be loaded into autoclaves for heating and transfer of the DUF_6 to the conversion units.

Cylinders that could not be processed through the normal process feed system would be processed through the cylinder transfer facility. If the cylinder was overfilled, the excess DUF_6 would be transferred to another cylinder. This same system would be used to transfer all of the

TABLE 2.2-1 Summary of Paducah Conversion Facility Parameters

Parameter/Characteristic	Value
Construction start	2004
Construction period	2 years
Start of operations	2006
Operational period	25 years
Facility footprint	10 acres (4 ha)
Facility throughput	18,000 t/yr (20,000 tons/yr) DUF_6 (≈1,400 cylinders/yr)
Conversion products	
Depleted U_3O_8	14,300 t/yr (15,800 tons/yr)
CaF_2	24 t/yr (26 tons/yr)
70% HF acid	3,300 t/yr (3,600 tons/yr)
49% HF acid	7,700 t/yr (8,500 tons/yr)
Steel (emptied cylinders, if not used as disposal containers)	1,980 t/yr (2,200 tons/yr)
Proposed conversion product disposition (see Table 2.2-2 for details)	
Depleted U_3O_8	Disposal; Envirocare (primary), NTS (secondary)[a]
CaF_2	Disposal; Envirocare (primary), NTS (secondary)
70% HF acid	Sale pending DOE approval
49% HF acid	Sale pending DOE approval
Steel (emptied cylinders, if not used as disposal containers)	Disposal; Envirocare (primary), NTS (secondary)

[a] DOE plans to decide the specific disposal location(s) for the depleted U_3O_8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

Sources: UDS (2003a,b).

contents from unacceptable cylinders to cylinders suitable for feeding into the conversion process.

After the emptied cylinder was removed from the autoclave, a stabilizing agent would be introduced into the cylinder to neutralize residual fluoride in the heel. The cylinders would then be moved out to the staging yard for an approximate 4-month aging period so that short-lived uranium decay products in the nonvolatile heel would decay, thereby reducing potential radiation exposure during the processing of emptied cylinders. Emptied cylinders would then be reused as disposal containers or processed and disposed of as LLW.

Major conversion system components are described further in the following subsections. The plant design includes several other supporting facilities and services, including an electrical system with backup, a communications system, a deionized water system, a control system, an air supply system, a fire protection system, and a heating, ventilation, and air-conditioning system.

2.2.2.1 Cylinder Transfer System

Some cylinders might be unacceptable for processing in the vaporization system autoclaves because of corrosion, damage, overfilling, or excessive size. A cylinder transfer system would be used to transfer the contents of up to four unacceptable cylinders per week to acceptable cylinders. Cylinder transfer system equipment would include two low-temperature autoclaves, four fill positions, a "hot box" containing controls and vacuum pumps, and an oversize cylinder heating room. Fill positions would include a water spray cooling system necessary for low-temperature DUF_6 transfer. The oversize cylinder heating room would contain radiant heating enclosure controls and connections.

2.2.2.2 Vaporization System

Cylinders that met the vaporization criteria would be brought to the vaporization room and loaded into electrically heated autoclaves. Autoclaves for each process line would be used to provide continuous feed to the DUF_6 conversion units. The cylinders would be heated to feed DUF_6 vapor to the process. The design will incorporate in-line filters to provide additional assurances that TRU isotopes would not enter the conversion system. The need for in-line filters would be evaluated during operations; they would be removed if they were not needed.

The DUF_6 vapor would flow through a heated enclosure called a "hot box," which would contain the equipment that would control flow to the conversion units, including vacuum pumps. The hot box would have the necessary controls to achieve stable DUF_6 flow to the conversion units.

The autoclaves would be used to heat DUF_6 cylinder by using internal electrical heating and to provide secondary DUF_6 containment. The selected autoclaves would be American Society of Mechanical Engineers standard pressure vessels, sufficiently designed to provide containment of DUF_6 and HF from a full, DUF_6 cylinder that had ruptured. Each autoclave system would include equipment and controls to connect to the cylinder, control DUF_6 flow, monitor DUF_6 weight, and control vaporization conditions.

Electrically heated autoclaves would provide a safety advantage over steam-heated units. If DUF_6 leaks in a steam autoclave, it reacts with the steam and generates HF gas, which pressurizes the autoclave and is extremely corrosive. If DUF_6 leaks in an electrically heated autoclave, however, the only moisture available is the humidity in the air, which limits HF generation and subsequent pressurization and corrosion. This also makes cleanup of the autoclave much easier since the autoclave is evacuated directly to the conversion unit and does not produce wet uranium recycle and liquid wastes.

2.2.2.3 Conversion System

DUF_6 vapor would be reacted with steam and hydrogen in fluidized-bed conversion units. The hydrogen would be generated by using anhydrous ammonia (NH_3). Nitrogen is also used as an inert purging gas and is released to the atmosphere through the building stack as part of the clean off-gas stream. The oxide powder would be retained in the conversion unit by passing the process off-gas through sintered metal filters. Uranium oxide powder would be continuously withdrawn from the conversion unit to match the feed rate of DUF_6. Each conversion unit would be electrically heated and integrated with a heating/insulation jacket.

All equipment components (vessels, filters, etc.) in the conversion system would be fabricated of corrosion-resistant alloys suited to process conditions. In the event of a system failure or an unscheduled shutdown, the DUF_6 shutoff valve in the autoclave would automatically close. The DUF_6 piping would then be purged with nitrogen. In the event of power, instrument, air, or other failure, a fail-safe design would be used for valves and for the control system.

2.2.2.4 Depleted Uranium Conversion Product Handling System

Depleted U_3O_8 powder would be cooled as it was discharged from the conversion unit. An in-line water-cooled heat exchanger would cool the powder before it dropped into a vacuum transfer station enclosure. The vacuum transfer station would include connections, a vacuum transfer pickup device, a support vessel, a hopper, and a secondary enclosure to facilitate packaging the depleted U_3O_8. A package fill station would be located below each hopper. Powder fill would be controlled by weight in the fill container, and a secondary containment enclosure would be provided at the fill station. The filled packages would be lifted and conveyed by using an overhead monorail crane through an airlock and loaded into railcars for shipment to the disposal site. Each packaging station would operate on a semicontinuous basis with intermittent package removal and installation. Continuous level control would maintain the oxide hopper at 20% to 25% of capacity. Prior to package change out, the oxide discharge would be stopped.

UDS proposes to use the emptied cylinders as disposal containers to the extent practicable. An option of using bulk bags (large capacity, strong, flexible bags) as disposal containers is also being considered. After being processed (see Section 2.2.2.6), the emptied cylinders would be moved to the conversion product transfer station and refilled with depleted U_3O_8 powder. The refilled cylinders would be sealed and loaded to railcars for shipment to the disposal site. Bulk bags would be processed similarly.

The conversion facilities are being designed with a short-term storage capacity for 6 months' worth of depleted uranium conversion products. This storage capacity is being provided in order to accommodate potential delays in disposal activities without affecting conversion operations. If a delay was to extend beyond 6 months, DOE would evaluate possible options and conduct appropriate NEPA review for those options.

2.2.2.5 HF Recovery System

The fluorine component of the DUF_6 would leave the conversion unit as HF gas through sintered metal filters that would retain nearly all (greater than 99.9%) of the uranium in the conversion unit. The HF would be condensed, along with the unreacted excess steam, and the resulting HF acid would flow by gravity to receiver tanks. In addition, the off-gas would be passed through a series of two scrubbers to recover most of the uncondensed HF. In each scrubber, process off-gas would come into contact with 20% potassium hydroxide (KOH) solution. HF vapor would combine with KOH in the solution to form potassium fluoride (KF) and water (H_2O); thus HF would be removed from the process off-gas stream.

The HF acid would be automatically transferred from the receivers to interim bulk storage tanks located outside the building. An in-line uranium analyzer in each transfer line would be used as a final verification that containment of the uranium is intact. High-integrity piping and equipment made with corrosion-resistant materials would result in zero leakage of HF, either gaseous or liquid, to the environment. The HF would be stored on site at each conversion facility for approximately 2 weeks or less under normal conditions and then shipped to a vendor. The storage capacity for HF at each site would be limited, and if the material could not be moved, it would be converted to CaF_2 or processing would stop.

2.2.2.6 Emptied Cylinder Processing

UDS proposes to use the emptied cylinders as disposal containers to the extent practicable. After removal of the cylinders from the autoclaves, a stabilizing agent would be introduced to the cylinders to neutralize residual fluoride in the heels. After an approximate 4-month aging period, emptied cylinders (with heel) would be transferred to the conversion product transfer stations, as described above. Alternatively, if bulk bags were used for depleted U_3O_8 disposal containers, after an approximate 4-month aging period, emptied cylinders (with heel) would be transported into the cylinder disposition facility. A forklift would be used to move the cylinders to the feed queue outside the facility airlock. Cylinders would then be brought into the disposition facility via an overhead monorail crane and placed into a compactor feed station. The plugs would be removed from the cylinder to vent the cylinder during crushing. The cylinder would then be pushed by a ram into the compactor itself, where it would be compacted radially to a maximum thickness of 8 in. (20 cm). The compacted cylinder would then be pushed to the cutting station, where it would be cut in half to reduce the length. The two pieces of metal would be picked up with an overhead crane and placed into an intermodal shipping container. Debris from these operations would then be collected in a container by a vacuum system and loaded into the intermodal container.

Secondary containment would be provided for the intermodal container loadout. In addition, small cylinders that had not been compacted, as well as valves, plugs, and facility secondary waste, might also be loaded into the intermodal containers. Cylinders that were destined for disposal at NTS would not be introduced into the facility but would instead be loaded directly onto trucks or railcars for transport.

2.2.2.7 Management of Potential Transuranic and PCB Contamination

As discussed in Section 1.2.2, as a result of enrichment of reprocessed uranium in the early years of gaseous diffusion, some of the DUF_6 inventory is contaminated with small amounts of Tc and the TRU elements Pu, Np, and Am. In addition, a portion of the cylinder inventory was originally painted with coatings containing PCBs.

TRU contamination in the cylinders would exist as fluoride compounds that would be both insoluble in liquid DUF_6 and nonvolatile but capable of being entrained from the cylinders during the vaporization and feeding of DUF_6 into the conversion process. The TRU contamination would exist primarily as (1) small particulates dispersed throughout the DUF_6 contents and (2) small quantities in the residual heels from the original feed cylinders in a relatively small but unknown number of cylinders (see Appendix B for more details). Tc contamination would exist as fluoride and oxyfluoride compounds that would be stable and partially volatile, and the contamination would be present both uniformly dispersed throughout the DUF_6 and in the heel material referred to previously.

The TRU contaminants that are dispersed throughout the DUF_6 might be entrained in the gaseous DUF_6 during the cylinder emptying operations and carried out of the cylinders. These contaminants could be captured in filters between the cylinders and the conversion units. These filters would be monitored and changed out periodically to prevent buildup of TRU. They would be disposed of as LLW.

It is also expected that the nonvolatile forms of Tc that exist in the cylinders would remain in the heels or be captured in the filters. However, because of the existence of some volatile technetium fluoride compounds, and for the purposes of analyses in this EIS, it is assumed that all of the Tc dispersed in the DUF_6 would volatilize with DUF_6 and be carried into the conversion process equipment. Any Tc compounds transferred into the conversion units would be oxidized along with the DUF_6. For this EIS, it is also assumed that the Tc in the form of oxides would partition into the U_3O_8 and HF products in the same ratio as the uranium. It is assumed that Tc left in the heels from the original feedstock would remain behind after the DUF_6 was vaporized.

If bulk bags were used for depleted U_3O_8 disposal, the emptied cylinders would be processed as described in Section 2.2.2.6. The emptied cylinders would be surveyed by using nondestructive assay techniques to determine the presence of a significant quantity of TRU isotopes. If TRU isotopes were detected, samples would be taken and analyzed. Cylinders that exceeded the disposal site limits at the Envirocare of Utah, Inc., facility would be treated to immobilize the heel (e.g., with grout) within the cylinder, compacted, and sectioned; then the cylinder/heel waste stream would be sent to NTS and disposed of as LLW.

As noted in Section 1.2.2, the paints applied to some cylinders prior to 1978 included PCBs, which were typically added as a fungicide and to increase durability and flexibility. Records of the PCB concentrations in the paints used were not kept, so it is currently unknown how many cylinders are coated with paint containing PCBs. However, paint chips from a representative sample of cylinders at the ETTP site have been analyzed for PCBs. The results indicate that up to 50% of the cylinders at ETTP may have coatings containing PCBs. Because the Portsmouth and Paducah inventories contain a large number of cylinders produced before 1978, it is reasonable to assume that a significant number of cylinders at those sites also are coated with paint containing PCBs.

For each of the three storage sites, the PCBs in cylinder paints constitute an extremely small proportion of the PCBs that were previously and are currently at the sites. For example, although the Paducah site has been working for several years to dispose of PCB-containing equipment, the site still had about 870 liquid PCB-containing items (mostly capacitors) in service at the end of 2001. The Portsmouth and ETTP sites also still have a large number of liquid PCB-containing items in service. The three sites are suspected to have had spills of PCB liquids during past operations, prior to the identification of the health and environmental hazards of PCBs.

Each of the three current DUF_6 cylinder storage sites has an existing program for managing PCB-contaminated waste under the TSCA. In addition, the environmental monitoring program at each site includes monitoring of PCB concentrations in soil, sediment, groundwater, surface water, and biota on and in the vicinity of the sites (see Sections 3.1 and 3.2). These programs would be expected to continue throughout cylinder management activities.

Under the proposed action, storage, conversion, transportation, and disposal operations will comply with applicable TSCA regulations. Additional details are provided in Appendix B.

2.2.3 Conversion Product Disposition

The conversion process would generate four conversion products that have a potential use or reuse: depleted U_3O_8, HF, CaF_2, and steel from emptied DUF_6 cylinders (if not used as disposal containers). DOE has been working with industrial and academic researchers for several years to identify potential uses for these products. Some potential uses for depleted uranium exist or are being developed, and DOE believes that a viable market exists for the HF generated during conversion. To take advantage of these to the extent possible, DOE requested in the RFP that the bidders for conversion services investigate and propose viable uses. The probable disposition paths identified by UDS for each of the conversion products are summarized in Table 2.2-2 (UDS 2003b).

According to UDS, of the four conversion products, only HF has a viable commercial market currently interested in the product. Therefore, UDS expects that the HF would be sold to a commercial vendor pending DOE approval of the residual contamination limits and the sale. Commercial-grade HF produced at the Framatome ANP, Inc. (a UDS partner), facility in Richland, Washington, is currently sold commercially under an NRC-approved license. UDS is currently working with DOE through a formal process to evaluate and establish authorized release limits for the HF. Details on this process and on HF sale and use are provided in Appendix E. Should the release of the HF not be allowed, it would be neutralized to CaF_2 for sale or disposal, creating about 2 t (2.2 tons) per 1 t (1.1 ton) of HF. UDS will seek to obtain DOE approval to sell this material as well. However, the market is not as strong as that for the HF; thus, the CaF_2 produced during normal operations might become waste.

TABLE 2.2-2 Summary of Proposed Conversion Product Treatment and Disposition

Conversion Product	Packaging/Storage	Proposed Disposition	Optional Disposition
Depleted U_3O_8	U_3O_8 would be loaded into emptied cylinders, which would be loaded onto railcars. An option of using bulk bags as disposal containers is also considered.	Disposal at Envirocare of Utah, Inc.[a]	Disposal at NTS.[a]
CaF_2	Packaged for sale or disposal.	Commercial sale pending DOE approval of authorized release limits, as appropriate.	Disposal at Envirocare of Utah, Inc.[a]
HF acid (49% and 70%)	HF produced by the dry conversion facility would be commercial grade. HF would be stored on site until loaded into rail tank cars.	Sale to commercial HF acid supplier pending DOE approval of authorized release limits, as appropriate.	Neutralization of HF to CaF_2 for use or disposal.
Steel (empty cylinders)	Emptied cylinders would be reused as disposal containers to the extent practicable. If bulk bags were used, emptied cylinders would have a stabilizing agent added to neutralize residual fluorine, be stored for 4 months, crushed to reduce the size, sectioned, and packaged in intermodal containers.	Disposal at Envirocare of Utah, Inc.[a]	Disposal at NTS.[a]

[a] DOE plans to decide the specific disposal location(s) for the depleted U_3O_8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

Although the depleted U_3O_8 and emptied cylinders have the potential for use or reuse, currently none of the uses have been shown to be viable because of cost, perception, feasibility, or the need for additional study. Thus, UDS expects that most, if not all, of the uranium oxide and emptied cylinders would require disposal. These materials would be processed and maybe shipped to Envirocare for disposal, as summarized in Table 2.2-2.

The EIS evaluation of conversion product disposition considers:

- Transportation of the uranium oxide conversion product and emptied cylinders by truck and rail to both Envirocare (proposed) and NTS (option) for disposal. DOE plans to decide the specific disposal location(s) for the depleted U_3O_8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

- Transportation and sale of the HF conversion product, and
- Neutralization of HF to CaF_2 and its sale or disposal in the event that the HF product is not sold.

Because specific destinations are unknown at this time, impacts from the shipment of HF and CaF_2 for use are based on a range of representative route distances. Additional details concerning the transportation assessment are provided in Appendix F, Section F.3.

2.2.4 Option of Shipping ETTP Cylinders to Paducah

DOE proposes to ship the DUF_6 and non-DUF_6 cylinders at ETTP to Portsmouth. However, this EIS considers an option of sending the ETTP cylinders to Paducah. If the ETTP DUF_6 cylinders were converted at Paducah, the Paducah facility would have to operate an additional 3 years, resulting in a total operational period of 28 years. For this option, this EIS evaluates the preparation of DUF_6 and non-DUF_6 cylinders at ETTP and the transportation of those cylinders to Paducah by several different methods, as described below.

All shipments of ETTP cylinders would have to be made consistent with DOT regulations for the shipment of radioactive materials as specified in Title 49 of the CFR (see text box and Chapter 6). The cylinders could be shipped by truck or rail.

The majority of DUF_6 cylinders were designed, built, tested, and certified to meet the

Transportation Requirements for DUF_6 Cylinders

All shipments of UF_6 cylinders have to be made in accordance with applicable DOT regulations for the shipment of radioactive materials; specifically, the provisions of 49 CFR Part 173, Subpart I. The DOT regulations require that each UF_6 cylinder be designed, fabricated, inspected, tested, and marked in accordance with the various engineering standards that were in effect at the time the cylinder was manufactured. The DOT requirements are intended to maintain the safety of shipments during both routine and accident conditions. The following provisions are particularly important relative to DUF_6 cylinder shipments:

1. A cylinder must be filled to less than 62% of the certified volumetric capacity (the fill limit was reduced from 64% to 62% in about 1987).
2. The pressure within a cylinder must be less than 14.8 psia (subatmospheric pressure).
3. A cylinder must be free of cracks, excessive distortion, bent or broken valves or plugs, and broken or torn stiffening rings or skirts, and it must not have a shell thickness that has decreased below a specified minimum value. (Shell thicknesses are assessed visually by a code vessel inspector, and ultrasonic testing may be specified at the discretion of the inspector to verify wall thickness, when and in areas the inspector deems necessary.)
4. A cylinder must be designed so that it will withstand (1) a hydraulic test at an internal pressure of at least 1.4 megapascals (200 psi) without leakage; (2) a free drop test onto a flat, horizontal surface from a height of 1 ft (0.3 m) to 4 ft (1.2 m), depending on the cylinder's mass, without loss or dispersal; and (3) a 30-minute thermal test equivalent to being engulfed in a hydrocarbon fuel/air fire having an average temperature of at least 800°C (1,475°F) without rupture of the containment system.

DOT requirements. The DOT requirements are intended to maintain the safety of shipments during both routine and accident conditions. A summary of the applicable transportation regulations for shipment of UF_6 is provided in Chapter 6 of this EIS; a detailed discussion of pertinent transportation regulations is presented in Biwer et al. (2001). Cylinders meeting the DOT requirements could be loaded directly onto specially designed truck trailers or railcars for shipment. However, after several decades in storage, some cylinders have physically deteriorated such that they no longer meet the DOT requirements.

It is unknown exactly how many DUF_6 cylinders do not meet DOT transportation requirements. As discussed in Section 1.7, it is estimated that up to 1,700 cylinders are DOT compliant, with the remainder not meeting the DOT requirements. Problems are related to the following DOT requirements that must be satisfied before shipment: (1) documentation must be available showing that each cylinder was properly designed, fabricated, inspected, and tested prior to being filled; (2) cylinders must be filled to less than 62% of the maximum capacity; (3) the pressure within cylinders must be less than atmospheric pressure; (4) cylinders must not leak or be damaged so they are unsafe; and (5) cylinders must have a specified minimum wall thickness. Cylinders not meeting these requirements are referred to as “noncompliant.” Some cylinders might fail to meet more than one requirement.

Three options exist for shipping noncompliant cylinders (Biwer et al. 2001):

1. The DUF_6 contents could be transferred from noncompliant cylinders into new or compliant cylinders.

2. An exemption could be obtained from DOT that would allow the DUF_6 cylinder to be transported either “as is” or following repairs. The primary finding that DOT would have to make to justify granting an exemption is this: the proposed alternative would have to achieve a safety level that would be at least equal to the level required by the otherwise applicable regulation or, if the otherwise applicable regulation did not establish a required safety level, would be consistent with the public interest and adequately protect against the risks to life and property that are inherent when transporting hazardous materials in commerce.

3. Noncompliant cylinders could be shipped in a protective overpack. In this case, the shipper would have to obtain an exemption from DOT that would allow the existing cylinder, regardless of its condition, to be transported if it was placed in an overpack. The overpack would have to be specially designed. Furthermore, DOT would have to determine that, if the overpack was fabricated, inspected, and marked according to its design, the resulting packaging (including the cylinder and the overpack) would have a safety level at least equal to the level required for a new UF_6 cylinder.

Before shipment, each cylinder would be inspected to determine if it met DOT requirements. This inspection would include a record review to determine if the cylinder was overfilled; a visual inspection for damage or defects; a pressure check to determine if the cylinder was overpressurized; and an ultrasonic wall thickness measurement (based on a visual inspection, if necessary). If a cylinder passed the inspection, the appropriate documentation would be prepared, and the cylinder would be loaded directly for shipment. The preparation of compliant cylinders (cylinders that meet DOT requirements) would include inspection activities, unstacking, on-site transfer, and loading onto a truck trailer or railcar. The cylinders would be secured by using the appropriate tiedowns, and the shipment would be labeled in accordance with DOT requirements. Handling and support equipment and the procedures for on-site movement and for loading the cylinders would be of the same type currently used for cylinder management activities at the storage sites.

This EIS considers three options for shipping noncompliant cylinders from ETTP. The information on these activities is based on preconceptual design data provided in the Engineering Analysis Report (Dubrin et al. 1997) prepared for the PEIS and the analysis of potential environmental impacts presented in Appendix E of the DUF_6 PEIS (DOE 1999a).

An overpack is a container into which a cylinder is placed for shipment. The overpack would be designed, tested, and certified to meet all DOT shipping requirements. It would be suitable for containing, transporting, and storing the cylinder contents regardless of cylinder condition. For transportation, a noncompliant cylinder would be placed into an overpack that was already on a truck trailer or railcar. The overpack would be closed and secured, and the shipment would be labeled in accordance with DOT requirements. The overpacks could be reused following shipment. If a decision were made to construct a transfer facility at ETTP, additional NEPA review would be conducted.

The second cylinder preparation option for transporting noncompliant cylinders considered in this EIS is the transfer of the DUF_6 from substandard cylinders to new or used cylinders that would meet all DOT requirements. This option could require the construction of a new cylinder transfer facility, for which there are no current plans. Following transfer of the DUF_6, the compliant cylinders could be shipped by placing them directly onto appropriate trucks or railcars.

The third option is to ship the cylinders “as-is” under a DOT exemption. As discussed above, for this to occur, it must be demonstrated that the cylinders would be shipped in a manner achieving a level of safety that would be at least equal to the level required by the regulations, which would likely require some compensatory measures.

In this EIS, transportation impacts are estimated for shipment by either truck or rail after cylinder preparation. The impacts are assessed by determining truck and rail routes between ETTP and the Paducah site.

2.2.5 Option of Expanding Conversion Facility Operations

The conversion facility at Paducah is currently being designed to process the DOE DUF_6 cylinder inventory at the site over 25 years by using four process lines. There are no current plans to operate the conversion facility beyond this time period or to increase the throughput of the facility by adding an additional process line. However, a future decision to extend conversion facility operations or increase throughput at the site could be made for several reasons. Consequently, this EIS includes an evaluation of the environmental impacts associated with expanding conversion facility operations at the site (either by process improvements or by extending operations beyond 25 years) in order to provide future planning flexibility. (Impacts are presented in Section 5.2.6.) The possible reasons for expanding operations in the future are discussed below.

The DOE Office of Inspector General (OIG) issued a final audit report in March 2004 reviewing the proposed DUF_6 conversion project (DOE 2004c). The OIG report recommends that EM conduct a cost benefit analysis to determine the optimum size of the Portsmouth conversion facility and, on the basis of the results of that review, implement the most cost-effective approach. The report states that by adding an additional process line to the Portsmouth facility, the time to process the Portsmouth and ETTP inventories of DUF_6 could be shortened by 5 years at a substantial cost savings of 55 million dollars.

In contrast to the findings at Portsmouth, the OIG report notes that it would not be feasible to add an additional conversion line to the Paducah facility (DOE 2004c). Consequently, this EIS evaluates the potential environmental impacts associated with increasing the Paducah plant throughput by implementing process improvements (see Section 5.2.6). The conversion contract provides significant incentives to the conversion contractor to improve efficiency. For example, the current facility designs are based on an assumption that the conversion plant would have an 84% on-line availability (percent of time system is on line and operational). However, Framatome’s experience at the Richland plant indicates that the on-line availability is expected to be at least 90%. Therefore, there is additional capacity expected to be realized in the current design.

A future decision to extend operations or expand throughput might also result from the fact that DOE could assume management responsibility for DUF_6 in addition to the current inventory. Two statutory provisions make this possible. First, Sections 161v. [42 USC 2201(v)] and 1311 [42 USC 2297b-10] of the Atomic Energy Act (AEA) of 1954 [P.L. 83-703], as amended, provide that DOE may supply services in support of USEC. In the past, these provisions were used once to transfer DUF_6 cylinders from USEC to DOE for disposition in accordance with DOE orders, regulations, and policies. Second, Section 3113(a) of the USEC Privatization Act [42 USC 2297h-11(a)] requires DOE to accept LLW, including depleted uranium that has been determined to be LLW, for disposal upon request and reimbursement of costs by USEC or any other person licensed by the NRC to operate a uranium enrichment facility. This provision has not been invoked, and the form in which depleted uranium would be transferred to DOE by a uranium enrichment facility invoking this provision is not specified. However, DOE believes depleted uranium transferred under this provision in the future would most likely be in the form of DUF_6, thus adding to the inventory of material needing conversion at the DUF_6 conversion facilities and disposition.

Several possible sources of additional DUF_6 generated from uranium enrichment activities include the following:

1. USEC continues to operate the gaseous diffusion plant at the Paducah site, generating approximately 1,000 cylinders per year of DUF_6. In the past, DOE signed MOAs with USEC transferring DUF_6 cylinders to DOE (DOE and USEC 1998a,b); the latest was signed in June 2002 for DUF_6 generated from 2002 through 2005. Future MOAs are possible. Consequently, DOE may assume responsibility for additional DUF_6 cylinders at the Paducah site.

2. USEC is currently in the process of developing and demonstrating an advanced enrichment technology based on gas centrifuges. A license for a lead test facility to be operated at the Portsmouth site was issued by the NRC in February 2004. In January 2004, USEC announced that its future enrichment facility using the advanced technology would be sited at the Portsmouth site. Consequently, additional DUF_6 could be generated at that site that ultimately could be transferred to DOE.

3. New commercial uranium enrichment facilities may be built and operated in the United States by commercial companies other than USEC. Although there are no agreements for DOE to accept DUF_6 from such commercial sources, it is possible in the future.

If DOE took responsibility for additional DUF_6 in the future, it is reasonable to assume that the conversion facilities at Portsmouth and/or Paducah could be operated longer than specified in the current plans in order to convert this material or that the throughput of the facilities could be increased. The duration of extended operations or the size of a throughput increase would depend on the quantity of material transferred and the location of the transfer.

In addition, because, under the current plans, the Portsmouth facility could conclude operations approximately 7 years before the current Paducah inventory would be converted at the Paducah site, it is possible that DUF_6 cylinders could be transferred from Paducah to Portsmouth to facilitate conversion of the entire inventory, particularly if DOE assumed responsibility for additional DUF_6 at Paducah.

The potential environmental impacts associated with extended plant operations, increased facility throughput through process improvements, and Paducah-to-Portsmouth cylinder shipments are discussed in Section 5.2.6.

2.3 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

2.3.1 Utilization of Commercial Conversion Capacity

During the scoping process for the PEIS, it was suggested that DOE consider using existing UF_6 conversion capacity at commercial nuclear fuel fabrication facilities that convert natural or enriched UF_6 to UO_2 in lieu of constructing new conversion capacity for DUF_6. Accordingly, in May 2001, DOE investigated the capabilities of existing commercial nuclear fuel fabrication facilities in the United States to determine whether this suggested approach would be a reasonable alternative. Publicly available information was reviewed, and an informal telephone survey of U.S. commercial fuel cycle facilities was conducted. The investigation report concluded that if 100% of the UF_6 conversion capacity of domestic commercial nuclear fuel fabrication facilities operating in May 2001 could be devoted to converting DOE's DUF_6 inventory, approximately 5,500 t (6,000 tons) of DUF_6 could be converted per year. On the basis of this conclusion, the investigation report estimated that it would take more than 125 years to convert DOE's DUF_6 inventory by using only existing conversion capacity. Furthermore, during the informal telephone survey, U.S. commercial fuel fabrication facilities were willing to confirm a capacity of only about 300 t (331 tons) of UF_6 per year as being possibly available to DOE. The investigation report indicated that there seems to be a general lack of interest on the part of the facility owners in committing existing operating or mothballed capacity to conversion of the DOE DUF_6 inventory (Ranek and Monette 2001).

Even though UF_6 conversion capacity at commercial nuclear fuel fabrication facilities might become available in the future, the small capacity identified in 2001 as being possibly available to DOE, coupled with the low interest level expressed at that time by facility owners, indicates that the feasibility of this suggested alternative is low. Therefore, this EIS does not analyze in detail the alternative of using existing capacity at commercial nuclear fuel fabrication facilities.

2.3.2 Other Sites

The consideration of alternative sites was limited to alternative locations within the Paducah site in response to Congressional direction. As discussed in detail in Section 1.1, Congress has acted twice regarding the construction and operation of DUF_6 conversion plants at Portsmouth and Paducah.

First, in July 1998, P.L. 105-204 directed DOE to make a plan consistent with NEPA for the construction and operation of conversion facilities at Portsmouth and Paducah. Consequently, DOE prepared a plan (DOE 1999b) and published an NOI in the *Federal Register* on September 18, 2001 (68 FR 48123) that identified the range of alternatives to be considered in a conversion facility EIS, including the alternative of constructing only one conversion plant.

Second, while the preparation of the conversion facility EIS was underway, Congress acted again regarding DUF_6 management by passing P.L. 107-206 in August 2002. The pertinent part of P.L. 107-206 directed DOE to award a contract for construction and operation of conversion facilities at the Portsmouth and Paducah sites and to commence construction no later than July 31, 2004. Subsequently, DOE reevaluated the appropriate approach of the NEPA review and decided to prepare two separate site-specific EISs. This change was announced in the *Federal Register* on April 28, 2003 (68 FR 22368). Consistent with the direction of P.L. 107-206, the alternatives for placing the conversion facilities were limited in each site-specific EIS to locations within the Portsmouth and Paducah sites, respectively.

2.3.3 Other Conversion Technologies

This EIS provides a detailed analysis of impacts associated with the proposed UDS conversion of DUF_6 to depleted U_3O_8. As discussed in Section 1.6.2.2, the conversion project RFP did not specify the conversion product technology or form. Three proposals submitted in response to the RFP were deemed to be in the competitive range; two of these proposals involved conversion of DUF_6 to U_3O_8 and the third involved conversion to depleted UF_4. Potential environmental impacts associated with these proposals were considered during the procurement process, including the preparation of an environmental critique and environmental synopsis, which were prepared in accordance with the requirements of 10 CFR 1021.216.

The environmental synopsis is presented in Appendix D. The environmental synopsis concluded that, on the basis of assessment of potential environmental impacts presented in the critique, no proposal was clearly environmentally preferable. Although differences in a number of impact areas were identified, none of the differences were considered to result in one proposal being preferable over the others. In addition, the potential environmental impacts associated with the proposals were found to be similar to, and generally less than, those presented in the DUF_6 PEIS (DOE 1999a) for representative conversion technologies.

2.3.4 Long-Term Storage and Disposal Alternatives

This EIS considers the site-specific impacts from conversion operations at the Paducah site, impacts from the transportation of depleted uranium conversion products to NTS and Envirocare for disposal, and impacts from the potential sale of HF and CaF_2 produced from conversion. Environmental impacts are not explicitly evaluated for the long-term storage of conversion products or for disposal.

At this time, there are no specific proposals for the long-term storage of conversion products that would warrant more detailed analysis. Long-term storage alternatives were analyzed in the PEIS, including storage as DUF_6 and storage as an oxide (either U_3O_8 or UO_2). For long-term storage of DUF_6, the options considered were storage in outdoor yards, buildings, and an underground mine. For long-term storage as an oxide, storage in buildings, underground vaults, and an underground mine were considered. The potential environmental impacts from long-term storage were evaluated for representative and generic sites. Preconceptual designs presented in the Engineering Analysis Report (Dubrin et al. 1997) were used as the basis for the analysis, and the evaluation of environmental impacts considered a 40-year period.

This EIS evaluates the impacts from packaging, handling, and transporting conversion products from the conversion facility to a LLW disposal facility. The disposal facility would be (1) selected in a manner consistent with DOE policies and orders and (2) authorized or licensed to receive the conversion products by either DOE (in conformance with DOE orders), the NRC (in conformance with NRC regulations), or an NRC Agreement State agency (in conformance with state laws and regulations determined to be equivalent to NRC regulations). Assessment of the impacts and risks from on-site handling and disposal at the LLW disposal facility is deferred to the disposal site's site-specific NEPA or licensing documents. However, this EIS covers the impacts from transporting the DUF_6 conversion products to both Envirocare and NTS.

2.3.5 Other Transportation Modes

Transportation by air and barge were considered but not analyzed in detail. Transportation by air was deemed to not be reasonable for the types and quantities of materials that would be transported to and from the conversion site. Any transportation by air would involve only small quantities of specialty materials or items generally carried through mail delivery services.

Transportation by barge was also considered, but deemed to be unreasonable and was not analyzed in detail. As explained more fully in Section 4.1 of the Engineering Analysis Report (Dubrin et al. 1997), ETTP is the only site with a nearby barge facility. Paducah would either have to build new facilities or use existing facilities that are located 20 to 30 mi (32 to 48 km) from the Paducah site. Use of existing facilities would require on-land transport by truck or rail over the 20- to 30-mi (32- to 48-km) distance, and the cylinders would have to go through one extra unloading/loading step at the end of the barge transport. Currently, there are no initiatives to build new barge facilities closer to the Paducah site. The closest distance to the Ohio River from the Paducah site is 6 mi (10 km). Therefore, even if a new barge facility was built, on-land transport of cylinders and an extra unloading/loading step would still be required at this site. If barge shipment was proposed in the future and considered to be a reasonable option, additional NEPA review would be conducted.

2.3.6 One Conversion Plant Alternative

In the NOI published in the *Federal Register* on September 18, 2001, construction and operation of one conversion plant was identified as a preliminary alternative that would be considered in the conversion EIS. However, with the passage of P.L. 107-206, which mandates the award of a contract for the construction and operation of conversion facilities at both Paducah and Portsmouth, the one conversion plant alternative was considered but not analyzed in this EIS.

2.4 COMPARISON OF ALTERNATIVES

2.4.1 General

This EIS includes analyses of a no action alternative and the proposed action of building and operating a conversion facility at three alternative locations within the Paducah site. Listed below is a general comparison of the activities required for each alternative and the types of environmental impacts that could be expected from each. A detailed comparison of the estimated environmental impacts associated with the alternatives is provided in Section 2.4.2.

- The no action alternative would consist of the continued surveillance and maintenance of the DUF_6 inventory at the Paducah site. No conversion facility would be constructed or operated. Only minor yard reconstruction would be required, and no cylinders would be shipped off site. Cylinder breaches could occur as a result of damage during handling or external corrosion.

  Potential environmental impacts associated with the no action alternative would be primarily limited to (1) the exposure of involved workers to external radiation in the cylinder yards during surveillance and maintenance activities, (2) impacts from reconstruction of three cylinder yards, (3) impacts associated with the possible release of depleted uranium and HF from breached cylinders and their dispersal in the environment (before the breaches were identified and repaired), and (4) potential accidents that could damage cylinders and result in a release of DUF_6.

- The proposed action would involve the construction and operation of a conversion facility at Paducah. Three alternative locations are considered. It would take the conversion facility approximately 25 years to convert the entire DUF_6 inventory to U_3O_8 at a rate of approximately 1,400 cylinders (18,000 t [20,000 tons]) per year. Aqueous HF could also be produced for sale during the conversion process, or the HF could be neutralized to CaF_2 for sale or disposal.

  The option of shipping approximately 5,900 cylinders (approximately 4,800 DUF_6 cylinders for conversion and about 1,100 non-DUF_6 cylinders) from ETTP to Paducah is also evaluated. This option would extend the period of operation from 25 to 28 years.

  After conversion, the conversion products (U_3O_8, aqueous HF or CaF_2, and emptied cylinders, if not used as disposal containers for U_3O_8) would be shipped by truck or rail to a user or disposal facility (NTS or Envirocare).

  Potential environmental impacts associated with the proposed action alternatives would include (1) impacts to local air, water, soil, ecological, and cultural resources during conversion facility construction; (2) impacts to workers from facility construction and operations; (3) impacts from small amounts of depleted uranium and other hazardous compounds released to the environment through normal conversion plant air effluents; (4) impacts from the shipment of cylinders, conversion products, and waste products; and (5) impacts from potential accidents involving the release of radioactive material or hazardous chemicals.

2.4.2 Summary and Comparison of Potential Environmental Impacts

This EIS includes analyses of potential impacts at the Paducah site under the no action alternative and the proposed action alternatives. Under the no action alternative, potential impacts associated with the continued storage of DUF_6 cylinders in yards are evaluated through 2039; in addition, the long-term impacts that could result from releases of DUF_6 and HF from future cylinder breaches are evaluated. For the proposed action, potential impacts are evaluated at three alternative locations for the following:

- The conversion facility construction period of approximately 2 years;
- The operational period required to convert the Paducah DUF_6 inventory, which would equal 25 years (28 years if the ETTP inventory was shipped to Paducah instead); and
- A facility D&D period of 3 years.

Under each alternative, potential consequences are evaluated in many areas: human health and safety (during normal operations, accidents, and transportation), air quality, noise, water, soil, socioeconomics, ecology, waste management, resource requirements, land use, cultural resources, and environmental justice. (Methodologies are discussed in Chapter 4 and Appendix F.) The assessment considers impacts that could result from the construction of necessary facilities, normal operations of facilities, accidents, preparation of cylinders for shipment, transportation of materials, and the D&D of facilities after conversion is complete. In addition, the production and sale of aqueous HF is evaluated, as is the possibility of neutralizing HF to CaF_2 for sale or disposal.

The potential environmental impacts at Paducah under the action alternatives and the no action alternative are presented in Table 2.4-1 (placed at the end of this chapter). To supplement the information in Table 2.4-1, each area of impact evaluated in the EIS is discussed below. Major similarities and differences among the alternatives are highlighted. This section provides a summary comparison; additional details and discussion are provided in Chapter 5 for each alternative and area of impact.

2.4.2.1 Human Health and Safety — Construction and Normal Facility Operations

Under the no action alternative and the action alternatives, it is estimated that potential exposures of workers and members of the public to radiation and chemicals would be well within applicable public health standards and regulations during normal facility operations (including 10 CFR 835, 40 CFR 61 Subpart H, and DOE Order 5400.5). The estimated doses and risks from radiation and/or chemical exposures of the general public and noninvolved workers would be very low, with zero latent cancer fatalities (LCFs) expected among these groups over the time periods considered, and with no adverse health impacts from chemical exposures expected. (Dose and risk estimates are shown in Table 2.4-1.) In general, the location of a conversion facility within the Paducah site would not significantly affect potential impacts to workers or the public during normal facility operations (i.e., no significant differences in impacts were identified at alternative Locations A, B, or C). Construction workers at Locations A and C and cylinder yard reconstruction workers under the no action alternative would receive low doses (i.e., up to 40 mrem/yr for the action alternatives and up to 230 mrem/yr for the no action alternative) because of the proximity of the construction sites to the cylinder yards.

Involved workers (persons directly involved in the handling of radioactive or hazardous materials) could be exposed to low-level radiation emitted by uranium during the normal course of their work activities, and this exposure could result in a slight increase in the risk for radiation-induced LCFs to individual involved workers. (The possible presence of TRU and Tc contamination in the cylinder inventory would not contribute to exposures during normal operations.) The annual number of workers exposed could range from about 40 (under the no action alternative) to 172 under the action alternatives. Under the no action alternative, it is estimated that radiation exposure of involved workers would result in a 1-in-2 chance of one additional LCF among the entire involved worker population over the life of the project. Under the action alternatives, a 1-in-7 chance of one additional LCF among involved workers over the life of the project was estimated.

Possible radiological exposures from using groundwater potentially contaminated as a result of releases from breached cylinders or facility releases were also evaluated. In general, these exposures would be at very low levels and within applicable public health standards and regulations. However, the uranium concentration in groundwater could exceed 20 μg/L (the drinking water guideline used for comparison in this EIS) at some time in the future under the no action alternative if cylinder corrosion was not controlled. This scenario is highly unlikely because ongoing cylinder inspections and maintenance would prevent significant releases from occurring.

2.4.2.2 Human Health and Safety — Facility Accidents

2.4.2.2.1 Physical Hazards. Under all alternatives, workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. On the basis of accident statistics for similar industries, it is estimated that under the no action alternative, zero fatalities and about 84 injuries might occur through 2039 at the Paducah site (about 2 injuries per year). Under the action alternatives, the risk of physical hazards would not depend on the location of the conversion facility. No fatalities are predicted, but about 11 injuries during construction and about 200 injuries during operations could occur at the conversion facility (about 6 injuries per year during a 2-year construction period and 8 injuries per year during operations). Accidental injuries and deaths are not unusual in industries that use heavy equipment to manipulate weighty objects and bulk materials.

2.4.2.2.2 Facility Accidents Involving Radiation or Chemical Releases. Under all alternatives, it is possible that accidents could release radiation or chemicals to the environment, potentially affecting workers and members of the public. Of all the accidents considered, those involving DUF_6 cylinders and those involving chemicals at the conversion facility would have the largest potential effects.

The cylinder management plan (Commonwealth of Kentucky and DOE 2003) outlines required cylinder maintenance activities and procedures to be undertaken in the event of a cylinder breach and/or release of DUF_6 from one or more cylinders. Under all alternatives, there is a low probability that accidents involving DUF_6 cylinders could occur at the current storage locations. If an accident occurred, DUF_6 could be released to the environment. The DUF_6 would combine with moisture in the air, forming gaseous HF and UO_2F_2, a soluble solid in the form of small particles. The depleted uranium and HF could be dispersed downwind, potentially exposing workers and members of the general public to radiation and chemical effects. The amount released would depend on the severity of the accident and the number of cylinders involved. The probability of cylinder accidents would decrease under the action alternatives as the DUF_6 was converted and the number of cylinders in storage decreased as a result.

For releases involving DUF_6 and other uranium compounds, both chemical and radiological effects could occur if the material was ingested or inhaled. The chemical effect of most concern associated with internal uranium exposure is kidney damage, and the radiological effect of concern is an increase in the probability of developing cancer. With regard to uranium, chemical effects occur at lower exposure levels than do radiological effects. Exposure to HF from accidental releases could result in a range of health effects, from eye and respiratory irritation to death, depending on the exposure level. Large anhydrous NH_3 releases could also cause severe respiratory irritation and death. (NH_3 is used to generate hydrogen, which is required for the conversion process.)

Chemical and radiological exposures to involved workers (those within 100 m [329 ft] of the release) under accident conditions would depend on how rapidly the accident developed, the exact location and response of the workers, the direction and amount of the release, the physical forces causing or caused by the accident, meteorological conditions, and the characteristics of the room or building if the accident occurred indoors. Impacts to involved workers under accident conditions would likely be dominated by physical forces from the accident itself; thus quantitative dose/effect estimates would not be meaningful. For these reasons, the impacts to involved workers during accidents are not quantified in this EIS. However, it is recognized that injuries and fatalities among involved workers would be possible if an accident did occur.

Under the no action alternative, for accidents involving cylinders that might happen at least once in 100 years (i.e., likely accidents [see Section 5.1.2.1.2]), it is estimated that the off-site concentrations of HF and uranium would be considerably below levels that would cause adverse chemical effects among members of the general public from exposure to these chemicals. However, up to 10 noninvolved workers might experience potential adverse effects from exposure to HF and uranium (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function). It is estimated that one noninvolved worker might experience potential irreversible adverse effects that are permanent in nature (such as lung damage or kidney damage), with no fatalities expected. Radiation exposures would be unlikely to result in additional LCFs among noninvolved workers or members of the general public for these types of accidents.

Cylinder accidents that are less likely to occur could be more severe, having greater consequences that could potentially affect off-site members of the general public. These types of accidents are considered extremely unlikely, expected to occur with a frequency of between once in 10,000 years and once in 1 million years of operations. Based on the expected frequency, through 2039, the probability of this type of accident was estimated to be about 1 chance in 2,500. Among all the cylinder accidents analyzed, the postulated accident that would result in the largest number of people with adverse effects (including mild and temporary as well as permanent effects) would be an accident that involves rupture of cylinders in a fire. If this type of accident occurred at the Paducah site, it is estimated that up to 2,000 members of the general public and 910 noninvolved workers might experience adverse chemical effects from HF and uranium exposure (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function). It is estimated that more adverse effects would occur among the general public than among noninvolved workers because of the buoyancy effects from the fire on contaminant plume spread (i.e., the concentrations that would occur would be higher at points farther from the release than at closer locations).

The postulated cylinder accident that would result in the largest number of persons with irreversible adverse health effects is a corroded cylinder spill under wet conditions, with an estimated frequency of between once in 10,000 years and once in 1 million years of operations. If this accident occurred, it is estimated that 1 member of the general public and 300 noninvolved workers might experience irreversible adverse effects (such as lung damage or kidney damage). No fatalities are expected among the members of the general public; there would be a potential for three fatalities among noninvolved workers from chemical effects. Radiation exposures would be unlikely to result in additional LCFs among noninvolved workers (1 chance in 170) or the general public (1 chance in 70).

In addition to the cylinder accidents discussed above is a certain class of accidents that the DOE investigated; however, because of security concerns, information about such accidents is not available for public review but is presented in a classified appendix to the EIS. All classified information will be presented to state and local officials, as appropriate.

The number of persons actually experiencing adverse or irreversible adverse effects from cylinder accidents would likely be considerably fewer than those estimated for this analysis and would depend on the actual circumstances of the accident and the individual chemical sensitivities of the affected persons. For example, although exposures to releases from cylinder accidents could be life-threatening (especially with respect to immediate effects from inhalation of HF at high concentrations), the guideline exposure level of 20 parts per million (ppm) of HF used to estimate the potential for irreversible adverse effects from HF exposure is likely to result in overestimates. This is because no animal or human deaths have been known to occur as a result of acute exposures (i.e., 1 hour or less) at concentrations of less than 50 ppm; generally, if death does not occur quickly after HF exposure, recovery is complete.

Similarly, the guideline intake level of 30 mg used to estimate the potential for irreversible adverse effects from the intake of uranium in this EIS is the level suggested in NRC guidance. This level is somewhat conservative; it is intended to overestimate (not underestimate) the potential number of irreversible adverse effects in the exposed population after uranium exposure. In more than 40 years of cylinder handling, no accidents involving releases from cylinders containing *solid* UF_6 have occurred that have caused diagnosable irreversible adverse effects among workers. In previous accidental exposure incidents involving *liquid* UF_6 in gaseous diffusion plants, some worker fatalities occurred immediately after the accident as a result of inhalation of HF generated from the UF_6. However, no fatalities occurred as a result of the toxicity of the uranium exposure. A few workers were exposed to amounts of uranium estimated to be about three times the guideline level (30 mg) used for assessing irreversible adverse effects; none of these workers, however, actually experienced such effects.

Under the action alternatives, low-probability accidents involving chemicals at the conversion facility could have large potential consequences for noninvolved workers and members of the public. At a conversion site, accidents involving chemical releases, such as NH_3 and HF, could occur. NH_3 is used to generate hydrogen for conversion, and HF can be produced as a co-product of converting DUF_6. Although the UDS proposal uses NH_3 to produce hydrogen, hydrogen can also be produced using natural gas. In that case, the accident impacts would be much less than those discussed here for NH_3 accidents. (Details on potential NH_3 and other accidents are in Section 5.2.2.2 [conversion facility] and Section 5.2.3 [transportation].)

The conversion accident estimated to have the largest potential consequences is an accident involving the rupture of an anhydrous NH_3 tank. Such an accident could be caused by a large earthquake and is expected to occur with a frequency of less than once in 1 million years per year of operations. The probability of this type of accident occurring during the operation of a conversion facility is a function of the period of operation; over 25 years of operations, the accident probability would be less than 1 chance in 40,000.

If an NH_3 tank ruptured at the conversion facility, a maximum of up to about 6,700 members of the general public might experience adverse effects (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function) as a result of chemical exposure. A maximum of about 370 people might experience irreversible adverse effects (such as lung damage or kidney damage), with the potential for about 7 fatalities. With regard to noninvolved workers, up to about 1,600 workers might experience adverse effects (mild and temporary) as a result of chemical exposures. A maximum of about 1,600 noninvolved workers might experience irreversible adverse effects, with the potential for about 30 fatalities.

The location of the conversion facility within the Paducah site would affect the number of noninvolved workers who might experience adverse or irreversible adverse effects from an NH_3 tank rupture accident. However, the accident analyses indicate that the impacts would not be consistently higher or lower at any of the alternative locations.

Although such high-consequence accidents at a conversion facility are possible, they are expected to be extremely rare. The risk (defined as consequence × probability) for these accidents would be less than 1 fatality and less than 1 irreversible adverse health effect for noninvolved workers and members of the public combined. NH_3 and HF are commonly used for industrial applications in the United States, and there are well-established accident prevention and mitigative measures for HF and NH_3 storage tanks. These include storage tank siting principles, design recommendations, spill detection measures, and containment measures. These measures would be implemented, as appropriate.

Under the action alternatives, the highest consequence radiological accident is estimated to be an earthquake damaging the depleted U_3O_8 product storage building. If this accident occurred, it is estimated that about 180 lb (82 kg) of depleted U_3O_8 would be released to the atmosphere outside of the building. The maximum collective dose received by the general public and noninvolved workers would be about 70 person-rem and 1,300 person-rem, respectively. There would be about a 1-in-40 chance of an LCF among the public and a 1-in-5 chance of an LCF among the noninvolved workers. Because the accident has a probability of occurrence that is about 1 chance in 4,000, the risk posed by the accident would be essentially zero LCFs among both the public and the workers.

2.4.2.3 Human Health and Safety — Transportation

Under the no action alternative, only small amounts of the LLW and LLMW that would be generated during routine cylinder maintenance activities would require transportation (about one shipment per year). Only negligible impacts are expected from such shipments. No DUF_6 or non-DUF_6 cylinders would be transported between sites.

Under the action alternatives, the number of shipments would include the following:

1. If U_3O_8 was disposed of in emptied cylinders, there would be approximately 7,240 railcar shipments of depleted U_3O_8 from the conversion facility to Envirocare (proposed) or NTS (option) or up to 36,200 truck shipments (alternative) to either Envirocare or NTS. The numbers of shipments would be about 16,400 for trucks or 4,100 for railcars if bulk bags were used as disposal containers.

2. About 15,300 truck or 3,060 railcar shipments of aqueous (70% and 49%) HF could occur; alternatively, the aqueous HF could be neutralized to CaF_2, requiring a total of about 25,000 truck or 6,300 railcar shipments. Currently, the destination for these shipments is not known.

3. About 1,300 truck or 650 railcar shipments of anhydrous NH_3 from a supplier to the site. Currently, the origin of these shipments is not known.

4. Emptied heel cylinders to Envirocare or NTS, if bulk bags were used to dispose of the depleted U_3O_8.

5. For the option of shipping ETTP cylinders to Paducah, approximately 5,400 truck or 1,400 railcar shipments of cylinders from ETTP.

During normal transportation operations, radioactive material and chemicals would be contained within their transport packages. Health impacts to crew members (i.e., workers) and members of the general public along the routes could occur if they were exposed to low-level external radiation in the vicinity of uranium material shipments. In addition, exposure to vehicle emissions (engine exhaust and fugitive dust) could potentially cause latent fatalities from inhalation.

The risk estimates for emissions are based on epidemiological data that associate mortality rates with particulate concentrations in ambient air. (Increased latent mortality rates resulting from cardiovascular and pulmonary diseases have been linked to incremental increases in particulate concentrations.) Thus, the increase in ambient air particulate concentrations caused by a transport vehicle, with its associated fugitive dust and diesel exhaust emissions, is related to such premature latent fatalities in the form of risk factors. Because of the conservatism of the assumptions made to reconcile results among independent epidemiological studies and associated uncertainties, the latent fatality risks estimated for normal vehicle emissions should be considered to be an upper bound (Biwer and Butler 1999).[2] For the transport of conversion products and co-products (depleted U_3O_8, aqueous HF, and emptied cylinders, if not used as disposal containers), it is conservatively estimated that a total of up to 20 fatalities from vehicle emissions could occur if shipments were only by truck and if aqueous HF product was sold and transported 620 mi (1,000 km) from the site (about 30 fatalities are estimated if HF was neutralized to CaF_2 and transported 620 mi [1,000 km]) from the site. The number of fatalities occurring from exhaust emissions if shipments were only by rail would be less than 1 if HF was sold and about 1 if the HF was neutralized to CaF_2.

Exposure to external radiation during normal transportation operations is estimated to cause less than 1 LCF under both truck and rail options. Members of the general public living along truck and rail transportation routes would receive extremely small doses of radiation from shipments, about 0.1 mrem or less over the duration of the program. This would be true even if a single person was exposed to every shipment of radioactive material during the program.

Traffic accidents could occur during the transportation of radioactive materials and chemicals. These accidents could potentially affect the health of workers (i.e., crew members)

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2 For perspective, in a recently published EIS for a geologic repository at Yucca Mountain, Nevada (DOE 2002h), the same risk factors were used for vehicle emissions; however, they were adjusted to reduce the amount of conservatism in the estimated health impacts. As reported in the Yucca Mountain EIS, the adjustments resulted in a reduction in the emission risks by a factor of about 30.

and members of the general public, either from the accident itself or from accidental releases of radioactive materials or chemicals.

The total number of traffic fatalities (unrelated to the type of cargo) was estimated on the basis of national traffic statistics for shipments by both truck and rail. If the aqueous HF was sold to users about 620 mi (1,000 km) from the site, about 2 traffic fatalities under the truck option would be estimated and 1 traffic fatality would be estimated under the rail option. If HF was neutralized to CaF_2, about 4 fatalities would be estimated for the truck option, and 2 fatalities for the rail option.

Severe transportation accidents could also result in a release of radioactive material or chemicals from a shipment. The consequences of such a release would depend on the material released, location of the accident, and atmospheric conditions at the time. Potential consequences would be greatest in urban areas because more people could be exposed. Accidents that occurred when atmospheric conditions were very stable (typical of nighttime) would have higher potential consequences than accidents that occurred when conditions were unstable (i.e., turbulent, typical of daytime) because the stability would determine how quickly the released material dispersed and diluted to lower concentrations as it moved downwind.

A detailed discussion of the accident scenarios modeled for the action alternatives is provided in Section 5.2.3.3. For the action alternatives, the highest potential accident consequences during transportation activities would be caused by a rail accident involving anhydrous NH_3. Although anhydrous NH_3 is a hazardous gas, it has many industrial applications and is commonly safely transported by industry as a pressurized liquid in trucks and rail tank cars.

The probability of a severe anhydrous NH_3 railcar accident occurring in a highly populated urban area under stable atmospheric conditions is extremely rare. The probability of such an accident occurring if all the anhydrous NH_3 needed was transported 620 mi (1,000 km) is estimated to be less than 1 chance in 200,000. Nonetheless, if such an accident (i.e., release of anhydrous NH_3 from a railcar in a densely populated urban area under stable atmospheric conditions) occurred, up to 5,000 persons might experience irreversible adverse effects (such as lung damage), with the potential for about 100 fatalities. If the same type of NH_3 rail accident occurred in a typical rural area, which would have a smaller population density than an urban area, potential impacts would be considerably less. It is estimated that in a rural area, approximately 20 persons might experience irreversible adverse effects, with no expected fatalities. The atmospheric conditions at the time of an accident would also significantly affect the consequences of a severe NH_3 accident. The consequences of an NH_3 accident would be less severe under unstable conditions, the most likely conditions in the daytime. Unstable conditions would result in more rapid dispersion of the airborne NH_3 plume and lower downwind concentrations. Under unstable conditions in an urban area, approximately 400 persons could experience irreversible adverse effects, with the potential for about 8 fatalities. If the accident occurred in a rural area under unstable conditions, 1 person would be expected to experience an irreversible adverse effect, with zero fatalities expected. When the probability of an NH_3 accident occurring is taken into account, it is expected that no irreversible adverse effects and no fatalities would occur over the shipment period.

For perspective, anhydrous NH_3 is routinely shipped commercially in the United States for industrial and agricultural applications. On the basis of information provided in the DOT *Hazardous Material Incident System (HMIS) Database* (DOT 2003b), for 1990 through 2002, 2 fatalities and 19 major injuries to the public or to transportation or emergency response personnel have occurred as a result of anhydrous NH_3 releases during nationwide commercial truck and rail operations. These fatalities and injuries occurred during transportation or loading and unloading operations. Over that period, truck and rail NH_3 spills resulted in more than 1,000 and 6,000 evacuations, respectively. Five very large spills, more than 10,000 gal (38,000 L), have occurred; however, these spills were all en-route derailments from large rail tank cars. The two largest spills, both around 20,000 gal (76,000 L), occurred in rural or lightly populated areas and resulted in one major injury. Over the past 30 years, the safety record for transporting anhydrous NH_3 has significantly improved. Safety measures contributing to this improved safety record include the installation of protective devices on railcars, fewer derailments, closer manufacturer supervision of container inspections, and participation of shippers in the Chemical Transportation Emergency Center.

After anhydrous NH_3, the types of accidents that are estimated to result in the second highest consequences are those involving shipment of 70% aqueous HF produced during the conversion process. The estimated numbers of irreversible adverse effects for 70% HF rail accidents are about one-third of those from the anhydrous NH_3 accidents. However, the number of estimated fatalities is about one-sixth of those from NH_3 accidents, because the percent of fatalities among the individuals experiencing irreversible adverse effects is 1% as opposed to 2% for NH_3 exposures (Policastro et al. 1997). For perspective, since 1971, the period covered by DOT records, no fatal or serious injuries to the public or to transportation or emergency response personnel have occurred as a result of anhydrous HF releases during transportation. (Most of the HF transported in the United States is anhydrous HF, which is more hazardous than aqueous HF.) Over that period, 11 releases from railcars were reported to have no evacuations or injuries associated with them. The only major release (estimated at 6,400 lb [29,000 kg] of HF) occurred in 1985 and resulted in approximately 100 minor injuries. Another minor HF release during transportation occurred in 1990. The safety record for transporting HF has improved in the past 10 years for the same reasons as those discussed above for NH_3. Transportation accidents involving the shipment of DUF_6 cylinders were also evaluated, with the estimated consequences being less than those discussed above for NH_3 and HF (see Section 5.2.5.3).

2.4.2.4 Air Quality and Noise

Under the no action alternative, air quality from construction and operations would be within national and state ambient air quality standards. However, estimated concentrations of particulate matter (PM) that could be generated during yard reconstruction activities at Paducah would be close to air quality standards; these temporary emissions could be controlled by good construction practices. Continued cylinder maintenance and painting are expected to be effective in controlling corrosion, and concentrations of HF would be kept within regulatory standards at the Paducah site.

Under the action alternatives, it was found that air quality impacts during construction would be similar for all three alternative locations. The total (modeled plus the measured background value representative of the site) concentrations due to emissions of most criteria pollutants — such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO) — would be well within applicable air quality standards. As is often the case for construction, the primary concern would be PM released from near-ground-level sources. Total concentrations of PM_{10} and $PM_{2.5}$ (PM with a mean aerodynamic diameter of 10 μm or less and 2.5 μm or less, respectively) at the construction site boundary would be close to or above the standards because of the high background concentrations and the proposed facility's proximity to potentially publicly accessible areas. Accordingly, construction activities should be conducted so as to minimize further impacts on ambient air quality. To mitigate impacts, water could be sprayed on disturbed areas more often, and dust suppressant or pavement could be applied to roads with frequent traffic.

During operations, it is estimated that total concentrations for all criteria pollutants (except for $PM_{2.5}$) would be well within standards. The background level of annual average $PM_{2.5}$ in the area of the Paducah site approaches the standard. Again, impacts during operations were found to be similar for all three alternative locations.

Noise impacts are expected to be negligible under the no action alternative. Under the action alternatives, estimated noise levels at the nearest residence (located 1.3 km [0.8 mi] from the construction location) would be below the U.S. Environmental Protection Agency (EPA) guideline of 55 dB(A)[3] as day-night average sound level (DNL)[4] for residential zones during construction and operations.

2.4.2.5 Water and Soil

Under the no action alternative, uranium concentrations in surface water, groundwater, and soil would remain below guidelines throughout the project duration. However, if cylinder maintenance and painting were not effective in reducing cylinder corrosion rates, the uranium concentration in groundwater could be greater than the guideline at some time in the future (no earlier than about 2100). If continued cylinder maintenance and painting were effective in controlling corrosion, as expected, groundwater uranium concentrations would remain less than the guideline.

During construction of the conversion facility, construction material spills could contaminate surface, water, groundwater, or soil. However, by implementing storm water management, sediment and erosion control (e.g., temporary and permanent seeding; mulching and matting; sediment barriers, traps, and basins; silt fences; runoff and earth diversion dikes),

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[3] dB(A) is a unit of weighted sound-pressure level, measured by the use of the metering characteristics and the A-weighting specified in the *American National Standard Specification for Sound Level Meters*, ANSI S1.4-1983, and in Amendment S1.4A-1985 (Acoustical Society of America 1983, 1985).

[4] DNL is the 24-hour average sound level, expressed in dB(A), with a 10-dB penalty artificially added to the nighttime (10 p.m.–7 a.m.) sound level to account for noise-sensitive activities (e.g., sleep) during these hours.

and good construction practices (e.g., covering chemicals with tarps to prevent interaction with rain; promptly cleaning up any spills), concentrations in soil and wastewater (and therefore surface water and groundwater) could be kept well within applicable standards or guidelines.

During operations, no appreciable impacts on surface water or groundwater would result from the conversion facility because no contaminated liquid effluents are anticipated, and because airborne emissions would be at very low levels (e.g., <0.25 g/yr of uranium). Impacts would be similar for all three alternative locations.

Contaminated soil associated with solid waste management unit (SWMU) 194 could be excavated during construction at Locations A and C. these soils would be managed as described in Section 2.4.2.8.

2.4.2.6 Socioeconomics

The socioeconomic analysis evaluates the effects of construction and operation on population, employment, income, regional growth, housing, and community resources in the region of influence (ROI) around the site. In general, socioeconomic impacts tend to be positive, creating jobs and income, with only minor impacts on housing, public finances, and employment in local public services.

The no action alternative would result in a small socioeconomic impact, creating 110 jobs during cylinder yard reconstruction (over 2 construction years) and 130 jobs during operations (direct and indirect jobs) and generating $3.2 million in personal income during construction and $3.8 million in personal income per operational year. No significant impacts on regional growth and housing, local finances, and public service employment in the ROI are expected.

Under the action alternatives, jobs and direct income would be generated during both construction and operation. Construction of the conversion facility would create 290 jobs and generate almost $10 million in personal income in the peak construction year (construction occurs over a 2-year period). Operation of the conversion facility would create 330 jobs and generate $13 million in personal income each year. Only minor impacts on regional growth and housing, local finances, and public service employment in the ROI are expected. The socioeconomic impacts would not depend on the location of the conversion facility; therefore, the impacts would be the same for alternative Locations A, B, and C.

2.4.2.7 Ecology

Under the no action alternative, continued cylinder maintenance and surveillance activities would have negligible impacts on ecological resources (i.e., vegetation, wildlife, wetlands, and threatened and endangered species). Only a small amount of yard reconstruction, in a previously disturbed area, would occur at the Paducah site. It is estimated that potential concentrations of contaminants in the environment from future cylinder breaches would be below levels harmful to biota. However, there is a potential for impacts to aquatic biota from cylinder yard runoff during painting activities.

Under the action alternatives, the total area disturbed during conversion facility construction would be 45 acres (18 ha). Vegetative communities would be impacted in this area from a loss of habitat. However, for all three alternative locations, impacts could be minimized depending on exactly where the facility was placed within each location. These habitat losses would constitute less than 1% of available land at the site. It was found that concentrations of contaminants in the environment during operations would be below harmful levels. Impacts to vegetation and wildlife would be negligible are at all three locations.

Wetlands at or near Locations A, B, and C could be adversely affected at the Paducah site. Impacts to wetlands could be minimized depending on where exactly the facility was placed within each location. Mitigation for unavoidable impacts may be developed in coordination with the appropriate regulatory agencies. Unavoidable impacts to wetlands that are within the jurisdiction of the USACE might require a Clean Water Act (CWA) Section 404 Permit, which would trigger the requirement for a CWA Section 401 water quality certification from the Commonwealth of Kentucky. A mitigation plan might be required prior to the initiation of construction.

Construction of the conversion facility in the eastern portion of Location C could impact potential habitat for cream wild indigo (state-listed as a species of special concern) and compass plant (state-listed as threatened). For construction at all three locations, impacts on deciduous forest might occur. Impacts to forested areas could be avoided if temporary construction areas were placed in previously disturbed locations. Trees with exfoliating bark, such as shagbark hickory, or dead trees with loose bark can be used by the Indiana bat (federal- and state-listed as endangered) as roosting trees during the summer. If either live or dead trees with exfoliating or loose bark are encountered on construction areas, they should be saved if possible. If necessary, the trees should be cut before March 31 or after October 15.

2.4.2.8 Waste Management

Under the no action alternative, LLW, LLMW, and PCB-containing waste could be generated from cylinder scraping and painting activities. The amount of LLMW generated could represent an increase of less than 1% in the site's LLMW load, representing a negligible impact on site waste management operations.

Under the action alternatives, waste management impacts would not be dependent on the location of the conversion facility within the site and would be the same for alternative Locations A, B, and C. Waste generated during construction and operations would have negligible impacts on the Paducah site waste management operations, with the exception of possible impacts from disposal of CaF_2. Industrial experience indicates that HF, if produced, would contain only trace amounts of depleted uranium (less than 1 ppm). It is expected that HF would be sold for use. If sold for use, the sale would be subject to review and approval by DOE in coordination with the NRC, depending on the specific use (as discussed in Appendix E).

The U_3O_8 produced during conversion would generate about 7,850 yd^3 (6,000 m^3) per year of LLW. This is 83% of Paducah's annual projected LLW volume and could have potentially large impacts on site LLW management. However, plans for off-site disposal of this LLW are included in the proposed action.

If the HF was not sold but instead neutralized to CaF_2, it is currently unknown whether (1) the CaF_2 could be sold, (2) the low uranium content would allow the CaF_2 to be disposed of as nonhazardous solid waste, or (3) disposal as LLW would be required. The low level of uranium contamination expected (i.e., less than 1 ppm) suggests that sale or disposal as nonhazardous solid waste would be most likely. If sold for use, the sale would be subject to review and approval by DOE in coordination with the NRC, depending on the specific use. Waste management for disposal as nonhazardous waste could be handled through appropriate planning and design of the facilities. If the CaF_2 had to be disposed of as LLW, it could represent a potentially large impact on waste management operations.

A small quantity of TRU could be entrained in the gaseous DUF_6 during the cylinder emptying operations. These contaminants would be captured in the filters between the cylinders and the conversion equipment. The filters would be monitored and replaced routinely to maintain concentrations below regulatory limits for TRU waste. The spent filters would be disposed of as LLW, generating up to 25 drums of LLW over the life of the project.

Current UDS plans are to leave the heels in the emptied cylinders, add a stabilizer, and use the cylinders as disposal containers for the U_3O_8 product to the extent practicable. An alternative is to process the emptied cylinders and dispose of them directly as LLW. Either one of these approaches is expected to meet the waste acceptance criteria of the disposal facilities and minimize the potential for generating TRU waste through washing of the cylinders to remove the heels. Although cylinder washing is not considered a foreseeable option at this time, for completeness, an analysis of the maximum potential quantities of TRU waste that could be generated from cylinder washing is included in Appendix B, as is a discussion of PCBs contained in some cylinder coatings.

In addition, potentially contaminated soil associated with SWMU 194 could be excavated during construction at Locations A and B. The excavated soil would be managed consistent with RCRA regulations and coordinated between the Commonwealth of Kentucky (Division of Waste Management) and DOE.

2.4.2.9 Resource Requirements

Resource requirements include construction materials, fuel, electricity, process chemicals, and containers. In general, all alternatives would have a negligible effect on the local or national availability of these resources.

2.4.2.10 Land Use

Under the no action alternative, all activities would occur in areas previously used for conducting similar activities; therefore, no land use impacts are expected. Under the action alternatives, a total of 45 acres (18 ha) could be disturbed, with some areas cleared for railroad or utility access and not adjacent to the site. All three alternative locations are within an already-industrialized facility, and impacts to land use would be similar for the three alternative locations. The permanently altered areas would represent less than 1% of available land already developed for industrial purposes. Negligible impacts on land use are thus expected.

2.4.2.11 Cultural Resources

Under the no action alternative, impacts on cultural resources at the current storage locations would be unlikely because all activities would occur in areas already dedicated to cylinder storage. Under the action alternatives, impacts on cultural resources could be possible at all three alternative locations. Archaeological and architectural surveys have not been completed for the candidate locations and would have to be undertaken prior to initiation of the action alternatives. If archaeological resources were encountered, or historical or traditional cultural properties were identified, a mitigation plan would be required.

2.4.2.12 Environmental Justice

No disproportionately high and adverse human health or environmental impacts are expected to minority or low-income populations during normal facility operations under the action alternatives. Although the consequences of facility accidents could be high if severe accidents occurred, the risk of irreversible adverse effects (including fatalities) among members of the general public from these accidents (taking into account the consequences and probability of the accidents) would be less than 1. Furthermore, transportation accidents with high and adverse impacts are unlikely; their locations cannot be projected, and the types of persons who would be involved cannot be reliably predicted. Thus, there is no reason to expect that minority and low-income populations would be affected disproportionately by high and adverse impacts.

2.4.2.13 Option of Shipping ETTP Cylinders to Paducah

If cylinders from ETTP were transported to Paducah, the cylinders would have to be prepared to be shipped by either truck or rail. Approximately 4,800 DUF_6 cylinders for conversion and about 1,100 non-DUF_6 cylinders would require preparation for shipment at ETTP. As discussed in Chapter 5 in this EIS, three cylinder preparation options are considered for the shipment of noncompliant cylinders.

In general, the use of cylinder overpacks would result in small potential impacts. Overpacking operations would be similar to current cylinder handling operations, and impacts would be limited to involved workers. No LCFs among involved workers from radiation exposure are expected. Impacts would be similar if noncompliant cylinders were shipped "as-is" or following repairs under a DOT exemption, assuming appropriate compensatory measures.

The use of a cylinder transfer facility would likely require the construction of a new facility at ETTP; there are no current plans to build such a facility. Operational impacts would generally be small and limited primarily to external radiation exposure of involved workers, with no LCFs expected. Transfer facility operations would generate a large number of emptied cylinders requiring disposition. If a decision were made to construct and operate a transfer facility at ETTP, additional NEPA review would be conducted.

Impacts from extended operations of the conversion plant from 25 to 28 years would not be expected to significantly increase overall impacts.

2.4.2.14 Impacts Associated with Conversion Product Sale and Use

The conversion of the DUF_6 inventory produces products having some potential for reuse. These products would include HF and CaF_2, which are commonly used as commercial materials (no large-scale market exists for depleted U_3O_8). An investigation of the potential reuse of HF and CaF_2 is included as part of this EIS (Chapter 5 and Appendix E). Areas examined include the characteristics of these materials as produced within the conversion process, the current markets for these products, and the potential socioeconomic impacts should these products be provided to the commercial sector. Because there would be some residual radioactivity associated with these materials, the DOE process for authorizing release of materials for unrestricted use (referred to as "free release") and an estimate of the potential human health effects of such free release are also considered in this investigation. The results of the analysis of HF and CaF_2 use are included in Table 2.4-1.

If the products were released for restricted use (e.g., in the nuclear industry for the manufacture of nuclear fuel), the impacts would be less than those for unrestricted release.

Conservative estimates of the amount of uranium and technetium that might transfer into the HF and CaF_2 were used to evaluate the maximum expected dose to workers using the material if it was released for commercial use. On the basis of very conservative assumptions concerning use, the maximum dose to workers was estimated to be less than 1 mrem/yr, much less than the regulatory limit of 100 mrem/yr specified for members of the general public. Doses to the general public would be even lower.

Socioeconomic impact analyses were conducted to evaluate the impacts of the introduction of the conversion-produced HF or CaF_2 into the commercial marketplace. A potential market for the aqueous HF has been identified as the current aqueous HF acid producers. The impact of HF sales on the local economy in which the existing producers are located and on the U.S. economy as a whole is likely to be minimal. No market for the CaF_2 that might be produced in the conversion facility has been identified. Should such a market be found, the impact of CaF_2 sales on the U.S. economy is also predicted to be minimal.

2.4.2.15 Impacts from D&D Activities

D&D would involve the disassembly and removal of all radioactive and hazardous components, equipment, and structures. For the purposes of analysis in this EIS, it was also assumed that the various buildings would be dismantled and "greenfield" (unrestricted use) conditions would be achieved. The "clean" waste would be sent to a landfill that accepts construction debris. LLW would be sent to a licensed or DOE disposal facility, where it would likely be buried in accordance with the waste acceptance criteria and other requirements in effect at that time. Hazardous and mixed waste would be disposed of in a licensed facility in accordance with applicable regulatory requirements. D&D impacts to involved workers would be primarily from external radiation; expected exposures would be a small fraction of operational doses; no LCFs would be expected. It is estimated that no fatalities and up to 5 injuries would result from occupational accidents. Impacts from waste management would include a total generation of about 275 yd^3 (210 m^3) of LLW, 157 yd^3 (120 m^3) of LLMW, and 157 yd^3 (120 m^3) of hazardous waste; these volumes would result in low impacts compared with projected site annual generation volumes.

2.4.2.16 Cumulative Impacts

The CEQ guidelines for implementing NEPA define cumulative effects as the impacts on the environment resulting from the incremental impact of an action under consideration when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7) Activities considered for cumulative analysis include those in the vicinity of the site.

Actions planned at the Paducah site include the continuation of uranium enrichment operations (by USEC), waste management activities, waste disposal activities, environmental restoration activities, and DUF_6 management activities considered in this EIS. Although Portsmouth was identified by USEC in January 2004 as the site of the American Centrifuge Facility, construction and operation of such a facility at Paducah has been included in the cumulative impacts analysis.

Actions occurring near the Paducah site that, because of their diffuse nature, could contribute to existing or future impacts on the site include continued operation of the Tennessee Valley Authority's (TVA's) Shawnee power plant; the Joppa, Illinois, power plant; and the Honeywell International uranium conversion plant in Metropolis, Illinois. Cumulative impacts of these actions at Paducah would be as follows for the no action alternative and the proposed action alternatives:

- The cumulative collective radiological exposure to the off-site population would be well below the maximum DOE dose limit of 100 mrem per year to the off-site maximally exposed individual (MEI) and below the limit of 25 mrem/yr specified in 40 CFR 190 for uranium fuel cycle facilities. Annual individual doses to involved workers would be monitored to maintain exposure below the regulatory limit of 5 rem per year.

- Under the no action alternative cumulative impacts assessment, although less than one shipment per year of radioactive wastes is expected from cylinder management activities, up to 14,400 truck shipments could be associated with existing and planned actions (no rail shipments are expected). Under the action alternatives, up to 6,000 rail shipments and 36,200 truck shipments of radioactive material could occur. The cumulative maximum dose to the MEI along the transportation route near the site entrance would be less than 1 mrem per year under all alternatives and for all transportation modes.

- The Paducah site is located in an attainment region. However, the background annual average $PM_{2.5}$ concentration is near the regulatory standard. Cumulative impacts would not affect attainment status.

- Data from the 2000 annual groundwater monitoring showed that four pollutants exceeded primary drinking water regulation levels in groundwater at the Paducah site. Good engineering and construction practices should ensure that indirect cumulative impacts on groundwater associated with the conversion facility would be minimal.

- Cumulative ecological impacts on habitats and biotic communities, including wetlands, would be negligible to minor for all alternatives. Construction of a conversion facility might remove a type of tree preferred by the Indiana bat; however, this federal- and state-listed endangered species is not known to utilize these areas.

- No cumulative land use impacts are anticipated for any of the alternatives.

- It is unlikely that any noteworthy cumulative impacts on cultural resources would occur under any alternative, and any such impacts would be adequately mitigated before activities for the chosen action would start.

- Given the absence of high and adverse cumulative impacts for any impact area considered in this EIS, no environmental justice cumulative impacts are anticipated for the Paducah site, despite the presence of disproportionately high percentages of low-income populations in the vicinity.

- Socioeconomic impacts under all alternatives considered are anticipated to be generally positive, often temporary, and relatively small.

2.4.2.17 Potential Impacts Associated with the Option of Expanding Conversion Facility Operations

As discussed in Section 2.2.5, several reasonably foreseeable activities could result in a future decision to increase the conversion facility throughput or extend the operational period at one or both of the conversion facility sites. Although there are no current plans to do so, to account for these future possibilities and provide future planning flexibility, Section 5.2.6 includes an evaluation of the environmental impacts associated with expanding conversion facility operations at Paducah, either by increasing throughput (by process improvements) or by extending operations.

As described in Section 5.2.6, a throughput increase through process improvements would not be expected to significantly change the overall environmental impacts when compared with those of the current plant design. Efficiency improvements are generally on the order of 10%, which is within the uncertainty that is inherent in the impact estimate calculations. Slight variations in plant throughput are not unusual from year to year because of operational factors (e.g., equipment maintenance or replacement) and are generally accounted for by the conservative nature of the impact calculations.

The conversion facility operations could also be expanded by operating the facility longer than the currently anticipated 25 years. There are no current plans to operate the conversion facility beyond this period. However, with routine facility and equipment maintenance and periodic equipment replacements or upgrades, it is believed that the conversion facility could be operated safely beyond this time period to process any additional DUF_6 for which DOE might assume responsibility. As discussed in Section 5.2.6, if operations were extended beyond 25 years and if the operational characteristics (e.g., estimated releases of contaminants to air and water) of the facility remained unchanged, it is expected that the annual impacts would be essentially the same as those presented above and summarized in Table 2.4-1. The overall cumulative impacts from the operation of the facility would increase proportionately with the increased life of the facility.

2.5 PREFERRED ALTERNATIVE

DOE's preferred alternative is to construct and operate the proposed DUF_6 conversion facility at alternative Location A, which is located south of the administration building and its parking lot and east of the main Paducah GDP site access road.

3 AFFECTED ENVIRONMENT

This EIS considers the proposed action of building and operating a conversion facility at the Paducah site for conversion of the Paducah DUF_6 cylinder inventory. Section 3.1 presents a detailed description of the affected environment for the Paducah site. The option of shipping cylinders from the ETTP site in Oak Ridge, Tennessee, to the Paducah site for conversion is also considered in this EIS. Therefore, information on the affected environment for the ETTP site is provided in Section 3.2.

3.1 PADUCAH SITE

The Paducah site is located in rural McCracken County, Kentucky, approximately 10 mi (16 km) west of the City of Paducah and 3.6 mi (6 km) south of the Ohio River (Figure 3.1-1). The Paducah site consists of 3,556 acres (1,439 ha) currently held by DOE (DOE 2001b). The site is surrounded by the West Kentucky Wildlife Management Area, an additional 2,781 acres (1,125 ha) conveyed by DOE to the Commonwealth of Kentucky for use in wildlife conservation and for recreational purposes. The City of Paducah is the largest urban area in the six counties surrounding the site. The six-county area is primarily rural, with industrial uses accounting for less than 5% of land use.

The Paducah GDP occupies a 750-acre (303-ha) complex within the Paducah site and is surrounded by a security fence (Figure 3.1-1). The Paducah GDP, previously operated by DOE and now operated by USEC, includes about 115 buildings with a combined floor space of approximately 8.2 million ft^2 (0.76 million m^2). The Paducah GDP has operated since 1955.

In 1994, the Paducah site was placed on the EPA National Priorities List (NPL), a list of sites across the nation that the EPA has designated as high priority for site remediation. The NPL designation was assigned primarily because of groundwater contamination with trichloroethylene (TCE) and Tc-99, first detected in 1988. Being placed on the NPL meant that the cleanup requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) would be met in conducting remediation efforts at the Paducah site. Hazardous waste and mixed waste management at the Paducah site must comply with RCRA regulations, which are administered by the Commonwealth of Kentucky (Division of Waste Management). The RCRA regulations also address implementation of corrective actions for SWMUs. Thus, both CERCLA and RCRA have requirements for remedial actions for contaminated environmental media. A Federal Facilities Agreement (FFA) has been developed to coordinate CERCLA/RCRA requirements into a single remediation procedure for the Paducah site.

The northern part of Location A and the southern part of Location B for the proposed conversion facility are located in an area that has been designated as SWMU 194 under the ongoing CERCLA/RCRA investigation. SWMU 194 previously was the site of several support facilities (e.g., administration building, hospital, boiler house, two leach fields) during the construction of the gaseous diffusion plant. These facilities are no longer present. In 2000, preferred Location A was characterized by using surface and subsurface soils samples, surface water and sediment samples, and groundwater data (Tetra Tech, Inc. 2000). Although several metals and radionuclides were detected above background levels in these environmental media, the study concluded that the site was suitable for constructing industrial facilities.

3.1.1 Cylinder Yards

The Paducah site has a total of 36,191 DOE-managed DUF_6 cylinders (Table 3.1-1). The cylinders are located in about 15 storage yards (Figure 3.1-2). Most of the cylinders are in yards managed by DOE, but a small number of cylinders are still stored in USEC-managed yards. Over several years, most of the storage yards that previously had gravel bases have been reconstructed with concrete bases for control of infiltration and runoff. Currently, only three DOE-managed yards have not been reconstructed: C-745-F (which is located on a former building foundation) and C-745-N and C-745-P (which both have gravel bases). The C-745-F yard has an area of about 247,000 ft^2 (23,000 m^2); the C-745-N and C-745-P yards have a combined area of about 164,000 ft^2 (15,000 m^2).

TABLE 3.1-1 DOE-Managed DUF_6 Cylinders at the Paducah Site

Cylinder Type	No. of Cylinders
Full	35,908
Partially full	136
Heel	147
Total	36,191

Source: Hightower (2004).

3.1.2 Site Infrastructure

The Paducah site is located in an area with an established transportation network. The area is served by two interstate highways, several U.S. and state highways, several rail lines, and a regional airport.

All water used by the site is obtained from the Ohio River through an intake at the steam plant near the Shawnee Power Plant north of the site. Before use, the water is treated on site. Water usage is approximately 15 million gal/d (57 million L/d). The maximum site capacity is 30 million gal/d (115 million L/d) (DOE 1996).

Electric Energy, Inc., supplies electric power to the Paducah site. The electrical need is about 1,600 MW, with a maximum capacity of 3,040 MW. The coal system uses 82 tons (74 t) per day, with a maximum capacity of 180 to 200 tons (160 to 180 t) (DOE 1996).

3.1.3 Climate, Air Quality, and Noise

3.1.3.1 Climate

The Paducah site is located in the humid continental zone, characterized by warm summers and moderately cold winters (DOE 2001b). For the period 1961 through 1990, the annual average temperature was 14.0°C (57.2°F), with the highest monthly average temperature of 26.0°C (78.8°F) in July and the lowest of 0.3°C (32.6°F) in January (Wood 1996). Annual precipitation averages about 125 cm (49.3 in.), mostly occurring as rain. Precipitation is relatively evenly distributed throughout the seasons, but the highest occurs in spring. For the period 1985 through 1993, average annual relative humidity was about 73%, ranging from 82% to 86% at midnight and 6 a.m. and from 58% to 64% at noon and 6 p.m.

Wind data collected at Barkley Regional Airport about 8 km (5 mi) to the southeast of the Paducah site were evaluated. For the period 1990 through 1994, the average wind speed at the 10-m (33-ft) level was about 3.8 m/s (8.6 mph), as shown in Figure 3.1-3 (National Climatic Data Center undated). The dominant wind direction was from the south, with a secondary peak from the south-southwest. Directional wind speeds ranged from 3.1 m/s (6.9 mph) from the east to 4.7 m/s (10.5 mph) from the north-northwest, and the wind speed from the dominant wind direction was also high, at about 4.6 m/s (10.3 mph).

Tornadoes are rare in the area surrounding the Paducah site, and the ones that do occur are less frequent and destructive than those occurring in the Midwest. For the period 1950 through 1995, 402 tornadoes were reported in Kentucky, with an average of 9 tornadoes per year (Storm Prediction Center 2002). For the same period, 6 tornadoes were reported in McCracken County, but most of those tornadoes were relatively weak — at most, F2 of the Fujita tornado scale.

3.1.3.2 Existing Air Emissions

Major air pollution sources around the Paducah site in Kentucky include USEC and the TVA's coal-fired Shawnee Power Plant, about 5 km (3 mi) northeast of the Paducah site (EPA 2003a). In Illinois, the Joppa Power Plant and Lafarge Corporation, located about 11 km (7 mi) north-northwest of the Paducah site, are major sources across the Ohio River. Table 3.1-2 lists the annual emissions from the four plants and total criteria pollutant and volatile organic compound (VOC) emissions for the respective counties. As a result of the transfer of the production part of the Paducah GDP to USEC, major air emission sources were transferred to USEC. Accordingly, air emissions from the DOE facilities at Paducah are negligible, and DOE does not currently hold any air quality permits (Knaus 2002). USEC is qualified as a major source and in 1998 applied for a Title V permit to the Kentucky Division of Air Quality. However, its emissions account for less than 1% of areawide emission totals.

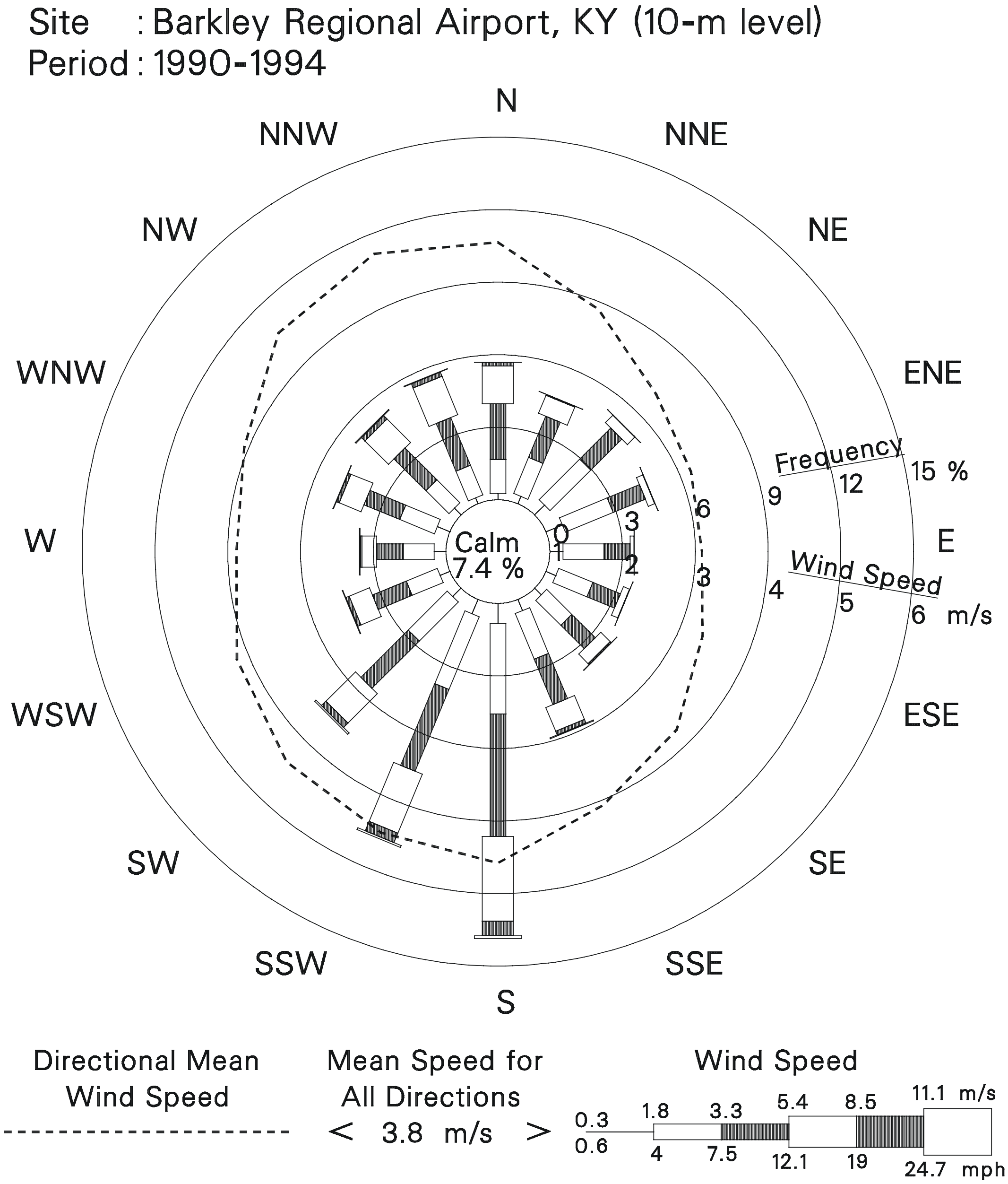

FIGURE 3.1-3 Wind Rose for the Barkley Regional Airport (10-m level), 1990–1994 (Source: National Climatic Data Center undated)

The Commonwealth of Kentucky and the EPA regulate airborne emissions of radionuclides from DOE facilities under 40 CFR Part 61, Subpart H, the National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations (DOE 2001b). Potential radionuclide sources from the Paducah site in 2000 were the Drum Mountain Removal Project, Northwest Plume Groundwater System, and fugitive emission sources.

TABLE 3.1-2 Annual Criteria Pollutant and Volatile Organic Compound Emissions from Selected Major Point Sources around the Paducah Site in 1999

	Emission Rate (tons/yr)					
Major Emission Source	SO_2	NO_x	CO	VOCs	PM_{10}	$PM_{2.5}$
TVA Shawnee Plant	35,874	23,956	3,699	112	75	46
USEC	427	320	8	1	9	5
McCracken County, Ky., total	36,317	24,283	3,713	352	126	74
Electric Energy, Inc., Joppa	23,744	8,447	1,250	152	927	680
Lafarge Corporation	11,466	1,516	0	0	204	113
Massac County, Ill., total	35,597	10,174	1,316	484	1,383	922

Source: EPA (2003a).

3.1.3.3 Air Quality

The Kentucky State Ambient Air Quality Standards (SAAQS) for six criteria pollutants — SO_2, nitrogen dioxide (NO_2), CO, ozone (O_3), PM (PM_{10} and $PM_{2.5}$), and lead (Pb) — are the same as the National Ambient Air Quality Standards (NAAQS)[1] (Kentucky Division for Air Quality 2002), as shown in Table 3.1-3. In addition, the state has adopted standards for hydrogen sulfide (H_2S), gaseous fluorides (expressed as HF), total fluorides, and odors, as presented in Table 3.1-4.

The Paducah site is located in the Paducah-Cairo Interstate Air Quality Control Region (AQCR), which covers the westernmost parts of Kentucky. McCracken County currently is designated as being in attainment for all criteria pollutants (40 CFR 81.318). Current ambient monitoring data for criteria pollutants, H_2S, and HF immediately around the site are not available (Knaus 2002). However, on the basis of 1997 through 2002 monitoring data, the highest concentration levels for SO_2, NO_2, CO, PM_{10}, 24-hour $PM_{2.5}$, and Pb around the Paducah site are less than or equal to 53% of their respective NAAQS, as given in Table 3.1-3 (EPA 2003a). The highest O_3 and annual $PM_{2.5}$ concentrations, however, are near to or somewhat higher than the applicable NAAQS. The high ozone concentrations of regional concern are associated with high precursor emissions from the Ohio Valley region and long-range transport from southern states.

Ambient air monitoring stations in and around the site mainly collect data on radionuclides released from the site. These data were used to assess whether air emissions from the Paducah GDP would affect air quality in the surrounding area. Monitoring results showed that all airborne radionuclide concentrations in the surrounding area were at or below background levels (DOE 2001b).

1 The EPA promulgated new O_3 8-hour and $PM_{2.5}$ standards in July 1997.

TABLE 3.1-4 Additional Commonwealth of Kentucky Ambient Air Quality Standards[a]

Pollutant	Averaging Time	Primary Standard	Secondary Standard	Highest Background Concentration ($\mu g/m^3$)
Hydrogen sulfide	1 hour	–[b]	14 $\mu g/m^3$ (0.01 ppm)[c]	-
Gaseous fluorides (expressed as HF)	12 hours	–	3.68 $\mu g/m^3$ (4.50 ppb)[c]	-
	24 hours	800 $\mu g/m^3$ (1.0 ppm)[c]	2.86 $\mu g/m^3$ (3.50 ppb)[c]	
	1 week	–	1.64 $\mu g/m^3$ (2.00 ppb)[c]	0.50
	1 month	–	0.82 $\mu g/m^3$ (1.00 ppb)[c]	-
	Annual	400 $\mu g/m^3$ (0.5 ppm)	–	0.17
Total fluorides[d]	1 month	–	80 ppm (w/w)[e]	-
	2 months	–	60 ppm (w/w)	-
	Growing season[f]	–	40 ppm (w/w)	-
Odors			At any time when 1 volume unit of ambient air is mixed with 7 volume units of odorless air, the mixture must have no detectable odor	

[a] These standards are in addition to the Kentucky SAAQS for criteria pollutants listed in Table 3.1-3.

[b] A dash indicates that no standard exists.

[c] This average is not to be exceeded more than once per year.

[d] Dry weight basis (as fluoride ion) in and on forage for consumption by grazing ruminants. The listed concentrations are not to be exceeded.

[e] w/w = weight of fluoride ion per weight of forage unit.

[f] Average concentration of monthly samples over the growing season (not to exceed six consecutive months).

Source: Appendix A of 401 *Kentucky Administrative Regulations* (KAR) 53:010 and ANL (1991a).

Prevention of significant deterioration (PSD) regulations (40 CFR 52.21) limit the maximum allowable incremental increases in ambient concentrations of SO_2, NO_2, and PM_{10} above established baseline levels, as shown in Table 3.1-3. The PSD regulations, which are designed to protect ambient air quality in Class I and Class II attainment areas, apply to major new sources and major modifications to existing sources. The nearest Class I PSD areas are Mingo National Wildlife Refuge in Missouri, about 113 km (70 mi) west of the Paducah site, and Mammoth Cave National Park, about 225 km (140 mi) east of the Paducah site. These Class I areas are not located downwind of prevailing winds at the Paducah GDP (Figure 3.1-3).

3.1.3.4 Existing Noise Environment

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978; 42 USC 4901–4918), delegates authority to the states to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. The Commonwealth of Kentucky and McCracken County, where the Paducah site is located, have no quantitative noise-limit regulations.

The EPA has recommended a maximum noise level of 55 dB(A) as the DNL to protect against outdoor activity interference and annoyance (EPA 1974). This is not a regulatory goal, but it is “intentionally conservative to protect the most sensitive portion of the American population” with “an additional margin of safety.” For protection against hearing loss in the general population from nonimpulsive noise, the EPA guideline recommends an L_{eq}(24 h) of 70 dB(A) or less.[2]

The noise-producing activities within the Paducah site are associated with processing and construction activities and local traffic, similar to those at any other industrial site. During site operations, noise levels near the cooling towers are relatively high, but most noise sources are enclosed in the buildings. Another noise source is associated with rail traffic in and out of the Paducah site. In particular, train whistle noise, at a typical noise level of 95 to 115 dB(A), is high at public grade crossings. Currently, rail traffic noise is not a factor in the local noise environment because of infrequent traffic (one train per week).

The Paducah site is in a rural setting, and no residences or other sensitive receptor locations (e.g., schools, hospitals) are located in the immediate vicinity of any noisy on-site operations. (The nearest sensitive receptor is located about 1 mi (2 km) from the proposed conversion facility.) Ambient noise levels around the site are relatively low. Measurements taken at the nearest residence ranged from 44 to 47 dB(A) when the site was in full operation (Pennington 2001; Argonne National Laboratory [ANL] 1991a). At nearby residences, noise emissions from the plant were reported as undetectable from background noise.

3.1.4 Geology and Soil

3.1.4.1 Topography, Structure, and Seismic Risk

The topography of the Paducah site is relatively flat. Western Kentucky has gently rolling terrain between 330 and 500 ft (101 and 152 m) above mean sea level (DOE 1999h). Within the boundaries of the Paducah GDP security fence, the maximum variation in elevation is about 10 ft (3 m) (ERC/EDGe 1989). The site is underlain by bedrock composed of limestone and shale. Several zones of faulting, including the New Madrid Seismic Zone, occur in the vicinity of the site (ANL 1991a).

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[2] L_{eq} is the equivalent steady sound level that, if continuous during a specific time period, would contain the same total energy as the actual time-varying sound. For example, L_{eq}(24 h) is the 24-hour equivalent sound level.

The Paducah site is located near the northern end of the Mississippian Embayment, which is characterized by unconsolidated Cretaceous, Tertiary, and Quaternary sediments overlying indurated Paleozoic bedrock that dip gently to the south. The Mississippian Embayment was a large sedimentary trough oriented nearly north to south that existed during Cretaceous and Tertiary time and received sediments from the central portion of the North American continent (Early et al. 1989).

The sedimentary sequence found in the vicinity of the Paducah site consists mainly of fine- to medium-grained clastic materials (sedimentary rocks formed from particles that were mechanically transported), including (from youngest to oldest) a basal gravel (Tuscaloosa Formation), the McNairy Formation (clay interlaminated with silt and fine-grained sand), the Porters Creek Clay (clay facies and variable thicknesses of sand and silt), and undifferentiated Eocene sands (fine sand with variable amounts of interbedded and interlensing silt and clay). The Eocene sands are thought to be thin and discontinuous beneath the northern portion of the Paducah site. At depth, the site is underlain by dense bedrock of Mississippian limestone and shale.

In the vicinity of the site, a unit designated as Continental Deposits lies immediately beneath variable thicknesses of Pleistocene Loess, which is typically an unstratified, silty clay-clayey silt (EDGe 1987). The loess originated as windblown material generated by glacial activity to the north. The Continental Deposits lie directly on an ancient unconformity (erosional surface) that truncates several formations. The angular nature of the unconformity — coupled with the fact that the Eocene sands, Porters Creek Clay and McNairy Formation lie unconformably on each other — creates a complex stratigraphy. The Continental Deposits resemble a large low-gradient alluvial fan deposited at the confluence of the ancestral Ohio and Tennessee Rivers.

Erosion and reworking of alluvial fan deposits modified the thickness and distribution of the Continental Deposits (DOE 1999h). The Continental Deposits can be subdivided into two components or facies: a lower gravel or sandy gravel unit that varies in thickness from 0 to 106 ft (0 to 32 m) and an upper clay-sand unit that has a comparable thickness (Early et al. 1989). Deposition of the gravel probably occurred in a high-energy braided stream environment closely associated with alluvial fans. Of particular interest is the presence of a prominent channel that passes in a northerly direction through the site and a second, less-prominent channel that occurs near the eastern side of the site boundary. The upper clay-sand unit represents sediments deposited in a fluvial and lacustrine (lake) environment (DOE 1999h).

Several zones of faulting occur in the vicinity of the site. These zones include the St. Genevieve, Rough Creek, Cottage Grove, Wabash Valley, and Shawneetown fault zones. In addition, there is a northeast-trending rift zone (ERC/EDGe 1989). A rift zone is a fault through a divergence zone (i.e., an area in which tectonic plates are moving away from each other) or other area of tension. These features are overlain by younger Cretaceous, Tertiary, and Quaternary sediments. The rift zone is inferred from seismic reflection profiling.

The New Madrid Seismic Zone lies within the central Mississippi Valley and extends from northeast Arkansas, through southeast Missouri, western Tennessee, and western Kentucky to southern Illinois (Saint Louis University Earthquake Center 2002). The area near the site has been the location of some of the largest earthquakes that have occurred in North America. The largest recorded earthquakes that occurred in the vicinity of the site happened between 1811 and 1812. Four of the earthquakes had Modified Mercalli intensities that ranged from IX to XI (Nuttli 1973). (The Modified Mercalli intensity scale relates an earthquake's intensity to a series of key responses of surface structures and people, such as people awakening, movement of furniture, damage to chimneys, and, finally, total destruction.) In an earthquake with a Modified Mercalli intensity of XI, few, if any, masonry structures remain standing, bridges are destroyed, and rails are greatly bent.

The series of 1811 to 1812 earthquakes completely destroyed the town of New Madrid. The epicenter of the largest 1812 earthquakes was about 60 mi (96 km) southwest of what is now the Paducah site (LMES 1997b). Hundreds of aftershocks occurred over a period of several years. The largest earthquakes that have occurred since then were on January 4, 1843, and October 31, 1895, with body wave magnitude estimates of 6.0 and 6.2, respectively. In addition to these events, seven events of magnitude greater than 5.0 have occurred in the area. Since 1895, more than 4,000 earthquakes have been located in the zone. Most of them were too small to be felt. On average, one earthquake per year is large enough to be felt in the area (Saint Louis University Earthquake Center 2002). On June 18, 2002, a moderate earthquake with a preliminary estimated magnitude of 5.0 occurred in southern Indiana with an epicenter near Evansville (CNN 2002). This earthquake occurred on the northern arm of the New Madrid Seismic Zone. There were no immediate reports of damage.

The seismic hazards at the Paducah site have been extensively studied. The safety analysis report (SAR) completed for this site in March 1997 provided comprehensive analyses and discussions of seismic hazards at the site (see Sections 1.5 and 3.3 of the SAR; LMES 1997b). The analyses considered the possibility of large-magnitude earthquakes similar to the New Madrid earthquakes of 1811 to 1812. The analyses performed by DOE were independently reviewed by the U.S. Geological Survey (USGS). The independent review indicated that the seismic sources, recurrence rates, maximum magnitudes, and attenuation functions used in the SAR analyses were representative of a wide range of professional opinion and were suitable for obtaining probabilistically based seismic hazard estimates. Because of the proximity of the site to the New Madrid Seismic Zone, special deterministic analyses were also performed to estimate the ground motions at the site in the case of recurrence of an earthquake of the same magnitude as the 1811 to 1812 New Madrid earthquakes. The results of the deterministic analyses were similar to the probabilistic seismic hazard results for the probabilities associated with the recurrence of the New Madrid earthquakes of 1811 to 1812.

For the Paducah site, the evaluation basis earthquake (EBE) was designated by DOE to have a return period of 250 years. A detailed analysis indicated that the peak ground motion for the EBE was 0.15 times the acceleration of gravity (LMES 1997b). An earthquake of this size would have an equal probability of occurring any time during a 250-year period.

3.1.4.2 Soils

Soils of the Calloway-Henry Association cover most of the Paducah site; soils of the Grenada-Calloway Association cover the remainder. Soils of the Calloway-Henry Association, which are nearly level and somewhat poorly drained soils of medium texture, occur on uplands. Soils of the Grenada-Calloway Association, which are nearly level to sloping and moderately well-drained, medium-textured soils, also occur on uplands. Calloway, Henry, and Granada soils have a slight potential for erosion, a low shrink-swell potential, and permeabilities ranging from 0.51 to 5.1 cm/h (0.20 to 2.0 in./h) (Humphrey 1976).

Undisturbed soils typically contain a low-permeability layer (fragipan) that occurs at a depth from 1 to 4 ft (0.30 to 1.22 m). Site development has destroyed much of this layer. In areas in which the fragipan is present, perched water may occur (ANL 1991a). Substances in soil possibly associated with past and present cylinder management activities would be uranium and fluoride compounds, which could be released in cases of breached cylinders or faulty valves. For the evaluation of ongoing activities at the Paducah site, soil sampling has been conducted to identify the accumulation of any airborne pollutants deposited on the ground. Annual soil samples have been collected from 10 off-site locations — 4 at the site boundary, 4 at distances of 5 mi (8 km) beyond the boundary, and 2 at more remote locations — to characterize background levels (LMES 1996a; Martin Marietta Energy Systems, Inc. [MMES] 1994a). In 1994, uranium concentrations for the 10 sampling locations ranged from 2.0 to 5.8 μg/g; plant boundary concentrations ranged from 2.3 to 4.9 μg/g (LMES 1996a).

Since the transfer of responsibility for air point sources from DOE to USEC, concentrations of nonradiological parameters in soil at these sampling locations are no longer monitored; however, analytical results for PCBs and metals are available. In 1993, no detectable concentrations of PCBs were found in any of the samples; however, elevated concentrations of bismuth, lead, manganese, thallium, and thorium were detected in several samples (MMES 1994a). Fluoride was not analyzed in soil samples, but it occurs naturally in soils and is of low toxicity.

As part of ongoing CERCLA/RCRA investigations of Paducah site operable units, soils in several areas have been identified as contaminated with radionuclides and chemicals, such as PCBs and metals. This contamination is not associated with the DUF_6 cylinder yards.

An investigation of Location A soils was conducted in 2000 (Tetra Tech, Inc. 2000). The results of several limited soil investigations for SWMU 194, incorporating parts of both Locations A and B, are also summarized in a subsequent risk assessment (DOE 2001a). These reports indicate a limited number of samples in both locations with elevated concentrations of uranium, polycyclic aromatic hydrocarbons (PAHs), and metals in comparison with human-health based guidelines. No characterization of soils in Location C has been conducted. There is no known past or current source of contamination at Location C.

3.1.5 Water Resources

The affected environment for water resources consists of surface water within and in the vicinity of the site boundary and groundwater beneath the site. Analyses of surface water, stream sediment, and groundwater samples have indicated the presence of some contamination resulting from previous site operations.

3.1.5.1 Surface Water

The Paducah site is located in the western part of the Ohio River drainage basin. Surface water from the site drains into tributaries of the Ohio River (Rogers et al. 1988). Bayou Creek (formerly Big Bayou Creek) is located on the western side of the site, and Little Bayou Creek is located on the eastern side (Figure 3.1-1). These two streams join north of the site and discharge to the Ohio River at about River Kilometer 1,524, which is about 34 mi (55 km) upstream from the confluence of the Ohio and Mississippi Rivers. The site is located about 3.5 mi (5.6 km) south of the Ohio River. The historical mean flow for this section of the river is about 200 million gal/min (757 million L/min) (DOE 2001b). All water used by the Paducah site is obtained from the Ohio River through an intake at the steam plant near the Shawnee Power Plant (ANL 1991a), which is located adjacent to the Ohio River north of the facility. Current water use is approximately 15 million gal/d (57 million L/d). Flow in Bayou Creek and Little Bayou Creek fluctuates greatly as a result of precipitation; however, during most of the year, most of the flow in both streams is derived from plant effluents. Bayou Creek has a mean flow of about 67,300 gal/min (254,758 L/min), with a stage (depth) of about 2 ft (0.6 m). The average annual low flow for this stream is about 22,400 gal/min (84,793 L/min) (Pennington 2001). The mean flow rate for Little Bayou Creek is approximately 44,900 gal/min (169,965 L/min), with a depth of about 1 to 2 ft (0.3 to 0.6 m). The average annual low flow for Little Bayou Creek is generally too low to be monitored or sampled. Annual precipitation in the vicinity of the site is about 49.3 in. (125 cm).

A number of wetlands and drainage ditches occur on the three sites identified as potential DUF_6 conversion facility locations. The Paducah site is not located in a 100-year floodplain (elevation of 333 ft [102 m]), nor would it be affected by the historical high-water elevation of 342 ft (104 m).

Most of the liquid effluents from the Paducah site consist of once-through non-contact cooling water, although a variety of the liquid wastes (contaminated with uranium and noncontaminated) are produced by activities such as metal finishing, uranium recovery, and facility cleaning (Rogers et al. 1988). In addition to these discharges, a large variety of conventional liquid wastes, including treated domestic sewage, steam plant wastewater, and coal pile runoff, enter the surface water system.

All effluent discharges are regulated under permits from the KPDES. Currently, there are a total of 15 outfalls — 10 outfalls authorized to USEC (KY0102083) and 5 outfalls authorized to DOE (KY000409). Three of the DOE outfalls are to Bayou Creek and one is to an unnamed tributary of Little Bayou Creek. The average discharge of wastewater to Bayou Creek is approximately 4 million gal/d (15 million L/d). The average discharge to the Ohio River through

Bayou and Little Bayou Creeks is about 4.1 million gal/d (16 million L/d). The average flow in the Ohio River is 1.7×10^{11} gal/d (6.5×10^{11} L/d).

Results of surface water monitoring in 2000 indicated that the maximum concentration of uranium from 20 surface water sampling locations monitored 3 to 5 times annually was 0.017 mg/L in the downstream portion of Little Bayou Creek (DOE 2001b). The maximum average concentration of fluoride was less than 0.224 mg/L in the north/south diversion ditch within the Paducah GDP grounds (MMES 1994b). Comparable data on fluoride were not reported for 1994, 1995, or 1996 (LMES 1996a, 1997a,c).

The KPDES-permitted outfalls are monitored for inorganic substances and about 45 organic substances, including PCBs. The monitoring frequency for most substances is two to four times per year; several substances are monitored monthly or quarterly to comply with KPDES Permit requirements. The maximum average uranium concentration in effluents from the DOE outfalls from 1994 through 1996 was 0.037 mg/L (LMES 1996a, 1997a,c). In 2000, the maximum uranium concentration from DOE outfalls was 0.09 mg/L (about 62 pCi/L) (DOE 2001b). This value is below the derived concentration guide (DCG) of 600 pCi/L.

KPDES Outfall 017 is located at the central-western edge of alternative Location B. This outfall receives runoff from the cylinder storage yards and from the cylinder painting facility area. Starting in 1998, and again in 2000 and 2001, acute toxicity tests at this outfall exceeded specified limits (DOE 2001b, 2002e). Zinc in runoff from painting activities was suspected of being the leading contributor to the toxicity exceedances (DOE 2001b), but the cause has not been established (DOE 2002e).

Sediment samples are also collected annually from six locations and analyzed for uranium, PCBs, and metals. In 1993, concentrations of uranium and PCBs were detected at levels substantially higher than background levels in Little Bayou Creek (Sampling Location SS2). The uranium concentration of 200 mg/kg at the measuring location was two times higher than it was in 1992. However, levels decreased in 1994 (22 mg/kg maximum uranium concentration, 1.4 mg/kg maximum PCB concentration) (LMES 1996a) and again in 1995 (13 mg/kg maximum uranium concentration, <0.1 mg/kg maximum PCB concentration) (LMES 1997a). In 1996, the uranium concentration in sediment at Location SS2 was 44 mg/kg; the PCB concentration was 1.3 mg/kg. A new sampling location (SS29) was added on Little Bayou Creek closer to the Paducah GDP. The uranium concentration at this location was 360 mg/kg; no PCB value was reported (LMES 1997c). In 2000, the maximum uranium concentration measured for all sediment sampling locations was 60 mg/kg (DOE 2001b).

3.1.5.2 Groundwater

Two near-surface aquifers are important at the Paducah site. The upper aquifer is a shallow, perched-water aquifer composed of upper continental deposits of sand and of sand and clay mixtures that are discontinuous. Water yields from this aquifer are very low, and the hydraulic gradient (change in water elevation with distance) is difficult to detect. Water movement is generally considered to be vertically downward (DOE 2001a).

The lower aquifer is a good-yielding gravel aquifer that has an upper surface at a depth of about 39 ft (12 m) and a thickness that ranges from about 20 to 59 ft (6 to 18 m). This aquifer appears to be continuous beneath the site. Hydraulic conductivity is estimated to be 0.0001 to 1 cm/s for the regional gravel aquifer and 0.00001 to 0.01 cm/s for the upper Continental Deposits (sands). Water movement is 2 to 5 ft/yr (0.6 to 1.5 m/yr) and toward the north-northeast (DOE 2001a).

Groundwater is sampled from about 200 monitoring wells, residential wells, and TVA wells on and off the Paducah site. Off-site sampling is performed to monitor three separate TCE and Tc plumes first detected in 1988 (LMES 1996a). Paducah has provided a municipal water supply to all residents whose wells are within the area of groundwater contamination from the site; wells that are no longer sampled are locked and capped.

Although the magnitude of groundwater contamination originating from the Paducah site is greatest for TCE and Tc, the primary drinking water standards or DCGs for several other inorganic, volatile organic, and radionuclide substances were also exceeded in one or more of the monitoring wells on or near the Paducah site in sampling conducted from 1993 through 1996 (MMES 1994b; LMES 1996a, 1997a,c). The DCG is equivalent to the maximum concentration limit (MCL); it is the concentration of a radionuclide that under conditions of continuous exposure for 1 year would result in an effective dose equivalent of 4 mrem (EPA 1996; DOE 1990). The uranium guideline of 20 μg/L in 1996 was exceeded in four wells, and the fluoride guideline of 4 mg/L was exceeded in two wells. The wells with uranium and fluoride exceedances are not located near the cylinder yards. Alternative Location C lies within the area of the northeastern groundwater plume that is contaminated with TCE.

Data from the 2000 annual groundwater monitoring program (DOE 2001b) showed that three pollutants exceeded primary drinking water regulation levels in groundwater at the Paducah site; chromium was present in all wells, nitrogen as nitrate in one well, and TCE in two wells. Beta activity was found in seven wells.

3.1.6 Biotic Resources

3.1.6.1 Vegetation

The Paducah site includes the highly developed Paducah GDP, which has few natural vegetation communities. The DOE property between the Paducah GDP and the surrounding West Kentucky Wildlife Management Area consists primarily of open, frequently mowed grassy areas. The DOE property also includes several small upland areas of mature forest, old-field, and transitional habitats. The banks of Bayou Creek and Little Bayou Creek support mature riparian forest with river birch, black willow, and cottonwood (ANL 1991a). The West Kentucky Wildlife Management Area contains wooded areas, from early and mid-successional stages to mature forest communities, as well as restored prairie. Nonforested areas are managed by controlled burns, mowing, and planting to promote the development of native prairie species.

Location A, one of the three potential facility locations for DUF_6 conversion at the Paducah site, is approximately 35 acres (14 ha) in size and includes previously disturbed and undisturbed areas. The northern portion of Location A is relatively level and previously contained facilities during the initial construction of the Paducah GDP. It now supports an open vegetation cover of grasses maintained as mowed lawn. The southern portion of Location A is relatively undisturbed and primarily supports a mature deciduous hardwood forest community of about 10 acres (4 ha). The dominant species in the forested area are red maple, sweet gum, cherry bark oak, and pin oak; swamp chestnut oak, swamp white oak, and hickories are also present (Pennington 2001). Saplings of red maple, American elm, green ash, white ash, and sweet gum are the primary species of the shrub layer. Vines are primarily Virginia creeper and poison ivy, while the dominant species of the herbaceous layer are stiff marsh bedstraw, blunt broom sedge, narrow-leaved cat tail sedge, Japanese chess, swamp rose, and water parsnip. An open grassland lies immediately south of the forested area within the electric power line right-of-way. A small area of shrubs is located adjacent to the forest and extends into the grassland.

Location B covers about 59 acres (24 ha) and consists of a previously disturbed open area in the northern half and mature deciduous hardwood forest in the southern half of the location. The northern portion of Location B (north of Curlee Road), as well as the northeastern area of the southern portion, is flat to gently sloping and is vegetated primarily with grasses maintained as mowed lawn. Two open woodland groves occur in the northern portion and are also mowed. A number of drainage channels within this portion are bordered by steep banks supporting a mosaic of upland herbaceous and immature woodland communities, which include willows, maples, sycamore, sweet gum, tulip tree, milkweed, dogbane, poison ivy, and fleabane. A large mature deciduous hardwood forest is located south of Curlee Road and extends south and west of Location B. Dominant species in the forested area are oaks and hickories, with sassafras and sweet gum also common. Virginia creeper and honeysuckle are common vines within the forested area.

Location C is approximately 53 acres (21 ha) in size and is relatively level throughout. The western half has been previously disturbed and supports a deciduous hardwood forest that includes many young trees and saplings. The dominant species are oaks and hickories. The western margin of this area is located under the electric power lines and consists of an open grassland area that is periodically mowed. A margin of shrubs and saplings borders the western edge of the forested area. The eastern half of Location C consists primarily of an open old-field community with scattered groves of mature deciduous trees, primarily oaks. The vegetation of the open field is predominantly herbaceous and consists primarily of grasses such as fescue and broom-sedge.

3.1.6.2 Wildlife

The habitats at the Paducah site support a relatively high diversity of wildlife species. Common species of the surrounding West Kentucky Wildlife Management Area and undeveloped areas of the Paducah site outside the Paducah GDP fence line include white-tailed deer, red fox, raccoon, opossum, coyote, turkey, and bobwhite quail. Ground-nesting species include the white-footed mouse, bobwhite, and eastern box turtle. Bayou Creek, upstream of the Paducah site, supports aquatic fauna indicative of oxygen-rich, clean water, including 14 fish species. Aquatic species just downstream of the Paducah site discharge points include 11 fish species (LMES 1997c). The abundance and diversity of aquatic organisms are generally lower near the outfalls than in upstream areas for both Little Bayou and Bayou Creeks (DOE 1994b).

The habitats within Locations A, B, and C support wildlife species typical of similar habitats in the vicinity. Species common to forested areas include slimy salamander, red-bellied woodpecker, Kentucky warbler, red-eyed vireo, white-footed mouse, eastern gray squirrel, and eastern fox squirrel. The forest and woodland communities within the three candidate locations provide foraging habitat for neotropical migratory songbirds during spring and fall migrations. Open areas and old-field habitats support bobwhite, indigo bunting, common grackle, and southeastern shrew. Species found in or near wetlands include American toad, Woodhouse's toad, green frog, red-eared turtle, snapping turtle, beaver, mink, and muskrat. Southern leopard frogs occur near the forested area of Location A.

3.1.6.3 Wetlands

Although no wetlands are identified on the Paducah GDP by the National Wetlands Inventory, approximately 5 acres (2 ha) of jurisdictional wetlands have been identified in drainage ditches scattered throughout the Paducah GDP (ANL 1991a; CDM Federal Programs Corporation 1994; Sadri 1995). Outside the Paducah GDP, a large number of wetlands are scattered throughout the Paducah site. These include forested wetlands, ponds, wet meadows, vernal pools, and wetlands converted to agriculture (U.S. Department of the Army 1994c). Palustrine forested wetlands occur extensively along the banks of Bayou and Little Bayou Creeks. The National Wetlands Inventory identifies many wetlands on the Paducah site, primarily ponds and forested wetlands. A forested wetland dominated by tupelo trees in the West Kentucky Wildlife Management Area has been designated by the Kentucky Nature Preserves Commission and Kentucky Department of Fish and Wildlife as an area of ecological concern (DOE 1996).

Several wetland areas occur at Location A (Figure 3.1-4) and total approximately 7.2 acres (2.9 ha) (Tetra Tech, Inc. 2000). The open area in the northern portion of this location is crossed by several drainage ditches and swales that contain wetlands. The northernmost of these drainages conveys storm water from the cylinder storage yard to KPDES Outfall 017, located west of the Paducah GDP entrance road. Two small isolated wetland areas occur about 300 ft (90 m) south of this drainage. Wetlands also occur in drainage ditches that border the gaseous diffusion plant entrance road and the service road that passes through this area. These areas support palustrine emergent wetlands, which are characterized by herbaceous vegetation in saturated or shallowly inundated soils. The dominant vegetation species in these wetlands are spikerush, green bulrush, needle-pod rush, fowl manna grass, field paspalum, twig-rush, and blunt broom sedge. These wetlands are seasonally flooded. They receive surface water runoff from adjacent areas and possibly groundwater discharge, and they generally drain through culverts into drainage channels west of the entrance road. The two isolated wetlands lack a surface outflow. Surface water also remains in the drainages except during periods of high water levels, when excess water is conveyed through the culvert system.

Two small isolated wetlands, as well as a drainage from the adjacent storage yard, also occur immediately east of the forested area. The drainage flows to the west and provides surface water input to a large wetland within the forested area. This area supports palustrine forested wetland, which is characterized by woody vegetation (over 20 ft [60 m] tall) in saturated or shallowly inundated soils. This wetland, approximately 6.3 acres (2.6 ha) in size, lacks a surface outflow and is seasonally flooded. Surface water is present early in the growing season but is absent by mid-summer. The dominant species are similar to those listed above for the forest community. The dominant canopy trees are red maple, sweet gum, cherry bark oak, and pin oak, with swamp chestnut oak, and swamp white oak also present. Saplings of red maple, American elm, green ash, white ash, and sweet gum are the primary species of the shrub layer. Vines are primarily Virginia creeper and poison ivy. The dominant species of the herbaceous layer are stiff marsh bedstraw, blunt broom sedge, narrow-leaved cat tail sedge, swamp rose, and water parsnip, with sensitive fern and fox sedge also present.

Location B contains a series of drainage channels that support riverine and palustrine emergent wetland and flow into Bayou Creek (Figure 3.1-4) (DOE 1994b). In the forested areas of the southern portion of Location B, trees and shrubs overhang these drainages. Two small palustrine emergent wetlands are also located immediately south of Curlee Road. The forested areas support a number of palustrine forested wetlands totaling approximately 1.8 acres [0.7 ha] in area. The dominant canopy species in two of these wetlands are silver maple and cherry bark oak, with green ash present in the shrub layer. Birch is the dominant species in three small forested wetlands; two wetlands are dominated by black willow and buttonbush; and one wetland is dominated by maple. Two wetlands are open water. The predominant forested wetland types are maple/oak, willow/buttonbush, and maple. The total area of wetlands within Location B is approximately 2.9 acres (1.2 ha).

The western portion of Location C contains several palustrine forested wetlands. Pin oak and cherry bark oak are the dominant canopy species in a large wetland area (3.3 acres [1.3 ha]); black gum and red maple are also present. Other forested wetlands in this area are also dominated by cherry bark oak. Small palustrine emergent wetlands along an open pathway support bulrush. Drainage ditches along both sides of Dyke Road contain wetlands with bulrush, sedge, and willow. The eastern portion of Location C contains four small wetlands. Birch is the dominant species of one forested wetland. A small palustrine emergent wetland is located in the southeast corner, and open water wetlands occur to the north. The total area of wetlands within Location C is approximately 5.6 acres (2.3 ha), with 5.3 acres (2.2 ha) in the western portion and 0.3 acre (0.1 ha) in the eastern portion.

3.1.6.4 Threatened and Endangered Species

Federal- and state-listed species in the vicinity of the Paducah site are identified in Table 3.1-5. Although no occurrence of federal-listed plant or animal species on the Paducah site itself has been documented, the Indiana bat (federal- and state-listed as endangered) has been found near the confluence of Bayou Creek and the Ohio River 3 mi (5 km) north of the Paducah GDP. Indiana bats use trees with loose bark (such as shagbark hickory or standing dead trees) in forested areas as roosting sites during spring or summer. Potential roosting habitat for this species occurs on the Paducah site outside the gaseous diffusion plant (U.S. Department of the Army 1994d) and in adjacent wooded areas (Figure 3.1-5). Good-quality habitat contains large trees, provides a dense canopy cover, and is located within 0.25 mi (0.4 km) of potential foraging areas (water bodies). Poor-quality habitat contains less mature trees, provides minimal amounts of canopy cover, and is greater than 0.25 mi (0.4 km) from potential foraging areas. Fair-quality habitat meets some of the requirements for good-quality habitat. Areas within 1,640 ft (500 m) of paved roads are not considered potential Indiana bat habitat.

TABLE 3.1-5 Federal- and State-Listed Endangered, Threatened, and Special Concern Species near the Paducah Site

Category and Scientific Name	Common Name	Status[a]	
		Federal	State
Mammals			
Myotis sodalis	Indiana bat	E	E
Birds			
Ardea herodias	Great blue heron		S
Vireo bellii	Bell’s vireo		S
Amphibians			
Rana areolata circulosa	Northern crawfish frog		S
Fish			
Erimyzon sucetta	Lake chubsucker		T
Plants			
Baptisia bracteata leucophaea	Cream wild indigo		S
Silphium laciniatum	Compass plant		T

[a] E = endangered; S = special concern; T = threatened.

Source: U.S. Department of the Army (1994d).

The compass plant, listed by the Commonwealth of Kentucky as threatened, and cream wild indigo, listed by Kentucky as a species of special concern, are prairie species known to occur in several locations on the Paducah site. State-listed species of special concern that occur on or near the Paducah site include Bell's vireo, great blue heron, and Northern crawfish frog. The lake chubsucker, listed by the state as threatened, is known from early, but not recent, surveys of Bayou Creek and Little Bayou Creek.

No federal- or state-listed species have been found to occur on Location A, B, or C (U.S. Department of the Army 1994d). Potential habitat for the Indiana bat has not been identified at any of the candidate locations (see Figure 3.1-5). The mature forest areas of Location B, near Bayou Creek, may provide good-quality summer roosting sites; however, their proximity to roads reduces their suitability. Trees in other wooded areas of the locations have the potential to be used by Indiana bats; however, their proximity to roads, their distance from foraging areas, and the presence of higher-quality habitat in the vicinity reduce their potential for being used. The nearest potential Indiana bat habitat is west of Bayou Creek, about 0.15 mi (0.24 km) from Location B and 0.35 mi (0.56 km) from Location A. It is rated as having poor potential habitat quality. Another area slightly farther south is rated as having fair potential habitat quality. The nearest location at which a state-listed species has been found is about 0.2 mi (0.3 km) west of Location A and southwest of Location B, where a population of cream wild indigo occurs.

Foraging habitat for the great blue heron includes ponds and other open water areas. Open water wetlands occur in the northeast portion of Location C. The Northern crawfish frog occurs approximately 0.35 mi (0.56 km) northeast of Location C and 0.6 mi (1 km) west of Location B. Habitat for the Northern crawfish frog is native prairie, particularly near fishless ponds or similar surface waters. Compass plant occurs about 0.3 mi (0.5 km) north of Location C. Although Location C supports an herbaceous old-field vegetation community, native prairie species are generally lacking. Prairie restoration and management activities in the vicinity of Location C, however, may increase the occurrence of prairie species in that area. These activities may also increase the potential for occurrence of cream wild indigo in or near Location C. Foraging habitat for the great blue heron includes ponds and other open water areas.

3.1.7 Public and Occupational Safety and Health

3.1.7.1 Radiation Environment

Operations at the Paducah site result in radiation exposure of both on-site workers and off-site members of the general public (Table 3.1-6). Exposures of on-site workers generally are associated with the handling of radioactive materials used in the on-site facilities and with the inhalation of radionuclides released from processes conducted on site. Off-site members of the public are exposed to radionuclides discharged from on-site facilities with airborne and/or waterborne emissions and, in some cases, to radiation emanated from radioactive materials handled in the on-site facilities.

The total radiation dose to a MEI of the general public is estimated to be 1.9 mrem/yr, which is much lower than the maximum radiation dose limit set for the general public of 100 mrem/yr (DOE 1990). The MEI dose is also a small fraction of the 95 mrem/yr dose received by an average individual living close to Paducah from natural background and medical sources. In 2001, the measured external radiation doses for cylinder yard workers ranged from 170 to 427 mrem, with an average of 254 mrem (Hicks 2002a). The measured doses are well below the maximum dose limit of 5,000 mrem/yr set for radiation workers (10 CFR Part 835).

3.1.7.2 Chemical Environment

Table 3.1-7 gives the estimated hazard quotients from chemical exposures for members of the general public under existing environmental conditions near the Paducah site. The hazard quotient represents a comparison of the estimated human intake level of a contaminant with an intake level below which adverse effects are very unlikely to occur (see Appendix F for further details). The estimated hazard quotients indicate that exposures to DUF_6-related contaminants in environmental media near the Paducah site are generally only a small fraction of those that might be associated with adverse health effects. An exception is groundwater, for which the hazard quotients for uranium and several other substances could exceed the threshold of 1. However, because this groundwater is not a drinking water source, there is no exposure. The residents near the Paducah site whose wells have been contaminated have been provided with alternative water sources.

The Occupational Safety and Health Administration (OSHA) has proposed permissible exposure limits (PELs) for uranium compounds and HF in the workplace (29 CFR Part 1910, Subpart Z, as of February 2003) as follows: 0.05 mg/m^3 for soluble uranium compounds, 0.25 mg/m^3 for insoluble uranium compounds, and 2.5 mg/m^3 for HF. Paducah worker exposures are kept below these limits.

3.1.8 Socioeconomics

Socioeconomic data for the Paducah site focus on a ROI surrounding the site consisting of six counties: Ballard, Carlisle, Graves, Marshall, and McCracken Counties in Kentucky, and Massac County in Illinois. The ROI is defined on the basis of the current residential locations of government workers directly connected to Paducah site activities and includes the area in which these workers spend much of their wages. More than 92% of Paducah workers currently reside in these counties (Sheppard 2002). Data are presented in the following sections for each of the counties in the ROI. However, the majority of Paducah site workers live in McCracken County and in the City of Paducah, and it is expected that the majority of impacts from the Paducah site would occur in these locations. Therefore, more emphasis is placed on these two areas.

3.1.8.1 Population

The population of the ROI in 2000 was 161,465 people (U.S. Bureau of the Census 2002a) and was projected to reach 165,000 by 2003 (Table 3.1-8). In 2000, 65,514 people (41% of the ROI total) resided in McCracken County, with 26,307 of them residing in the City of Paducah (U.S. Bureau of the Census 2002a). During the 1990s, each of the counties in the ROI experienced a small increase in population, with an ROI average of 0.6%. The City of Paducah experienced a decline of –0.4% in its population during that period. Over the same period, the population grew at a rate of 0.9% in Kentucky and 0.8% in Illinois.

3.1.8.2 Employment

Total employment in McCracken County in 2000 was 37,426, and it was projected to reach 40,500 by 2003. The economy of the county is dominated by the trade and service industries, with employment in these activities currently contributing almost 71% of all employment in the county (see Table 3.1-9). Excluding mining, which grew from a very small base, employment growth in the highest growth sector (services) was 6.7% during the 1990s, compared with 2.7% in the county for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b).

In 2000, total employment in the ROI was 67,866, and it was projected to reach 69,300 by 2003. The economy of the ROI is dominated by the trade and service industries, with employment in these activities currently contributing 60% of all employment in the ROI

TABLE 3.1-8 Population in the Paducah Region of Influence, Kentucky, and Illinois in 1990, 2000, and 2003

Location	1990	2000	Growth Rate (%), 1990–2000[a]	2003 (Projected)[b]
City of Paducah	27,256	26,307	-0.4	26,000
McCracken County	62,879	65,514	0.4	66,300
Ballard County	7,902	8,286	0.5	8,400
Carlisle County	5,238	5,351	0.2	5,400
Graves County	33,550	37,028	1.0	38,100
Marshall County	27,205	30,125	1.1	31,100
Massac County	14,752	15,161	0.3	15,300
ROI total	151,526	161,465	0.6	164,600
Kentucky	3,685,296	4,041,769	0.9	4,155,000
Illinois	11,430,602	12,419,293	0.8	12,732,000

[a] Average annual rate.

[b] ANL projections, as detailed in Appendix F.

Source: U.S. Bureau of the Census (2002a), except as noted.

TABLE 3.1-9 Employment in McCracken County by Industry in 1990 and 2000

Sector	No. of People Employed in 1990[a]	Percentage of County Total	No. of People Employed in 2000[b]	Percentage of County Total	Growth Rate (%), 1990–2000
Agriculture	785[c]	2.7	489[d]	1.3	-4.62[e]
Mining	10	0.0	175	0.5	33.1
Construction	1,604	5.6	1,786	4.8	1.1
Manufacturing	3,965	13.8	4,210	11.2	0.6
Transportation and public utilities	2,316	8.0	3,400	9.1	3.9
Trade	9,951	34.6	9,258	24.7	-0.7
Finance, insurance, and real estate	1,042	3.6	914	2.4	-1.3
Services	9,022	31.3	17,174	45.9	6.7
Total	28,791		37,426		2.7

[a] U.S. Bureau of the Census (1992).

[b] U.S. Bureau of the Census (2002b).

[c] These agricultural data are for 1992 and are taken from USDA (1994).

[d] These agricultural data are for 1999 and are taken from USDA (1999).

[e] Agricultural data are for 1992 and 1997.

(see Table 3.1-10). Employment growth in the highest growth sector, services, was 6.4% during the 1990s, compared with 0.7% in the ROI for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b). Employment at the Paducah site currently stands at 1,799 (Sheppard 2002).

Unemployment in McCracken County steadily declined during the late 1990s from a peak rate of 6.2% in 1990 to the current rate of 5.4% (Table 3.1-11) (Bureau of Labor Statistics [BLS] 2002). Unemployment in the ROI in December 2002 was 6.0% compared with 5.4% for the state.

3.1.8.3 Personal Income

Personal income in McCracken County was about $1.9 billion (in 2002 dollars) in 2000, and it was projected to reach $2.2 billion in 2003, with an annual average rate of growth of 2.1% over the period 1990 through 2000 (Table 3.1-12). County per capita income also rose in the 1990s, and it was projected to reach $33,200 in 2003, compared with $24,771 at the beginning of the period. In the ROI, total personal income grew at an annual rate of 2.1% over the period 1990 through 2000, and it was expected to reach $4.8 billion by 2003. ROI per capita income was expected to grow from $22,054 in 1990 to $29,000 in 2003, an average annual growth rate of 1.5%.

TABLE 3.1-10 Employment in the Paducah Region of Influence by Industry in 1990 and 2000

Sector	No. of People Employed in 1990[a]	Percentage of ROI Total	No. of People Employed in 2000[b]	Percentage of ROI Total	Growth Rate (%), 1990–2000
Agriculture	5,758[c]	9.1	4,652[d]	6.9	-2.1[e]
Mining	245	0.4	175	0.3	-3.3
Construction	3,730	5.9	3,651	5.4	-0.2
Manufacturing	14,748	23.3	11,866	17.5	-2.2
Transportation and public utilities	4,335	6.8	4,795	7.1	1.0
Trade	17,803	28.1	13,639	20.1	-2.6
Finance, insurance, and real estate	2,356	3.7	1,842	2.7	-2.4
Services	14,578	23.0	27,170	40.0	6.4
Total	63,410		67,866		0.7

[a] U.S. Bureau of the Census (1992).

[b] U.S. Bureau of the Census (2002b).

[c] These agricultural data are for 1992 and are taken from U.S. Department of Agriculture (USDA) (1994).

[d] These agricultural data are for 1999 and are taken from USDA (1999).

[e] Agricultural data are for 1992 and 1997.

3.1.8.4 Housing

Housing stock in McCracken County grew at an annual rate of 1.0% over the period 1990 through 2000 (Table 3.1-13) (U.S. Bureau of the Census 2002a), with total housing units projected to reach 30,900 in 2003, reflecting the relatively slow growth in county population. Growth in the City of Paducah was slight at 0.1% per year, with total housing units projected to reach 13,100 in 2003.

Almost 2,800 new units were added to the existing housing stock in the county during the 1990s; fewer than 100 of those units were constructed in Paducah. Vacancy rates in 2000 stood at 10.6% in the city and 8.6% in the county as a whole for all types of housing. On the basis of annual population growth rates, 2,700 vacant housing units were expected in the county in 2003. About 850 of these were expected to be rental units available to incoming construction workers at the proposed facility.

In the ROI as a whole, housing grew at a higher rate than in McCracken County or Paducah during the 1990s, with an overall growth rate of 1.1% per year. Total housing units were expected to reach 76,600 by 2003, with more than 7,800 housing units added in the 1990s. On the basis of vacancy rates in 2000, which stood at 10.5%, more than 2,000 rental units were expected to be available for incoming construction workers at the proposed facility.

TABLE 3.1-11 Unemployment Rates in McCracken County, the Paducah Region of Influence, and Kentucky

Location and Period	Rate (%)
McCracken County	
1992–2002 average	4.6
Dec. 2002 (current rate)	5.4
ROI	
1992–2002 average	5.8
Dec. 2002 (current rate)	6.0
Kentucky	
1992–2002 average	5.4
Dec. 2002 (current rate)	5.4

Source: BLS (2002).

3.1.8.5 Community Resources

3.1.8.5.1 Community Fiscal Conditions. Revenues and expenditures for local government jurisdictions, including counties, cities, and school districts constitute community fiscal conditions. Revenues would come primarily from state and local sales tax revenues associated with employee spending during construction and operation and would be used to support additional local community services currently provided by each jurisdiction. Tables 1 and 2 in Allison (2002) present information on revenues and expenditures by the various local government jurisdictions in the ROI.

TABLE 3.1-12 Personal Income in McCracken County and the Paducah Region of Influence in 1990, 2000, and 2003

Location and Type of Income	1990	2000	Growth Rate (%), 1990–1997	2003 (Projected)[a]
McCracken County				
Total personal income (millions of 2002 $)	1,558	1,910	2.1	2,200
Personal per capita income (2002 $)	24,771	29,147	1.6	33,200
Total ROI				
Total personal income (millions of 2002 $)	3,342	4,125	2.1	4,800
Personal per capita income (2002 $)	22,054	25,548	1.5	29,000

[a] ANL projections, as detailed in Appendix F.

Source: U.S. Department of Commerce (2002).

3.1.8.5.2 Community Public Services. Construction and operation of the proposed facility would increase demand for community services in the counties, cities, and school districts likely to host relocating construction workers and operations employees. Additional demands would also be placed on local medical facilities and physician services. Tables 3.1-14 and 3.1-15 present data on employment and levels of service (number of employees per 1,000 population) for public safety, general local government services, and physicians. Tables 3.1-16 and 3.1-17 provide staffing data for school districts and hospitals.

TABLE 3.1-13 Housing Characteristics in the City of Paducah, McCracken County, and the Paducah Region of Influence in 1990 and 2000

Location and Type of Unit	No. of Units	
	1990	2000
City of Paducah		
Owner-occupied	6,501	6,254
Rental	5,454	5,571
Total unoccupied	1,195	1,396
Total	13,150	13,221
McCracken County		
Owner-occupied	17,470	19,054
Rental	8,155	8,682
Total unoccupied	1,956	2,625
Total	27,581	30,361
ROI Total		
Owner-occupied	45,815	50,412
Rental	15,181	16,441
Total unoccupied	5,935	7,856
Total	66,931	74,709

Source: U.S. Bureau of the Census (2002a).

3.1.9 Waste Management

The Paducah site generates wastewater, solid LLW, solid and liquid LLMW, nonradioactive hazardous waste, and nonradioactive nonhazardous solid waste. Wastes generated from site operations and environmental restoration are managed by DOE. DOE also manages the disposal of waste generated from ongoing management of the DOE-generated DUF_6 cylinders currently in storage. The cylinder storage yards at Paducah currently generate only a very small amount of waste compared with the volume of waste generated from ongoing gaseous diffusion plant operations and environmental restoration. Cylinder yard waste consists of small amounts of metal, scrapings from cylinder maintenance operations, potentially contaminated soil, and miscellaneous items.

The site has an active program to minimize the generation of solid LLW, hazardous waste, and LLMW. Waste minimization efforts for radioactive waste include preventing packaging material from entering radiological areas and replacing wood pallets used in radiological areas. Hazardous waste and LLMW minimization actions include using chlorinated solvents less, recycling paint waste, and compacting PCB wastes. Solid waste minimization actions include recycling of paper and cardboard and off-site recycling of fluorescent bulbs and used batteries.

Table 3.1-18 lists the Paducah site waste loads assumed for the analysis of impacts of projected activities.

TABLE 3.1-14 Public Service Employment in the City of Paducah, McCracken County, and Kentucky in 2002

	City of Paducah		McCracken County		Kentucky[b]
Employment Category	No. of Workers	Level of Service[a]	No. of Workers	Level of Service[a]	Level of Service[a]
Police	74	2.8	41	1.0	1.5
Fire[c]	77	2.9	0	0	1.3
General	174	6.6	180	4.5	34.1
Total	325	12.4	221	5.6	36.9

[a] Level of service represents the number of employees per 1,000 persons in each jurisdiction.

[b] 2000 data.

[c] Does not include volunteers.

Sources: City of Paducah: Moriarty (2002); McCracken County: Brown (2002); Kentucky: U.S. Bureau of the Census (2002d).

TABLE 3.1-15 Number of Physicians in McCracken County and Kentucky in 1997

	McCracken County		Kentucky
Employment Category	No.	Level of Service[a]	Level of Service[a]
Physicians	205	3.1	2.2

[a] Level of service represents the number of physicians per 1,000 persons in each jurisdiction.

Source: American Medical Association (1999).

TABLE 3.1-16 School District Data for McCracken County and Kentucky in 2001

	McCracken County		Kentucky
Employment Category	No.	Student-to-Teacher Ratio[a]	Student-to-Teacher Ratio[a]
Teachers	510	12.6	12.4

[a] The number of students per teacher in each school district.

Source: Kentucky Department of Education (2002).

TABLE 3.1-17 Medical Facility Data for McCracken County in 1998

Hospital	No. of Staffed Beds	Occupancy Rate (%)[a]
Carter Behavioral Health System	56	NA[b]
Lourdes Hospital	290	55
Western Baptist Hospital	325	57
McCracken County total	671	NA

[a] Percentage of staffed beds occupied.

[b] NA = not available.

Source: Healthcare InfoSource, Inc. (1998).

3.1.9.1 Wastewater

Wastewater at the Paducah site consists of nonradioactive sanitary and process-related wastewater streams, cooling water blowdown, and radioactive process-related liquid effluents. Wastewater is processed at on-site treatment facilities and is discharged to Bayou Creek or Little Bayou Creek through eight permitted outfalls. The total capacity of the site wastewater control facilities is approximately 1.75 million gal/d (6.6 million L/d).

3.1.9.2 Solid Nonhazardous, Nonradioactive Waste

Solid waste — including sanitary refuse, cafeteria waste, industrial waste, and construction and demolition waste — is collected and disposed of at the on-site landfill, which consists of three cells. The landfill is permitted for 1 million yd^3 (764,600 m^3) per Permit KY073-00045.

TABLE 3.1-18 Projected Waste Generation Volumes for the Paducah Site[a]

Waste Category	Waste Treatment Volume (m^3/yr)
LLW	7,200
LLMW	7,600
TRU	0.6
Hazardous waste	370
Nonhazardous waste[b]	
Solids	18,900
Wastewater	72

[a] Volumes include operational and environmental restoration wastes projected from FY 2002 to FY 2025.

[b] Volumes include sanitary and industrial wastes.

Source: Cain (2002c).

3.1.9.3 Nonradioactive Hazardous and Toxic Waste

Nonradioactive waste that is considered hazardous waste according to RCRA or contains PCBs as defined under the TSCA requires special handling, storage, and disposal. The Paducah site generates hazardous waste, including spent solvents, heavy-metal-contaminated waste, and PCB-contaminated toxic waste. The site has a permit that authorizes it to treat and store hazardous waste in 10 treatment units, 16 tanks, and 4 container storage areas at the site. Several additional 90-day storage areas for temporary storage of hazardous waste are located on the site.

Certain hazardous/toxic wastes are sent to permitted off-site contractors for final treatment and/or disposal. Much of the hazardous/toxic waste load consists of PCB-contaminated waste. Some liquid hazardous and/or mixed waste streams are shipped to the ETTP site for incineration in a TSCA incinerator with a capacity of 1,800 yd^3/yr (1,400 m^3/yr).

3.1.9.4 Low-Level Radioactive Waste

LLW generated at the Paducah site is stored on site pending shipment to a commercial facility in Tennessee for volume reduction. Solid LLW generated at the Paducah site includes refuse, sludge, and debris contaminated with radionuclides, primarily uranium and technetium. Site wastewater treatment facilities can process up to 1,480 yd^3 (1,140 m^3) per year of aqueous LLW.

3.1.9.5 Low-Level Radioactive Mixed Waste

LLW that contains PCBs or RCRA hazardous components is considered to be LLMW. On-site capacity for storing LLMW containers at the Paducah site is 3,600 yd^3 (2,800 m^3). The site can treat up to 204 ft^3/yr (156 m^3/yr) of aqueous LLMW (DOE 1996).

3.1.10 Land Use

The Paducah site is located in western Kentucky, in the northwestern portion of rural McCracken County about 10 mi (16 km) west of the City of Paducah. On the basis of an analysis of Landsat satellite imagery from 1992, dominant land cover categories in McCracken County include pasture/hay (27.8%), row crops (27.0%), and deciduous forest (17.8%) (Figure 3.1-6). The most recent agricultural census recorded 457 farms in McCracken County in 1997, covering more than 66,500 acres (26,900 ha) (U.S. Department of Agriculture [USDA] 1999). Residential land use occurs throughout much of McCracken County; most of it occurs in the eastern half of the county in the communities of Concord, Hendron, Lone Oak, Massac, Paducah, Reidland, and Woodlawn-Oakdale. The western half of the county, where the site lies, consists primarily of pasture/hay and row crops.

The Paducah site encompasses 3,556 acres (1,439 ha) currently held by DOE (DOE 2001b). It is surrounded by the West Kentucky Wildlife Management Area, an additional 2,781 acres (1,125 ha) conveyed by DOE to the Commonwealth of Kentucky for use in wildlife conservation and for recreational purposes. According to a 1953 agreement granting the land to the Kentucky Department of Fish and Wildlife Resources, DOE can use any or all of this surrounding land whenever the need arises (MMES 1990). The Paducah GDP occupies a 750-acre (303-ha) complex within the Paducah site and is surrounded by a security fence (see Figure 3.1-1). The site is heavily developed and includes about 115 buildings with a combined floor space of about 8.2 million ft^2 (0.76 million m^2). The areas between buildings consist primarily of mowed grassy areas, while the area immediately surrounding the Paducah site generally features a combination of pasture, row crops, and deciduous forest.

3.1.11 Cultural Resources

Prehistoric and historic cultural resources are present at the Paducah site and within its immediate surroundings. Prehistoric archaeological sites at the Paducah site, found chiefly on floodplains, include remains from the Archaic (8000–1000 B.C.), Woodland (1000 B.C.–A.D. 1000), and Mississippian (A.D. 1000–1700) periods. The Paducah GDP is located in what were once traditional Chickasaw hunting grounds, and Chickasaw were reported in the Paducah area as late as 1827. In addition, the Peoria of Oklahoma have land claims in McCracken County. Consultation with these groups as well as the Kentucky State Historic Preservation Officer (SHPO) has been initiated (see Appendix G for consultation letters). No religious or sacred sites, burial sites, or resources significant to Native Americans have been identified at the Paducah site to date.

Historically, what is now the Paducah GDP site was included in the Jackson Purchase — land purchased from the Chickasaw in 1818. Uplands included dispersed 19th century farmsteads, settlements, and three associated cemeteries. The Paducah site was initially acquired in 1942 for the construction of the Kentucky Ordnance Works (KOW). Some KOW structures still remain. The AEC acquired KOW for the construction of a gaseous diffusion plant in 1950 as part of the nation's Cold War nuclear armament program. Construction began in 1951 (U.S. Department of the Army 1994a). The plant was completed in 1954, with enriched uranium production beginning in 1955. The plant's mission has continued unchanged, and the upgraded and refurbished original enrichment facilities remain in operation under lease to USEC (DOE 2001b).

Although the Paducah GDP has not undergone a complete archaeological survey, 32 archaeological sites have been recorded. Of these, at least three prehistoric sites and one historic site are potentially eligible for the *National Register of Historic Places* (NRHP) (U.S. Department of the Army 1994a,b). In 1994, a 20% stratified random sample archaeological survey was conducted at the Paducah GDP. Results of a sensitivity analysis based on this survey indicate that, for the most part, the candidate DUF_6 construction locations have a "low" to "very low" sensitivity index (low to very low probability of containing significant archaeological resources) (U.S. Department of the Army 1994a,b).

No archaeological sites are known from Location A, which was not included in the 1994 survey of the site. Several temporary buildings were located at this site during the construction of the Paducah GDP. These buildings have since been removed, but their foundations may remain. The southern end of the location includes old growth forest and appears to be relatively undisturbed. Only this southern portion of Location A appears to have been considered in the archaeological sensitivity analysis. It has a "low" to "very low" sensitivity index (U.S. Department of the Army 1994b).

The undeveloped portion of Location B includes rolling fields and the margins of the Bayou Creek floodplain. The rolling fields appear to have been created by the dumping of spoil during the construction or operation of the Paducah GDP. The portions of the site directly overlooking Bayou Creek appear to be undisturbed and have a "high" archaeological sensitivity. The remaining undeveloped sections vary in archaeological sensitivity from "low" to "very low" (U.S. Department of the Army 1994b).

Location C is a flat, densely wooded area outside the eastern fences of the Paducah GDP main compound. About half the location was included in the 1994 survey, but no archaeological sites were identified. The location has a "low" to "very low" sensitivity index (U.S. Department of the Army 1994b).

A pending programmatic agreement (PA) among DOE, the Kentucky SHPO, and the Advisory Council on Historic Preservation calls for a complete cultural resource survey of the Paducah GDP, including an architectural survey of Cold War era scientific facilities. That survey will be undertaken once the agreement is finalized. The PA also stipulates the development and implementation of a cultural resource management plan (CRMP).

3.1.12 Environmental Justice

3.1.12.1 Minority Populations

This EIS uses data from the most recent decennial census in 2000 to evaluate environmental justice implications of the proposed action and the no action alternative with respect to minority populations. The CEQ guidelines on environmental justice recommend that "minority" be defined as members of American Indian or Alaska Native, Asian or Pacific Islander, Black non-Hispanic, and Hispanic populations (CEQ 1997). The earliest release of 2000 census data that included information necessary to identify minority populations identified individuals both according to race and Hispanic origin (U.S. Bureau of the Census 2001). It also identified individuals claiming multiple racial identities (up to six races). To remain consistent with the CEQ guidelines, the phrase "minority populations" in this document refers to persons who identified themselves as partially or totally Black (including Black or Negro, African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian), American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or "Other Race." The minority category also includes White individuals of Hispanic origin, although the latter is technically an ethnic category. To avoid double counting, tabulations included only

White Hispanics; the above racial groups already account for non-White Hispanics. In sum, then, the minority population considered under environmental justice consisted of all non-White persons (including those of multiple racial affiliations) plus White persons of Hispanic origin.

To identify census tracts with disproportionately high minority populations, this EIS uses the percentage of minorities in each state containing a given tract as a reference point. Using the individual states to identify disproportionality acknowledges that minority distributions in the state can differ from those found in the nation as a whole. In 2000, of the 173 census tracts within 50 mi (80 km) of the proposed conversion facility at Paducah, 42 had minority populations in excess of state-specific thresholds — a total of 47,093 minority persons in all (Figure 3.1-7). In McCracken County, 13.2% of the population in 2000 was minority (U.S. Bureau of the Census 2002c).

3.1.12.2 Low-Income Populations

As recommended by the CEQ guidelines, the environmental justice analysis identifies low-income populations as those falling below the statistical poverty level identified annually by the U.S. Bureau of the Census in its Series P-60 documents on income and poverty. The Census Bureau defines poverty levels on the basis of a statistical threshold that considers for each family both overall family size and the number of related children younger than 18 years old. For example, in 1999, the poverty threshold annual income for a family of three with one related child younger than 18 was $13,410, while the poverty threshold for a family of five with one related child younger than 18 was $21,024 (U.S. Bureau of the Census 2000). The 2000 census used 1999 thresholds, because 1999 was the most recent year for which annual income data were available when the census was conducted. If a family fell below the poverty line for its particular composition, the census considered all individuals in that family to be below the poverty line.

To identify census tracts with disproportionately high low-income populations, this EIS uses the percentage of low-income persons living in each state containing a given tract as a reference point. In 1999, of the 204 census tracts within 50 mi (80 km) of the proposed conversion facility at Paducah, 109 had low-income populations in excess of state-specific thresholds — a total of 118,029 low-income persons in all (Figure 3.1-8). In McCracken County in 1999, 15.1% of the individuals for whom poverty status was known were low-income (U.S. Bureau of the Census 2002c).

3.2 EAST TENNESSEE TECHNOLOGY PARK

ETTP is located in eastern Roane County about 25 mi (40 km) west of Knoxville, Tennessee (Figure 3.2-1). ETTP is part of the ORR in the City of Oak Ridge, Tennessee. The site was established in 1940 with initiation of construction of the Oak Ridge Gaseous Diffusion Plant. Uranium enrichment was the site's mission until the mid-1980s, when gaseous diffusion operations ceased. In 1990, the site was renamed as the K-25 Site, and it was renamed again in 1997 as the ETTP. Previous missions were waste management and restoration; the current

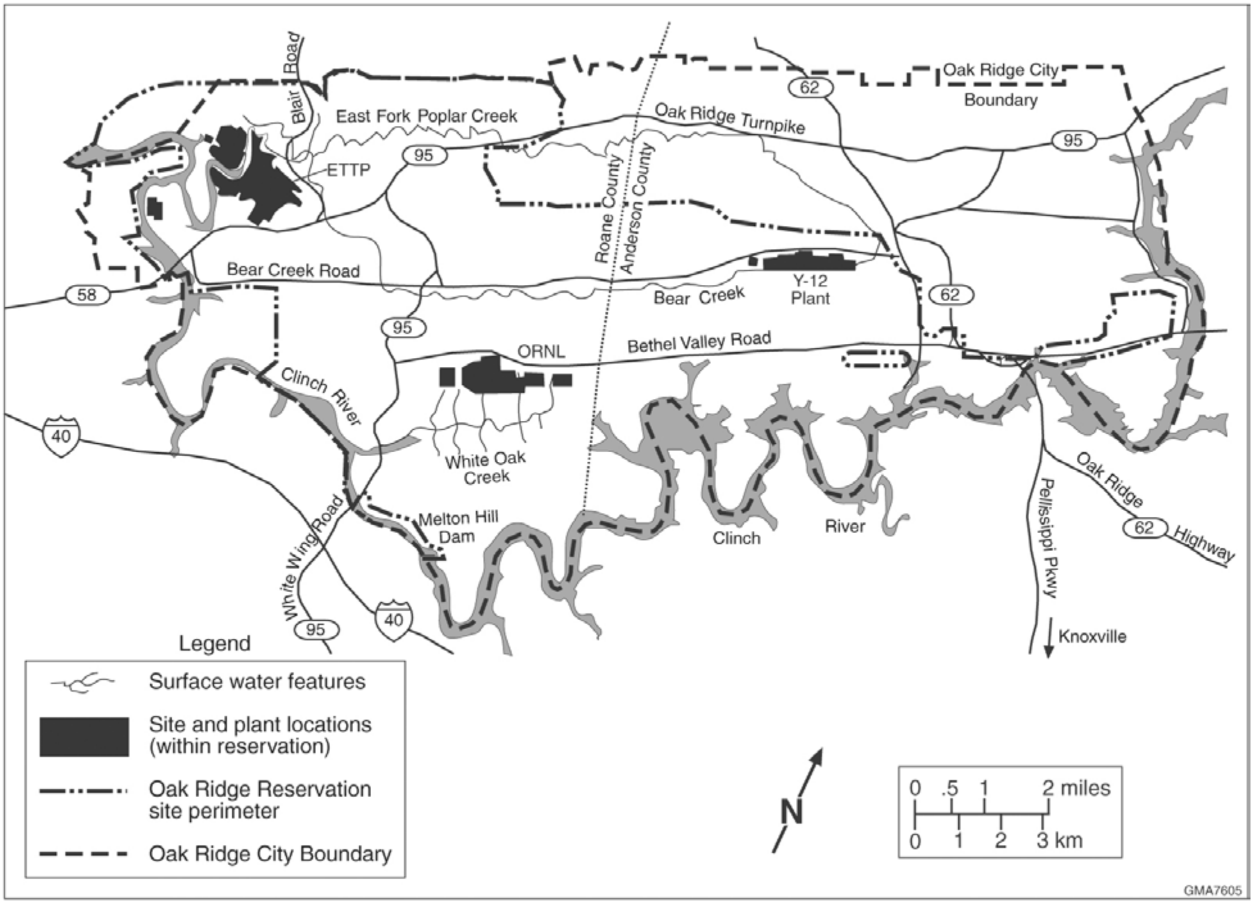

FIGURE 3.2-1 Regional Map of the ETTP Vicinity

mission is to "reindustrialize and reuse site assets through leasing of vacated facilities and incorporation of commercial industrial organizations as partners in the ongoing environmental restoration (ER), D&D, waste treatment and disposal, and diffusion technology development activities" (DOE 2001b).

TABLE 3.2-1 DOE-Managed DUF_6 Cylinders at the ETTP Site

Cylinder Type	No. of Cylinders
Full	4,719
Partially full	83
Heel	20
Total	4,822

Source: Hightower (2004).

3.2.1 Cylinder Yards

There are 4,822 DUF_6 storage cylinders located in ETTP site cylinder yards (Table 3.2-1, Figure 3.2-2). Cylinders are stacked two high to conserve space. About 30% of the cylinders are stored in yard K-1066-E (constructed with a concrete base), and 30% are stored in yard K-1066-K (constructed with a gravel base). The other cylinders are stored in four smaller yards.

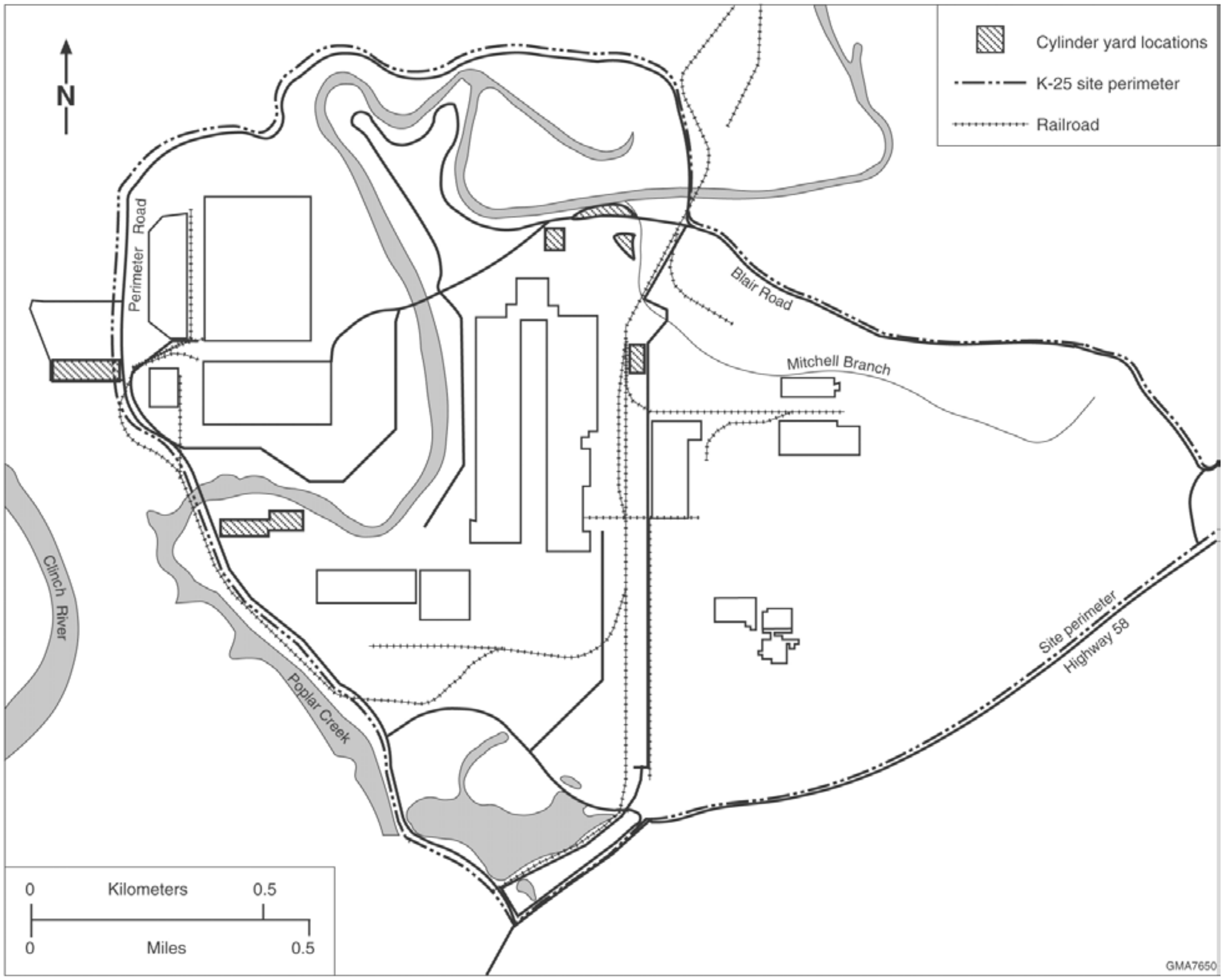

FIGURE 3.2-2 Locations of Storage Yards at ETTP That Are Used to Store DOE-Managed Cylinders

In storage at ETTP, in addition to the cylinders that contain DUF_6, are a number of cylinders in various sizes that contain enriched UF_6 or normal UF_6 or are empty. The non-DUF_6 cylinders total 1,102 and contain a total of about 26 t (29 tons) of UF_6 (7 t [8 tons] of enriched UF_6 plus 19 t [21 tons] of normal UF_6) (Hightower 2004). About 20 cylinders are empty. Of the 881 non-DUF_6 cylinders that contain enriched uranium, fewer than 30 contain uranium enriched to greater than 5% uranium-235, and all of these are small, sample cylinders containing less than 3 lb (1.4 kg) of UF_6 each. Over 98% of the enriched uranium in cylinders at ETTP contains less than 5% uranium-235. It is assumed that the natural and enriched UF_6 would be put to beneficial uses; therefore, conversion of the contents of the non-DUF_6 cylinders is not considered in this EIS. This EIS does, however, include these cylinders in its evaluation of an alternative that considers the transportation of cylinders from ETTP to Paducah for conversion.

It is expected that many of the full DUF_6 cylinders at the ETTP site would not meet DOT transportation requirements because of damage and corrosion from poor historical storage conditions. It was estimated in the PEIS that a range of one-half to all of the full DUF_6 cylinders would not meet DOT transportation requirements (DOE 1999a). More recent estimates indicate that 1,700 cylinders are DOT compliant, with the remainder not meeting DOT requirements (see Section 1.7). No similar estimate of the condition of the non-DUF_6 cylinders at ETTP is available.

3.2.2 Site Infrastructure

The ETTP site is located in an area with a well-established transportation network. The site is near two interstate highways, several U.S. and state highways, two major rail lines, and a regional airport (Figure 3.2-1).

The ETTP water supply is pumped from Clinch River. The water is treated and stored in two storage tanks. This system, with a capacity of 4 million gal/d (15 million L/d), provides water to the Transportation Safeguards Facility and the ETTP site.

Electric power is supplied by the TVA. The distribution of power is managed through the ETTP Power Operations Department. The average demand for electricity by all of the DOE facilities at Oak Ridge, including the ETTP site, is approximately 100 MVA. The maximum capacity of the system is 920 MVA (DOE 1995). Natural gas is supplied by the East Tennessee Natural Gas Company; the daily capacity of 7,600 decatherms can be increased, if necessary. The average daily usage in 1994 was 3,600 decatherms (DOE 1995).

3.2.3 Climate, Air Quality, and Noise

3.2.3.1 Climate

The climate of the region, including the ETTP site, may be broadly classified as humid continental. The region is located in a broad valley between the Cumberland Mountains to the northwest and the Great Smoky Mountains to the southeast, which influence meteorological patterns over the region (Wood 1996). During the summer, tropical air masses from the south provide warm and humid conditions that often produce thunderstorms. In winter, the Cumberland Mountains have a moderating influence on local climate by shielding the region from cold air masses from the north and west.

For the period 1961 through 1990, the annual average temperature was 13.7°C (56.6°F), with the highest monthly average temperature of 24.3°C (75.8°F) occurring in July and the lowest of 1.7°C (35.0°F) occurring in January (Wood 1996). Annual precipitation averages about 137 cm (53.8 in.), including about 25 cm (9.8 in.) of snowfall. Precipitation is evenly distributed throughout the season, with the highest occurring in spring.

Winds in the region are controlled in large part by the valley-and-ridge topography. Prevailing wind directions are from the northeast and southwest, reflecting the channeling of winds parallel to the ridges and valleys in the area. The average wind speed at Oak Ridge is about 2.0 m/s (4.4 mph); the dominant wind direction is from the southwest (Wood 1996). For 2001, the average wind speed at the 10-m (33-ft) level of the ETTP K1209 meteorological tower was 1.5 m/s (3.4 mph), as shown in Figure 3.2-3 (ORNL 2002). The lower wind speed in the region reflects the air stagnation relatively common in eastern Tennessee. The dominant wind direction is southwest, with secondary peaks from the south-southwest and the east.

Tornadoes rarely occur in the valley surrounding the ETTP site between the Cumberlands and the Great Smokies, and they historically have been less destructive than those in the Midwest. For the period 1950 through 1995, 541 tornadoes were reported in Tennessee, with an average of 12 tornadoes per year (Storm Prediction Center 2002). For the same period, 3 tornadoes were reported in Anderson and Roane Counties each, but these tornadoes were relatively weak, being F3 of the Fujita tornado scale, at most.

3.2.3.2 Existing Air Emissions

At the end of calendar year 2001, there were 88 active air emission sources under DOE control at ETTP (DOE 2002c). Of these 88 sources, ETTP operated 30; these were covered under 8 major air emission sources subject to rules in the Tennessee Title V Major Source Operating Permit Program under an application shield granted by the TDEC Division of Air Pollution Control. All remaining active air emission sources are exempt from permitting requirements.

Major sources for criteria pollutants and VOCs in Anderson and Roane Counties in Tennessee include TVA steam plants and DOE operations, including the Y-12, ORNL, and ETTP sites. Annual emissions from major sources and total county emissions are presented in Table 3.2-2. The SO_2 and NO_x emissions from ETTP operations are negligible compared with those from the two TVA steam plants in Anderson and Roane Counties. However, VOC emissions account for about 39% of the Roane County emission total, and PM (PM_{10} and $PM_{2.5}$) emissions account for about 8% of the Roane County emission total. The amount of actual emissions from the ETTP site is much less than the amount of allowable emissions presented in Table 3.2-2 (DOE 2002c).

The State of Tennessee and the EPA regulate airborne emissions of radionuclides from DOE facilities under 40 CFR Part 61, Subpart H, NESHAPs regulations (DOE 2002c). The three ETTP major sources that operated during 2000 were the TSCA incinerator and the two stacks in the K-33 building operated by British Nuclear Fuels, Ltd. Emissions from these exhaust stacks are controlled by a particulate filtration system, and continuous sampling for radionuclides emissions is conducted at these stacks to assess the dose to the public.

TABLE 3.2-2 Annual Criteria Pollutant and Volatile Organic Compound Emissions from Selected Major Point Sources around the ETTP Site in 1999

	Emission Rate (tons/yr)					
Major Emission Source	SO_2	NO_x	CO	VOC	PM_{10}	$PM_{2.5}$
TVA Bull Run Steam Plant, Clinton	38,179	13,528	420	50	529	267
Y-12 Plant (DOE)	13,375	1,672	38	19	61	21
Anderson County, Tenn., total	51,555	15,237	460	405	731	365
TVA Kingston Steam Plant, Kingston	109,194	26,055	995	122	95	98
ORNL (DOE)	361	25	53	14	363	267
ETTP (formerly K-25) (DOE)	222 (0.20%, 0.14%)[a]	60 (0.23%, 0.14%)	29 (2.5%, 1.8%)	86 (39%, 14%)	41 (8.2%, 3.2%)	34 (8.5%, 4.5%)
Roane County, Tenn., total	109,777	26,149	1,157	222	498	399

[a] First and second values in parentheses are ETTP emissions as percentages of Roane County emissions total and combined Anderson and Roane Counties emissions total, respectively.

Source: EPA (2003a).

3.2.3.3 Air Quality

The Tennessee SAAQS for six criteria pollutants — SO_2, NO_2, CO, O_3, PM (PM_{10} and $PM_{2.5}$), and Pb — are almost the same as the NAAQS (Waynick 2002), as shown in Table 3.2-3. In addition, the state has adopted standards for gaseous fluorides (expressed as HF), as presented in Table 3.2-4.

The ETTP site in Roane County is located in the Eastern Tennessee-Southwestern Virginia Interstate AQCR. Currently, the county is designated as being in attainment for all criteria pollutants (40 CFR 81.343).

Although uranium enrichment activities at ETTP were discontinued in 1985, ambient air monitoring for radionuclides, criteria pollutants (PM_{10} and Pb),[3] and several metals has continued at on-site and off-site locations (DOE 2002c). Monitoring indicates that no standards were exceeded, and there was no statistically significant elevation of pollutant concentrations associated with site operations. On the basis of modeling radionuclide emissions from all major and minor point sources, the effective dose equivalent to the most exposed member of the public was 0.8 mrem/yr in 2001, well below the NESHAPs dose limit of 10 mrem/yr (DOE 2002c).

[3] At the end of 2001, all PM_{10} sampling was discontinued after a review of PM_{10} data over a 10-year period (1991 through 2000) in which all concentrations were below the ambient air quality standards.

TABLE 3.2-4 Additional Tennessee Ambient Air Quality Standards[a]

Pollutant	Averaging Time	Primary Standard	Secondary Standard
Gaseous fluorides (as HF)	12 hours	–[b]	3.7 μg/m^3(4.5 ppb)[c]
	24 hours	–	2.9 μg/m^3 (3.5 ppb)[c]
	7 days	–	1.6 μg/m^3 (2.0 ppb)[c]
	30 days	–	1.2 μg/m^3 (1.5 ppb)[c]
Gaseous fluorides (as HF)[d]	30 days	–	0.5 μg/m^3 (0.6 ppb)[c]

[a] These standards are in addition to the Tennessee SAAQS listed in Table 3.2-3.

[b] A dash indicates that no standard exists.

[c] This average is not to be exceeded more than once per year.

[d] Applied in the vicinity of primary aluminum reduction plants in operation on or before December 31, 1973.

Source: TDEC (1999).

Also, the airborne dose from all ETTP radionuclide emissions was still less than the ORR maximum. The highest concentration levels for SO_2, NO_2, CO, PM_{10}, 24-hour $PM_{2.5}$, and Pb around and within the ETTP site are less than or equal to 78% of their respective NAAQS in Table 3.2-3 (EPA 2003; DOE 2002c). However, the highest O_3 and annual $PM_{2.5}$ concentrations that are of regional concern are approaching or somewhat higher than the applicable NAAQS.

PSD regulations (40 CFR 52.21) limit the maximum allowable incremental increases in ambient concentrations of SO_2, NO_2, and PM_{10} above established baseline levels, as shown in Table 3.2-3. The PSD regulations, which are designed to protect ambient air quality in Class I and Class II attainment areas, apply to major new sources and major modifications to existing sources. The nearest Class I PSD is the Great Smoky Mountains National Park, about 55 km (34 mi) southeast of ETTP. The Joyce Kilmer-Slickrock Wilderness Area just south of the western end of Great Smoky Mountains National Park is also a Class I area. These Class I areas are not located downwind of prevailing winds at the ETTP (see Figure 3.2-3).

3.2.3.4 Existing Noise Environment

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978, 42 USC Parts 4901–4918), delegates to the states the authority to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Anderson County has quantitative noise-limit regulations, as shown in Table 3.2-5 (Anderson County 2002), although the State of Tennessee and Roane County do not.

The EPA has recommended a maximum noise level of 55 dB(A) as DNL to protect against outdoor activity interference and annoyance (EPA 1974). This level is not a regulatory goal but is "intentionally conservative to protect the most sensitive portion of the American population," with "an additional margin of safety." For protection against hearing loss in the general population from nonimpulsive noise, the EPA guideline recommends an L_{eq}(24 h) of 70 dB(A) or less over a 40-year period.

The noise-producing activities within the ETTP site are associated with the DUF_6 cylinder project and local traffic, similar to that at any other industrial site. Major noise sources within the ETTP site consist of heavy equipment, forklift, and crane operations associated with cylinder handling, steel grit blasting operations, welding/burning/hotwork activities during breach repairs, etc. (Cain 2002a).

ETTP is in a rural setting, and no residences and sensitive receptors (e.g., schools, hospitals) are located in the immediate vicinity. As part of hearing protection for workers, industrial hygiene measurements of noise associated with the DUF_6 cylinder project have been made since 1998. Ambient noise levels around the site are relatively low. Measurements taken at the nearby residence along Poplar Creek Road (off Blair Road) to the north of the site on June 1991 at 8:30 a.m. was about 39 dB(A), typical of a rural environment (ANL 1991b). At three residences on Blair Road nearest the site, noises from the K-25 activities were not distinguishable from background noise. To date, there have been no complaints about noise from neighboring communities.

TABLE 3.2-5 Allowable Noise Level by Zoning District in Anderson County, Tennessee

Zoning		Allowable Noise Level (dBA)	
District	Abbreviation	7 a.m.–10 p.m.	10 p.m.–7 a.m.
Suburban-residential	R-1	60	55
Rural-residential	A-2	65	60
Agriculture-forest	A-1	65	60
General commercial	C-1	70	65
Light industrial	I-1	70	70
Heavy industrial	I-2	80	80
Floodway	F-1	80	80

Source: Anderson County (2002).

3.2.4 Geology and Soil

3.2.4.1 Topography, Structure, and Seismic Risk

The topography of the Oak Ridge site is varied; the maximum change in elevation across the site is about 420 ft (130 m). The site is underlain by sedimentary rocks composed of limestone and dolomite. Sinkholes, large springs, and other karst features can occur in the limestone formations adjacent to the site (DOE 1995).

The ETTP site is situated in the Valley and Ridge Subregion of the Appalachian Highlands Province near the boundary with the Cumberland Plateau (DOE 1995). This subregion consists of a series of northeast-southwest trending ridges bounded by the Cumberland Escarpment on the west and by the Blue Ridge Front on the east.

The major stratigraphic units underlying the site and its confining ridges are the Rome Formation (silty shale and shale), the Conasauga Group (calcareous shale interbedded with limestone and siltstone), the Knox Group (silty dolomite), and the Chickamauga Limestone (interbedded with layers of bentonite). These units range in age from Lower Cambrian (Rome Formation) to Middle Ordovician (Chickamauga Limestone). Contacts between the members are gradational and discontinuous. Sinkholes, large springs, and other karst features are common in the Knox Group, and areas underlain with limestone or dolomites are, for the most part, classified as karst terrains (DOE 1995).

The most important structural feature near the site is a fault system consisting of the Whiteoak Mountain Fault, which runs through the southeastern corner of the Oak Ridge facility; the Kingston Fault, a parallel fault that occurs north of Poplar Creek; and the Copper Creek Fault, located in Melton Valley. A branch of the Whiteoak Mountain Fault originates just south of the facility and runs due north through its center. None of these faults appear to have any topographic expression, and it is assumed that displacement took place prior to the development of the present surface of erosion (DOE 1979). These faults can probably be considered inactive; no seismic events have been associated with these faults near the site, and no surface movement has been reported along the faults.

3.2.4.2 Soils

The typical soil types of the Valley and Ridge Province at ETTP are red-yellow podsols, reddish-brown laterites, or lithosols (DOE 1979). They are usually strongly leached and acidic and have a low organic content. The thickness of alluvium beneath the site ranges from nearly 0 to 60 ft (0 to 18 m). Soils developed on the Chickamauga Formation, which underlies most of the site, are typically yellow to yellow-brown montmorillonites. The Conasauga Shale, which underlies the southeastern corner of the site, develops a silty brown, tan, greenish, and maroon clay that is micaceous and contains fragments of unweathered parent rock. In upland areas around the site, the Fullerton Soil Series is dominant. This soil has moderate infiltration rates and is moderately drained to well drained. The Nolichucky and Talbott Series soils are the most abundant valley and terrace soils within the site proper. The Nolichucky and Talbott Series soils are similar to the Fullerton Series soils (Geraghty & Miller, Inc. 1989).

Soil and groundwater data have been collected to determine whether contamination is associated with the Oak Ridge cylinder yards (DOE 1994a). Substances in soil possibly associated with cylinder management activities are uranium and fluoride compounds, which could be released to soil if breached cylinders or faulty valves were present. In 1991, 122 systematic soil samples were collected at the K-yard; these samples had maximum concentrations of 0.14 mg/kg of uranium-235 and 13 mg/kg of uranium-238. Soil samples collected in March 1992 at the K-yard had a maximum uranium concentration of 36 ±2 mg/kg.

In 1994, 200 systematic and 28 biased soil samples were collected in areas surrounding the cylinder yards; the maximum concentrations detected in these samples were 0.83 mg/kg of uranium-235 at the K-1066-F yard (F-yard) and 75 mg/kg of uranium-238 at the E-yard. Groundwater concentrations of total uranium (measured as gross alpha and gross beta) for upgradient and downgradient wells indicate that although some elevated levels of uranium have been detected in cylinder yard soil, no migration to groundwater has occurred (DOE 1994a).

Soil samples collected as part of general site monitoring in the immediate surrounding area in 1994 had the following maximum concentrations: uranium, 6.7 mg/kg; Aroclor® 1254 (a PCB), 0.16 mg/kg; cadmium, 0.34 mg/kg; mercury, 0.15 mg/kg; and nickel, 33 mg/kg (LMES 1996c). Fluoride was not analyzed in the soil samples, but it is naturally occurring and of low toxicity. Concentrations of uranium in 1995 and 1996 soil monitoring were lower than the previous results (LMES 1996b, 1997b).

As part of ongoing CERCLA/RCRA investigations, several areas of soil at the ETTP site have been identified as contaminated with radionuclides and/or chemicals. Remediation of this contamination is being implemented as a part of ongoing CERCLA/RCRA activities at the site.

3.2.5 Water Resources

The affected environment for water resources consists of surface water within and in the vicinity of the site boundary and groundwater beneath the site. Analyses of surface water, stream sediment, and groundwater samples have indicated the presence of some contamination resulting from previous gaseous diffusion plant operations. Although several contaminants are present in the water, only small amounts of uranium and fluoride compounds are related to releases from the cylinders.

3.2.5.1 Surface Water

The ETTP site is located near the confluence of the Clinch River (a tributary of the Tennessee River) and Poplar Creek (Figure 3.2-4). Effluent discharge points are located on both Poplar Creek and the Clinch River, and two water withdrawal points are on the Clinch River (DOE 1979).

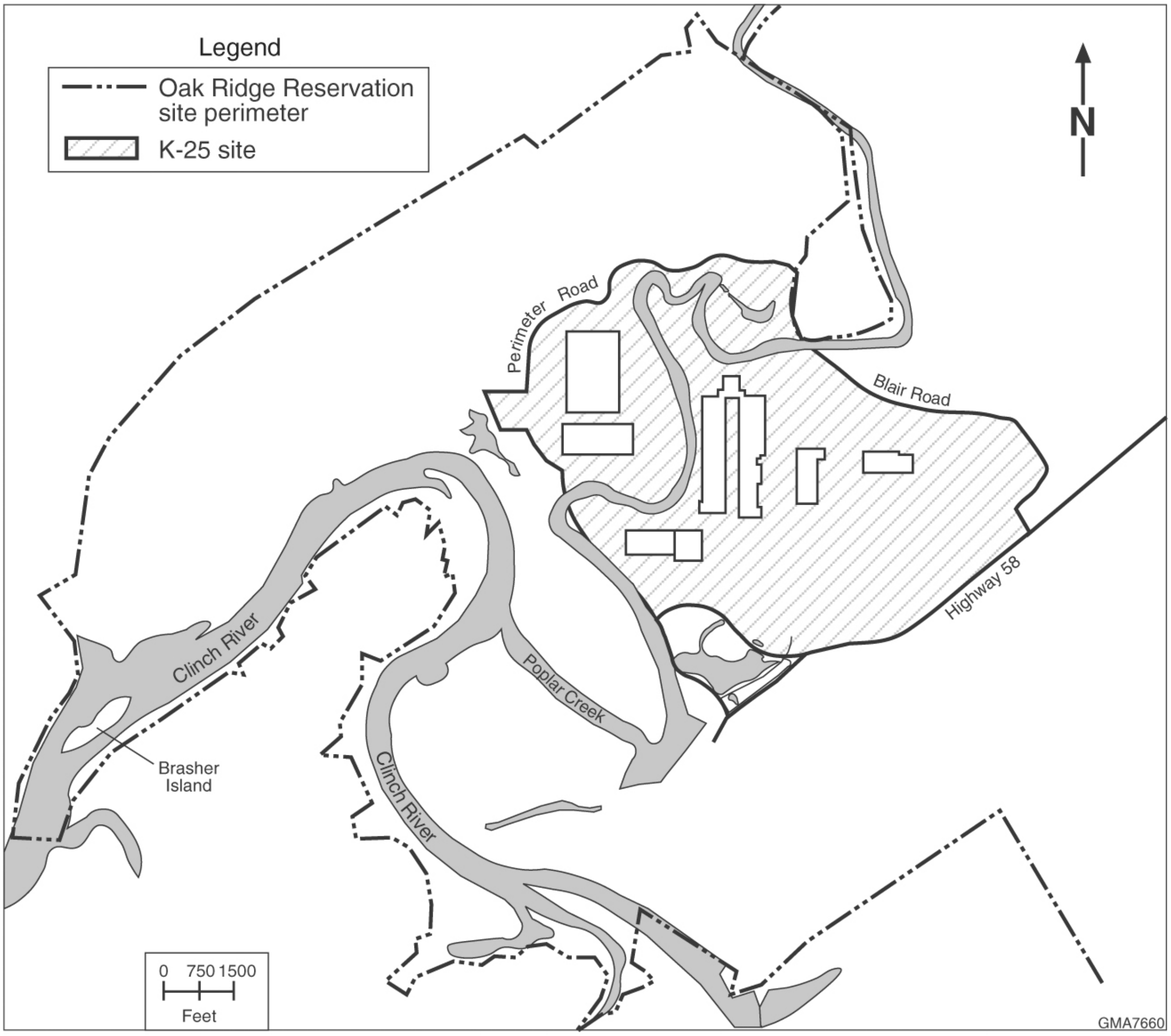

FIGURE 3.2-4 Surface Water Features in the Vicinity of ETTP

All waters that drain the ETTP site eventually reach the Tennessee-Ohio-Mississippi river system. The Clinch River provides the most immediate destination for waters discharged from the site and flows southwest into the Tennessee River near Kingston, Tennessee (Geraghty & Miller, Inc. 1989). A dam constructed in 1963 at River Mile 23.1 created the Melton Hill Reservoir, which establishes the eastern and southeastern boundaries of the Oak Ridge facility. Before this dam was constructed, flows were regulated by Watts Bar Dam, which is located about 38 mi [61 km] downstream from the mouth of the Clinch River. Because of the presence of Melton Hill and Watts Bar dams, the hydrology of the Clinch River-Poplar Creek system is very complex. Average flows in Melton Branch, Whiteoak Creek, and the East Fork of Poplar Creek were 1,120, 4,320, and 21,680 gal/min (4,240, 16,350, and 82,060 L/min), respectively, for a period of record circa 1960. The average daily discharge below Melton Hill Dam was 2 million gal/min (128.5 m^3/s) for a 39-year period of record (Geraghty & Miller, Inc. 1989).

The ETTP site contains a series of limited drainage basins through which small streams traverse and ultimately join with the Clinch River (DOE 1979). Poplar Creek (Figure 3.2-4) is one such stream; it receives drainage from an area of 136 mi^2 (352 km^2), including the northwestern sector of the site. The headwaters of the East Fork are collected in the vicinity of Y-12, where they receive treated wastewater in the form of cooling tower blowdown, waste stream condensate, and process cooling water. In the uplands around the site, surface runoff is largely controlled by soil cover. Within the site, runoff is largely controlled by subsurface drains and diversion ditches. Annual precipitation is 54.8 in. (139 cm). In the vicinity of ETTP, most of the facilities are free from flood hazards for both the 100-year and 500-year maximum probable floods in Poplar Creek (Rothschild et al. 1984).

The ORR site takes water from the Clinch River for makeup cooling water for its reactors at a rate of approximately 20 million gal/d (76 million L/d). An additional 4 million gal/d (15 million L/d) is withdrawn for other process water. These withdrawals occur at Clinch River Miles 11.5 and 14.4. About 25% of this water is returned to the river as treated effluent or blowdown water. As of 1979, no withdrawals were reported from Poplar Creek (DOE 1979). Average water consumption for ETTP in 1994 was 1,324 gal/min (5,011 L/min), equaling about 700 million gal (2.6 billion L) per year.

As of 2000, surface water was being monitored at seven locations at ETTP (DOE 2002c). In the last quarter of 1999, sampling at most monitoring stations was scaled back to a semiannual frequency. Uranium levels were well within permitted levels based on radiological standards. In most instances, results for nonradiological parameters were also well within their applicable Tennessee water quality standards. Heavy metals were detected, but they were always well within applicable standards. In general, analytical results for samples collected upstream of ETTP were chemically similar to those collected downstream of the site, indicating that the site has little effect on chemical concentrations in surface water.

Sediment samples have also been collected at points that coincided with the ORR water sampling locations. The sediment samples were analyzed for uranium and other parameters. For 1994, the following maximum concentrations were measured: uranium, 43 mg/kg; mercury, 6 mg/kg; nickel, 89 mg/kg; and Aroclor 1254, 10 mg/kg (LMES 1996c).

3.2.5.2 Groundwater

Groundwater occurs in a surficial aquifer and in bedrock aquifers in the vicinity of ETTP. The surficial aquifer consists of man-made fill, alluvium, and the residuum of weathered bedrock (Geraghty & Miller, Inc. 1989). The depth to unweathered bedrock varies from less than 10 to more than 50 ft (<3 to >15 m), depending on the characteristics of the underlying rocks.

Bedrock aquifers in the area are composed of Cambrian to Ordovician sandstones, siltstones, shales, dolostones, and limestones. The uppermost bedrock aquifer occurs in the Chickamauga Group. This formation disconformably overlies the Knox Dolostone and is the most extensive bedrock unit underlying the site. Shale beds restrict groundwater flow in the aquifer, resulting in concentrated flow along the limestone-shale contact, with resultant solution cavities.

The next-lower aquifer occurs in the Knox Group. It is composed of dolostone with interbeds of limestone. Solution features such as sinkholes and caverns are common and are an important route for groundwater flow. This unit is the principal aquifer on the site (Rothschild et al. 1984); the mean yield of wells and springs is about 268 gal/min (1,014 L/min).

As in the Knox Group, solution cavities in the Conasauga Group are an important controlling influence for groundwater flow. Because shale beds within the group are generally less transmissive, groundwater flow is concentrated in the limestone strata. In addition to solution features, folds and faults can also control flow in this unit (Rothschild et al. 1984). The oldest units in the area are the Shady Dolomite and the Rome Formation. Groundwater in these units is largely controlled by fractures and vugs (Geraghty & Miller, Inc. 1989).

During the late spring and summer of 1981, a series of tests to determine properties of the bedrock aquifers directly across the Clinch River from site K-770 were conducted (Geraghty & Miller, Inc. 1989). Transmissivity values for the bedrock aquifers (Upper Rome Formation, Chickamauga and Knox Groups) ranged from 22 to 15,000 gal/d per foot (270 to 185,000 L/d per meter), with most values ranging from 22 to 6,000 gal/d per foot (270 to 73,600 L/d per meter). Slug tests performed in the unconsolidated surficial aquifer indicated that the hydraulic conductivity ranged from 1×10^{-7} to 0.01 cm/s. Bedrock values ranged from 1×10^{-6} to 1×10^{-3} cm/s.

On May 29 and 30, 1991 water-level measurements were collected from 185 of 191 monitoring wells at the ETTP site (Geraghty & Miller, Inc. 1991). Inferred directions of groundwater flow are to the south and southwest toward Poplar Creek. Recharge to the groundwater system occurs from surface water bodies and infiltrating precipitation.

Groundwater contamination is a significant problem on the site (Rothschild et al. 1984). The problem is compounded by use of land underlain by shallow groundwater (found in most of the valleys on the reservation) and by the presence of direct conduits to groundwater (e.g., solution features and fractures), which are common. Contamination is associated with waste disposal activities, buried pipelines, and accidental spills.

In 1994 and 1995, groundwater samples were collected from a network of between 200 and 225 monitoring wells at the site (LMES 1996b,c). The number of wells monitored was greatly decreased in 1996 as a result of the reorganization of the site into six watersheds and reduced monitoring requirements (LMES 1997b). In the 1994 and 1995 sampling conducted for the larger network of monitoring wells, the following substances were detected at levels exceeding their associated primary drinking water standards: antimony, arsenic, barium, cadmium, chromium (up to 0.741 mg/L), fluoride (only at two wells), lead, nickel (up to 0.626 mg/L), thallium (up to 0.021 mg/L), benzene (up to 6 μg/L), carbon tetrachloride, 1,1-dichloroethene (greater than 1,000 μg/L), chloroform, 1,2 dichloroethene (greater than 1,000 μg/L), methylene chloride, toluene (greater than 1,000 μg/L), 1,1,2-trichloro-1,2,2-trifluoroethane (greater than 1,000 μg/L), TCE (up to 11,000 μg/L), 1,1,1-trichloroethane (up to 140,000 μg/L), 1,1,2-trichloroethane, tetrachloroethene (up to 17 μg/L), vinyl chloride, gross alpha activity (up to 43 pCi/L), and gross beta activity (up to 6,770 pCi/L) (LMES 1996b,c). Aluminum, iron, and manganese also consistently exceeded secondary, non-health-based standards because of the natural geochemical nature of the groundwater underlying the site (LMES 1996b).

Data from the 2000 annual groundwater monitoring program showed that aluminum and lead exceeded maximum contaminant levels for groundwater at ETTP (DOE 2002c). Copper, iron, and zinc were also found at elevated concentrations, but MCLs are not available for these analytes.

Exit-pathway groundwater surveillance monitoring was conducted in 1994 and 1995 at convergence points where shallow groundwater flows from relatively large areas of the site and converges before discharging to surface water locations (LMES 1996b,c). The exit-pathway monitoring data are representative of maximum groundwater contamination levels associated with the site at areas to which the general public might possibly have access in the future. For 1994, monitoring indicated that thallium, bis(2-ethylhexyl)phthalate, and TCE were present in at least one exit-pathway well sample at concentrations exceeding primary drinking water standards (LMES 1996c). The following average concentrations of these constituents were measured: thallium, 0.007 mg/L; bis(2-ethylhexyl)phthalate, 0.169 mg/L; and TCE, 0.008 mg/L. Alpha activity and fluoride levels were also measured but did not exceed reference levels (the average concentration was 4.4 pCi/L for alpha activity and 0.4 mg/L for fluoride). For 1995, monitoring indicated that no inorganic or organic substances exceeded primary drinking water standards; however, alpha activity exceeded the reference level in one well during the spring sampling event (level of 17 pCi/L) (LMES 1996b).

3.2.6 Biotic Resources

3.2.6.1 Vegetation

About 65% of the land within a 5-mi (8-km) radius of the ETTP site is forested, although most of the ETTP site consists of mowed grasses. Oak-hickory forest is the predominant community on ridges and dry slopes. Mixed pine forests or pine plantations, many of which are managed, have replaced former agricultural fields. Selective logging occurred over much of the site before 1986. Cedar barrens are small communities, primarily on shallow limestone soils, that support drought-tolerant species such as little bluestem, dropseed, eastern red cedar, and stunted oak. A cedar barrens across the Clinch River from the ETTP site may be the best example of this habitat in the state and has been designated as a State Natural Area.

3.2.6.2 Wildlife

The high diversity of habitats in the area supports many wildlife species. Ground-nesting species commonly occurring on the ETTP site include red fox, ruffed grouse, and eastern box turtle. Canada geese are also common in the ETTP area, and most are probably residents (ANL 1991b). Waterfowl, wading birds, and shorebirds are numerous along the Clinch River, in its backwaters, and in ponds. Two great blue heron rookeries are located north of the ETTP site on Poplar Creek (ANL 1991b). Species commonly associated with streams and ponds include muskrat, beaver, and several species of turtles and frogs.

The aquatic communities within the Clinch River and Poplar Creek support a high diversity of fish species and other aquatic fauna. Mitchell Branch supports fewer fish species, although the diversity of fish species has increased downstream of most ETTP discharges since 1990 (DOE 2002c; LMES 1996b).

3.2.6.3 Wetlands

Numerous wetlands occur in the vicinity of ETTP, including three small wetlands along Mitchell Branch (ANL 1991b). Extensive forested wetlands occur along Poplar Creek, East Fork Poplar Creek, Bear Creek, and their tributaries. Shallow water embayments of Melton Hill Reservoir and Watts Bar Reservoir support large areas of palustrine emergent wetlands with persistent vegetation. Forested wetlands occur along these marshy areas and extend into tributaries (DOE 1995).

3.2.6.4 Threatened and Endangered Species

No occurrence of federal- or state-listed threatened or endangered species on the ETTP site has been documented. Table 3.2-6 gives the federal- and state-listed species that occur on the ORR. Gray bats, which are federal and state listed as endangered, have been observed on ORR as transient individuals (DOE 2002c). The bald eagle, federal listed as threatened, is a winter visitor on the reservation (DOE 2001c). Bachman's sparrow, state listed as endangered, may be present on ORR, although it has not been observed recently (DOE 2002c). Suitable nesting habitat on the reservation includes open pine woods with shrubs and dense ground cover (ANL 1991b).

3.2.7 Public and Occupational Safety and Health

3.2.7.1 Radiation Environment

Table 3.2-7 gives the radiation doses to the ETTP cylinder yard workers and to off-site members of the general public. Exposure to airborne emissions from ETTP operations is approximately 13% of that from operations of the entire ORR. Radiation exposure of the general public MEI is estimated to be 6.7 mrem/yr. This dose is about 7% of the maximum dose limit of 100 mrem/yr set for the general public (DOE 1990) and much smaller than the average dose from natural background radiation in the State of Tennessee. The estimated dose of 6.7 mrem/yr for the MEI was based on the assumption that the off-site public would stay far away from the cylinder yards, which is the case under normal conditions. However, potential external exposure could occur and reach 100 mrem/yr if an off-site individual spends more than 90 hours in a year immediately at the cylinder yard fence line.

Between 1991 and 1995, the average annual dose to cylinder yard workers ranged from 32 to 92 mrem/yr, which is less than 2% of the maximum radiation dose limit of 5,000 mrem/yr set for radiation workers (10 CFR Part 835). In 1998, 400 cylinders were repainted; the maximum worker exposure was 107 mrem/yr (Cain 2002b).

3.2.7.2 Chemical Environment

Table 3.2-8 gives the estimated hazard quotients for members of the general public under existing environmental conditions near the ETTP site. The hazard quotient represents a comparison of the estimated human intake level of a contaminant with an intake level below which adverse effects are very unlikely to occur. The estimated hazard quotients indicate that exposures to DUF_6-related contaminants in environmental media near the ETTP site are generally a small fraction of those that might be associated with adverse health effects. An exception is groundwater, for which the hazard quotient for fluoride could exceed the threshold of 1. However, it is highly unlikely that this groundwater would be used as a drinking water source.

OSHA has proposed PELs for uranium compounds and HF in the workplace (29 CFR Part 1910, Subpart Z, as of February 2003) as follows: 0.05 mg/m^3 for soluble uranium compounds, 0.25 mg/m^3 for insoluble uranium compounds, and 2.5 mg/m^3 for HF. ETTP worker exposures are kept below these limits.

3.2.8 Socioeconomics

Socioeconomic data for the ETTP site focus on an ROI comprising four Tennessee counties surrounding the site: Anderson, Knox, Loudon, and Roane. The counties included in the ROI were selected on the basis of the current residential locations of government workers directly involved in ETTP activities. The ROI is defined on the basis of the current residential locations of government workers directly connected to ETTP site activities and includes the area in which these workers spend much of their salaries. More than 90% of ETTP workers currently reside in these counties (Cain 2002b). Because the majority of ETTP workers live in Anderson and Knox Counties and the City of Knoxville, the majority of impacts from ETTP would be expected to occur in these locations; therefore, the following discussions emphasize those areas.

3.2.8.1 Population

The population of the ROI in 2000 was 544,358 people (U.S. Bureau of the Census 2002a) and was expected to reach 565,000 by 2003 (Table 3.2-9). In 2000, 382,032 people (70%

TABLE 3.2-9 Population in the ETTP Region of Influence and Tennessee in 1990, 2000, and 2003

Location	1990	2000	Growth Rate (%), 1990–2000[a]	2003[b] (Projected)
City of Knoxville	165,121	173,890	0.5	176,600
Knox County	335,749	382,032	1.3	397,100
Anderson County	68,250	71,330	0.4	72,300
Loudon County	31,255	39,086	2.3	41,800
Roane County	47,227	51,910	1.0	53,400
ROI total	482,481	544,358	1.2	564,600
Tennessee	4,877,185	5,689,283	1.6	5,958,000

[a] Average annual rate.

[b] ANL projections, as detailed in Appendix F.

Source: U.S. Bureau of the Census (2002a), except as noted.

of the ROI total) resided in Knox County, 71,330 people resided in Anderson County, and 173,890 people resided in the City of Knoxville itself (U.S. Bureau of the Census 2002a). During the 1990s, each of the counties in the ROI and the City of Knoxville experienced moderate increases in population, with an ROI average growth of 1.2%. A slightly higher growth rate was experienced in Loudon County (2.3%), which had the smallest population in the ROI. Over the same period, the population in Tennessee grew at a rate of 1.6%.

3.2.8.2 Employment

Total employment in Knox County was 188,114 in 2000; it was projected to reach 199,400 by 2003. The economy of the county is dominated by the trade and service sectors, with employment in those sectors currently contributing more than 75% of all employment in the county (Table 3.2-10). Employment growth in the highest growth sector, the service sector, was 7.1% during the 1990s, compared with 2.0% in the county for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b).

Total employment in Anderson County was 39,797 in 2000; it was projected to reach 42,000 by 2003. The economy of the county is dominated by the manufacturing and service sectors, with employment in those sectors currently contributing more than 82% of all employment in the county (Table 3.2-11). Employment growth in the highest growth sector, services, was 5.5% during the 1990s, compared with 1.8% in the county for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b).

TABLE 3.2-10 Employment in Knox County by Industry in 1990 and 2000

Sector	No. of People Employed in 1990[a]	Percentage of County Total	No. of People Employed in 2000[b]	Percentage of County Total	Growth Rate (%), 1990–2000
Agriculture	2,010[c]	1.3	951[d]	0.5	-7.2[e]
Mining	775	0.5	315	0.2	-8.6
Construction	9,817	6.3	12,225	6.5	2.2
Manufacturing	22,720	14.7	16,912	9.0	-2.9
Transportation and public utilities	9,823	6.3	5,272	2.8	-6.0
Trade	52,258	33.7	41,951	22.3	-2.2
Finance, insurance, and real estate	7,228	4.7	10,668	5.7	4.0
Services	50,032	32.3	99,707	53.0	7.1
Total	154,968		188,114		2.0

[a] U.S. Bureau of the Census (1992).

[b] U.S. Bureau of the Census (2002b).

[c] These agricultural data are for 1992 and are taken from USDA (1994).

[d] These agricultural data are for 1997 and are taken from USDA (1999).

[e] Agricultural data are for 1992 and 1997.

Total employment in the ROI was 248,003 in 2000; it was projected to reach 262,600 by 2003. The economy of the ROI is dominated by the trade and service sectors; combined, they contribute 72% of all employment in the ROI (Table 3.2-12). Employment growth in the highest growth sector, services, was almost 6.8% during the 1990s, compared with 1.9% in the ROI for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b). Employment at the ETTP site currently stands at 1,740 (Cain 2002b).

Unemployment in the Knoxville Metropolitan Statistical Area was 2.8% in December 2002, slightly lower than the average rate during the 1990s (Table 3.2-13). Unemployment for the state was 4.1% in December 2002, which is also slightly lower than the average rates for the last 10 years.

3.2.8.3 Personal Income

Personal income in Knox County totaled about $11.3 billion in 2000 (in 2002 dollars) and was projected to reach $13.5 billion by 2003. The annual average rate of growth was 2.8%

over the period 1990 through 2000 (Table 3.2-14). County per capita income also rose in the 1990s and was expected to reach $34,400 in 2003, compared with $29,600 at the beginning of the period.

Personal income in Anderson County was almost $2 billion in 2000 (in 2002 dollars) and was expected to reach $2.2 billion by 2003. The annual average rate of growth was 1.9% over the period 1990 through 2000 (Table 3.2-14). County per capita income also rose in the 1990s and was expected to reach $31,100 in 2003, compared with about $27,200 at the beginning of the period.

Growth rates in total personal income in the ROI as a whole were the same as those for Knox County and slightly higher than those for Anderson County. Total personal income in the ROI grew at a rate of 2.8% over the period 1990 through 2000 and was expected to reach almost $18.5 billion by 2003. ROI per capita income was expected to grow from about $28,500 in 1990 to $33,000 by 2003, which is an average annual growth rate of 1.4%.

TABLE 3.2-13 Unemployment Rates in the Knoxville Metropolitan Statistical Area and Tennessee

Location and Period	Rate (%)
Knoxville MSA[a]	
1992–2002 average	3.7
Dec. 2002 (current rate)	2.8
Tennessee	
1992–2002 average	4.6
Dec. 2002 (current rate)	4.1

[a] Knoxville Metropolitan Statistical Area (MSA) consists of Anderson, Blount, Knox, Loudon, Sevier, and Union Counties.

Source: BLS (2002).

TABLE 3.2-14 Personal Income in Knox and Anderson Counties and the ETTP Region of Influence in 1990, 2000, and 2003

Location and Type of Income	1990	2000	Growth Rate (%), 1990–2000	2003 (Projected)[a]
Knox County				
Total personal income (millions of 2002 $)	8,790	11,308	2.8	13,500
Personal per capita income (2002 $)	26,180	29,599	1.4	34,400
Anderson County				
Total personal income (millions of 2002 $)	1,643	1,938	1.9	2,200
Personal per capita income (2002 $)	24,074	27,173	1.4	31,100
Total ROI				
Total personal income (millions of 2002 $)	12,118	15,516	2.8	18,500
Personal per capita income (2002 $)	25,115	28,503	1.4	33,000

[a] ANL projections, as detailed in Appendix F.

Source: U.S. Department of Commerce (2002).

3.2.8.4 Housing

Housing stock in Knox County grew at an annual rate of 1.8% over the period 1990 through 2000 (Table 3.2-15) (U.S. Bureau of the Census 2002a), with 178,000 housing units expected by 2002, reflecting the growth in county population. Growth in the City of Knoxville during this period was 1.1%, with total housing units expected to reach 86,300 by 2003. During the 1990s, 27,900 new units were added to the existing housing stock in the county, with 8,528 of these units in the City of Knoxville in 2000. Vacancy rates in 2000 stood at 9.8% in the city and 7.9% in the county as a whole for all types of housing. On the basis of annual population growth rates, 14,900 housing units were expected to be vacant in the county in 2003; 4,800 of these were expected to be rental units.

Housing stock in Anderson County grew at an annual rate of 1.0% over the period 1990 to 2000 (Table 3.2-15) (U.S. Bureau of the Census 2002a), with total housing units expected to reach 33,500 in 2003, reflecting moderate growth in county population. Almost 3,130 new units were added to the existing housing stock in the county during the 1990s. Vacancy rates in 2000 stood at 8.2% in the county for all types of housing. On the basis of annual population growth rates, 2,900 housing units were expected to be vacant in the county in 2003, of which 800 were expected to be rental units.

TABLE 3.2-15 Housing Characteristics in the City of Knoxville, Knox and Anderson Counties, and the ETTP Region of Influence in 1990 and 2000

	No. of Units	
Location and Type of Unit	1990	2000
City of Knoxville		
Owner-occupied	34,892	39,208
Rental	35,081	37,442
Total unoccupied	6,480	8,331
Total	76,453	84,981
Knox County		
Owner-occupied	85,369	105,562
Rental	48,270	52,310
Total unoccupied	9,943	13,567
Total	143,582	171,439
Anderson County		
Owner-occupied	19,401	21,592
Rental	7,983	8,188
Total unoccupied	1,939	2,671
Total	29,323	32,451
ROI Total		
Owner-occupied	128,300	156,219
Rental	63,331	68,577
Total unoccupied	14,603	19,740
Total	206,234	244,536

Source: U.S. Bureau of the Census (2002a).

Housing stock grew at a slightly slower rate in the ROI as a whole than it did in Knox County during the 1990s, with an overall growth rate of 1.7%. Total housing units were expected to reach 257,400 by 2003, with more than 38,300 housing units added in the 1990s. On the basis of vacancy rates in 2000, which stood at 8.1%, more than 6,400 rental units were expected to be available in 2003.

3.2.8.5 Community Resources

3.2.8.5.1 Community Fiscal Conditions. Construction and operation of the proposed facility might result in increased revenues and expenditures for local government jurisdictions, including counties, cities, and school districts. Revenues would come primarily from state and local sales tax revenues associated with employee spending during construction and operations, and they would be used to support additional local community services currently provided by each jurisdiction. Tables 1 and 2 of Allison (2002) present information on revenues and expenditures by the various local government jurisdictions in the ROI.

3.2.8.5.2 Community Public Services. Construction and operation of the proposed facility would result in increased demand for community services in the counties, cities, and school districts likely to host relocating construction workers and operations employees. Additional demands would also be placed on local medical facilities and physician services. Table 3.2-16 presents data on employment and levels of service (number of employees per 1,000 population) for public safety and general local government services, and Table 3.2-17 covers physicians. Tables 3.2-18 and 3.2-19 provide staffing data for school districts and hospitals.

3.2.9 Waste Management

The ETTP site generates industrial and sanitary waste, including wastewater, solid nonhazardous waste, solid and liquid hazardous waste, radioactive waste, and radioactive hazardous mixed waste. The ETTP site is an active participant in the waste minimization and recycling program within the ORR complex. Much of the waste generated at ETTP is from the ongoing environmental remediation efforts at the site. The ETTP site has the capability to treat wastewater and certain radioactive and hazardous wastes. Some of the wastes generated at ETTP can also be processed or disposed of at facilities located at the Y-12 Plant and ORNL. The ETTP facilities also store and process waste generated at Y-12, ORNL, and from other DOE installations at Paducah, Portsmouth, and Fernald. Most radioactive waste at ETTP is contaminated with uranium and uranium decay products, with small amounts of fission products and TRU radionuclides from nuclear fuel recycling programs. Table 3.2-20 lists the ETTP site waste loads assumed for the analysis of impacts of projected activities.

3.2.9.1 Wastewater

Treated wastewater at the ETTP site is discharged under a National Pollution Discharge Elimination System (NPDES) permit. Sanitary wastewater is processed at an on-site sewage treatment plant with a capacity of 0.92 million gal/d (3.5 million L/d).

3.2.9.2 Solid Nonhazardous, Nonradioactive Waste

About 35,000 yd^3/yr (27,500 m^3/yr) of solid nonhazardous waste is generated at ORR, which includes waste from the ETTP site. The waste is disposed of at the Y-12 landfill; it is projected that about 50% of the landfill's capacity, or about 920,000 yd^3 (700,000 m^3), would be available in the year 2020.

TABLE 3.2-20 Projected Waste Generation Volumes for ETTP[a]

Waste Category	Waste Treatment Volume (m^3/yr)
LLW	41,000
LLMW	2,700
TRU	0
Hazardous waste	350
Nonhazardous waste[b]	
Solids	12,000
Wastewater	47,000

[a] Volumes include operational and environmental restoration waste projected from FY 2002 to FY 2025. However, it is projected that the majority of the waste would be generated by FY 2008.

[b] Volumes include sanitary and industrial wastes.

Source: Cain (2002c).

3.2.9.3 Nonradioactive Hazardous and Toxic Waste

The ETTP site generates both RCRA-hazardous and TSCA-hazardous waste. The site operates several RCRA hazardous waste treatment and storage facilities. The site also operates a permitted TSCA incinerator to treat hazardous and LLMW liquids contaminated with PCBs. The incinerator also processes PCB waste from other facilities at ORR and from off-site DOE installations.

3.2.9.4 Low-Level Radioactive Waste

Current ORR policy for newly generated LLW is to perform necessary packaging for direct shipment to appropriate on- and off-site treatment, storage, and disposal facilities. LLW that is not treated or disposed of at ORR is placed in storage, pending either treatment or disposal, or both, at off-site facilities.

3.2.9.5 Low-Level Radioactive Mixed Waste

The majority of radioactive waste generated at ETTP is LLMW, which consists of two categories: (1) aqueous RCRA-hazardous radioactive waste contaminated with corrosives or metals and (2) organic liquids contaminated with PCBs.

Aqueous LLMW is treated on site, and resulting wastewaters are discharged to the NPDES-permitted discharges, which have a capacity of 450,000 yd^3/yr (340,000 m^3/yr). Organic LLMW liquids contaminated with PCBs are treated by the ETTP TSCA incinerator, which has a capacity of 1,800 yd^3/yr (1,400 m^3/yr).

ETTP has the capacity to treat approximately 6,500 yd^3/yr (5,000 m^3/yr) of liquid LLMW via grout stabilization. The site has the capacity to store 88,600 yd^3 (67,800 m^3) of LLMW containers.

3.2.10 Land Use

ETTP is located in east-central Tennessee, in the eastern part of Roane County about 25 mi (40 km) west of the City of Knoxville. An analysis of Landsat satellite imagery from 1992 shows that the dominant land cover categories in Roane County include deciduous forest (42.0%), mixed forest (19.7%), evergreen forest (13.6%), and pasture/hay (10.3%) (Figure 3.2-5). The 1997 agricultural census recorded 99 farms in Roane County, covering more than 53,100 acres (21,489 ha) (USDA 1999). Human settlement is sparse throughout much of the county, with most of the population residing in the communities of Harriman, Kingston, Oak Ridge, and Rockwood. The eastern third of Roane County, where ETTP is located, is dominated by deciduous and mixed forest and pasture.

The 1,700-acre (690-ha) ETTP site contains more than 300 buildings with a combined floor space of 13 million ft^2 (1.2 million m^2) (MMES 1994b).

Land use at ETTP focuses on the reuse of facilities, equipment, materials, and utilities previously associated with the gaseous diffusion plant, with an emphasis on reindustrialization (Bechtel Jacobs Company LLC 2002). Activities at the site include a range of operations associated with environmental management at the DOE Oak Ridge Operations facilities, such as management of the TSCA incinerator and the treatment, storage, and disposal of hazardous and radioactive waste (including DUF_6) (Operations Management International, Inc. 2002a). Currently, ETTP is home to two business centers: Heritage Center and Horizon Center. The Heritage Center encompasses 125 of the main buildings of the former gaseous diffusion facility, which are currently leased to more than 40 companies (Operations Management International, Inc. 2002b). The Horizon Center encompasses 1,000 acres (447 ha) of building sites aimed primarily at high-tech companies.

3.2.11 Cultural Resources

The ETTP site falls under the CRMP for ORR. That plan, which contains procedures for managing archaeological sites, historic structures, traditional cultural properties, and Native American sacred sites, was finalized in July 2001 (Souza et al. 2001). Under the plan, ETTP has responsibility for cultural resources at the eastern end of the reservation.

Cultural resource surveys at ORR have provided a considerable body of knowledge regarding the history and prehistory of the area. Archaeological evidence indicates that there has been a human presence at ORR for at least 12,000 years. All the major prehistoric Eastern Woodland archaeological periods are represented there: Paleo-Indian (10,000 B.C.–8,000 B.C.), Archaic (8,000 B.C.–900 B.C.), Woodland (900 B.C.–A.D. 900), and Mississippian

(A.D. 900–A.D. 1600). While the ETTP area has not been completely surveyed, six prehistoric sites were identified there. Three of them were determined to be eligible for the NRHP. Five of the six sites lie outside the ETTP security fences. The area within the ETTP security fences underwent massive earthmoving operations during the construction of the gaseous diffusion plant. It is unlikely that unidentified intact archaeological sites remain within the fences (Morris 1998; Souza et al. 2001).

The Overhill Cherokee occupied part of eastern Tennessee from the 1700s until their relocation to Oklahoma in 1838. DOE Oak Ridge Operations has initiated consultations with the Eastern Band of the Cherokee Indians and the Cherokee Nation of Oklahoma regarding Native American issues related to the DUF_6 conversion project at ORR (see Appendix G). No religious or sacred sites, burial sites, or resources significant to the Cherokee have been identified at ETTP to date. However, there are mounds and other prehistoric sites at ORR thought likely to contain prehistoric burials. Similar resources could exist in the unsurveyed portions of the ETTP area (Souza et al. 2001).

Euro-American settlers began entering eastern Tennessee after 1798, and by 1804, settlement of the area that would become ORR in the 20th century had begun. An economy based on subsistence farming and, later, on coal mining developed. A survey of pre-World War II historic structures at ORR was conducted; 254 structures were evaluated, and 41 were recommended as being eligible for the NRHP, in addition to the 6 that were already listed (DuVall and Souza 1996). Two historic archaeological districts were proposed. Of these, the Wheat Community Historic District lies within the ETTP area. It includes 28 contributing structures; one (the George Jones Memorial Church) is already listed on the NRHP. The ETTP site also includes six historic cemeteries (Morris 1998; Souza et al. 2001).

In 1942, the U.S. Army began to acquire land in eastern Tennessee for the Manhattan Project’s “Site X.” Renamed the Clinton Engineer Works in 1943, the new facility included a gaseous diffusion plant at the K-25 Site. The K-25 Site played a significant role in the production of highly enriched uranium for weapons manufacture between 1944 and 1964, materially contributing to the development of nuclear weapons during World War II and the Cold War. The K-25 site forms the heart of ETTP. Buildings at the ETTP site were evaluated for their historical significance in 1994. One historic district, the Main Plant Historic District, is eligible for the NRHP. The district consists of 157 buildings, 120 of which contribute to the district (37 do not). Eleven additional buildings not adjacent to the district are also considered eligible by virtue of their supporting roles in the uranium-235 enrichment process (DuVall and Souza 1996; Holcombe-Burdette 1998; Souza et al. 2001).

3.2.12 Environmental Justice

3.2.12.1 Minority Populations

This EIS uses data from the most recent decennial census in 2000 to evaluate environmental justice implications of the proposed action and all alternatives with respect to minority populations. The CEQ guidelines on environmental justice recommend that "minority" be defined as members of American Indian or Alaska Native, Asian or Pacific Islander, Black non-Hispanic, and Hispanic populations (CEQ 1997). The earliest release of 2000 census data that included information necessary to identify minority populations identified individuals both according to race and Hispanic origin (U.S. Bureau of the Census 2001). It also identified individuals claiming multiple racial identities (up to six races). To remain consistent with the CEQ guidelines, the term "minority population" in this document refers to persons who identified themselves as partially or totally Black (including Black or Negro, African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian), American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or "Other Race." The minority category also includes White individuals of Hispanic origin, although the latter is technically an ethnic category. To avoid double counting, tabulations included only White Hispanics; the above racial groups already account for non-White Hispanics. In sum, then, the minority population considered under environmental justice consisted of all non-White persons (including those of multiple racial affiliations) plus White persons of Hispanic origin.

To identify census tracts with disproportionately high minority populations, this EIS uses the percentage of minorities in each state containing a given tract as the reference point. Using the individual states to identify disproportionality acknowledges that minority distributions in the state can differ from those found in the nation as a whole. In 2000, of the 240 census tracts within 50 mi (80 km) of the storage facility at ETTP, 19 had minority populations in excess of state-specified thresholds — a total of 24,235 minority persons in all (Figure 3.2-6). In 2000, 5.2% of the Roane County population was minority (U.S. Bureau of the Census 2002e).

3.2.12.2 Low-Income Populations

As recommended by the CEQ guidelines, the environmental justice analysis identifies low-income populations as those falling below the statistical poverty level identified annually by the U.S. Bureau of the Census in its Series P-60 documents on income and poverty. The Census Bureau defines poverty levels on the basis of a statistical threshold that considers for each family both overall family size and the number of related children younger than 18 years old. For example, in 1999, the poverty threshold annual income for a family of three with one related child younger than 18 was $13,410, while the poverty threshold for a family of five with one related child younger than 18 was $21,024 (U.S. Bureau of the Census 2000). The 2000 census used 1999 thresholds because 1999 was the most recent year for which annual income data were available when the census was conducted. If a family fell below the poverty line for its particular composition, the census considered all individuals in that family to be below the poverty line.

To identify census tracts with disproportionately high low-income populations, this EIS uses the percentage of low-income persons in each state containing a given tract as a reference point. In 1999, of the 240 census tracts within 50 mi (80 km) of the storage facility at ETTP, 128 had low-income populations in excess of state-specified thresholds — a total of 157,843 low-income persons in all (Figure 3.2-7). In 1999, in Roane County, 13.9% of those individuals for whom poverty status was known were low-income (U.S. Bureau of the Census 2002e).

4 ENVIRONMENTAL IMPACT ASSESSMENT APPROACH, ASSUMPTIONS, AND METHODOLOGY

This EIS evaluates potential impacts on human health and the natural environment from building and operating a DUF_6 conversion facility at three alternative locations at the Paducah site and for a no action alternative. These impacts might be positive, in that they would improve conditions in the human or natural environment, or negative, in that they would cause a decline in those conditions. This chapter provides an overview of the methods used to estimate the potential impacts associated with the EIS alternatives, summarizes the major assumptions that formed the basis of the evaluation, and provides some background information on human health impacts. More detailed information on the assessment methods used to evaluate potential environmental impacts is provided in Appendix F.

4.1 GENERAL APPROACH

Potential environmental impacts were assessed by examining all of the activities required to implement each alternative, including construction of the required facility, operation of the facility, and transportation of materials between sites. Potential long-term impacts from cylinder breaches occurring at Paducah were also estimated. For each alternative, potential impacts to workers, members of the general public, and the environment were estimated for both normal operations and for potential accidents.

The analysis for this EIS considered all potential areas of impact but emphasized those that might have a significant impact on human health or the environment, would be different under different alternatives, or would be of special interest to the public (such as potential radiation effects). The environmental characteristics of the Paducah site, where the conversion facility would be built and operated, are described in Section 3.1. The environmental setting of the ETTP site, where cylinders would be prepared for shipment if they were to be transported to Paducah, is described in Section 3.2.

The estimates of potential environmental impacts for the proposed action were based on characteristics of the proposed UDS conversion facility. The two primary sources of information were excerpts from the UDS conversion facility conceptual design report (UDS 2003a) and the updated UDS NEPA data package (UDS 2003b). As noted in Section 2.2, current facility designs are at the 100% conceptual design stage. Several design options are considered in the EIS to provide future flexibility.

The NEPA data package (UDS 2003b) was prepared by UDS to support preparation of this EIS. For the proposed Paducah conversion facility, the NEPA data package includes facility descriptions, process descriptions and material flows, anticipated waste generation, anticipated air emissions, anticipated liquid effluents, waste minimization and pollution prevention approaches, anticipated water usage, anticipated energy consumption, anticipated materials usage, anticipated toxic or hazardous chemical storage, floodplain and wetland information, anticipated noise levels, estimated land use, employment needs, anticipated transportation needs, and safety analysis data.

The NEPA data and a variety of assessment tools and methods were used to evaluate the potential impacts that construction and operation of the conversion facility would have on human health and the environment. These methods are described by technical discipline in Appendix F. The following sections summarize the major assessment assumptions and provide overview information on the estimation of human health impacts from radiation and chemical exposures.

4.2 MAJOR ASSUMPTIONS AND PARAMETERS

Table 4.2-1 gives the major assumptions and parameters that formed the basis of the analyses in this EIS. The primary source for conversion facility data was the updated UDS NEPA data package (UDS 2003b). Discipline-specific information and technical assumptions are provided in the methods described in Appendix F.

4.3 METHODOLOGY

In general, the activities assessed in this EIS could affect workers, members of the general public, and the environment during construction of the new facility, during routine facility operations, during transportation, and during facility or transportation accidents. Activities could have adverse effects (e.g., human health impairment) or positive effects (e.g., regional socioeconomic benefits, such as the creation of jobs). Some impacts would result primarily from the unique characteristics of the uranium and other chemical compounds handled or generated under the alternatives. Other impacts would occur regardless of the types of materials involved, such as the impacts on air and water quality that can occur during any construction project and the vehicle-related impacts that can occur during transportation.

The areas of potential environmental impacts evaluated in this EIS are shown and described in Figure 4.3-1 (the order of presentation does not imply relative importance). For each area, different analytical methods were used to estimate the potential impacts from construction, operations, and accidents for each of the alternatives. The assessment methodologies are summarized in Appendix F.

Because of the chemical and radioactive nature of the materials being processed and produced, and the fact that the conversion facility would be built on a previously disturbed industrialized site, the potential impact to the health of workers and the public is one of the areas of primary concern in this EIS. Therefore, the following sections provide background information on radiation and chemical health effects and on the approach used to evaluate accidents. The information is presented to aid in the understanding and interpretation of the potential human health impacts presented in Chapters 2 and 5.

TABLE 4.2-1 Summary of Major EIS Data and Assumptions

Parameter/Characteristic	Data/Assumption
General	
Paducah DUF_6 inventory	36,191 cylinders, 436,400 t (484,000 tons)
Paducah non-DUF_6 inventory	1,667 cylinders; 17,600 t (19,400 tons)
ETTP DUF_6 inventory	4,822 cylinders; 54,300 t (60,000 tons)
ETTP Non-DUF_6 cylinder inventory	1,102 cylinders; 26 t (29 tons)
No Action Alternative	No conversion facility constructed; continued long-term storage of DUF_6 in cylinders at Paducah.
Assessment period	Through 2039, plus long-term groundwater impacts
Construction	3 storage yards reconstructed
Cylinder management	Continued surveillance and maintenance activities consistent with current plans and procedures.
Assumed total number of future cylinder breaches:	
Controlled-corrosion case	36
Uncontrolled-corrosion case	444
Action Alternatives	Build and operate a conversion facility at the Paducah site for conversion of the Paducah DUF_6 inventory.
Construction start	2004
Construction period	≈2 years
Start of operations	2006
Operational period	25 years (28 years if ETTP cylinders are converted at Paducah)
Facility footprint	10 acres (4 ha)
Facility throughput	18,000 t/yr (20,000 tons/yr) DUF_6
Conversion products	
Depleted U_3O_8	14,300 t/yr (15,800 tons/yr)
CaF_2	24 t/yr (26 tons/yr)
70% HF acid	3,300 t/yr (3,600 tons/yr)
49% HF acid	7,700 t/yr (8,500 tons/yr)
Steel (empty cylinders, if not used as disposal containers)	1,980 t/yr (2,200 tons/yr)
Proposed conversion product disposition (see Table 2.2-2 for details):	
Depleted U_3O_8	Disposal; Envirocare (primary), NTS (secondary)[a]
CaF_2	Disposal; Envirocare (primary), NTS (secondary)
70% HF acid	Sale pending DOE approval
49% HF acid	Sale pending DOE approval
Steel (empty cylinders, if not used as disposal containers)	Disposal; Envirocare (primary), NTS (secondary)

[a] DOE plans to decide the specific disposal location(s) for the depleted U_3O_8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

Sources: UDS (2003a,b).

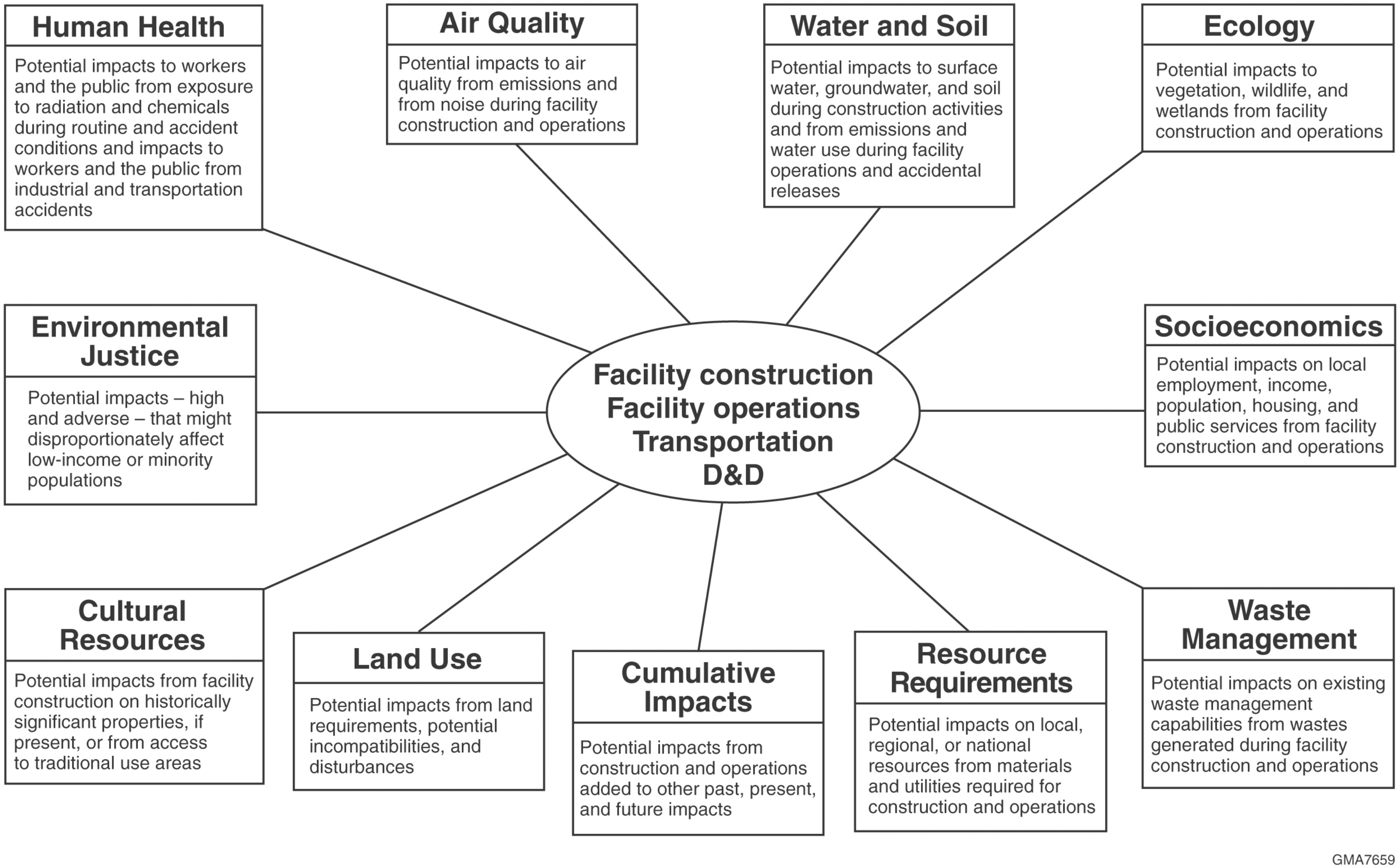

FIGURE 4.3-1 Areas of Potential Impact Evaluated for Each Alternative

4.3.1 Overview of the Human Health Assessment

Human health impacts were estimated for three types of potential exposures: exposure to radiation, exposure to chemicals, and exposure to physical hazards (e.g., on-the-job injuries or fatalities from falls, lifting, or equipment malfunctions). These potential human exposures could occur in and around facilities or during transportation of materials. Exposures could take place during incident-free (normal) operations or following accidents in the facilities or during transportation.

The nature of the potential impacts resulting from the three types of exposure differ. Table 4.3-1 lists and compares the key features of these types of exposures. Because of the differences in these features, it is not always appropriate to combine impacts from different exposures to get a total impact for a given human receptor.

4.3.2 Radiation

All of the alternatives would involve handling compounds of the element uranium, which is radioactive. Radiation, which occurs naturally, is released when one form of an element (an isotope) changes into some other atomic form. This process, called radioactive decay, occurs because unstable isotopes tend to transform into a more stable state. The radiation emitted may be in the form of particles, such as neutrons, alpha particles, or beta particles, or waves of pure energy, such as gamma rays.

The radiation released by radioactive materials (i.e., alpha, beta, neutron, and gamma radiation) can impart sufficient localized energy to living cells to cause cell damage. This damage may be repaired by the cell, the cell may die, or the cell may reproduce other altered cells, sometimes leading to the induction of cancer. An individual may be exposed to radiation from outside the body (called external exposure) or, if the radioactive material has entered the body through inhalation (breathing) or ingestion (swallowing), from inside the body (called internal exposure).

4.3.2.1 Background Radiation

Everyone is exposed to radiation on a daily basis, primarily from naturally occurring cosmic rays, radioactive elements in the soil, and radioactive elements incorporated in the body. Man-made sources of radiation, such as medical x-rays or fallout from historical nuclear weapons testing, also contribute, but to a lesser extent. About 80% of background radiation originates from naturally occurring sources, with the remaining 20% resulting from man-made sources.

The amount of exposure to radiation is commonly referred to as “dose.” The estimation of radiation dose takes into account many factors, including the type of radiation exposure (neutron, alpha, gamma, or beta), the different effects each type of radiation has on living tissues,

TABLE 4.3-1 Key Features of Potential Human Exposures to Radiological, Chemical, and Physical Hazards

	Potential Exposures		
Feature	Radiological	Chemical	Physical Hazard
Materials of concern	Uranium and its compounds.	Uranium and its compounds, HF, and NH_3.	Physical hazards associated with all facilities and transportation conditions.
Health effects	Radiation-induced cancer incidence and potential fatalities would occur a considerable time after exposure (typically 10 to 50 years). The risks were assessed in terms of LCFs above background levels.	Adverse health effects (e.g., kidney damage and respiratory irritation or injury) could be immediate or could develop over time (typically less than 1 year).	Impacts would result from occurrences in the workplace or during transportation that were unrelated to the radiological and/or chemical nature of the materials being handled. Potential impacts would include bodily injury or death due to falls, lifting heavy objects, electrical fires, and traffic accidents.
Receptor	Generally the whole body of the receptor would be affected by external radiation, with internal organs affected by ingested or inhaled radioactive materials. Internal and external doses were combined to estimate the effective dose equivalent (see Appendix F).	Generally certain internal organs (e.g., kidneys and lungs) of the receptor would be affected.	Generally any part of the body of the receptor could be affected.
Threshold	No radiological threshold exists before the onset of impacts, that is, any radiation exposure could result in a chance of LCFs. To show the significance of radiation exposures, the estimated number of LCFs is presented, and radiation doses are compared with existing regulatory limits.	A chemical threshold exposure level exists (different for each chemical) below which exposures are considered safe (see Section 4.3.3). Where exposures were calculated at below threshold levels, "no impacts" are reported.	No threshold exists for physical hazards. Impact estimates are based on the statistical occurrence of impacts in similar industries and on the amount of labor required.

the type of exposure (i.e., internal or external), and, for internal exposure, the fact that radioactive material may be retained in the body for long periods of time. The common unit for radiation dose that accounts for these factors is the rem (1 rem equals 1,000 mrem).

In the United States, the average dose from background radiation is about 360 mrem/yr per person, of which about 300 mrem is from natural sources. For perspective, Table 4.3-2 provides the radiation doses resulting from a number of common activities. The total dose to an individual member of the general public from DOE and other federal activities is limited by law to 100 mrem/yr (in addition to background radiation), and the dose to a member of the public from airborne emissions released from DOE facilities must be below 10 mrem/yr (40 CFR Part 61).

4.3.2.2 Radiation Doses and Health Effects

Radiation exposure can cause a variety of adverse health effects in humans. Very large doses of radiation (about 450,000 mrem) delivered rapidly can cause death within days to weeks from tissue and organ damage. The potential adverse effect associated with the low doses typical of most environmental and occupational exposures is the inducement of cancers that may be fatal. This latter effect is called a “latent” cancer fatality (LCF) because the cancer may take years to develop and cause death. In general, cancer caused by radiation is indistinguishable from cancer caused by other sources.

For this EIS, radiation effects were estimated by first calculating the radiation dose to workers and members of the general public from the anticipated activities required under each alternative. Doses were estimated for internal and external exposures that might occur during normal (or routine) operations and following hypothetical accidents. The analysis considered three groups of people: (1) involved workers, (2) noninvolved workers, and (3) members of the general public.

For each of these groups, doses were estimated for the group as a whole (population or collective dose). For noninvolved workers and the general public, doses were also estimated for an MEI. The MEI was defined as a hypothetical person who — because of proximity, activities, or living habits — could receive the highest possible dose. The MEI for noninvolved workers and members of the

Key Concepts in Estimating Risks from Radiation

The health effect of concern from exposure to radiation at levels typical of environmental and occupational exposures is the inducement of cancer. Radiation-induced cancers may take years to develop following exposure and are generally indistinguishable from cancers caused by other sources. Current radiation protection standards and practices are based on the premise that any radiation dose, no matter how small, can result in detrimental health effects (cancer) and that the number of effects produced is in direct proportion to the radiation dose. Therefore, doubling the radiation dose is assumed to result in doubling the number of induced cancers. This approach is called the “linear-no-threshold hypothesis” and is generally considered to result in conservative estimates (i.e., over-estimates) of the health effects from low doses of radiation.

TABLE 4.3-2 Comparison of Radiation Doses from Various Sources

Radiation Source	Dose to an Individual
Annual background radiation — U.S. average	
Total	360 mrem/yr
From natural sources (cosmic, terrestrial, radon)	300 mrem/yr
From man-made sources (medical, consumer products, fallout)	60 mrem/yr
Daily background radiation — U.S. average	1 mrem/d
Increase in cosmic radiation dose due to moving to a higher altitude, such as from Miami, Florida, to Denver, Colorado	25 mrem/yr
Chest x-ray	10 mrem
U.S. transcontinental flight (5 hours)	2.5 mrem
Dose from naturally occurring radioactive material in agricultural fertilizer — U.S. average	1 to 2 mrem/yr
Dose from standing 6 ft (2 m) from a full DUF_6 cylinder for 5 hours	1 mrem

Sources: National Council on Radiation Protection and Measurements (NCRP 1987).

general public usually was assumed to be at the location of the highest on-site or off-site air concentrations of contaminants, respectively — even if no individual actually worked or lived there. Under actual conditions, all radiation exposures and releases of radioactive material to the environment are required to be kept as low as reasonably achievable (ALARA), a practice that has as its objective the attainment of dose levels as far below applicable limits as possible.

Following estimation of the radiation dose, the number of potential LCFs was calculated by using health risk conversion factors. These factors relate the radiation dose to the potential number of expected LCFs on the basis of comprehensive studies of groups of people historically exposed to large doses of radiation, such as the Japanese atomic bomb survivors. The factors used for the analysis in this EIS were 0.0004 LCF/person-rem of exposure for workers and 0.0005 LCF/person-rem of exposure for members of the general public (International Commission on Radiological Protection [ICRP] 1991). The latter factor is slightly higher because some individuals in the public, such as infants, are more sensitive to radiation than the average worker. These factors imply that if a population of workers receives a total dose of 2,500 person-rem, on average, 1 additional LCF will occur among the workers. Similarly, if the general public receives a total dose of 2,000 person-rem, on average, 1 additional LCF will occur.

The calculation of human health effects from radiation is relatively straightforward. For example, assume the following situation:

- Each of 100,000 persons receives a radiation dose equal to background, or 360 mrem/yr (0.36 rem/yr), and

- The health risk conversion factor for the public is 0.0005 LCF/person-rem.

In this case, the number of radiation-induced LCFs caused by 1 year of exposure among the population would be 1 yr × 100,000 persons × 0.36 rem/yr × 0.0005 LCF/person-rem, or about 18 cancer cases, which would occur over the lifetimes of the individuals exposed. For perspective, in the same population of 100,000 persons, a total of about 23,000 (23%) would be expected to die of cancer from all causes over their lifetimes (Centers for Disease Control and Prevention 1996).

Sometimes the estimation of number of LCFs does not yield whole numbers and, especially in environmental applications, yields numbers less than 1. For example, if 100,000 persons were exposed to 1 mrem (0.001 rem) each, the estimated number of LCFs would be 0.05. The estimate of 0.05 LCF should be interpreted statistically — as the average number of deaths if the same radiation exposure was applied to many groups of 100,000 persons. In most groups, no one (zero persons) would incur an LCF from the 1-mrem exposure each person received. In some groups, 1 LCF would occur, and in exceptionally few groups, 2 or more LCFs would occur. The average number of deaths would be 0.05 (just as the average of 0, 0, 0, and 1 is 0.25). The result, 0.05 LCF, may also be interpreted as a 5% chance (1 in 20) of 1 radiation-induced LCF in the exposed population. In this EIS, fractional estimates of LCFs were rounded to the nearest whole number for purposes of comparison. Therefore, if a calculation yielded an estimate of 0.6 LCF, the outcome is presented as 1 LCF, the most likely outcome.

The same concept is assumed to apply to exposure of a single individual, such as the MEI. For example, the chance that an individual exposed to 360 mrem/yr (0.36 rem/yr) over a lifetime of 70 years would die from a radiation-induced cancer is about 0.01 (0.36 rem/yr × 0.0005 LCF/rem × 70 yr = 0.01 LCF). Again, this should be interpreted statistically; the estimated effect of radiation on this individual would be a 1% (1 in 100) increase in the chance of incurring an LCF over the individual's lifetime. In this EIS, the risk to individuals is generally presented as the increased chance that the individual exposed would die from a radiation-induced cancer. As noted, the baseline chance of dying from cancer in the United States is approximately 1 in 4.

4.3.3 Chemicals

For this EIS, the chemicals of greatest concern are soluble and insoluble uranium compounds, HF, and anhydrous NH_3. Uranium compounds can cause chemical toxicity to the kidneys; soluble compounds are more readily absorbed into the body and thus are more toxic to the kidneys. HF and NH_3 are corrosive gases that can cause respiratory irritation in humans, with tissue destruction or death resulting from exposure to large concentrations. Both have a pungent and irritating odor. No deaths are known to have occurred as a result of short-term (i.e., 1 hour or less) exposures to 50 ppm or less of HF, or 1,000 ppm or less of NH_3. Uranium compounds, HF, and NH_3 are not chemical carcinogens; thus, cancer risk calculations are not applicable for the chemical hazard assessment.

For long-term, low-level (chronic) exposures to uranium compounds and HF emitted during normal operations, potential adverse health effects for the hypothetical MEI in the noninvolved worker and general public populations were calculated by estimating the intake levels associated with anticipated activities. Intake levels were then compared with reference levels below which adverse effects are very unlikely. Risks from normal operations were quantified as hazard quotients and hazard indices (see text box).

Key Concepts in Estimating Risks from Low-Level Chemical Exposures

Reference Level

- Intake level of a chemical below which adverse effects are very unlikely.

Hazard Quotient

- A comparison of the estimated intake level or dose of a chemical with its reference dose.
- Expressed as a ratio of estimated intake level to reference dose.
- Example:
  - The EPA reference level (reference dose) for ingestion of soluble compounds of uranium is 0.003 mg/kg of body weight per day.
  - If a 150-lb (70-kg) person ingested 0.1 mg of soluble uranium per day, the daily rate would be $0.1 \div 70 \approx 0.001$ mg/kg, which is below the reference dose and thus unlikely to cause adverse health effects. This would yield a hazard quotient of $0.001 \div 0.003 = 0.33$.

Hazard Index

- Sum of the hazard quotients for all chemicals to which an individual is exposed.
- A value less than 1 indicates that the exposed person is unlikely to develop adverse human health effects.

4.3.4 Accidents

This EIS considers a range of potential accidents that could occur during conversion operations and transportation. An accident is defined as a series of unexpected or undesirable events leading to a release of radioactive or hazardous material within a facility or into the natural environment. Because an accident could involve a large and uncontrolled release, such an event potentially could pose considerable health risks to workers and members of the general public. Two important elements must be considered in the assessment of risks from accidents: the consequence of the accident and the expected frequency (or probability) of the accident.

4.3.4.1 Accident Consequences

The term accident consequence refers to the estimated impacts if an accident were to occur — including health effects such as fatalities. For accidents involving releases of radioactive material, the consequences are expressed in the same way as the consequences from routine operations — that is, LCFs are estimated for the MEI and for populations on the basis of estimated doses from all important exposure pathways.

Assessing the consequences of accidental releases of chemicals differs from assessing routine chemical exposures, primarily because the reference doses used to generate hazard indices for long-term, low-level exposures were not intended for use in the evaluation of the short-term (e.g., duration of several hours or less), higher-level exposures often accompanying accidents. In addition, the analysis of accidental releases often requires evaluation of different chemicals, especially irritant gases, which can cause tissue damage at higher levels associated with accidental releases but are not generally associated with adverse effects from chronic, low-level exposures.

Health Effects from Accidental Chemical Releases

The impacts from accidental chemical releases were estimated by determining the numbers of people downwind who might experience adverse effects and irreversible adverse effects:

Adverse Effects: Any adverse health effects from exposure to a chemical release, ranging from mild and transient effects, such as respiratory irritation or skin rash (associated with lower chemical concentrations), to irreversible (permanent) effects, including death or impaired organ function (associated with higher chemical concentrations).

Irreversible Adverse Effects: A subset of adverse effects, irreversible adverse effects are those that generally occur at higher concentrations and are permanent in nature. Irreversible effects may include death, impaired organ function (such as central nervous system or lung damage), and other effects that may impair everyday functions.

To estimate the consequences of chemical accidents, two potential health effects endpoints were evaluated: (1) adverse effects and (2) irreversible adverse effects (see text box). In addition, the number of fatalities from accidental chemical exposures was estimated. For exposures to uranium and HF, it was estimated that the number of fatalities occurring would be about 1% of the number of irreversible adverse effects (EPA 1993; Policastro et al. 1997). Similarly, for exposure to NH_3, the number of fatalities was estimated to be about 2% of the number of irreversible adverse effects (Policastro et al. 1997).

Human responses to chemicals do not occur at precise exposure levels but can extend over a wide range of concentrations. However, in this EIS, the values used to estimate the number of potential chemical effects should be applicable to most individuals in the general population. In all populations, there are hypersensitive individuals who will show adverse responses at exposure concentrations far below levels at which most individuals would normally respond (American Industrial Hygiene Association [AIHA] 2002). Similarly, many individuals will show no adverse response at exposure concentrations even somewhat higher than the guideline values. For comparative purposes in this EIS analysis, use of the guideline values discussed above allowed a uniform comparison of the impacts from potential accidental chemical releases across all alternatives.

4.3.4.2 Accident Frequencies

The expected frequency of an accident is the chance that the accident might occur while an operation is being conducted. If an accident is expected to happen once every 50 years, the frequency of occurrence is 0.02 per year: 1 occurrence every 50 years = 1 ÷ 50 = 0.02 occurrence per year. A frequency estimate can be converted to a probability statement. If the frequency of an accident is 0.02 per year, the probability of the accident occurring sometime during a 10-year program is 0.2 (10 years × 0.02 occurrence per year).

The accidents evaluated in this EIS were anticipated to occur over a wide range of frequencies, from once every few years to less than once in 1 million years. In general, the more unlikely it would be for an accident to occur (the lower its probability), the greater the expected consequences. Accidents were evaluated for each activity required for four frequency categories: likely, unlikely, extremely unlikely, and incredible (see text box). To interpret the importance of a predicted accident, the analysis considered the estimated frequency of occurrence of that accident. Although the predicted consequences of an incredible accident might be high, the lower consequences of a likely accident (i.e., one much more likely to occur) might be considered more important.

Accident Categories and Frequency Ranges

Likely (L): Accidents estimated to occur one or more times in 100 years of facility operations (frequency $\geq 1 \times 10^{-2}$/yr).

Unlikely (U): Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency = from 1×10^{-2}/yr to 1×10^{-4}/yr).

Extremely Unlikely (EU): Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency = from 1×10^{-4}/yr to 1×10^{-6}/yr).

Incredible (I): Accidents estimated to occur less than one time in 1 million years of facility operations (frequency < 1×10^{-6}/yr).

4.3.4.3 Accident Risk

The term "accident risk" refers to a quantity that considers both the severity of an accident (consequence) and the probability that the accident will occur. Accident risk is calculated by multiplying the consequence of an accident by the accident frequency. For example, if the frequency of occurrence of a facility accident is estimated to be once in 100 years (0.01 per year) and if the consequence, should the accident occur, is estimated to be 10 LCFs among the people exposed, then the risk of the accident would be reported as 0.1 LCF per year (0.01 per year × 10 LCFs). If the facility was operated for a period of 20 years, the accident risk over the operational phase of the facility would be 2 LCFs (20 years × 0.1 LCF per year).

This definition of accident risk was used to compare accidents that have different frequencies and consequences. Certain high-frequency accidents that have relatively low consequences might pose a larger overall risk than low-frequency accidents that have potentially high consequences. When calculating accident risk, the consequences are expressed in terms of

LCFs for radiological releases or adverse health effects, irreversible adverse health effects, and fatalities for chemical releases.

4.3.4.4 Physical Hazard (On-the-Job) Accidents

Physical hazards, unrelated to radiation or chemical exposures, were assessed for each alternative by estimating the number of on-the-job fatalities and injuries that could occur among workers. These impacts were calculated by using industry-specific statistics from the BLS. The injury incidence rates were for injuries involving lost workdays (excluding the day of injury). The analysis calculated the predicted number of worker fatalities and injuries as the product of the appropriate annual incidence rate, the number of years estimated for the project, and the number of FTEs required for the project each year. Estimates for construction and operation of the facilities were computed separately because these activities have different incidence statistics. The calculation of fatalities and injuries from industrial accidents was based solely on historical industrywide statistics and therefore did not consider a threshold (i.e., any activity would result in some estimated risk of fatality and injury).

4.4 UNCERTAINTY IN ESTIMATED IMPACTS

Estimates of the environmental impacts from DUF_6 conversion are subject to considerable uncertainty. This uncertainty is a consequence primarily of characteristics of the methods used to estimate impacts. To account for this uncertainty, the impact assessment was designed to ensure — through uniform and careful selection of assumptions, models, and input parameters — that impacts would not be underestimated and that relative comparisons among the alternatives would be meaningful. This goal was accomplished by uniformly applying common assumptions to each alternative and by choosing assumptions that would produce conservative estimates of impacts (i.e., assumptions that would lead to overestimates of the expected impacts). Although using a uniform approach to assess impacts can still result in some uncertainty in estimates of the absolute magnitude of impacts, this approach enhances the ability to make valid comparisons among alternatives.

5 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This chapter discusses estimated potential impacts to the environment, including impacts to workers and members of the general public, under the no action alternative (Section 5.1) and the action alternatives (Section 5.2). The general assessment methodologies and major assumptions used to estimate the impacts are described in Chapter 4 and Appendix F of this EIS.

This EIS evaluates the proposed action, which is construction and operation of a conversion facility at the Paducah site for conversion of the Paducah inventory into depleted uranium oxide and other conversion products. Three alternative locations at the site are evaluated, one of which has been selected as the preferred location. This EIS also discusses impacts from preparation of cylinders for shipment at ETTP and shipment of these cylinders to the Paducah site. Shipment of ETTP cylinders to Paducah is evaluated as a reasonable option to the proposed action.

Under the no action alternative, potential environmental impacts from continued storage and maintenance of the cylinders at their current locations at the Paducah site are evaluated primarily through the year 2039, although potential long-term impacts from releases of DUF_6 and HF from future cylinder breaches are also evaluated. The potential impacts from no action at the ETTP site (i.e., continued storage and maintenance of the ETTP cylinders in their current locations) are not presented in this EIS, but in the EIS for construction and operation of a conversion facility at the Portsmouth site (DOE 2003b), the location to which the ETTP cylinder inventory is planned to be shipped.

This chapter also discusses the potential cumulative impacts of the alternatives (Section 5.3), potential mitigation actions (Section 5.4), unavoidable adverse impacts of the alternatives (Section 5.5), irreversible and irretrievable commitment of resources (Section 5.6), the relationship between short-term use of the environment and long-term productivity (Section 5.7), pollution prevention and waste minimization (Section 5.8), and D&D of the conversion facility (Section 5.9).

5.1 NO ACTION ALTERNATIVE

5.1.1 Introduction

Under the no action alternative, it is assumed that storage of DUF_6 cylinders would continue indefinitely at the Paducah site and that DOE surveillance and maintenance activities would be ongoing to ensure the continued safe storage of cylinders. Potential environmental impacts from this alternative are estimated through 2039 in this EIS, and

No Action Alternative

The no action alternative assumes that storage of the DUF_6 cylinders would continue for an indefinite period at the Paducah site, along with continued cylinder surveillance and maintenance. Impacts were evaluated through the year 2039, and potential long-term (beyond 2039) impacts were also evaluated.

long-term impacts (i.e., those that would occur after 2039) from cylinder breaches are also estimated. A similarly defined no action alternative is evaluated in the DUF_6 PEIS (DOE 1999a). The assessment of the no action alternative in this EIS has been updated to reflect changes that have occurred since publication of the PEIS (e.g., changes in plans for new cylinder yard construction and changes in noninvolved worker and general population numbers).

A detailed discussion of the assumptions about and impacts from continued cylinder storage activities is included in Appendix D of the PEIS; changes in impacts due to the addition of USEC-generated cylinders are discussed in Section 6.3.1 of the PEIS (DOE 1999a). Updated information on ongoing and planned cylinder maintenance activities as of June 2002 has been compiled from a database on the cylinders at the three sites and from life-cycle baseline documents for cylinder maintenance (Hightower 2002). This information was compiled prior to awarding the conversion contract to UDS and thus represents DOE's plans for long-term maintenance of cylinders without conversion, as would be the case under the no action alternative. In Section 5.1.1.1, the ongoing and planned cylinder maintenance activities assumed for the Paducah site under the no action alternative are reviewed.

Impacts associated with the following activities under the no action alternative are considered in both the PEIS and this EIS: (1) storage yard reconstruction and cylinder relocations, (2) routine and ultrasonic test inspections of cylinders and radiological monitoring and maintenance of the cylinder exteriors and valves, (3) cylinder painting, and (4) repair and removal of the contents of any cylinders that might be breached during the storage period. The frequencies for each activity assumed for the Paducah site in the PEIS are compared with planned future frequencies in Table 5.1-1. Overall, the assumptions in the PEIS result in the PEIS impacts bounding the actual impacts that could occur under current and planned future activities.

5.1.1.1 Cylinder Maintenance Activities

The PEIS assessment covered maintenance of an upper bound of 40,351 cylinders at the Paducah site. The actual inventory of cylinders actively managed by DOE is changing over time as USEC transfers cylinders to DOE under three MOAs. As of January 2004, the DOE inventory at the Paducah site consisted of 36,191 full, partially full, and heels DUF_6 cylinders (Hightower 2004). Maintenance efforts completed or underway include (1) relocation of some cylinders that either are too close to one another to allow for adequate inspections or are located in yards that require reconstruction, and (2) construction of new storage yards or reconstruction of existing storage yards to provide a stabilized concrete base and monitored drainage for the cylinder storage areas. Over the last several years, more cylinders have been relocated annually than the number assumed in the PEIS (Table 5.1-1). This relocation effort has been undertaken to achieve optimal storage conditions for all cylinders. It is expected to be completed over the next several years; consequently, after about 2008, the annual number of relocations will decrease.

TABLE 5.1-1 No Action Alternative: Comparison of Frequencies Assumed in the PEIS with Planned Frequencies for Activities at the Paducah Site

Activity	Activity-Specific Assumption	PEIS-Assumed Average Annual Activity Frequency[a]	Planned Average Annual Frequency for 2003–2007[b]
Routine cylinder inspections	30-min exposure at 1-ft (0.30-m) distance per inspection	17,200	11,500
Ultrasonic inspections	90-min exposure at about 2-ft (0.61-m) distance per inspection	440	100
Radiological monitoring and valve maintenance	1-h exposure at 1-ft (0.30-m) distance per inspection	12	860
Cylinder relocations	4-h exposure at about 8-ft (2.44-m) distance per relocation	1,020	2,800[c]
Cylinder painting	7-h exposure at 1- to 10-ft (0.30- to 3.05-m) distance per cylinder, 2 gal (8 L) of paint used, 2 gal (8 L) of LLMW generated per cylinder	4,200	1,100

[a] Source: Parks (1997), with the addition of the assumption that there would be an overall increase of 42% in activities to address the addition of USEC cylinders.

[b] Maintenance activities will be conducted in accordance with the approved cylinder management plan (Commonwealth of Kentucky and DOE, 2003). These activities are consistent with planned activities for 2003-2007 presented in this table, except the Agreed Order does not include requirements for painting.

[c] Value is the average for 2003 to 2007; after that time, few relocations are expected.

Under the DOE approved cylinder management plan (Commonwealth of Kentucky and DOE 2003), the stored cylinders are regularly inspected for evidence of damage or accelerated corrosion. Each cylinder must be inspected at least once every 4 years; however, annual inspections are required for cylinders that were previously stored in substandard conditions and those that show areas of heavy pitting or corrosion. In addition to these routine inspections, ultrasonic inspections are conducted on some of the relocated cylinders. The ultrasonic testing is a nondestructive method of measuring the thickness of cylinder walls. Radiological monitoring of the cylinder surface, especially around the valves, is also conducted for cylinders that exhibit discoloration of the valve or surrounding area during routine inspections. Leaking valves are replaced in the field. Impacts from routine inspections, ultrasonic inspections, and radiological monitoring and valve maintenance are evaluated as components of the no action alternative. In the PEIS assessment, the assumed frequencies of routine and ultrasonic inspections were overestimated by factors of about 1.5 and 4.4, respectively, in comparison with rates planned for 2003 to 2007. Radiological monitoring and valve maintenance was underestimated by a factor of about 70; however, this activity is of short duration, with little radiological exposure.

At the time the PEIS was prepared, a painting program was undertaken in an effort to arrest corrosion of the cylinders. Because the long-term painting schedule was unknown at the time, the PEIS assessment of the no action alternative assumed that as an upper bound, each cylinder would be painted every 10 years. However, after the PEIS was prepared, it was discovered that painting the cylinders increased toxicity indicators in cylinder yard runoff, such that NPDES Permit violations were occurring at the Paducah site (DOE 2000b; see Section 5.1.2.4). Also, the ongoing rate of cylinder breaches was found to be much less than the rate that had been predicted on the basis of theoretical estimates of cylinder corrosion rates, indicating that the other steps that had been taken to improve storage conditions (e.g., regular inspections and relocating cylinders out of ground contact onto concrete saddles in well-drained, concrete storage yards) were also effective in controlling corrosion. Therefore, continued cylinder maintenance plans call for a greatly reduced frequency of cylinder painting in comparison with the frequency that was assumed in the PEIS (overestimated by a factor of 3.8; Table 5.1-1). The most frequent ongoing painting activity is partial painting of the ends of skirted cylinders, which are problem areas for corrosion.

The levels of worker activity, worker exposure, and waste generation associated with cylinder painting are much higher than the levels associated with inspection, relocation, and radiological monitoring and valve maintenance activities (Table 5.1-1). Therefore, because the PEIS assumed a high frequency of cylinder painting, its estimates of impacts in several technical areas (e.g., radiological exposures of involved workers, socioeconomics, waste management) represent an upper bound on the impacts that are expected under the current and planned future cylinder maintenance programs. For this EIS, the continued storage impacts for the Paducah site estimated in the PEIS were used as the basis for the no action alternative impacts. The data have been revised as appropriate (e.g., the worker and general population numbers have been updated).

With respect to impacts on air quality, yard reconstruction results in criteria pollutant emissions from vehicle exhaust and fugitive dust generation. The quantity of emissions is generally proportional to the disturbed land area. The PEIS modeled the maximum annual impacts from reconstruction of four yards at the Paducah site. The largest yard (C-745-L) was estimated to be about 310,000 ft^2 (28,800 m^2). Since publication of the PEIS, reconstruction of four yards has been completed. If no conversion facility was constructed, the cylinder management plan for the site calls for the reconstruction of C-745-N and C-745-P (N-yard and P-yard) concurrently over about 6 months in 2006, and the reconstruction of C-745-F (F-yard) over 7 months in the following year. The combined area of N-yard and P-yard is about 164,000 ft^2 (15,200 m^2); the area of F-yard is about 250,000 ft^2 (23,200 m^2).

This EIS includes the reconstruction of N-yard, P-yard, and F-yard in the impacts assessment. It is assumed that the PEIS air quality impact estimates are representative and bounding for the estimate of impacts of new yard construction under the no action alternative for the following reasons: (1) both planned yard reconstruction projects are smaller than the largest project modeled for the PEIS, (2) the PEIS projects and the planned reconstruction projects are located in close proximity to one another on the site; and (3) air quality impacts are measured on an annual basis (they are not cumulative). Also, because all of the recently constructed or to-be-constructed yards are in previously disturbed areas, impacts to cultural resources and ecological resources would be similar to impacts discussed in the PEIS. The specific impacts of yard reconstruction under the no action alternative for each technical area are discussed in Section 5.1.2.

5.1.1.2 Assumptions and Methods Used to Assess Impacts Associated with Cylinder Breaches

To estimate the impacts from continued cylinder storage, it is necessary to predict the number of cylinder breaches that might occur in the future. A cylinder is considered breached if it has a hole of any size at some location on the cylinder wall. At the time the PEIS was published (1999), 8 breached cylinders had been identified at the three storage sites; 1 of these was at the Paducah site. Investigation of these breaches indicated that 6 of the 8 were initiated by mechanical damage during stacking; the damage was not noticed immediately, and subsequent corrosion occurred at the point of damage. It was concluded that the other 2 cylinder breaches (both at the ETTP site) had been caused by external corrosion due to prolonged ground contact. The breached cylinders were patched, pending decisions on long-term management. However, these breached cylinders may eventually require emptying through cold-feeding (a lengthy process of heating a cylinder to a temperature just below the UF_6 liquefaction point so that the UF_6 changes directly from solid to gaseous form).

From 1998 through 2002, 2 additional breaches were discovered at the Paducah site (Hightower 2002).[1] These breaches were the result of missing cylinder plugs. The breach rate over this time period was 0.4 per year (2 breaches in 5 years). The breached cylinders were repaired.

For assessment purposes in this EIS, 2 cylinder breach cases were evaluated. The first is a case in which it was assumed that the planned cylinder maintenance and painting program would maintain the cylinders in a protected condition and control further corrosion. It was assumed that after the initial painting, some cylinder breaches would result from handling damage. For this case, the total number of future breaches estimated to occur through 2039 at the Paducah site is 36 (i.e., about 1 per year). In the second case, it was assumed that external corrosion would not be halted by improved storage conditions, cylinder maintenance, and/or painting. This case was considered in order to account for uncertainties in both the effectiveness of painting in controlling cylinder corrosion and uncertainties in the future painting schedule. For this scenario,

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[1] A breach that occurred at the ETTP site in 1998 was discussed in Section B.2 of the PEIS (DOE 1999a). A total of 11 breaches have been identified at the Portsmouth, ETTP, and Paducah sites (Hightower 2002).

the number of breaches estimated through 2039 was 444 for the Paducah site (i.e., 11 per year). This breach estimate is based on the historical corrosion rate determined when the cylinders were stored under poor conditions (i.e., cylinders were stacked too close together, were stacked on wooden chocks, or came in contact with the ground). Details concerning development of the breach estimates are provided in Appendix B of the PEIS (DOE 1999a).

The impacts to human health and safety, surface water, groundwater, soil, air quality, and ecology from uranium and HF releases from breached cylinders are assessed in this EIS. For all hypothetical cylinder breaches, it was assumed that the breach would go undetected for 4 years, which is the period between planned inspections for most of the cylinders. In practice, cylinders that show evidence of damage or heavy external corrosion are inspected annually, so it is very unlikely that a breach would go undetected for a 4-year period. For each hypothetical cylinder breach, it was further assumed that 1 lb (0.45 kg) of uranium (as UO_2F_2) and 4.4 lb (2 kg) of HF would be released from the cylinder annually for a period of 4 years. The cylinder management plan (Commonwealth of Kentucky and DOE 2003) outlines procedures to be taken in the event of a cylinder breach and/or release of DUF_6 from one or more cylinders.

Radiological exposures of involved workers could result from patching breached cylinders or emptying the contents of breached cylinders into new cylinders. The assumptions used to estimate impacts to involved workers were that (1) it would require 32 hours of exposure at a distance of 1 ft (0.30 m) to temporarily patch each cylinder, and (2) it would require an additional 961 hours of exposure at a distance of about 10 ft (3.05 m) to empty a cylinder by cold-feeding.

Groundwater impacts were assessed by first estimating the amount of uranium that could be transported from the yards in surface runoff, and then by estimating migration through the soil to groundwater. HF air concentrations were also modeled.

The lower breach estimate for breaches due to cylinder handling is likely to be a reasonable upper-bound estimate of a breach rate that would occur during long-term continued storage under a no action alternative (e.g., the actual rate over the last 5 years was 0.4 breach per year; the model estimates 1 breach per year). Because storage conditions have improved dramatically as a result of cylinder yard upgrades and restacking activities over the last several years, the breach estimate based on the historical corrosion rate (i.e., 11 breaches per year) is likely a worst-case estimate of what could occur if DOE discontinued active management of the cylinders. In this assessment, the worst-case scenario is used to estimate the earliest time when continued cylinder storage could begin to raise regulatory concerns, such as when drinking water standards would be exceeded in groundwater or when air quality criteria would be exceeded (see Sections 5.1.2.3 and 5.1.2.4.2).

5.1.2 Impacts of No Action at the Paducah Site

The impacts described in this section are similar to those presented in Section 3.5.2 of the data compilation report for the Paducah site (Hartmann et al. 1999); however, they have been adjusted to account for changes in noninvolved worker and general population numbers since the time of that assessment.

5.1.2.1 Human Health and Safety

Under the no action alternative, impacts to human health and safety could result from cylinder maintenance operations during both routine conditions and accidents. In general, the impacts during normal operations at the Paducah site would be limited to workers directly involved in handling cylinders. Under accident conditions, the health and safety of both workers and members of the general public around the site could be affected.

5.1.2.1.1 Normal Facility Operations

Workers. Cylinders containing DUF_6 emit low levels of gamma and neutron radiation. Involved workers would be exposed to this radiation when near cylinders, such as during routine cylinder monitoring and maintenance activities, cylinder yard reconstruction, cylinder relocation and painting, and cylinder patching or repair. It is estimated that an average of about 43 cylinder yard maintenance workers would be required at the Paducah site. These workers would be trained to work in a radiation environment, they would use protective equipment as necessary, and their radiation exposure levels would be measured and monitored by safety personnel at the sites. Radiation exposure of workers is required by law to be maintained ALARA and not to exceed 5,000 mrem/yr (10 CFR Part 835).

Involved workers reconstructing existing cylinder yards would incur external radiation from the DUF_6 cylinders stored at nearby yards. According to radiation survey data for two empty cylinder yards, C-745-K and C-745-K1, in February 2002, the average dose rate within the empty yards was about 0.2 mrem/h (Hicks 2002b). On the basis of the assumptions that the reconstruction projects would last for a maximum of 7 months and the workers would spend, at most, 1,170 hours per reconstruction project working in the vicinity of the storage yards, it is estimated that the maximum dose a worker would receive would be about 230 mrem per reconstruction project. If the same workers conducted both planned reconstruction projects, the maximum total dose over 2 years would be 460 mrem. This is well within the standard required by law of 5,000 mrem/yr for radiation workers (10 CFR Part 835).

The radiation exposure of involved workers (cylinder yard workers) in future years through 2039 is estimated to be well within public health standards (10 CFR Part 835). If the same 43 workers conducted all cylinder management activities, the average annual dose to individual involved workers would be about 740 mrem/yr. The estimated future doses do not account for standard ALARA practices that would be used to keep the actual doses as far below the limit as practicable. Thus, the future doses to workers are expected to be less than those estimated because of the conservatism in the assumptions and models used to generate the estimates. In fact, in 2001, the measured doses to cylinder yard workers ranged from about 170 to 427 mrem/yr, with an average of 254 mrem/yr (Hicks 2002a). The radiation exposure of the noninvolved workers was estimated to be less than 0.15 mrem/yr.

It is estimated that the total collective dose to all involved cylinder maintenance workers at the Paducah site from 1999 through 2039 would be about 1,300 person-rem. (The collective dose to noninvolved workers would be negligible [i.e., less than 0.01%], compared with the collective dose to involved workers.) This dose would be distributed among all of the workers involved with cylinder activities over the no action period. Although about 43 workers would be required each year, the actual number of different individuals involved over the period would probably be much greater than 43 because workers could be rotated to different jobs and could change jobs. It is estimated that this level of exposure could potentially result in less than 1 LCF (i.e., 0.5 LCF) among all the workers exposed, in addition to the cancer cases that would result from all other causes not related to the no action alternative activities.

As discussed in Chapter 1 and Appendix B of this EIS, some portion of the DUF_6 inventory contains TRU and Tc contamination. The contribution of these contaminants to potential external radiation exposures under normal operations was evaluated on the basis of the bounding concentrations presented in Appendix B. The dose from these contaminants was estimated and compared with the dose from the depleted uranium and uranium decay products in the DUF_6. It is estimated that under typical cylinder maintenance conditions, the TRU and Tc contaminants would make only a very small contribution to the radiation doses, amounting to approximately 0.2% of the dose from the depleted uranium and its decay products.

No impacts to involved workers are expected from exposure to chemicals during normal cylinder maintenance operations. Exposures to chemicals during cylinder painting operations would be monitored to ensure that airborne chemical concentrations were within applicable health standards protective of human health and safety. If planned work activities were likely to expose involved workers to chemicals, those workers would be provided with appropriate protective equipment as necessary.

Chemical exposures to noninvolved workers could result from airborne emissions of UO_2F_2 and HF that could be dispersed from hypothetical cylinder breaches into the atmosphere and to ground surfaces. It is estimated that the potential chemical exposures of noninvolved workers from any airborne releases during normal operations would be below levels expected to cause adverse effects. (The hazard index was estimated to be less than 0.1 for noninvolved workers.)

General Public. Potential health impacts to members of the general public could occur if material released from breached cylinders entered the environment and was transported from the site through the air, surface water, or groundwater. Off-site releases of uranium and HF from breached cylinders are possible. However, it is estimated that the off-site concentrations of these contaminants in the future would be much less than levels expected to cause adverse effects. Potential exposures of members of the general public would be well within public health standards. No adverse effects (LCFs or chemical effects) are expected to occur among members of the general public residing within 50 mi (80 km) of the Paducah site as a result of DUF_6 continued storage activities.

If all the uranium and HF assumed to be released from hypothetical breached cylinders through 2039 were dispersed from the site through the air, the total collective radiation dose to the general public (all persons within 50 mi [80 km]) would be less than 0.3 person-rem. This level of exposure would most likely result in zero cancer fatalities among members of the general public. For comparison, the total collective radiation dose from natural background and medical sources to the same population group in 40 years would be about 7.4×10^6 person-rem. The maximum radiation dose to an individual near the site would be less than 0.1 mrem/yr, well within health standards. Radiation doses to the general public are required by health regulations to be maintained at below 10 mrem/yr from airborne sources (40 CFR Part 61) and below a total of 100 mrem/yr from all sources combined (DOE 1990). If an individual received the maximum estimated dose every year, the total dose would be less than 4 mrem, resulting in an additional chance of dying from a latent cancer of about 1 in 500,000. No noncancer health effects from exposure to airborne uranium and HF releases are expected; the estimated hazard index for an MEI is less than 0.1. This means that the total exposure would be at least 10 times less than exposure levels that might cause adverse effects.

The material released from breached cylinders could also have the potential to be transported from the site in water, either in surface water runoff or by infiltrating the soil and contaminating groundwater. Members of the general public could be exposed if they used this contaminated surface water or groundwater as a source of drinking water. The results of the surface water and groundwater analyses indicate that the maximum estimated uranium concentrations in surface water accessible to the general public and in groundwater beneath the site would be less than 20 μg/L (the proposed EPA drinking water standard has now been finalized at 30 μg/L and became effective in December 2003 [EPA 2003b]). Drinking water standards, meant to apply to water "at the tap" of the user, are set at levels protective of human health. In this assessment, 20 μg/L was used as a guideline level for the surface water and groundwater analyses.

If a member of the general public used contaminated water at the maximum concentrations estimated, adverse effects would be unlikely. Even if a member of the general public used contaminated surface water or groundwater as his or her primary water source, the maximum radiation dose in the future would be less than 0.5 mrem/yr. The corresponding increased risk to this individual of dying from a latent cancer would be less than 1 in 1 million per year. Noncancer health effects from exposure to possible water contamination are not expected; the estimated maximum hazard index for an individual assumed to use the groundwater is less than 0.05. This result means that the total exposure would be 20 times less than the exposure that might cause adverse effects.

If no credit was taken for the reduction in cylinder corrosion rates as a result of cylinder maintenance and painting activities, the groundwater analysis indicates that the uranium concentration in groundwater could exceed 20 μg/L at some time in the future (see Section 5.1.2.4). This scenario is highly unlikely because ongoing cylinder inspection and maintenance would prevent significant releases from occurring, especially for as many cylinders as are assumed here (i.e., 444 breaches). Nonetheless, if contamination of groundwater used as drinking water occurred in the future, treating the water or supplying an alternative source of water might be required to ensure the safety of those potentially using the water.

5.1.2.1.2 Facility Accidents

Physical Hazards (On-the-Job Injuries and Fatalities). Accidents occur in all work environments. In 2000, about 5,200 people in the United States were killed in accidents while at work, and approximately 3.9 million disabling work-related injuries were reported (National Safety Council 2002). Although all work activities would be conducted in as safe a manner as possible, there is a chance that workers could be accidentally killed or injured under the no action alternative, unrelated to any radiation or chemical exposures.

The numbers of accidental worker injuries and fatalities that might occur through 2039 were estimated on the basis of the number of workers required and the historical accident fatality and injury rates in similar types of industries. It is estimated that a total of less than 1 accidental fatality (i.e., about 0.07, or about 7 chances in 100 of a single fatality) might occur at the Paducah site over the no action period evaluated. A total of about 82 accidental injuries (defined as injuries resulting in lost workdays) are estimated for cylinder maintenance activities. Two accidental injuries would be associated with cylinder yard reconstruction. The rates are not unique to the activities required for the no action alternative but are typical of any industrial project of similar size and scope.

Accidents Involving Radiation or Chemical Releases. Under the no action alternative, accidents could release radiation and chemicals from cylinders. Several types of accidents were evaluated. Included were those initiated by operational events, such as equipment or operator failure; external hazards, such as aircraft crashes; and natural phenomena, such as earthquakes. The assessment considered accidents ranging from those that would be reasonably likely to occur (one or more times in 100 years on average) to those that would be extremely rare (estimated to occur less than once in 1 million years on average).

The accidents of most concern at the Paducah site under the no action alternative would be accidents that could cause a release of UF_6 from cylinders. In a given accident, the amount potentially released would depend on the severity of the accident and the number of cylinders involved. Following a release, the UF_6 could combine with moisture in the air, forming gaseous HF and UO_2F_2, a soluble solid in the form of small particles. The depleted uranium and HF could be dispersed downwind, potentially exposing workers and members of the general public living near the site to radiation and chemical effects. The workers considered in the accident assessment were those noninvolved workers not immediately in the vicinity of the accident; fatalities and injuries among involved workers would be possible if accidents were severe.

The estimated consequences of cylinder accidents are summarized in Table 5.1-2 for chemical effects and Table 5.1-3 for radiation effects. The impacts are the maximums estimated for the Paducah site. The impacts are presented separately for likely accidents and for rare, low-probability accidents estimated to result in the largest potential impacts. Although other accidents were evaluated (see Hartmann 1999, Section 3.2.2), the estimated consequences of those other accidents would be less than the consequences of the accidents summarized in these tables. The estimated consequences are conservative in that they were based on the assumption

TABLE 5.1-2 No Action Alternative: Estimated Consequences of Chemical Exposures for Cylinder Accidents at the Paducah Site[a]

Receptor[b]	Accident Scenario	Accident Frequency Category[c]	Potential Effect[d]	Consequence[e] (no. of persons affected)
Likely Accidents				
General public	Corroded cylinder spill, dry conditions	L	Adverse effects	0
	Corroded cylinder spill, dry conditions	L	Irreversible adverse effects	0
	Corroded cylinder spill, dry conditions	L	Fatalities	0
Noninvolved workers	Corroded cylinder spill, dry conditions	L	Adverse effects	0–10
	Corroded cylinder spill, dry conditions	L	Irreversible adverse effects	0–1
	Corroded cylinder spill, dry conditions	L	Fatalities	0
Low Frequency-High Consequence Accidents				
General public	Rupture of cylinders – fire	EU	Adverse effects	3–2,000
	Corroded cylinder spill, wet conditions – water pool	EU	Irreversible adverse effects	0–1
	Corroded cylinder spill, wet conditions – water pool	EU	Fatalities	0
Noninvolved workers	Rupture of cylinders – fire	EU	Adverse effects	4–910
	Corroded cylinder spill, wet conditions – water pool	EU	Irreversible adverse effects	1–300
	Corroded cylinder spill, wet conditions – water pool	EU	Fatalities	0–3

Footnotes on next page.

TABLE 5.1-2 (Cont.)

[a] The accidents listed are those estimated to result in the greatest impacts among all the accidents considered (except for certain accidents with security concerns). The site-specific impacts for a range of accidents at the Paducah site are given in Hartmann et al. (1999).

[b] Noninvolved workers are persons who work at the site but who are not involved in handling materials. Depending on the circumstances of the accident, injuries and fatalities among involved workers are possible for all accidents.

[c] Accident frequencies: L = likely, estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); EU = extremely unlikely, estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} to 10^{-6}/yr).

[d] Potential adverse effects include exposures that could result in mild and transient injury, such as respiratory irritation. Potential irreversible adverse effects include exposures that could result in permanent injury (e.g., impaired organ function) or death. The majority of the adverse effects would be mild and temporary in nature. It is estimated that less than 1% of the predicted potential irreversible adverse effects would result in fatalities (see text).

[e] The consequence is expressed as the number of individuals with a predicted exposure level sufficient to cause the corresponding health endpoint. The range of estimated consequences reflects different atmospheric conditions at the time of an accident assumed to occur at the cylinder yard closest to the site boundary. In general, maximum risks would occur under atmospheric conditions of F stability with a 1-m/s (2-mph) wind speed; minimum risks would occur under D stability with a 4-m/s (9-mph) wind speed. For both conditions, it was assumed that the wind would be blowing in the direction of the highest density of worker or public populations.

that the wind would be blowing in the direction of the greatest number of people at the time of the accident. In addition, the effects of protective measures, such as evacuation, were not considered.

An exception to the discussion above would be a certain class of accidents that DOE investigated; however, because of security concerns, information about such accidents is not available for public review but is presented in a classified appendix to this EIS. All classified information will be presented to state and local officials, as appropriate.

Chemical Effects. The potential likely accident (defined as an accident estimated to occur one or more times in 100 years) that would cause the largest chemical health effects is the failure of a corroded cylinder that would spill part of its contents under dry weather conditions. Such an accident could occur, for example, during cylinder handling activities. It is estimated that about 24 lb (11 kg) of DUF_6 could be released in such an accident. The potential consequences from this type of accident would be limited to on-site workers. The off-site concentrations of HF and uranium were calculated to be less than the levels that would cause adverse effects from exposure to these chemicals, so that zero adverse effects would occur among members of the general public. It is estimated that if this accident did occur, up to 10 noninvolved workers might experience potential adverse effects from exposure to HF and

TABLE 5.1-3 No Action Alternative: Estimated Consequences from Radiation Exposures for Cylinder Accidents at the Paducah Site[a]

			MEI		Population	
Receptor[b]	Accident Scenario	Accident Frequency Category[c]	Dose (rem)	Lifetime Risk of LCF	Dose (person-rem)	Number of LCFs
Likely Accidents						
General public	Corroded cylinder spill, dry conditions	L	0.0023	1×10^{-6}	0.27	0.0001
Noninvolved workers	Corroded cylinder spill, dry conditions	L	0.077	3×10^{-5}	1.4	0.0006
Low Frequency-High Consequence Accidents						
General public	Rupture of cylinders – fire	EU	0.015	7×10^{-6}	29	0.01
Noninvolved workers	Rupture of cylinders – fire	EU	0.02	8×10^{-6}	15	0.006

[a] The accidents listed are those estimated to have the greatest impacts among all the accidents considered (except for certain accidents with security concerns). The site-specific impacts for a range of accidents at the Paducah site are given in Hartmann et al. (1999). The estimated consequences were based on the assumption that at the time of the accident, the wind would be blowing in the direction of the highest density of workers or public population and that weather conditions would limit dispersion.

[b] Noninvolved workers are persons who work at the site but who are not involved in handling materials. Depending on the circumstances of the accident, injuries and fatalities among involved workers are possible for all accidents.

[c] Accident frequencies: L = likely, estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); EU = extremely unlikely, estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} to 10^{-6}/yr).

uranium (mostly mild and transient effects, such as respiratory irritation or temporary decrease in kidney function). It is estimated that one noninvolved worker might experience potential irreversible adverse effects (such as lung or kidney damage). The number of fatalities following an HF or uranium exposure is expected to be somewhat less than 1% of the number of potential irreversible adverse effects (Policastro et al. 1997). Therefore, no fatalities are expected.

For assessment purposes, the estimated frequency of a corroded cylinder spill accident is assumed to be about once in 10 years. Therefore, over the no action period, about four such accidents are expected. The accident risk (defined as consequence × probability) would be about 40 workers with potential adverse effects, and 4 workers with potential irreversible adverse effects. The number of workers actually experiencing these effects would probably be considerably less, depending on the actual circumstances of the accidents and the individual chemical sensitivity of the workers. In previous accidental exposure incidents involving liquid

UF_6 in gaseous diffusion plants, a few workers were exposed to amounts of uranium estimated to be approximately three times the guidelines used for assessing irreversible adverse effects in this EIS, and none actually experienced irreversible adverse effects (McGuire 1991).

Accidents that are less likely to occur could have higher consequences. The potential cylinder accident at the site estimated to result in the greatest total number of adverse chemical effects would be an accident involving several cylinders in a fire. It is estimated that about 24,000 lb (11,000 kg) of DUF_6 could be released in such an accident. If this accident occurred, it is estimated that up to 2,000 members of the general public and 910 noninvolved workers might experience adverse effects from HF and uranium exposure (mostly mild and transient effects, such as respiratory irritation or temporary decrease in kidney function). This accident is considered extremely unlikely, it is estimated to occur between once in 10,000 years and once in 1 million years. If the frequency is assumed to be once in 100,000 years, the accident risk over the no action period would be less than 1 adverse effect for both workers and members of the general public.

The potential cylinder accident estimated to result in the largest total number of irreversible adverse effects is a corroded cylinder spill under wet conditions, for which the UF_6 is assumed to be released into a pool of standing water. This accident is also considered extremely unlikely; that is, it is expected to occur between once in 10,000 years and once in 1 million years. It is estimated that if this accident did occur, about 1 member of the general public and 300 noninvolved workers might experience irreversible adverse effects (such as lung damage) from HF and uranium exposure. The number of fatalities would be somewhat less than 1% of the estimated number of potential irreversible adverse effects (Policastro et al. 1997). Thus, no fatalities are expected among the general public, although three fatalities could occur among noninvolved workers (1% of 300). If the frequency of this accident is assumed to be once in 100,000 years, the accident risk through 2039 would be less than 1 (0.1) irreversible adverse health effect among workers and the general public combined.

Radiation Effects. Potential cylinder accidents could release uranium, which is radioactive in addition to being chemically toxic. The potential radiation exposures of members of the general public and noninvolved workers were estimated for the same cylinder accidents as those for which chemical effects were estimated (Table 5.1-3). For all cylinder accidents considered, it is estimated that the radiation doses from released uranium would be considerably below levels likely to cause radiation-induced effects among noninvolved workers and the general public and below the 25-rem total effective dose equivalent established by DOE as a guideline for assessing the adequacy of protection of public health and safety from potential accidents (DOE 2000c).

For the corroded cylinder spill accident (dry conditions), it is estimated that the radiation dose to a maximally exposed member of the general public would be less than 3 mrem (lifetime dose), resulting in an increased risk of death from cancer of about 1 in 1 million. The total population dose to the general public within 50 mi (80 km) would be less than 1 person-rem, most likely resulting in zero LCFs. Among noninvolved workers, the dose to an MEI would be 77 mrem, resulting in an increased risk of death from cancer of about 1 in 30,000. The total dose to all noninvolved workers would be about 1.4 person-rem. It is estimated that this dose to workers would result in no LCFs. The risk (consequence × probability) of additional LCFs among members of the general public and workers combined would be much less than 1 through 2039.

The cylinder accident estimated to result in the largest potential radiation doses would be the accident involving several cylinders in a fire. For this accident, it is estimated that the radiation dose to a maximally exposed member of the general public would be about 15 mrem, resulting in an increased risk of death from cancer of about 1 in 150,000. The total population dose to the general public within 50 mi (80 km) would be 29 person-rem, most likely resulting in no LCFs. Among noninvolved workers, the dose to an MEI would be about 20 mrem, resulting in an increased risk of death from cancer of about 1 in 100,000. The total dose to all noninvolved workers would be about 15 person-rem. This dose to workers would result in no LCFs. The risk (consequence × probability) of additional LCFs among members of the general public and workers combined would be much less than 1 through 2039.

5.1.2.2 Transportation

Continued cylinder storage under the no action alternative would have the potential to generate small amounts of LLW and LLMW during cylinder monitoring and maintenance activities. This material could require transportation to a treatment or disposal facility. Shipments would be made in accordance with all DOE and DOT regulations and guidelines. It is estimated that less than one waste shipment would be required each year. Because of the small number of shipments and the low concentrations of contaminants expected, the potential environmental impacts from these shipments would be negligible.

5.1.2.3 Air Quality and Noise

The assessment of potential impacts to air quality under the no action alternative included a consideration of air pollutant emissions from continued cylinder storage activities, including emissions from reconstruction of cylinder yards (engine exhaust and particulate matter emissions [i.e., dust]), emissions from operations (cylinder painting and vehicle emissions), and HF emissions from breached cylinders. An atmospheric dispersion model was used to estimate the concentrations of criteria pollutants at the site boundaries: SO_2, NO_2, CO_2, O_3, PM (PM_{10} and $PM_{2.5}$), and Pb. The site boundary concentrations were compared with existing air quality standards given in Chapter 3. For the no action alternative, it is estimated that concentrations of criteria pollutants and HF would be within applicable standards. However, because potential PM_{10} concentrations during yard reconstruction activities would be very close to the standards, mitigation measures to reduce these emissions might have to be implemented during construction.

The highest levels of criteria pollutants generally would be generated by yard reconstruction activities. Except for PM, the air concentrations of all criteria pollutants resulting from no action alternative activities would be less than or equal to 0.02% of the respective standards. PM emissions from construction could result in maximum 24-hour average PM_{10} concentrations just below the standards (about 90% of the 24-hour standard value of 150 μg/m^3), although the estimated annual average concentrations would be lower (about 33% of the standard value of 50 μg/m^3). During yard reconstruction activities, mitigative measures, such as spraying the soil with water and covering excavated soil, would be taken to reduce the generation of particulate matter. Such measures are commonly employed during construction but were not accounted for in the modeling. Planned construction activities at the Paducah site for the no action alternative are the reconstruction of cylinder yards C-745-N and C-745-P (combined area of 164,000 ft^2 [15,200 m^2] in 2006, and of C-745-F, with an area of about 250,000 ft^2 (23,000 m^2), in 2007.

Operations would emit much lower concentrations of criteria pollutants than would reconstruction. Criteria pollutant emissions would all be lower than 0.3% of standards. Painting of cylinders could generate hydrocarbon emissions. Although no explicit air quality standard has been set for hydrocarbon emissions, these emissions are associated with ozone formation. Standards have been set for ozone. For the Paducah site, hydrocarbon emissions from painting activities were estimated to be less than 1.2% of the hydrocarbon emissions from the entire surrounding county. Because ozone formation is a regional issue affected by emissions for an entire area, this small additional contribution to the county total would be unlikely to substantially alter the ozone levels of the county. In addition, the actual frequency of cylinder painting is expected to be greatly reduced from the level assumed.

When credit is taken for reduced corrosion from better maintenance and painting, the estimated maximum 24-hour and annual average site boundary HF concentrations from hypothetical cylinder breaches occurring under the no action alternative at the Paducah site are 0.08 μg/m^3 and 0.0093 μg/m^3, respectively. The Kentucky HF standards are 2.9 μg/m^3 (secondary standard for 24-hour maximum average) and 400 μg/m^3 (primary annual average standard). The annual average HF concentration for the Paducah site is estimated to be less than 0.002% of the standard; the maximum 24-hour average is estimated to be 2.8% of the standard.

Calculations indicate that if no credit was taken for the reduction in corrosion as a result of painting and continued maintenance and if storage continued at the Paducah site indefinitely, breaches occurring at the site by around 2039 could result in maximum 24-hour average HF concentrations at the site boundary of 2 μg/m^3, about 69% of the state secondary standard. Because of the ongoing maintenance program, it is not expected that a breach rate this high would occur at the Paducah site.

At Paducah, planned reconstruction of cylinder yards over several months could result in increased noise levels. At the nearest residence, located about 1.9 km (1.2 mi) from the cylinder yards, estimated noise levels would be well below the EPA guideline of 55 dB(A) as DNL for residential zones (EPA 1974). Adverse noise impacts from cylinder yard reconstruction activities are not expected.

Continued storage operations could result in somewhat increased noise levels at the site as a result of activities such as painting or repairing any infrequent cylinder breaches. However, it is expected that the noise levels at off-site residences would not increase noticeably. Noise impacts are expected to be negligible under the no action alternative.

5.1.2.4 Water and Soil

Under the no action alternative, continued storage of the cylinders at the Paducah site would have the potential to affect surface water, groundwater, and soil. Important elements in assessing potential impacts on surface water include changes in runoff, floodplain encroachment, and water quality. Groundwater impacts were assessed in terms of changes in recharge to the underlying aquifers, depth to groundwater, direction of groundwater flow, and groundwater quality. Potential soil impacts considered were changes in topography, permeability, erosion potential, and soil quality.

Under the no action alternative, the planned cylinder yard reconstruction activity would occur in previously developed areas. Water use and wastewater discharge would be limited. Therefore, the assessment area in which potentially important impacts might occur was determined to be quality of surface water, groundwater, and soil. All the other potential impacts would depend on changes in permeable land areas at the sites as a result of construction activities or would depend on water use, effluent volumes, and effluent composition and concentrations.

A contaminant of concern for evaluating surface water, groundwater, and soil quality is uranium. Surface water and groundwater concentrations of contaminants are generally evaluated through comparison with EPA MCLs, as given in Safe Drinking Water Act regulations (40 CFR Part 141), although these limits are only directly applicable "at the tap" of the water user. The water concentration value for uranium used for comparison in this EIS is 20 μg/L (i.e., the proposed MCL for uranium has now been finalized at 30 μg/L and became effective in December 2003 [EPA 2003b]). The 20-μg/L level is used as a guideline for evaluating surface water and groundwater concentrations of uranium in this EIS, even though it is not directly applicable as a standard. There is also no standard available for limiting concentrations of uranium in soil. A health-based value of 230 μg/g (EPA 1995), applicable for residential settings, is used as a guideline for comparison.

The nearest surface water to the Paducah site is Little Bayou Creek, which is a tributary to the Ohio River. The Ohio River is used as a drinking water source. Because of very large dilution effects, even high levels of contaminants in Little Bayou Creek would not be expected to cause levels exceeding guidelines at the drinking water intakes of the Ohio River.

Reconstruction of storage yards is estimated to require approximately 0.5 million gal (2 million L) of water for each of the two projects. Maximum water use for continued maintenance activities would be 230,000 gal/yr (870,000 L/yr).

5.1.2.4.1 Surface Water. Potential impacts on the nearest receiving water at the site (i.e., Little Bayou Creek) were estimated for uranium released from hypothetical cylinder breaches occurring through 2039. The estimated maximum concentration of uranium in Little Bayou Creek would be 0.3 μg/L, considerably below the 20-μg/L level used for comparison.

At the Paducah site, KPDES Outfall 017 receives runoff from the cylinder storage yards and from the cylinder painting facility area. Cylinder painting operations were ongoing in 1998; the entire bodies of 1,200 cylinders were painted in that year (Hightower 2002). Toward the end of 1998, results from two separate acute toxicity tests of water fleas (*Ceriodaphnia dubia*) conducted at KPDES Outfall 017 exceeded specified limits; the runoff was not toxic to flathead minnows (*Pimephales promelas*). Evaluations seemed to indicate that zinc in runoff from recent painting activities was the leading contributor to the toxicity of the runoff (DOE 2000b). No cylinder painting was conducted at the site in 1999, and effluent from KPDES Outfall 017 did not exceed toxicity limits in that year (DOE 2001b). In 2000 and 2001, acute toxicity tests at the outfall again exceeded toxicity limits, although no cylinder painting was occurring (DOE 2002e). It is possible that cylinder painting activities at the Paducah site might result in KPDES Permit violations in the future. Mitigating actions, such as treating runoff, could be implemented if this problem arose.

5.1.2.4.2 Groundwater. Groundwater in the vicinity of the Paducah site is used for domestic and industrial supplies. Existing groundwater quality at the site is discussed in Section 3.1-5. The Paducah site provides a municipal water supply to residents whose wells are within an area of groundwater contaminated with TCE and Tc-99. Activities associated with the no action alternative would not affect migration of existing groundwater contamination or further impact off-site water supplies.

Potential impacts on groundwater quality from hypothetical releases of uranium from breached cylinders were also assessed. The maximum future concentration of uranium in groundwater directly below the Paducah site is estimated to be 6 μg/L, which is considerably below the 20-μg/L level used for comparison. It is estimated that if the rate of uranium migration was rapid, this concentration would occur sometime after 2070. A lower concentration would occur if uranium migration through the soil was slower than assumed for this analysis.

Calculations indicate that if no credit was taken for the reduction in corrosion as a result of cylinder painting and maintenance and if storage continued at the Paducah site indefinitely, uranium releases from future cylinder breaches occurring before about 2020 could result in a sufficient amount of uranium in the soil column to increase the groundwater concentration of uranium to 20 μg/L in the future. The groundwater concentration would not actually reach 20 μg/L at the site until about 2100 or later. However, because of the ongoing cylinder maintenance program, it is expected that breaches occurring prior to 2039 would not be sufficient to increase the groundwater concentration of uranium to 20 μg/L at the site.

5.1.2.4.3 Soil. Potential impacts on soil that could receive contaminated rainwater runoff from the cylinder storage yards were estimated. The source is assumed to be uranium released from hypothetical breached cylinders. It is assumed that any releases from future cylinder painting activities would be controlled or treated to avoid soil contamination. The estimated maximum soil concentration is 1 μg/g for the Paducah site, considerably below the 230-μg/g guideline used for comparison.

5.1.2.5 Socioeconomics

The potential socioeconomic impacts of reconstruction and operational activities under the no action alternative at the Paducah site would be low. Reconstruction activities would create short-term employment (30 direct jobs, 110 total jobs over each of 2 construction years), and operational activities at the site would create 90 direct jobs and 130 total jobs per year. Direct and total income from reconstruction in the peak year would be $1.6 million and $3.2 million, respectively. During operations, direct and total income would be $3.0 million/yr and $3.8 million/yr, respectively.

The employment created in the ROI for the Paducah site would represent a change of less than 0.1 of a percentage point in the projected average annual growth in employment over the period 2004 to 2039. With no in-migration into the ROI expected during continued storage, no impacts on housing, local public finances, or local service employment are expected.

5.1.2.6 Ecology

The no action alternative would have a negligible impact on ecological resources in the area of the Paducah site. Very limited construction activity is planned, and all activities that are expected would occur in previously developed areas. Thus, impacts on wetlands and federal- and state-protected species from construction are expected to be negligible.

The assessment results indicate that impacts to ecological resources from continued storage, including hypothetical cylinder breaches, would be negligible. Analysis of potential impacts was based on exposure of biota to airborne contaminants or contaminants released to soil, groundwater, or surface water (e.g., from painting activities or from breached cylinders). Predicted concentrations of contaminants in environmental media were compared with benchmark values for toxic and radiological effects (see Appendix F). At the Paducah site, air, soil, and surface water concentrations would be below levels harmful to biota. However, as discussed in Section 5.1.2.4.1, cylinder painting activities may potentially result in future reductions in surface water quality, and they may consequently cause impacts to aquatic biota downstream at KPDES Outfall 017. Although groundwater uranium concentrations (6 to 20 μg/L) would be below the lowest effects level (150 μg/L) and below radiological benchmark levels (4.55×10^3 pCi/L), they would exceed the ecological screening value for surface water (2.6 μg/L). However, contaminants in groundwater discharging to a surface water body, such as a local stream, would be quickly diluted to negligible concentrations.

5.1.2.7 Waste Management

Under the no action alternative, construction and operations at the Paducah site would generate relatively small amounts of LLW and LLMW (including PCB-containing wastes). The volume of LLW generated by continued storage activities would represent less than 1% of the annual generation at the site from all activities. The maximum annual amount of LLMW generation from stripping/painting operations at the Paducah site would be about 30 yd^3/yr (23 m^3/yr), which is about 0.3% of the site's total annual LLMW load. Thus, the overall impact on waste management operations from the no action alternative would be negligible.

5.1.2.8 Resource Requirements

Cylinder yard reconstruction and operations under the no action alternative would require supplies of electricity, fuel, concrete, steel and other metals, and miscellaneous chemicals. The total quantities of commonly used materials would be small compared with local sources and would not affect local, regional, or national availability of these materials. No strategic or critical materials are expected to be consumed. The anticipated utilities requirements would be within the supply capacities at the Paducah site. The required material resources would be readily available.

5.1.2.9 Land Use

For the Paducah site, reconstruction of three storage yards within the boundaries of existing yards is planned, so additional land clearing would not be necessary. Therefore, impacts of the no action alternative on land use would be negligible.

5.1.2.10 Cultural Resources

Impacts to cultural resources under the no action alternative would not be likely at the Paducah site. The existing storage yards at Paducah are located in previously disturbed areas unlikely to contain cultural properties or resources listed on or eligible for listing on the NRHP. Three cylinder yards are scheduled for reconstruction at their existing locations. Cylinder breaches are not expected to result in HF or criteria pollutant emissions sufficient to impact cultural resources (see Section 5.1.2.3).

5.1.2.11 Environmental Justice

A review of the potential human health and safety impacts anticipated under the no action alternative indicates that no disproportionately high and adverse effects to minority or low-income populations are expected in the vicinity of the Paducah site during continued cylinder storage. Although such populations occur in certain areas on or within the 50-mi (80-km) radius used to identify the maximum geographic extent of human health impacts (see Section 3.1.12), no noteworthy impacts are expected. The results of accident analyses for the no action alternative also did not identify high and adverse impacts to the general public; the risk of accidents (consequence × probability) is less than 1 fatality for all accidents considered.

5.2 PROPOSED ACTION ALTERNATIVES

This section presents the estimated potential environmental impacts for the proposed action alternatives, including:

- Impacts from construction of the conversion facility at three alternative locations within the Paducah site (Section 5.2.1);
- Impacts from operation of the conversion facility at the three alternative locations (Section 5.2.2);
- Impacts from the transportation of uranium conversion products and waste materials to a disposal facility (Section 5.2.3);
- Impacts associated with the potential sale and use of HF and CaF_2 (Section 5.2.4);
- Impacts that would occur if the cylinders at ETTP were shipped to Paducah for conversion rather than to Portsmouth (Section 5.2.5); and
- Impacts from expanded plant operations, including extending the operational period and increasing throughput (Section 5.2.6).

In general, within each technical area, impacts are discussed for the construction and operation of the facility at the preferred location (Location A) as well as for two alternative locations (Locations B and C). The time period considered is a construction period of approximately 2 years and an operational period of 25 years.

5.2.1 Conversion Facility Construction Impacts

This section discusses the potential environmental impacts during construction of a conversion facility at the three alternative locations within the Paducah site. When completed, the conversion facility would occupy approximately 10 acres (4 ha), including process and support buildings and parking areas. However, up to 45 acres (18 ha) of land might be disturbed during construction, including temporary lay-down areas (areas for staging construction material and equipment or for excavated material) and for utility access. Some of the disturbed areas would not be adjacent to the construction area. The disturbed area includes access roads, rail lines, and utility corridors.

5.2.1.1 Human Health and Safety — Normal Construction Activities

5.2.1.1.1 Radiological Impacts. Three alternative locations at the Paducah site are considered for construction of the conversion facility (Figure 2.2-1). Location A is next to the current cylinder storage yards managed by DOE and is the preferred location for constructing the conversion facility. According to on-site radiation monitoring data, potential external radiation exposure also could be incurred by construction workers at Location C during construction activities because of the location's proximity to a USEC storage area. On-site radiation monitoring data near Location B are near background levels; thus, direct radiation from the cylinders would be negligible.

On the basis of the closest site monitoring data (DOE 2001b), direct external radiation would range from 0 to 0.035 mrem/h (data from thermoluminescence dosimeter [TLD]-1) across Location A and from 0 to 0.04 mrem/h (data from TLD-3) across Location C. The estimated external radiation exposure would be 35 mrem/yr for a hypothetical construction worker working 1,000 hours per year (4 hours per day and 250 days per year) at the spot of the highest radiation level within Location A. For a similar employee working within Location C, the potential dose would be about 40 mrem/yr. The potential doses were estimated on the basis of conservative assumptions; in reality, a worker would work at various spots around the project and would likely spend much less time than 1,000 hours per year at the same location. Furthermore, external radiation would be reduced by the construction of walls around the conversion facility. The radiation dose limit set to protect the general public from operations of the DOE facilities is 100 mrem/yr (DOE 1990); radiation workers are limited to a dose of 5,000 mrem/yr (10 CFR Part 835).

5.2.1.1.2 Chemical Impacts. Chemical exposures during construction at the Paducah site are expected to be low and mitigated by using personal protective equipment and engineering controls to comply with OSHA PELs that are applicable for construction activities. No differences between the three alternative locations are expected.

5.2.1.2 Human Health and Safety — Accidents

The risk of on-the-job fatalities and injuries to conversion facility construction workers would not depend on the location of the facility. The estimated injuries and fatalities were calculated by using industry-specific statistics from the BLS, as reported by the National Safety Council (2002). Annual fatality and injury rates from the BLS construction industry division were used for the 20-month construction phase. Construction of the conversion facility is estimated to require approximately 164 FTEs per year. For all three alternative locations, no on-the-job fatalities are predicted during the conversion facility construction phase; however, approximately 11 injuries are predicted (Table 5.2-1).

TABLE 5.2-1 Potential Impacts to Human Health from Physical Hazards during Conversion Facility Construction and Operations at the Paducah Site

	Impacts to Conversion Facility Workers[a]			
	Incidence of Fatalities		Incidence of Injuries	
Activity	Construction	Operations	Construction	Operations
Conversion to U_3O_8	0.04	0.14	11	197
Conversion to U_3O_8 (with ETTP cylinders)	0.04	0.16	11	221

[a] Potential hazards were estimated for all conversion facility workers over the entire construction (20 months) and operation (28 and 25 years, with and without ETTP cylinders, respectively) phases.

Source: Injury and fatality rates used in calculations were taken from National Safety Council (2002).

5.2.1.3 Air Quality and Noise

5.2.1.3.1 Air Quality Impacts. Currently, detailed information on the location of facility boundaries is available only for preferred Location A. For modeling air quality impacts at Locations B and C, the proposed facilities were assumed to be placed in the middle of the alternative locations.

Emissions of criteria pollutants — SO_2, NO_x (emissions are in NO_x but the ambient air quality standards are in NO_2), CO, and PM (PM_{10} and $PM_{2.5}$) — and of VOCs would occur during the construction period. These emissions would include fugitive dust emissions from earthmoving activities and exhaust emissions from heavy equipment and commuter/delivery vehicles. The annual emissions of criteria pollutants and VOCs expected during facility construction are presented in Table 5.2-2. Estimated maximum pollutant concentrations during construction are shown in Table 5.2-3 for the three alternative locations.

All of the pollutant concentration increments would remain below NAAQS and SAAQS. For SO_2, NO_2, and CO, concentration increments would be below 20% of their applicable standards. The highest concentration increment would occur for 24-hour average PM_{10}, which is predicted to be about 52% of the standard. Concentration increments for $PM_{2.5}$ are predicted to be less than 29% of the standard.

TABLE 5.2-2 Annual Criteria Pollutant and Volatile Organic Compound Emissions from Construction of the Conversion Facility at the Paducah Site

	Emission Rate (tons/yr)					
Emission Source	SO_2	NO_x	CO	VOCs	PM_{10}	$PM_{2.5}$
Exhaust	1.5	21.7	14.6	6.1	2.2	2.2[a]
Fugitive	–[b]	–	–	–	17.1[c]	2.5[c]

[a] For exhaust emissions, $PM_{2.5}$ emissions were conservatively assumed to be 100% of PM_{10} emissions.

[b] A dash indicates no emissions.

[c] Fugitive dust emissions were estimated under the assumption that the conversion facility construction area would continuously disturb about 9.1 acres (3.7 ha); this is the maximum amount of the approximately 10-acre (4-ha) facility footprint that would be disturbed at one time. A conventional control measure of water spraying with an emission control efficiency of 50% would be applied over the disturbed area. For fugitive dust emissions from earthmoving activities, $PM_{2.5}$ emissions were assumed to be 15% of PM_{10} emissions (EPA 2002).

Source: Folga (2003).

To obtain the total concentrations for comparison with applicable air quality standards, the modeled concentration increments were added to measured background values (given in Table 3.1-3). The total concentrations for SO_2, NO_2, and CO would be below 42% of their standards. The total concentrations for annual PM_{10} and 24-hour $PM_{2.5}$ are estimated to be 87% and 72% of their applicable standards, respectively. For all three alternative locations, total 24-hour PM_{10} and annual $PM_{2.5}$ concentrations would be above their applicable standards. In fact, annual average concentrations of $PM_{2.5}$ at most statewide monitoring stations either approach or are above the standard. PM (PM_{10} and $PM_{2.5}$) concentration increments at the site boundaries would be relatively high because the conversion facility would be constructed outside the current gaseous diffusion plant boundaries; thus, the general public would theoretically have access right at the conversion plant boundary.[2] Accordingly, construction activities should be conducted so as to minimize potential impacts on ambient air quality. Water could be sprayed on disturbed areas frequently, as needed, and dust suppressant or pavement could be applied to roads with frequent traffic.

[2] Formerly, the general public had access to the existing fenced boundaries. However, since the September 11, 2001, terrorist attack, site access for the general public has been restricted indefinitely to the DOE property boundaries.

TABLE 5.2-3 Maximum Air Quality Impacts at the Construction Site Boundary Due to Emissions from Activities Associated with Construction of the Conversion Facility at the Paducah Site

			Concentration ($\mu g/m^3$)				Percent of NAAQS/SAAQS[e]	
Location	Pollutant[a]	Averaging Time	Maximum Increment[b]	Back-ground[c]	Total[d]	NAAQS and SAAQS	Increment	Total
A	SO_2	3 hours	30.0	169	199	1,300	2.3	15.3
		24 hours	11.1	86	97.1	365	3.0	26.6
		Annual	1.3	13.3	14.6	80	1.7	18.3
	NO_2	Annual	19.9	22.6	42.5	100	19.8	42.4
	CO	1 hour	868	6,970	7,840	40,000	2.2	19.6
		8 hours	332	3,220	3,550	10,000	3.3	35.5
	PM_{10}	24 hours	78.0	79	157	150	52.0	105
		Annual	18.3	25	43.3	50	36.6	86.6
	$PM_{2.5}$	24 hours	15.1	31.1	46.2	65	23.3	71.1
		Annual	4.4	14.7	19.1	15	29.2	127
B	SO_2	3 hours	29.8	169	199	1,300	2.3	15.3
		24 hours	11.2	86	97.2	365	3.1	26.6
		Annual	1.3	13.3	14.6	80	1.7	18.3
	NO_2	Annual	19.8	22.6	42.4	100	19.8	42.4
	CO	1 hour	895	6,970	7,860	40,000	2.2	19.7
		8 hours	336	3,220	3,560	10,000	3.4	35.6
	PM_{10}	24 hours	75.4	79	154	150	50.3	103
		Annual	18.2	25	43.2	50	36.4	86.4
	$PM_{2.5}$	24 hours	15.2	31.1	46.3	65	23.4	71.3
		Annual	4.4	14.7	19.1	15	29.1	127
C	SO_2	3 hours	30.1	169	199	1,300	2.3	15.3
		24 hours	11.2	86	97.2	365	3.1	26.6
		Annual	1.3	13.3	14.6	80	1.7	18.3
	NO_2	Annual	19.8	22.6	42.4	100	19.8	42.4
	CO	1 hour	904	6,970	7,870	40,000	2.3	19.7
		8 hours	337	3,220	3,560	10,000	3.4	35.6
	PM_{10}	24 hours	77.6	79	157	150	51.7	104
		Annual	18.3	25	43.3	50	36.5	86.5
	$PM_{2.5}$	24 hours	15.5	31.1	46.6	65	23.8	71.6
		Annual	4.4	14.7	19.1	15	29.2	127

Footnotes on next page.

TABLE 5.2-3 (Cont.)

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[a] Emissions are from equipment and vehicle engine exhaust, except for PM_{10} and $PM_{2.5}$, which are also from soil disturbance.

[b] Data represent the maximum concentration increments estimated, except that the fourth- and eighth-highest concentration increments estimated are listed for 24-hour PM_{10} and $PM_{2.5}$.

[c] See Table 3.1-3.

[d] Total equals maximum modeled concentration plus background concentration.

[e] The values in the next-to-last column are maximum concentration increments as a percent of NAAQS and SAAQS. The values in the last column are total concentration increments as a percent of NAAQS and SAAQS.

The potential impacts of PM (PM_{10} and $PM_{2.5}$) released from near-ground level would be limited to the immediate vicinity of the site boundaries — areas that the general public is expected to occupy only infrequently. The PM concentrations would decrease rapidly with distance from the source. At the nearest residence on McCall Road just east of the DOE boundary (about 1.3 km [0.8 mi] southeast of candidate Location C), predicted concentrations would be less than 5% of the highest concentration increments at the site boundaries.

Among the three alternative locations, potential air quality impacts due to construction activities would be similar, with the highest at Locations A and C, and the lowest at Location B, as shown in Table 5.2-3. However, as mentioned previously, the locations of facility boundaries for Locations B and C are assumed arbitrarily; thus, the results for the two alternative locations should be interpreted in that context.

5.2.1.3.2 Noise Impacts. Noise levels from construction would be similar among the alternative locations. During construction, the commuting/delivery vehicular traffic around the facilities would generate intermittent noise. However, the contribution to noise from these intermittent sources would be limited to the immediate vicinity of the traffic route and would be minor in comparison with the contribution from continuous noise sources such as compressors or bulldozers during construction. Sources of noise during construction of the conversion facility would include standard commercial and industrial activities for moving earth and erecting concrete and steel structures. Noise levels from these activities would be comparable to those from other construction sites of similar size.

The noise levels would be highest during the early phases of construction, when heavy equipment would be used to clear the site. This early phase of construction would be about 6 months of the entire construction period of 1.5 years. Average noise levels for construction equipment range from 76 dB(A) for a pump, to 85 dB(A) for a bulldozer, to 101 dB(A) at peak for a pile driver (Harris Miller Miller & Hanson, Inc. [HMMH] 1995). To estimate noise levels at the nearest residence, it was assumed that the two noisiest pieces of equipment would operate simultaneously. A scraper and a heavy truck operating continuously typically generate noise levels of 89 and 88 dB(A), respectively, at a distance of 15 m (50 ft) from the source (HMMH 1995),[3] which result in a combined noise level of about 91.5 dB(A) at a distance of 15 m (50 ft).

The nearest residence to alternative Locations A, B, and C would be the same one; it is located at McCall Road just off the DOE boundary. This residence, located about 1.3 km (0.8 mi) southeast of Location C, was selected as the receptor for the analysis of potential noise impacts. Noise levels decrease about 6 dB per doubling of distance from the point source because of the way sound spreads geometrically over an increasing distance. Thus, construction activities would result in estimated noise levels of about 53 dB(A) at the nearest residence. This level would be 48 dB(A) as DNL if it is assumed that construction activities would be limited to an 8-hour daytime shift. This 48-dB(A) estimate is below the EPA guideline of 55 dB(A) as DNL for residential zones (see Section 3.1.3.4), which was established to prevent interference with activity, annoyance, or hearing impairment. This 48-dB(A) estimate is probably an upper bound because it does not account for other types of attenuation, such as air absorption and ground effects due to terrain and vegetation. If only ground effects were considered (HMMH 1995), more than 10 dB(A) of attenuation would occur at the nearest residence, which would result in less than 38 dB(A), which is below background levels.

Most of these construction activities would occur during the day, when noise is tolerated better than at night, because of the masking effects of background noise. Nighttime noise levels would drop for all three alternative locations to the background levels of a rural environment because construction activities would cease at night.

5.2.1.4 Water and Soil

Construction of a conversion facility at the Paducah site would disturb land, use water, and produce liquid wastes. The following sections discuss impacts to surface water, groundwater, and soil resources at Paducah during construction. Because site-specific impacts were not identified, impacts to water and soil at alternative Locations A, B, and C would be the same.

5.2.1.4.1 Surface Water. Construction of a conversion facility at the Paducah site would produce increased runoff to nearby surface waters because soils and vegetation would be replaced with either buildings or paved areas. The amount of increased runoff from the new, impermeable land surface would be negligible (less than about 1.3% of the site area) compared with the existing area that contributes to runoff. None of the construction activities would measurably affect the existing floodplains.

Water would be required during construction. Peak water use would be 5,500 gal/d (20,800 L/d) or 2 million gal/yr (7.6 million L/yr). About 1,500 gal/d (5,700 L/d) of water would be used in actual construction; 4,000 gal/d (15,140 L/d) of water would be used by the

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3 Pile drivers were excluded because piles would not be required for buildings at the site.

workforce. Construction water would be obtained from the Ohio River. If the rate of withdrawal was constant in time, about 3.8 gal/min (14 L/min) would be needed. This rate of withdrawal would be about 0.000003% of the mean flow in the Ohio River.

Wastewater would also be produced during construction. For the assumed workforce, about 4,000 gal/d (15,140 L/d) or 1.5 million gal/yr (5.7 million L/yr) of sanitary wastewater would be generated. There would be no sanitary wastewater discharged to the environment because portable toilets would be used.

5.2.1.4.2 Groundwater. Potential impacts to groundwater could occur during construction. These impacts could include changes in effective recharge to underlying aquifers, changes in the depth to groundwater, changes in the direction of groundwater flow, and changes in groundwater quality.

Because all water used at the Paducah site would be obtained from the Ohio River, there would be no direct impacts to groundwater recharge, depth, or flow direction from construction activities. However, these parameters could be minutely affected by changes in the permeability of the surface soil produced by construction activities and building and parking lot construction. Because of the small associated operational areas (less than 1.3% of the total site area), these changes would not be measurable. Similarly, the quality of groundwater beneath the selected site could be affected by surface construction activities through infiltration of surface water contaminated from spills of construction materials. These impacts would be indirect because there would be no direct releases of contaminants to groundwater. Indirect contamination could result from the mobilization of exposed chemicals by precipitation, followed by infiltration of contaminated runoff water. Following good engineering and construction practices and implementing storm water and erosion control measures would minimize impacts to groundwater quality.

5.2.1.4.3 Soils. Impacts to soil could occur during construction for the Paducah conversion facility. These impacts could include changes in topography, permeability, quality, and erosion potential.

All three of the alternative locations (A, B, and C) would be sufficiently large (35, 59, and 53 acres [14, 24, and 21 ha], respectively) to accommodate the conversion facility and most of the disturbed area (45 acres [18 ha]). Because the sites are relatively flat there would be no significant changes to topography, and the maximum amount of land needed for construction would be small relative to the total land available at the site (less than about 1.3%). Erosion potential would increase during construction; the impacts, however, would be local, temporary, and about the same for each of the three alternative locations.

Construction activities could also affect the quality of the land at the selected location for the conversion facility. Impacts on quality could result from spills and other construction activities that could release contaminants to the surface. Following good engineering and construction practices would minimize impacts to soil quality.

Contaminated soil associated with SWMU 194 could be excavated during construction at either Location A or B. Management of these soils is discussed in Section 5.2.1.7.

5.2.1.5 Socioeconomics

The socioeconomic analysis covers the effects of construction on population, employment, income, regional growth, housing, and community resources in the ROI around the Paducah site. Impacts from construction are summarized in Table 5.2-4. The socioeconomic impacts are not dependent on the location of the conversion facility; thus, the impacts would be the same for alternative Locations A, B, and C.

The potential socioeconomic impacts would be relatively small. It is estimated that construction activities would create direct employment of about 190 people in the peak construction year and about 100 additional indirect jobs in the ROI. Construction activities would increase the annual average employment growth rate by about 0.1 of a percentage point over the duration of construction. A conversion facility would produce about $10 million in personal income in the peak year of construction.

It is estimated that about 290 people would in-migrate to the ROI in the peak year of construction. However, in-migration would have only a marginal effect on population growth and would require only about 5% of vacant rental housing in the peak year. No significant impact on public finances would occur as a result of in-migration. Fewer than five local public service employees would be required to maintain existing levels of service in the various local public service jurisdictions in McCracken County.

TABLE 5.2-4 Socioeconomic Impacts from Construction of the Conversion Facility at the Paducah Site

Impact Area	Construction Impacts[a]
Employment	
Direct	190
Total	290
Income (millions of 2002 $)	
Direct	5.3
Total	9.5
Population (no. of new ROI residents)	290
Housing (no. of units required)	100
Public finances (% impact on fiscal balance)	
Cities in McCracken County[b]	0.3
McCracken County	0.2
Schools in McCracken County[c]	0.3
Public service employment (no. of new employees in McCracken County)[c]	
Police	0
Firefighters	0
General	1
Physicians	0
Teachers	1
No. of new staffed hospital beds in McCracken County	1

[a] Impacts are shown for the peak year of construction (2005).

[b] Includes impacts that would occur in the City of Paducah.

[c] Includes impacts that would occur in the McCracken County school district.

5.2.1.6 Ecology

Potential impacts to vegetation, wildlife, wetlands, and threatened and endangered species that would result from the construction of a conversion facility are described below. Additional information regarding wetlands and federally-listed species can be found in Van Lonkhuyzen (2004).

5.2.1.6.1 Vegetation. Existing vegetation within the disturbed area would be destroyed during land clearing activities. Construction of a conversion facility at any of the three alternative locations at the Paducah site is not expected to threaten the local population of any species. Replanting disturbed areas with native species would comply with Executive Order 13148, *Greening the Government through Leadership in Environmental Management* (U.S. President 2000). Erosion of exposed soil at construction sites could reduce the effectiveness of restoration efforts and create sedimentation downgradient of the construction site. However, the implementation of standard erosion control measures, installation of storm water retention ponds, and immediate replanting of disturbed areas with native species would help minimize impacts to vegetation. Deposition of fugitive dust resulting from construction activities could adversely affect vegetation; however, the use of control measures to reduce dust production could minimize impacts (see Section 5.2.1.3).

Constructing a facility at Location A, the preferred location, would result in the loss of approximately 10 acres (4 ha) of previously disturbed managed grassland vegetation that is maintained by frequent mowing. The facility would not replace undisturbed natural communities. Managed grassland comprises most of the vegetation on the Paducah site. The loss of 10 acres (4 ha) would therefore represent a minor decrease in this habitat on the Paducah site. This area represents about 29% of the area available at the 35-acre (14-ha) Location A. The total area of construction-related disturbance, however, would be approximately 45 acres (18 ha) in size. Although construction-related activities would primarily affect managed grassland vegetation, impacts to the wooded area at this location could also occur during the construction period, unless temporary construction areas, such as lay-down areas, were positioned outside the southern portion of Location A in adjacent, previously disturbed areas. If facility construction required the disturbance of all of Location A, the undisturbed mature deciduous forest at this location would potentially be eliminated. Although deciduous forest is not uncommon in the vicinity of the Paducah site, impacts to mature deciduous forest communities would generally be considered a greater adverse impact than those to managed grassland because of the (1) undisturbed condition of mature forest, (2) high biodiversity and habitat value, and (3) considerably greater length of time required for restoration of mature forest. The construction of utility lines and rail lines would extend beyond Location A and would result in additional impacts to vegetation. Construction of rail lines west of Location A would affect previously disturbed areas supporting both managed grassland and scrub-shrub communities within the existing railroad bed. Mature deciduous hardwood forest adjacent to the railroad bed could be affected by the construction of the new rail line if construction-related activities occur beyond the railroad bed.

The specific vegetation communities impacted by construction at Location B would depend on the placement of the facility within the available area. A facility of 10 acres (4 ha) would occupy 17% of the area available at this 59-acre (24-ha) location. Placement of the facility at the northern end of Location B would primarily result in impacts to areas that are predominantly already disturbed and support managed grassland vegetation (consisting of 38 acres [15 ha]). The groves of mature trees in this area might be affected by facility construction. However, depending on the placement of the facility, these impacts might be avoided. Avoidance of the tree groves during construction might not be possible unless temporary construction areas were positioned outside Location B in adjacent, previously disturbed areas. Impacts to the undisturbed mature deciduous forest at Location B may be avoided, although impacts would be expected to occur if facility construction required the disturbance of 45 acres (18 ha) of this location.

The specific vegetation communities impacted by construction at Location C would also depend on the placement of the facility within the available area. A facility of 10 acres (4 ha) would occupy 19% of the area available at this 53-acre (21-ha) location. Placement of the facility in the western portion of this location (west of Dyke Road) would primarily impact a previously disturbed immature deciduous forest community. Facility placement in the eastern portion of the location would impact primarily old-field open grassland community, with likely impacts to the small groves of mature trees in this area. Facility construction would disturb a total area of up to 45 acres (18 ha) and potentially result in impacts to both deciduous forest and grassland areas.

5.2.1.6.2 Wildlife. Wildlife would be disturbed by land clearing, noise, and human presence. Wildlife with restricted mobility, such as burrowing species or juveniles of nesting species, would be destroyed during land clearing activities. More mobile individuals would relocate to adjacent available areas with suitable habitat: abundant habitat is available on the Paducah site and the adjacent West Kentucky Wildlife Management Area. Population densities, and thus competition for food and nesting sites, would increase in these areas, potentially reducing the survivability or reproductive capacity of displaced individuals. Some wildlife species would be expected to recolonize replanted areas near the conversion facility following completion of construction. Construction of a conversion facility at any of the three alternative locations at the Paducah site is not expected to threaten the local population of any wildlife species because similar habitat would be available in the vicinity of the site.

Constructing a conversion facility at Location A would primarily impact those species commonly associated with managed grasslands maintained by frequent mowing; however, larger areas of similar habitat would be available nearby. Construction could also impact habitat for species associated with mature deciduous forest, such as neotropical migratory birds, unless temporary construction areas were positioned outside the southern portion of Location A in previously disturbed areas. Noise associated with construction activities up to 79.5 dB(A) at 60 m (200 ft) may reduce the suitability of the forest habitat at Location A for some species during the construction period. The construction of utility lines and rail lines would result in additional impacts to wildlife habitat. Habitat for species associated with both managed grassland and scrub-shrub communities within the existing railroad bed could be lost during construction of rail lines west of Location A. If construction-related activities occur beyond the railroad bed, species supported by mature deciduous hardwood forest could be affected. In addition, noise associated with rail construction might reduce the suitability of the forest habitat for some species.

Constructing a conversion facility in the northern portion of Location B would impact habitat for those species commonly associated with frequently mowed grasslands and other disturbed areas, such as along drainage channels. Similar habitat would be abundant in other areas of the Paducah site. Impacts to habitat for species associated with mature deciduous forest could likely be avoided by placing the facility in the northern portion of this location. Construction of a facility immediately adjacent to the forest could reduce that habitat's suitability for some wildlife species. Species that occur in the tree groves at this location, such as neotropical migratory birds, might be impacted during construction; however, impacts may potentially be avoided if temporary construction areas were positioned outside Location B in adjacent disturbed areas. If facility construction required the disturbance of 45 acres (18 ha) of this location, however, impacts to the mature forest habitat at Location B would be expected to occur.

Species associated with deciduous forest or open grassland habitat could be impacted by construction of a conversion facility at Location C. Construction west of Dyke Road would primarily impact forested habitat, while construction in the eastern half would impact old field grassland habitat. In addition, species such as neotropical migratory birds, which are associated with the groves of mature trees in the eastern half of this location, would likely be impacted by construction in that area. Although these habitats are not uncommon in the vicinity of the Paducah site, open grassland areas provide opportunities for restoration of native prairie habitat. Construction of a conversion facility at Location C may decrease the suitability of the remainder of the location for some wildlife species.

5.2.1.6.3 Wetlands. Wetlands could potentially be impacted by filling or draining during construction of a conversion facility. Wetlands could be impacted by alteration of surface water runoff patterns, soil compaction, or groundwater flow if the conversion facility was located immediately adjacent to wetland areas. Impacts to wetlands would be minimized, however, by maintaining a buffer area around them during facility construction. Executive Order 11990, *Protection of Wetlands* (U.S. President 1977a), requires federal agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial uses of wetlands. 10 CFR Part 1022 sets forth DOE regulations for implementing Executive Order 11990 as well as Executive Order 11988, *Floodplain Management* (U.S. President 1977b). Mitigation for unavoidable impacts may be developed in coordination with the appropriate regulatory agencies. Unavoidable impacts to wetlands within the jurisdiction of the USACE might require a CWA Section 404 Permit, which would trigger the need for a CWA Section 401 Water Quality Certification from the Commonwealth of Kentucky. An approved mitigation plan might be required prior to the initiation of construction.

Water-level changes in the Ohio River because of water withdrawal for construction would be negligible. Regional groundwater changes due to the increase in impermeable surface related to facility construction would also be negligible. Therefore, except for the potential local indirect impacts noted above, impacts to regional wetlands due to changes in groundwater or surface water levels or flow patterns would be expected to be negligible.

Construction of a conversion facility at Location A could result in impacts to wetlands located in the central and southern portion of this location (Figure 5.2-1). Although the wetlands within the open, previously disturbed area are outside of the facility footprint, construction of access roads and rail lines could eliminate a portion of the wetlands in this area. The larger, undisturbed forested wetland in the southern portion of Location A, however, could likely be avoided. Two new rail lines, an access road from Patrol Road A, and a walkway leading from the south parking area to Building C1100, would cross the wetland within the drainage swale leading to KPDES Outfall 017 and Bayou Creek. Direct impacts to this wetland could occur from the placement of fill material and culverts for the crossings.

Impacts could also occur to the wetlands located in drainage swales to the south, which would be crossed by a new rail line and an access road from Patrol Road 4. In addition, two small isolated wetlands in the open, grassy area could be filled as a result of the construction of the rail line and access road. The drainage swale along the south margin of Patrol Road 4 may be impacted if widening or other improvements to that road are made, and impacts to wetlands in drainages along the Entrance Highway could potentially result from improvements to the adjacent roadway to the east. Approximately 6,900 ft^2 (640 m^2) of palustrine emergent wetland would likely be eliminated by culvert construction or direct placement of fill material within Location A. Wetland areas that are not filled may be indirectly affected by an altered hydrologic regime, due to the proximity of construction, possibly resulting in a decreased frequency or duration of inundation or soil saturation and potential loss of hydrology necessary to sustain wetland conditions. Indirect impacts could be minimized by maintaining a buffer near adjacent wetlands. In addition, placement of temporary construction areas outside Location A might be necessary to avoid additional direct or indirect impacts to these wetlands.

The increase in impervious surface and discharge of storm water runoff, due to construction of a conversion facility, could result in alteration of hydrology in the drainage system within Location A or downstream in Bayou Creek, with greater fluctuations in high and low flows, as well as in the other headwater drainages immediately west of the Entrance Highway. However, because only a small portion of the Bayou Creek watershed would be involved, impacts would likely be small. Downstream wetlands could be affected by sedimentation during construction; however, the implementation of erosion control measures would reduce the likelihood of such impacts. The total area of construction-related disturbance would be up to 45 acres (18 ha). The forested wetland at this location could be impacted unless temporary construction areas were positioned outside the southern portion of Location A in adjacent, previously disturbed areas.

Wetlands could also be impacted by the construction of infrastructure for facility utility requirements or new rail lines extending outside of Location A. Although the rail lines would primarily be constructed on an existing railroad bed, wetlands in drainages along the margin of the rail bed, forested wetlands adjacent to the south margin east of Bayou Creek, or forested wetlands along each side of the rail bed west of Bayou Creek could be impacted if rail bed

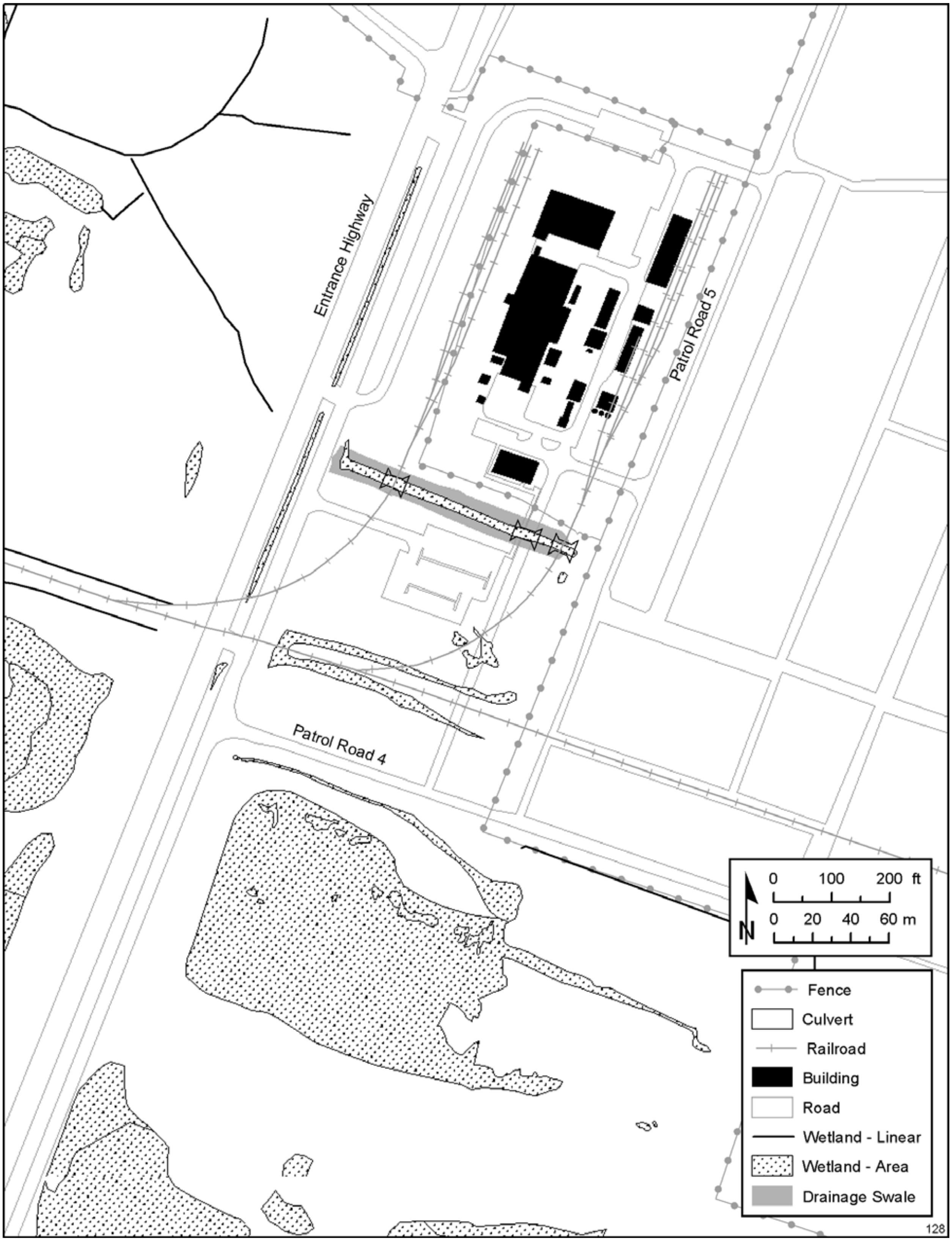

FIGURE 5.2-1 Wetlands within Location A at the Paducah Site

repairs or reconstruction are necessary, or by the operation of heavy equipment within these wetlands while laying track (Figure 5.2-2). The drainage along the north side of the rail bed, just west of the Entrance Highway, may potentially be affected by construction of the new rail line serving the western portion of the conversion facility. In addition, impacts to Bayou Creek and adjacent wetlands could result from reconstruction of the rail bridge crossing Bayou Creek; however, wetland impacts from replacement of bridge supports would be expected to be small.

Construction of a conversion facility at Location B might also impact wetlands. Placement of a facility in the northern, disturbed portion of this location would minimize wetland impacts and avoid impacts to the forested wetlands in the southern portion. However, the drainage channels in the northern area would likely be impacted. The channels could be rerouted to continue to convey flows to Bayou Creek. Wetlands could also be impacted by the construction of infrastructure for facility utility requirements, transportation corridors from cylinder storage yards, or rail lines. In addition, placement of temporary construction areas outside Location B may be necessary to avoid additional direct or indirect impacts to wetlands, including forested wetlands in the southern portion of this location. Indirect impacts to wetlands could also occur. The hydrologic characteristics of wetlands could be indirectly affected by adjacent construction, possibly resulting in a decreased frequency or duration of inundation or soil saturation. Indirect impacts could be minimized by maintaining a buffer near adjacent wetlands. Facility construction could result in alteration of hydrology in the drainage system within Location B, or downstream in Bayou Creek, with greater fluctuations in high and low flows. However, because of the small portion of the watershed involved, impacts would likely be small. Downstream wetlands could be impacted by sedimentation during construction; however, the implementation of erosion control measures would reduce the likelihood of such impacts.

Construction of a facility at Location C could potentially result in impacts to wetlands. Facility placement in the western or northeastern portions of this location would likely result in direct impacts to wetlands. Placement of a facility in the southeastern portion of Location C may best avoid direct impacts to wetlands; however, wetlands located in drainage ditches along Dyke Road may be impacted. Indirect impacts, however, could result from construction of a facility immediately adjacent to wetlands in this area. The total area disturbed during construction would be up to 45 acres (18 ha), resulting in direct impacts unless temporary construction areas were located outside of Location C. Facility construction could result in alteration of hydrology in the drainage channel southeast of Location C, or downstream in Little Bayou Creek, with greater fluctuations in high and low flows. However, because of the small portion of the watershed involved, impacts would likely be small. Downstream wetlands could be impacted by sedimentation during construction; the likelihood of such impacts would be reduced, however, with the implementation of erosion control measures.

5.2.1.6.4 Threatened and Endangered Species. Construction of a conversion facility at Location A is not expected to directly impact federal- or state-listed species. However, impacts to deciduous forest may occur unless temporary construction areas were positioned outside the southern portion of Location A. Trees with exfoliating bark, such as shagbark hickory or dead trees with loose bark, could potentially be used by the Indiana bat (federal- and state-listed as

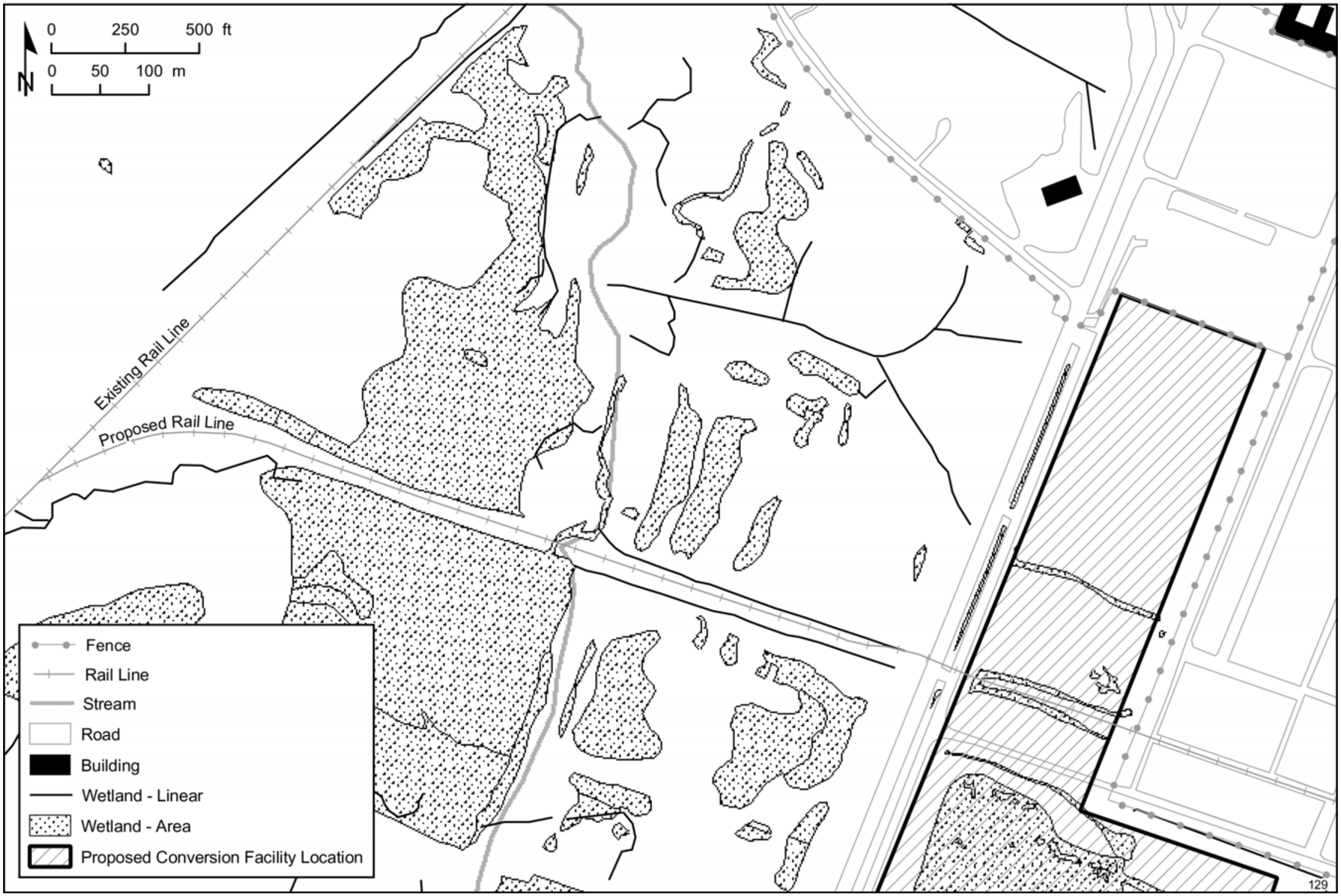

FIGURE 5.2-2 Wetlands along the Proposed Rail Line at the Paducah Site

endangered) as roosting trees during summer, although the forested area at the southern portion of Location A has not been identified as summer habitat. If trees (either live or dead) with exfoliating bark were encountered on construction areas, they should be saved if possible. If necessary, the trees should be cut only before March 31 or after October 15 to avoid the period when they might be used by Indiana bats, according to recommendations of the U.S. Fish and Wildlife Service (USFWS) (Andrews 2004).

Disturbance due to increased noise, lighting, and human presence during construction could decrease the quality of mature forested habitats for the Indiana bat. However, Indiana bats using habitat near the Paducah site would be currently exposed to noise and other effects of human disturbance. Consequently, these effects related to construction activities would be expected to be minor. Construction of the conversion facility or new rail lines in Location A could disturb Indiana bats that may use the forested area in the southern portion of that location. In addition, construction of rail lines adjacent to the mature deciduous forest habitats west of Entrance Highway could likely disturb Indiana bats. In addition to trees east of Bayou Creek that might potentially be used by Indiana bats (such as in or near Location B), portions of the forested area west of the creek are identified as fair quality Indiana bat habitat (Figure 5.2-3), with additional areas identified as poor potential habitat. Because good Indiana bat habitat is not available in that immediate area, bats might likely be disturbed in, or prevented from using, the fair quality habitat.

Impacts to the forested area at Location B could likely be avoided; however, construction of a conversion facility in the southern portion of Location B could result in the removal of trees potentially used by Indiana bats and indirectly impact the Indiana bat by reducing the quality of potential habitat west of Bayou Creek. Construction activities and the presence of a facility in proximity to potential habitat may decrease the suitability of these areas for summer habitat.

Impacts to either the forested area or groves at Location C could occur and result in the removal of trees potentially used by Indiana bats. Construction in the eastern portion of Location C could impact potential habitat for cream wild indigo (state-listed as a species of special concern) and compass plant (state-listed as threatened). Although these species are not known to occur at or near this location, current restoration efforts are increasing the suitability of the open grassland habitat for these species. Impacts to wetlands with open water, such as the drainage channels in Location B or the small ponds in the eastern portion of Location C, could reduce habitat for the great blue heron (state-listed as a species of special concern).

5.2.1.7 Waste Management

Potential waste management impacts for construction were evaluated by determining the types and estimating the volumes of wastes that would be generated. These estimates were then compared with projected site generation volumes.

Construction of the facility would generate both hazardous and nonhazardous waste. Hazardous waste would be sent to off-site permitted contractors for disposal. Nonhazardous

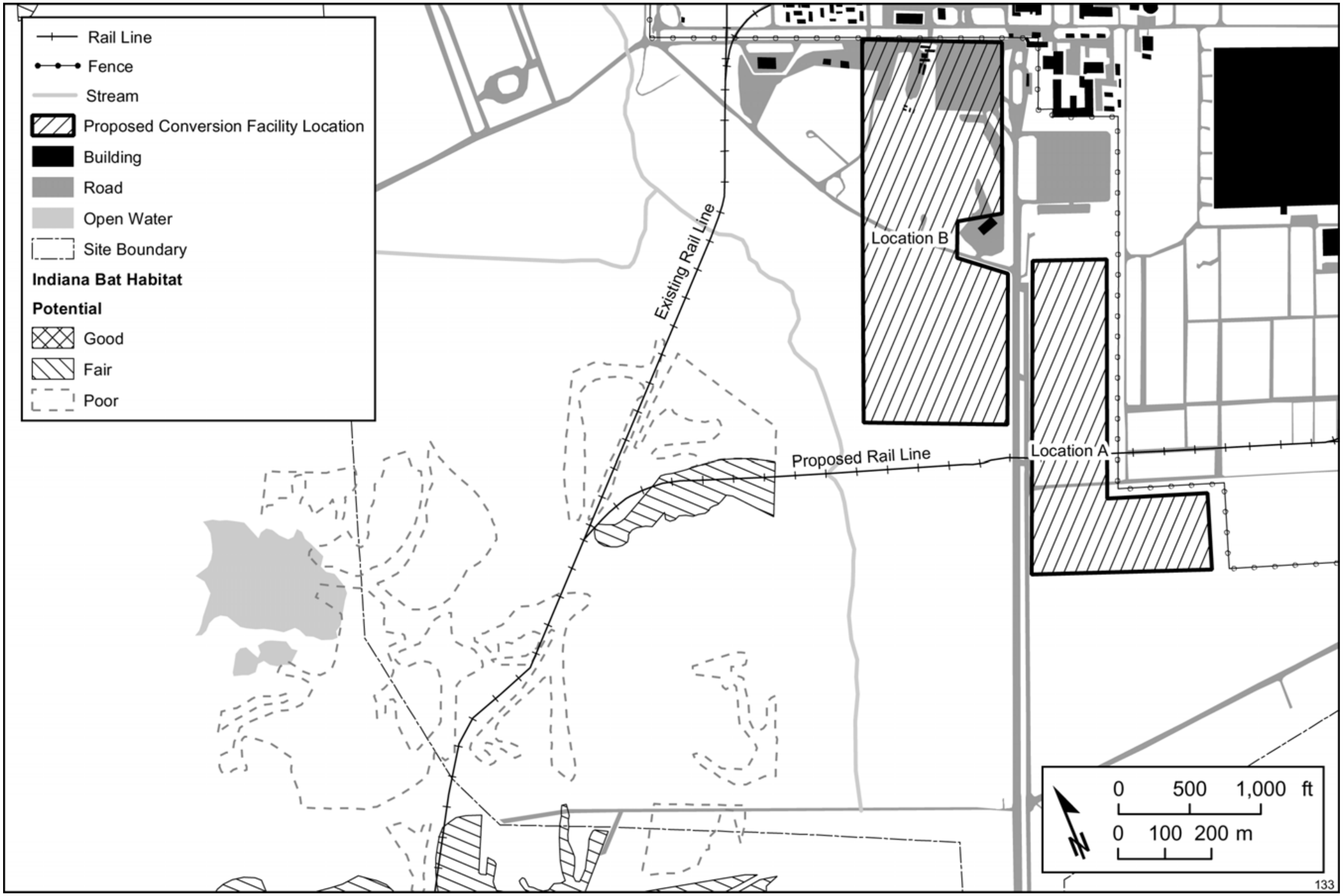

FIGURE 5.2-3 Areas of Potential Indiana Bat Habitat at the Paducah Site

waste would be disposed of on site at a state-permitted landfill. Table 5.2-5 presents the total waste volumes that would be generated. No radioactive waste would be generated during the construction phase of the conversion facility. Overall, only minimal waste management impacts would result from construction-generated wastes.

In addition to construction-related waste that would be generated, potentially contaminated soil could be excavated during construction of the facility at either Location A or B at Paducah. On the basis of SWMU 194 investigation results and the site characterization report for Location A (Tetra Tech, Inc. 2000), contaminated soil may be located at both locations (see Section 3.1.4.2). The excavated soil would be managed consistent with RCRA regulations and coordinated between the Commonwealth of Kentucky (Division of Waste Management) and DOE.

TABLE 5.2-5 Wastes Generated from Construction Activities for the Conversion Facility at the Paducah Site[a]

Waste Category	Volume
Hazardous waste	115 m^3
Nonhazardous waste	
Solids	700 m^3
Wastewater	3.8×10^6 L
Sanitary wastewater	1.1×10^7 L

[a] Total waste generated during a construction period of 2 years. Because data were not available for the UDS conversion facility, data developed for the DUF_6 PEIS (Dubrin et al. 1997) were used.

5.2.1.8 Resource Requirements

The resources required for facility construction would not depend on the location of the facility. Materials related to construction would include concrete, sand, gravel, steel, and other metals (Table 5.2-6). At this time, no unusual construction material requirements have been identified. The construction resources, except for those that could be recovered and recycled with current technology, would be irretrievably lost. None of the identified construction resources is in short supply, and all should be readily available in the local region.

Small to moderate amounts of specialty materials (i.e., Monel and Inconel) would be required for construction of the conversion facility in quantities that would not seriously reduce the national or world supply. This material would be used throughout the facilities and is used in the generation of HF in the conversion process. The autoclaves and conversion units (process reactors) are long-lead-time procurements with few qualified bidders. Many suppliers are available for the remainder of the equipment.

5.2.1.9 Land Use

The preferred location for the facility (Location A) covers approximately 35 acres (14 ha) and consists primarily of a grassy field, with a wooded area in the southeastern section of the tract. Although constructing a conversion facility at this location would involve modifying existing land use on the specified tract, the resulting facility would be consistent with the heavy

TABLE 5.2-6 Materials/Resources Consumed during Construction of the Conversion Facility at the Paducah Site

Materials/Resources	Total Consumption	Unit	Peak Demand	Unit
Utilities				
Water	4×10^6	gal	1,500	gal/h
Electricity	1,500	MWh	7.2	MWh/d
Solids				
Concrete	9,139	yd^3	NA[a]	NA
Steel	511	tons	NA	NA
Inconel/Monel	33	tons	NA	NA
Liquids				
Fuel	73,000	gal	250	gal/d
Gases				
Industrial gases (propane)	15,000	gal	50	gal/d

[a] NA = not applicable.

industrialized land use currently found at the Paducah site — a consequence of producing enriched uranium and its DUF_6 by-product. As a consequence, at most, negligible land use impacts are anticipated as a result of constructing the facility at Location A.

Constructing a conversion facility on either of the two other locations being considered would have land use impacts similar to those from construction on Location A. Both locations are slightly larger than Location A; Location B covers about 59 acres (23 ha) and Location C covers roughly 53 acres (21 ha), with both comprising largely undeveloped tracts on the Paducah site. As with Location A, constructing a conversion facility on either of these alternate locations would require modifying existing land use on the tract of land involved; however, the resulting facility would be consistent with the heavy industrialized land use currently found at the Paducah site. Once again, at most, negligible land use impacts are anticipated from constructing the facility.

5.2.1.10 Cultural Resources

Construction could potentially impact cultural resources. Neither an archaeological nor an architectural survey has been completed for the Paducah site as a whole or for any of the alternative locations, although an archaeological sensitivity study has been conducted (see Section 3.1.11). Consultations with the SHPO and Native American groups regarding traditional Native American cultural properties at these locations have been initiated (see Appendix G). In accordance with Section 106 of the National Historic Preservation Act of 1966, the adverse effects of this undertaking must be evaluated once a location is chosen.

- *Location A.* While no archaeological survey has been completed for Location A, the southern, undisturbed portion of this location has a "low" to "very low" archaeological sensitivity index (U.S. Department of the Army 1994b). Although a low sensitivity index suggests a low probability for encountering significant archaeological resources in Location A, further archaeological analysis would be required if this location was chosen and the southern undisturbed portion was disturbed. If significant archaeological resources were discovered or if traditional properties were identified, a mitigation plan must be prepared and executed in consultation with the Kentucky SHPO and appropriate Tribal governments.

- *Location B.* Location B has not been surveyed for archaeological resources but contains areas of high archaeological sensitivity overlooking Bayou Creek (U.S. Department of the Army 1994b) and a standing structure. An additional cultural resource survey would be required in consultation with the Kentucky SHPO if this location was chosen. If archaeological sites were encountered and determined to be significant, or if the known structure proved to be historically significant, or if traditional cultural properties were identified, a mitigation plan must be prepared and executed in consultation with the Kentucky SHPO and appropriate Tribal governments.

- *Location C.* About 50% of Location C has undergone an archaeological survey. No archaeological sites were recorded in the surveyed area, and the remainder of the location has "low" to "very low" archaeological sensitivity. The access roads that lead to this location would have to be widened if this location was chosen as the site for the conversion facility. A small segment of Dyke Road borders land with high archaeological sensitivity (U.S. Department of the Army 1994b). If this location was chosen, an archaeological survey of the unsurveyed portion of the location and areas likely to be affected by road widening would have to be completed. If significant archaeological resources were encountered or if traditional cultural properties were identified, mitigation plans must be prepared and executed in consultation with the Kentucky SHPO and appropriate Tribal governments.

5.2.1.11 Environmental Justice

The evaluation of environmental justice impacts associated with construction is based on the identification of high and adverse impacts in other impact areas considered in this EIS, followed by a determination of whether those impacts would affect minority and low-income populations disproportionately. Disproportionate impacts could take two forms: (1) when the environmental justice population is present at a higher percentage in the affected area than in the reference population (i.e., the state in which a potentially impacted population occurs), and (2) when the environmental justice population is more susceptible to impacts than the population as a whole. In either case, high and adverse impacts are a necessary precondition for environmental justice concerns in an EIS.

Analyses of construction-related impacts under the proposed action do not indicate the presence of high and adverse impacts for any of the other impact areas considered in this EIS (see Section 5.2.1). Despite the presence of disproportionately high percentages of both minority and low-income populations within 50 mi (80 km) of the site, no environmental justice impacts from constructing a conversion facility at the Paducah site are anticipated for Locations A, B, or C. Similarly, no evidence indicates that minority or low-income populations would experience high and adverse impacts from the proposed construction in the absence of such impacts in the population as a whole.

5.2.2 Operational Impacts

This section discusses the potential environmental impacts during operation of a conversion facility at the three alternative locations within the Paducah site. During normal operations, the facility would emit only small amounts of contaminants through air emissions; no contaminated liquid effluents would be produced during the dry conversion process. The operational period would be 25 years. If the ETTP cylinders were transported to and converted at Paducah (considered as an option), the operational period would be 28 years.

5.2.2.1 Human Health and Safety — Normal Facility Operations

5.2.2.1.1 Radiological Impacts. Radiological impacts to involved workers during normal operation of the conversion facility would result primarily from external radiation from the handling of depleted uranium materials. Potential impacts to noninvolved workers and members of the public would result primarily from trace amounts of uranium compounds released to the environment. Impacts to involved workers, noninvolved workers, and the general public would be similar for the three alternative locations. Background information on radiation exposure is provided in Chapter 4; details on the methodologies are provided in Appendix F.

Radiation exposures of the involved workers in the conversion facility were estimated on the basis of the measurement data on worker exposures in the Framatome ANP, Inc., facility in Richland, Washington. The Framatome ANP facility uses a dry conversion process to convert UF_6 into uranium oxide and has been in operation since 1997. UDS would implement a similar conversion technology in the Paducah facility, and the key components would be similar to those of the Framatome facility. Therefore, conditions for potential worker exposures at Paducah are expected to be similar to those at Framatome. However, the annual processing rate of uranium at Paducah (50 t [55 tons] per day) would be greater than that of Framatome (9 t [10 tons] per day). To process more uranium materials, four conversion lines would be installed, and more workers or longer work hours from each worker would be required. On the other hand, the specific activity of the uranium materials handled at Framatome (about 3.5×10^6 pCi/g [Edgar 1994]) is greater than that of depleted uranium (about 4.0×10^5 pCi/g). Consequently, the total radiological activities contained in each key component at Paducah would be less than those at Framatome, resulting in a smaller radiation dose rate from each component at Paducah. Because the actual worker activities and the activity duration and frequencies are not available for the conversion facility at this time, using worker exposure data from the Framatome facility is expected to provide a reasonable estimate of the potential radiation exposures of the involved workers at the Paducah facility. According to UDS (2003a,b), the conversion process would be very automated; therefore, the requirement of working at close distances to radiation sources would be limited. Potential radiation exposures of workers would be monitored by a dosimetry program and be kept below the regulatory limit. The implementation of ALARA practices would further reduce the potential for exposures.

Potential radiation exposures of the involved cylinder yard workers would result mainly from maintenance of both DUF_6 and non-DUF_6 cylinders and preparing and transferring DUF_6 cylinders to the conversion facility. Under the action alternatives, cylinder maintenance activities during the 25-year conversion period would most likely be the same as those currently being implemented, except that the number of DUF_6 cylinders would decrease steadily from the current level. Therefore, potential radiation exposures caused by maintenance activities were estimated by scaling the cylinder yard exposure data.

Potential exposures resulting from transferring cylinders to the conversion facility were estimated using the following assumptions: (1) retrieving each cylinder onto transportation equipment would require two workers to each work half an hour at a distance of 3 ft (1 m) from the cylinder, (2) inspecting a cylinder would require two workers to each work half an hour at a distance of 1 ft (0.30 m) from the cylinder, and (3) each transfer from the cylinder yard to the conversion facility would require two workers for about half an hour at a distance of 6 ft (2 m) from the cylinders. These assumptions were developed for the purpose of modeling potential radiation exposures; in actuality, preparing and transferring cylinders would probably take less time and involve fewer workers. As a result, radiation doses estimated on the basis of these assumptions are conservative.

Noninvolved workers would be those who would work in the conversion facility but would not perform hands-on activities, and those who would work elsewhere on the Paducah site. Depending on the location of the conversion facility, the location of the MEI would be different, and the associated radiation exposure might also vary. However, according to the previous analyses in the DUF_6 PEIS and the small uranium emission rate provided by UDS (2003b) for the conversion facility, potential radiation exposures of the noninvolved workers would be very small. An estimate of the bounding exposure, on the basis of the estimated maximum downwind air concentrations, is provided for the MEI in this section. According to the estimated bounding exposure, which is less than 1×10^{-5} mrem/yr, it is anticipated that the potential collective exposure of the noninvolved workers would also be very small and would be less than the product of the bounding MEI dose and the number of the noninvolved workers.

The location of the conversion facility within the Paducah site would have very little impact on collective exposures of the off-site public because of the much larger area (a circle with a radius of 50 mi [80 km]) considered for the collective exposures than the area of the Paducah site. The estimate of the collective exposure was obtained by using the emission rate (< 0.25 g/yr for uranium) provided by UDS (2003b) and the population distribution information obtained from the 2000 census. The actual location of the off-site public MEI would depend on the selected location of the conversion facility and the site boundary. The potential exposure would be bounded by the exposure associated with the maximum air concentrations, which are the same as those used for estimating the bounding exposure of the noninvolved worker MEI. The bounding exposure of the off-site public MEI would be greater than that of the noninvolved worker MEI because of the longer exposure duration (8,760 h/yr versus 2,000 h/yr) assumed for the off-site public than for the noninvolved workers, and because of consideration of the food ingestion pathway for the general public (see Appendix F for more detailed information).

As discussed in Chapter 1 and Appendix B, some portion of the DUF_6 inventory contains TRU and Tc contamination. The TRU materials and most of the Tc material are expected to remain in the emptied cylinders after the withdrawal of DUF_6. A small quantity of Tc might become vaporized and end up in the conversion process equipment, having been converted to technetium oxide. However, airborne emission of Tc is not anticipated because the oxide particles would be captured in the U_3O_8 product. The contribution to the potential external radiation exposures from these contaminants under normal operations were evaluated on the basis of bounding concentrations presented in Appendix B. The dose from these contaminants was estimated and compared with the dose from the depleted uranium and uranium decay products in the DUF_6. It is estimated that under normal operational conditions, the TRU and Tc contaminants would result in a very small contribution to the radiation doses to the involved workers — approximately 0.2% of the dose from the depleted uranium and its decay products.

Estimated potential annual radiation exposures and the corresponding estimates of potential LCFs of the various receptors as a result of normal operations of the conversion facility are presented in Table 5.2-7 (impacts would be the same for all three alternative locations). The average individual dose for involved workers in the conversion facility is estimated to be about 75 mrem/yr (UDS 2003b). The average individual dose for workers working at the cylinders yards was estimated to range from about 430 to 690 mrem/yr, assuming a total of eight workers each year (UDS 2003b). The larger exposure corresponds to the first year of conversion operations and the smaller exposure corresponds to the last year of operations. The estimated average doses for the involved workers are well below the dose limit of 5,000 mrem/yr set for radiation workers (10 CFR Part 835). The corresponding latent cancer risk for an average cylinder yard worker would be about 3×10^{-4} per year (1 chance in 3,300 of developing 1 LCF per year) or less. UDS has proposed 30 workers for cylinder management activities; therefore, the actual average dose and risk to individual workers would likely be less than the above estimated values that are based on 8 workers.

Collective exposures of the involved workers would depend on the number of workers required in the conversion facility. The estimated number of involved workers in the Paducah facility would be about 142 (UDS 2003b). The total collective exposure of the involved workers would then be about 10.7 person-rem/yr. The collective exposure of the cylinder yard workers is expected to range from 5.5 person-rem/yr for the first year of conversion operation to 3.4 person-rem/yr for the last year of conversion operation. Excess LCFs estimated for all the involved workers (both in the conversion facility and in the cylinder yards) would be less than 6×10^{-3}/yr (i.e., 1 chance in 160 of developing 1 LCF per year).

TABLE 5.2-7 Estimated Radiological Doses and Cancer Risks under Normal Conversion Facility Operations at the Paducah Site[a]

	Receptors					
	Involved Workers[b]		Noninvolved Workers[c]		General Public	
Locations	Average Dose/Risk (mrem/yr)/(risk/yr)	Collective Dose/Risk (person-rem/yr)/(fatalities/yr)	MEI Dose/Risk[d] (mrem/yr)/(risk/yr)	Collective Dose/Risk (person-rem/yr)/(fatalities/yr)	MEI Dose/Risk[e] (mrem/yr)/(risk/yr)	Collective Dose/Risk[f] (person-rem/yr)/(fatalities/yr)
Radiation doses						
Conversion facility	75	10.7	$< 1.0 \times 10^{-5}$	$< 1.9 \times 10^{-5}$	$< 3.9 \times 10^{-5}$	4.7×10^{-5}
Cylinder yards	430 – 690	3.4 – 5.5	–[g]	–	–	–
Cancer risks						
Conversion facility	3×10^{-5}	4×10^{-3}	$< 5 \times 10^{-12}$	$< 1 \times 10^{-8}$	$< 2 \times 10^{-11}$	2×10^{-8}
Cylinder yards	2×10^{-4} – 3×10^{-4}	1×10^{-3} – 2×10^{-3}	–	–	–	–

[a] Impacts are reported as best estimates or bounding values. They are the same regardless of the location of the conversion facility.

[b] Involved workers are those workers directly involved with handling radioactive materials. For the conversion facility, 142 involved workers were assumed. Calculation results are presented as average individual dose and collective dose for the worker population.

[c] Noninvolved workers include individuals who work at the conversion facility but are not directly involved in handling materials, and individuals who work at the Paducah site but not within the conversion facility. The population size of noninvolved workers is about 1,900.

[d] The noninvolved worker MEI doses are the bounding estimates corresponding to the estimated maximum downwind air concentrations. The exposures would result from inhalation, external radiation, and incidental soil ingestion.

[e] The general public MEI doses are the bounding estimates corresponding to the estimated maximum downwind air concentrations. The exposure would result from inhalation; external radiation; and ingestion of plant foods, meat, milk, and soil.

[f] Collective exposures were estimated for the population (about 520,000 persons) within a 50-mi (80-km) radius around the Paducah site. The exposure pathways considered were inhalation; external radiation; and ingestion of plant foods, meat, milk, and soil.

[g] A dash indicates that potential air emissions from cylinder maintenance or preparation activities are expected to be negligible. Therefore, no impacts were estimated for the noninvolved workers and the off-site general public.

Because of the small airborne release rates of depleted uranium during normal operations, potential radiation exposures of the noninvolved workers would be very small regardless of where the conversion facility was located within the Paducah site. The radiation dose incurred by the MEI was modeled to be less than 1.0×10^{-5} mrem/yr. This small radiation dose would correspond to potential excess latent cancer risks of less than 5×10^{-12} per year (1 chance in 200 billion of developing 1 LCF per year). For comparison, the dose limit set for airborne releases from operations of DOE facilities is 10 mrem/yr (40 CFR 61).

Radiation exposures of the off-site public also would be very small regardless of the location of the conversion facility. The MEI dose was modeled to be less than 3.9×10^{-5} mrem/yr. This dose is insignificant compared with the radiation dose limits of 100 mrem/yr (DOE 1990) from all pathways and 10 mrem/yr (40 CFR Part 61) from airborne pathways set to protect the general public from operations of DOE facilities. The corresponding latent cancer risk would be less than 2×10^{-11} per year (1 chance in 50 billion of developing 1 LCF per year). Because of no waterborne discharge of uranium (UDS 2003b), radiation exposure to the off-site public from using surface water near the facility would be negligible.

5.2.2.1.2 Chemical Impacts. Potential chemical impacts to human health from normal operations at the conversion facility would result primarily from exposure to trace amounts of the insoluble uranium compound U_3O_8 and to HF released from the process exhaust stack. Risks from normal operations were quantified on the basis of calculated hazard indices. General information concerning the chemical impact analysis methodology is provided in Chapter 4.

The hazard indices were calculated on the basis of air dispersion modeling, which identified the locations of maximum ground-level concentrations of uranium compounds and HF emitted from the conversion facility. Since the maximum concentration locations were used for modeling both noninvolved worker and general public exposures, the impacts would be the same for the three alternative locations assessed.

Conversion to U_3O_8 would result in very low levels of exposure to hazardous chemicals. No adverse health effects to noninvolved workers or the general public are expected during normal operations. Human health impacts resulting from exposure to hazardous chemicals during normal operations of the conversion facilities are estimated as hazard indices of 1.3×10^{-6} and 1.4×10^{-4} for the noninvolved worker and general public MEIs, respectively. The hazard indices for the conversion process would be at least four orders of magnitude lower than the hazard index of 1, which is the level at which adverse health effects might be expected to occur in some exposed individuals.

Impacts to involved workers from exposure to chemicals during normal operations are not expected. The workplace would be monitored to ensure that airborne chemical concentrations were within applicable health standards that are protective of human health and safety. If planned work activities were likely to expose involved workers to chemicals, workers would be provided with appropriate protective equipment, as necessary.

5.2.2.2 Human Health and Safety — Facility Accidents

A range of accidents covering the spectrum from high-frequency/low-consequence events to low-frequency/high-consequence accidents was considered for DUF_6 conversion operations. The accident scenarios considered such events as releases due to cylinder damage, fires, plane crashes, equipment leaks and ruptures, hydrogen explosions, earthquakes, and tornadoes. The accident scenarios considered in the assessment were those identified in the DUF_6 PEIS (DOE 1999a); the scenarios were modified to take into account the specific conversion technology and facility design proposed by UDS (UDS 2003b; Folga 2003). A list of bounding radiological and chemical accidents — that is, those accidents expected to result in the highest consequences in each frequency category should the accident occur — for the UDS conversion facility is provided in UDS (2003b). The bounding accident scenarios and their estimated consequences are discussed below for both radiological and chemical impacts.

5.2.2.2.1 Radiological Impacts. Potential radiation doses from accidents were estimated for noninvolved workers at the Paducah site and members of the public within a 50-mi (80-km) radius of the site for both MEIs and the collective populations. Impacts to involved workers under accident conditions would likely be dominated by physical forces from the accident itself; thus quantitative dose/effect estimates would not be meaningful. For these reasons, the impacts to involved workers during accidents are not quantified in this EIS. However, it is recognized that injuries and fatalities among involved workers would be possible if an accident occurred.

Table 5.2-8 lists the bounding accidents in each frequency category (i.e., the accidents that were found to have the highest consequences) for radiological impacts. The estimated radiation doses to members of the public and noninvolved workers (both MEIs and collective populations) for these accidents are presented in Table 5.2-9. Table 5.2-10 gives the corresponding risks of LCFs associated with the estimated doses for these accidents. The doses and risks are presented as ranges (minimum and maximum) because two different atmospheric conditions were considered for each accident. The estimated doses and LCFs were calculated on the basis of the assumption that the accidents would occur, without taking into account the probability of the accident's occurring. The probability of occurrence for each accident is indicated by the frequency category to which it is assigned. For example, accidents in the extremely unlikely category have an estimated probability of occurrence of between 1 in 10,000 and 1 in 1 million per year.

The accident assessment took into account the three alternative locations within the Paducah site. Because of the close proximity of the alternative locations to the site boundary and the uncertainty associated with both the wind direction at the time of the accident and the exact location of the release point, it was conservatively assumed that both the noninvolved worker MEI and the general public MEI would be located 328 ft (100 m) from accidents with a ground-level release. For accidents with the potential for plume rise due to a fire or for releases from a stack, both the worker and public MEIs were assumed to be located at the point of maximum ground-level concentrations of the released contaminants. As discussed in Appendix F, the noninvolved worker MEI was assumed to be exposed to the passing plume for

TABLE 5.2-8 Bounding Radiological Accidents Considered for Conversion Operations at the Paducah Site[a]

Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[b]
Likely Accidents (frequency: 1 or more times in 100 years)					
Corroded cylinder spill, dry conditions	A 1-ft (0.30-m) hole results during handling, with solid UF_6 forming a 4-ft^2 (0.37-m^2) area on the dry ground.	UF_6	24	60 (continuous)	Ground
U_3O_8 drum spill	A single U_3O_8 drum is damaged by a forklift and spills its contents onto the ground outside the storage facility.	U_3O_8	2.4	30	Ground
Extremely Unlikely Accidents (frequency: 1 time in 10,000 years to 1 time in 1 million years)					
Earthquake	The U_3O_8 storage building is damaged during a design-basis earthquake, and 10% of the containers are breached.	U_3O_8	180	30	Stack
Rupture of cylinders – fire	Several cylinders hydraulically rupture during a fire.	UF_6	0 11,500 8,930 3,580	0–12 12 12–30 30–121	Ground
Tornado	A windblown missile from a design-basis tornado pierces a single U_3O_8 container in the storage building.	U_3O_8	1,200	0.5	Ground

[a] The accident assessment considered a spectrum of accidents in four categories, likely, unlikely, extremely unlikely, and incredible. Potential accidents in the unlikely and incredible frequency categories would not result in radiological releases, but they are considered in the chemical assessment.

[b] Ground-level releases were assumed to occur outdoors on concrete pads in the cylinder storage yards. To prevent contaminant migration, cleanup of residuals was assumed to begin immediately after the release was stopped.

2 hours after the accident, after which time he or she would be evacuated; the public MEI was assumed to remain indefinitely in the path of the passing plume and consume contaminated food grown on site.

The estimated doses and risks to the noninvolved worker and public MEIs are presented in Tables 5.2-9 and 5.2-10. The estimated impacts to the noninvolved worker MEI and public MEI are similar because 99% of the dose is due to the inhalation pathway within the first 2 hours after the accident.

TABLE 5.2-9 Estimated Radiological Doses per Accident Occurrence during Conversion at the Paducah Site[a]

		Maximum Dose				Minimum Dose			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Conversion Product/Accident[b]	Frequency Category[c]	MEI (rem)	Population[d] (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population[d] (person-rem)	MEI (rem)	Population (person-rem)
Corroded cylinder spill, dry conditions	L	7.8×10^{-2}	1.1/2.4/0.6	7.8×10^{-2}	2.4×10^{-1}	3.3×10^{-3}	$(4.7/9.9/2.8) \times 10^{-2}$	3.3×10^{-3}	2.5×10^{-3}
Failure of U_3O_8 container while in transit	L	5.3×10^{-1}	7.1/17/4.0	5.3×10^{-1}	1.0	2.2×10^{-2}	$(3.2/6.6/1.9) \times 10^{-1}$	2.3×10^{-2}	1.7×10^{-1}
Earthquake	EU	40	$(5.3/12.7/3.0) \times 10^{2}$	40	73	1.7	$(2.4/5.0/1.4) \times 10^{-1}$	1.7	13
Rupture of cylinders – fire	EU	2.0×10^{-2}	9.5/6.8/8.0	2.0×10^{-2}	21	3.7×10^{-3}	$(9.6/6.7/11) \times 10^{-1}$	3.7×10^{-3}	1.2
Tornado[e]	EU	7.5	110/230/64	7.5	34	7.5	110/230/64	7.5	34

[a] Maximum and minimum doses reflect differences in meteorological conditions at the time of the accident. In general, maximum doses would occur under meteorological conditions of F stability with a 1-m/s wind (2-mph) speed; minimum doses would occur under D stability with a 4-m/s (9-mph) wind speed.

[b] The bounding accident chosen to represent each frequency category is the one that would result in the highest dose to the general public MEI. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[c] Accident frequencies: L = likely, estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); EU = extremely unlikely, estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} to 10^{-6}/yr).

[d] For the noninvolved worker population dose, three estimates are provided, corresponding to Locations A, B, and C within the Paducah site.

[e] Meteorological conditions analyzed for the tornado were D stability with a 20-m/s (45-mph) wind speed.

TABLE 5.2-10 Estimated Radiological Health Risks per Accident Occurrence during Conversion at the Paducah Site

		Maximum Risk (LCFs)[a]				Minimum Risk (LCFs)[a]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Conversion Product/Accident[b]	Frequency Category[c]	MEI	Population[d]	MEI	Population	MEI	Population[d]	MEI	Population
Corroded cylinder spill, dry conditions	L	3×10^{-5}	$(0.4/1/0.2) \times 10^{-3}$	3×10^{-5}	3×10^{-5}	1×10^{-6}	$2/5/1 \times 10^{-5}$	1×10^{-6}	1×10^{-5}
U_3O_8 drum spill	L	2×10^{-4}	$(3/7/2) \times 10^{-3}$	3×10^{-4}	5×10^{-4}	9×10^{-6}	$2/3/0.9 \times 10^{-4}$	1×10^{-5}	8×10^{-5}
Earthquake	EU	2×10^{-2}	$(2/5/1) \times 10^{-1}$	2×10^{-2}	4×10^{-2}	7×10^{-4}	$1/2/0.7 \times 10^{-3}$	8×10^{-4}	6×10^{-3}
Rupture of cylinders – fire	EU	8×10^{-6}	$(4/3/3) \times 10^{-3}$	8×10^{-6}	1×10^{-2}	1×10^{-6}	$5/3/6 \times 10^{-4}$	1×10^{-6}	5×10^{-4}
Tornado[e]	EU	3×10^{-3}	$(5/10/3) \times 10^{-2}$	4×10^{-3}	2×10^{-2}	3×10^{-3}	$5/10/3 \times 10^{-2}$	4×10^{-3}	2×10^{-2}

[a] Maximum and minimum risks reflect differences in meteorological conditions at the time of the accident. In general, maximum risks would occur under meteorological conditions of F stability with a 1-m/s (2-mph) wind speed; minimum risks would occur under D stability with a 4-m/s (9-mph) wind speed. Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (LCFs) times the estimated frequency times 25 years of operations.

[b] The bounding accident chosen to represent each frequency category is the one that would result in the highest risks to the general public MEI. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[c] Accident frequencies: L = likely, estimated to occur one or more times in 100 years of facility operations ($> 10^{-2}$/yr); EU = extremely unlikely, estimated to occur between once in 10,000 years and once in 1 million years of facility operations ($10^{-4} – 10^{-6}$/yr).

[d] For the noninvolved worker population dose, three estimates are provided, corresponding to Locations A, B, and C within the Paducah site.

[e] Meteorological conditions analyzed for the tornado were D stability with a 20-m/s (45-mph) wind speed.

For the off-site public, the location of the conversion facility within the Paducah site would have very little impact on collective exposures because the area considered (a circle with a radius of 80 km [50 mi]) would be so much larger than the area of the Paducah site. The population dose estimates are based on population distributions from the 2000 census. The collective dose to noninvolved workers, however, would depend on the location of the conversion facility with respect to other buildings within the site. Therefore, for the noninvolved worker population, three estimates are provided in Tables 5.2-9 and 5.2-10, corresponding to Locations A, B, and C within the site.

The postulated accident estimated to have the largest consequence is the extremely unlikely accident caused by an earthquake involving the conversion facility. In this scenario, it is assumed that the U_3O_8 storage building would be damaged during the earthquake and that 10% of the stored containers would be breached. Under conservative meteorological conditions (F stability class with a 1-m/s [2 mph] wind speed) expected to result in the highest possible exposures, it is estimated that the dose to the MEI member of the public and noninvolved worker from this accident would be approximately 40 rem if it is assumed that the product storage building contained 6 month's worth of production. The RFP for conversion services required the bidders to provide enough capacity to be able to store up to 6 month's worth of inventory on site. The estimated MEI doses are well below levels expected to cause immediate fatalities from radiation exposure (approximately 450 rem) and would result in a lifetime increase in the probability of developing an LCF of about 0.02 (about 1 chance in 50) in the public MEI and about 0.02 (1 chance in 50) in the worker MEI.

It is estimated that the collective doses from the U_3O_8 storage building earthquake accident would be 300 to 1,270 person-rem to the worker population and 73 person-rem to the off-site general population. These collective doses would result in less than 1 additional LCF in the worker population (0.5 LCF) and in the general population (0.04 LCF).

The accident scenario with the second-highest impacts was the extremely unlikely scenario caused by a tornado strike. In this scenario, it is assumed that a windblown missile from a tornado would pierce a single U_3O_8 container in storage. In this hypothetical accident, and if bulk bags were being used to transport and dispose of the U_3O_8 product, approximately 1,200 lb (550 kg) of U_3O_8 could be released at ground level. Under conservative meteorological conditions, it is estimated that the dose to the MEI and noninvolved worker would be 7.5 rem. The collective doses would be up to 230 person-rem to the worker population and up to 35 person-rem to the general population. If the emptied cylinders were used rather than the bulk bags as U_3O_8 containers, the resulting doses would be approximately half of the above results.

To account for the possible TRU and Tc contamination in some of the cylinders, a ratio of the dose from the TRU and Tc radionuclides at bounding maximum concentrations to the dose from the depleted uranium was calculated (see Appendix B for details). For accidents involving full DUF_6 cylinders, the relative dose contribution from TRU and Tc was found to be less than 0.02% of the dose from the depleted uranium. This approach is conservative because only a fraction of the cylinders in the inventory are contaminated with TRU, and because it is expected that the concentration in any one cylinder would be less than the bounding concentrations assumed in the analysis.

The following conclusions may be drawn from the radiological health impact results:

- No cancer fatalities are predicted for any of the accidents.

- The maximum radiological dose to the noninvolved worker and general public MEIs (assuming that an accident occurred) would be about 7.5 to 40 rem, depending on the quantity of product stored on site at the time of the accident. This dose could thus be greater than the 25-rem total effective dose equivalent established by DOE as a guideline for assessing the adequacy of protection of public health and safety from potential accidents (DOE 2000c). Therefore, more detailed analysis during facility design and siting may be necessary.

- The overall radiological risk to noninvolved worker and general public MEI receptors (estimated by multiplying the risk per occurrence [Table 5.2-10] by the annual probability of occurrence by the number of years of operations) would be less than 1 for all of the conversion facility accidents.

- At most, there would be a factor of 5 difference in noninvolved worker population impacts among the three locations. Location C would have the lowest impact for the earthquake bounding scenario. Location B would have the highest impact for this scenario.

5.2.2.2.2 Chemical Impacts. This section presents the results for chemical health impacts for the highest-consequence accident in each frequency category for conversion operations at the Paducah site. The estimated numbers of adverse and irreversible adverse effects among noninvolved workers and the general public were calculated separately for each of the three alternative locations within the site by using 2000 census data for the off-site population. The methodology and assumptions used in the calculations are summarized in Appendix F, Section F.4.

The bounding conversion facility chemical accidents are listed in Table 5.2-11 and cover events that could occur during conversion. Note that an anhydrous NH_3 tank rupture is one of the bounding chemical accidents and the accident expected to cause the greatest impacts. NH_3 is used to produce hydrogen required for the conversion process. Although the use of NH_3 for hydrogen production is part of the UDS facility design, the use of natural gas for hydrogen production, which would eliminate the need for NH_3, is also possible.

The consequences from accidental chemical releases derived from the accident consequence modeling for conversion are presented in Tables 5.2-12 and 5.2-13. The results are presented as the number of people with the potential for (1) adverse effects and (2) irreversible adverse effects. Within each frequency category, the tables present the results for the accident that would affect the largest number of people (total of workers and off-site population). The numbers of noninvolved workers and members of the off-site public represent the impacts if the associated accident occurred. The accident scenarios given in Tables 5.2-12 and 5.2-13 are not

TABLE 5.2-11 Bounding Chemical Accidents during Conversion Operations at the Paducah Site

Frequency Category/ Accident Scenario	Accident Description	Chemical Form of Release	Release Amount (lb)	Release Duration (min)	Release Level/ Medium
Likely Accidents (frequency: 1 or more times in 100 years)					
Corroded cylinder spill, dry conditions	A 1-ft (0.30-m) hole results during handling, with solid UF_6 forming a 4-ft^2 (0.37-m^2) area on the dry ground.	UF_6	24	60	Ground/ air
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Corroded cylinder spill, wet conditions – rain	A 1-ft (0.30-m) hole results during handling, with solid UF_6 forming a 4-ft^2 (0.37-m^2) area on the wet ground.	HF	96	60	Ground/ air
Aqueous HF pipe rupture	An earthquake ruptures an aboveground pipeline transporting aqueous HF, releasing it to the ground.	HF	910[a]	10	Ground/ air-soil
Anhydrous NH_3 line leak	An NH_3 fill line is momentarily disconnected, and NH_3 is released at grade.	NH_3	255	1	Ground/ air
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Corroded cylinder spill, wet conditions – water pool	A 1-ft (0.30-m) hole results during handling, with solid UF_6 forming a 4-ft^2 (0.37-m^2) area into a 0.25-in. (0.64-cm)-deep water pool.	HF	147	60	Ground/ air
Rupture of cylinders – fire	Several cylinders hydraulically rupture during a fire.	UF_6	0 11,500 8,930 3,580	0 to 12 12 12 to 30 30 to 121	Ground/ air
Incredible Accidents (frequency: less than 1 in 1 million years)					
Aqueous HF (70%) tank rupture	Large seismic or beyond-design-basis event causes rupture of a filled HF storage tank.	HF	F1: 8,710[b] D4: 25,680[b]	120	Ground/ air
Anhydrous NH_3 tank rupture	Large seismic or beyond-design-basis event causes rupture of a filled NH_3 storage tank.	NH_3	29,500	20	Ground/ air

[a] The estimate assumes that 10% of the spill evaporates, with the remainder absorbed into the soil. It should be noted that the soil/groundwater assessment conservatively assumes that 100% of the spill is absorbed into the soil.

[b] The two different atmospheric conditions considered would cause different amounts to be released. These release amounts were computed on the basis of evaporation rates estimated by assuming 77°F (25°C; F-1 conditions) and 95°F (35°C; D-4 conditions).

TABLE 5.2-12 Consequences of Chemical Accidents during Conversion at the Paducah Site: Number of Persons with the Potential for Adverse Effects[a]

		Maximum No. of Persons per Location[d]												Minimum No. of Persons per Location[d]											
		Noninvolved Worker						General Public						Noninvolved Workers						General Public					
		MEI[e]			No. Affected			MEI[e]			No. Affected			MEI[e]			No. Affected			MEI[e]			No. Affected		
Accident[b]	Freq. Cat.[c]	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Corroded cylinder spill, dry conditions	L	Yes	Yes	Yes	13	110	71	No	No	No	0	0	0	Yes[f]	Yes[f]	Yes[f]	0	0	0	No	No	No	0	0	0
Corroded cylinder spill, wet conditions – rain	U	Yes	Yes	Yes	730	590	670	Yes	Yes	Yes	18	13	11	Yes	Yes	Yes	0	22	0	No	No	No	0	0	0
Rupture of cylinders – fire	EU	Yes	Yes	Yes	800	440	1,000	Yes	Yes	Yes	1,300	1,400	3,100	Yes	Yes	Yes	260	120	270	Yes	Yes	Yes	7	4	5
HF tank rupture	I	Yes	Yes	Yes	1,400	1,100	1,100	Yes	Yes	Yes	3,800	3,500	4,400	Yes	Yes	Yes	1,080	930	900	Yes	Yes	Yes	42	29	24
NH_3 tank rupture	I	Yes	Yes	Yes	1,600	1,400	1,600	Yes	Yes	Yes	4,800	4,900	6,700	Yes	Yes	Yes	1,100	1,100	1,400	Yes	Yes	Yes	26	14	17

[a] The values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency, times 25 years of operations. The estimated frequencies are as follows: L = likely, 0.1; U = unlikely, 0.001; EU = extremely unlikely, 0.00001; I = incredible, 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site population) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: L = likely, estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); U = unlikely, estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} to 10^{-4}/yr); EU = extremely unlikely, estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} to 10^{-6}/yr); I = incredible, estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum values reflect differences in assumed meteorological conditions at the time of the accident. In general, the maximum risks would occur under meteorological conditions of F stability with a 1-m/s (2-mph) wind speed; the minimum risks would occur under D stability with a 4-m/s (9-mph) wind speed.

[e] At the MEI location, the determination is either “Yes” or “No” for potential adverse effects to an individual.

[f] MEI locations were evaluated at 100 m (328 ft) from ground-level releases for workers and at the location of highest off-site concentration for members of the general public; the population risks are 0 because the worker and general public population distributions for the site were used, which did not show receptors at the MEI locations.

TABLE 5.2-13 Consequences of Chemical Accidents during Conversion at the Paducah Site: Number of Persons with the Potential for Irreversible Adverse Effects[a]

		Maximum No. of Persons per Location[d]												Minimum No. of Persons per Location[d]											
		Noninvolved Worker						General Public						Noninvolved Workers						General Public					
		MEI[e]			No. Affected			MEI[e]			No. Affected			MEI[e]			No. Affected			MEI[e]			No. Affected		
Conversion Product/Accident[b]	Freq. Cat.[c]	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Conversion to U_3O_8																									
Corroded cylinder spill, dry conditions	L	Yes[f]	Yes	Yes	0	9	0	No	No	No	0	0	0	No	Yes	Yes	0	0	0	No	No	No	0	0	0
Corroded cylinder spill, wet conditions – rain	U	Yes	Yes	Yes	130	310	71	No	No	No	0	0	0	Yes	Yes	Yes	0	7	0	No	No	No	0	0	0
Corroded cylinder spill, wet conditions – water pool	EU	Yes	Yes	Yes	400	410	71	Yes	Yes	Yes	0	0	0	Yes	Yes	Yes	0	19	0	No	No	No	0	0	0
NH_3 tank rupture[g]	I	Yes	Yes	Yes	1,600	1,400	1,600	Yes	Yes	Yes	370	320	220	Yes	Yes	Yes	600	700	130	Yes	Yes	Yes	2	0	1

[a] The values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency, times 25 years of operations. The estimated frequencies are as follows: L = likely, 0.1; U = unlikely, 0.001; EU = extremely unlikely, 0.00001; I = incredible, 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site population) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: L = likely, estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); U = unlikely, estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} to 10^{-4}/yr); EU = extremely unlikely, estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} to 10^{-6}/yr); I = incredible, estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum values reflect differences in assumed meteorological conditions at the time of the accident. In general, the maximum risks would occur under meteorological conditions of F stability with a 1-m/s (2-mph) wind speed; the minimum risks would occur under D stability with a 4-m/s (9-mph) wind speed.

[e] At the MEI location, the determination is either "Yes" or "No" for potential adverse effects to an individual.

[f] MEI locations were evaluated at 100 m (328 ft) from ground-level releases for workers and at the location of highest off-site concentration for members of the general public; the population risks are 0 because the worker and general public population distributions for the site were used, which did not show receptors at the MEI locations.

[g] Under D-stability, 4-m/s (9-mph) meteorological conditions (minimum no. of persons affected), an aqueous HF tank rupture would have higher consequences to noninvolved workers than would the NH_3 tank rupture, resulting in about 200 to 300 more irreversible adverse effects at Locations A and B, respectively. However, under F-stability, 1-m/s (2-mph) meteorological conditions (maximum number of persons affected), the NH_3 tank rupture would have the maximum consequences to noninvolved workers and the general public.

identical because an accident with the largest impacts for adverse effects might not lead to the largest impacts for irreversible adverse effects. The impacts may be summarized as follows:

- The largest impacts would be caused by the following accident scenarios: an HF storage tank rupture; a corroded cylinder spill under wet conditions (i.e., rain and formation of a water pool); an NH_3 tank rupture; and rupture of several cylinders in a fire. Accidents involving stack emissions would have smaller impacts than would accidents involving releases at ground level because of the relatively larger dilution rates and smaller release rates (due to filtration) involved with the stack emissions.

- If the accidents identified in Tables 5.2-12 and 5.2-13 did occur, the number of persons in the off-site population with the potential for adverse effects would range from 0 to around 6,700 (maximum corresponding to a release from an NH_3 pressurized tank rupture at Location C), and the number of off-site persons with the potential for irreversible adverse effects would range from 0 to around 370 (maximum corresponding to a release from an NH_3 pressurized tank rupture at Location A).

- If the accidents identified in Tables 5.2-12 and 5.2-13 did occur, the number of noninvolved workers with the potential for adverse and irreversible adverse effects would be about the same, ranging from 0 to around 1,600 (maximum corresponding to an NH_3 pressurized tank rupture at Locations A and C). Although the calculated hazard distances for adverse effects are over twice the hazard distances for irreversible affects (i.e., 7 mi [11 km] versus 2 mi [4 km]), the hazard zones for each of the health effect levels (Emergency Response Planning Guide [ERPG]-1 and ERPG-2) cover approximately the same noninvolved worker areas near the release locations for Locations A, B, or C.

- For over half of the bounding accident scenarios (NH_3 pressurized tank rupture, HF tank rupture, and rupture of cylinders in a fire), the greatest number of adverse effects among the off-site public and noninvolved workers would occur at Location C. The NH_3 pressurized tank rupture and the rupture of cylinders at Location C would result in the greatest number of affected noninvolved workers, while the HF tank rupture and corroded cylinder spill in wet conditions at Location A would result in the greatest number of affected noninvolved workers. For the cylinder spill scenario under either dry or wet conditions, the maximum number of adverse effects would occur at Locations A or B.

- The greatest number of irreversible adverse effects (associated with an NH_3 pressurized tank rupture) would occur at Location A for the off-site public and at Locations A or C for the noninvolved workers. For corroded cylinder spill scenarios, the greatest number of irreversible adverse effects for noninvolved workers would occur at Location B.

- For the most severe accidents in each frequency category, the noninvolved worker MEI and the public MEI would have the potential for both adverse effects and irreversible adverse effects. The likely accidents for each conversion option (frequency of more than 1 chance in 100 per year) would result in no potential adverse or irreversible adverse effects for the general public. The generally reduced impacts to the public compared with the noninvolved worker would be related to the dispersion or dilution of the chemical plume with downwind distance (except for a UF_6 cylinder rupture in a fire). The buoyancy effect of the plume in a fire tends to move the location of maximum impacts away from the accident and closer to the higher population areas.

- The maximum risk was computed as the product of the consequence (number of people) times the frequency of occurrence (occurrences per year) times the number of years of operations (25 years). These risk values presented below are conservative because the numbers of people affected were based on the following assumptions: (1) occurrence of very low wind speed and moderately stable meteorological conditions that would result in the maximum reasonably foreseeable plume size (i.e., F stability and a 1-m/s [2-mph] wind speed), and (2) steady or nonmeandering wind direction, lasting up to 3 hours and blowing toward locations that would lead to the maximum number of individuals exposed for noninvolved workers or for the general population. The results indicate that the maximum risk values would be less than 1 for all accidents except the following:

  – *Potential Adverse Effects:*
  Corroded cylinder spill, dry conditions (L, likely), workers
  Assuming the accident occurred once every 10 years (frequency = 0.1 per year), about 33 workers would potentially experience an adverse effect over the 25-year operational period at alternative Location A, about 280 at alternative Location B, and about 180 at alternative Location C.
  Corroded cylinder spill, wet conditions – rain (U, unlikely), workers
  Assuming the accident occurred once every 1,000 years (frequency = 0.001 per year), about 18 workers would potentially experience an adverse effect over the 25-year operational period at alternative Location A, about 15 at alternative Location B, and about 17 at alternative Location C.

  – *Potential Irreversible Adverse Effects:*
  Corroded cylinder spill, dry conditions (L, likely), workers
  Assuming the accident occurred once every 10 years (frequency = 0.1 per year), the expected numbers of workers who would potentially experience an irreversible adverse effect over the 25-year operational period at alternative Locations A, B, and C would be 0, 23, and 0, respectively.

Corroded cylinder spill, wet conditions – rain (U, unlikely), workers
Assuming the accident occurred once every 1,000 years (frequency = 0.001 per year), about 3 workers would potentially experience an irreversible adverse effect over the 25-year operational period at alternative Location A, about 8 at alternative Location B, and about 2 at alternative Location C.

The number of fatalities that could potentially be associated with the estimated irreversible adverse effects was also calculated. Previous analyses indicated that exposure to HF and uranium compounds, if sufficiently high, could result in death to 1% or less of the persons experiencing irreversible adverse effects (Policastro et al. 1997). Similarly, it was estimated that exposure to NH_3 could result in death to about 2% of the persons experiencing irreversible adverse effects (Policastro et al. 1997). Therefore, if the corroded cylinder spill, wet conditions – rain accident occurred (Table 5.2-13), about 1 fatality might be expected among the noninvolved workers at alternative Locations A and C; about 3 fatalities might be expected if the accident occurred at alternative Location B. However, this accident is classified as an unlikely accident, meaning that it is estimated to occur between once in 100 years and once in 10,000 years of facility operation. Assuming that it would occur once every 1,000 years, the risk of fatalities among the noninvolved workers from this accident over the 25-year operational period would be less than 1 ($1 \times 0.0001 \times 25 = \approx 0.03$ at Locations A and C, and $3 \times 0.001 \times 25 = \approx 0.08$ at Location B). (See Section 4.3 for discussion on interpretation of risk numbers that are less than 1.)

Similarly, if the higher-consequence accident in the extremely unlikely frequency category (corroded cylinder spill, wet conditions – water pool) in Table 5.2-13 occurred, approximately 4 fatalities might be expected among the noninvolved workers at alternative Locations A and B, and about 1 fatality at alternative Location C. However, because of the low frequency of this accident, the risk of a fatality over the lifetime of the conversion facility would be about 0.001 at Locations A and C and about 0.0003 at Location B, assuming a frequency of 0.00001 per year.

For the NH_3 tank rupture accident, which belongs to the incredible frequency category (frequency of less than 0.000001 per year), the expected numbers of fatalities among the noninvolved workers would be about 32, 28, and 32 for Locations A, B, and C, respectively, if the accident occurred. However, the risk of a fatality would be much less than 1 at any of the locations (about 0.0004, assuming a frequency of 5×10^{-7} per year) over the facility lifetime. Among the general public, about 7, 6, or 4 fatalities might be expected if the same accident occurred at Locations A, B, or C, respectively. However, because of the low frequency of the accident, the risk of fatalities would be much less than 1 (about 0.0001).

Even though the risks are relatively low, the consequences for a few of the accidents are considered to be high. These high-consequence accidents are generally associated with the storage of anhydrous NH_3 and aqueous HF on site. The consequences can be reduced or mitigated through design (e.g., by limiting their capacity), operational procedures (e.g., by controlling accessibility to the tanks), and emergency response actions (e.g., by sheltering, evacuation, and interdiction of contaminated food materials following an accident.) As an example, UDS is proposing to reduce the size of the anhydrous NH_3 storage tanks from 9,200 gal to 3,300 gal (34,826 L to 12,492 L). This change would reduce the consequences of an ammonia release accident. However, to conservatively estimate the consequences of an anhydrous ammonia tank rupture and preserve process flexibility, this analysis retained the assumption of a 9,200-gal (34,826-L) tank size.

5.2.2.2.3 Physical Hazards. The risk of on-the-job fatalities and injuries to conversion facility workers was calculated by using industry-specific statistics from the BLS, as reported by the National Safety Council (2002). Annual fatality and injury rates from the BLS manufacturing industry division were used for the 25-year operations phase, assuming no ETTP cylinders are processed. Operation of the conversion facility is estimated to require approximately 175 FTEs per year. No on-the-job fatalities are predicted during the conversion facility operational phase. It is estimated, however, that about 197 injuries would occur (Table 5.2-1).

5.2.2.3 Air Quality and Noise

5.2.2.3.1 Air Quality Impacts. Three alternative locations (Locations A, B, and C) were considered for air quality impacts. Detailed information on facility boundaries and the orientations and locations of buildings and stacks is currently available for preferred Location A only. For Locations B and C, the layout of the facility for Location A was assumed to be placed in the middle of the other two locations.

At the conversion facility, air pollutants would be emitted from four point sources: the boiler stack, backup generator stack, conversion building stack, and HF processing building stack. UDS is proposing to use electrical heating in the conversion facility, but it is evaluating other options. If natural gas was chosen, furnaces or boilers could be used. To assess bounding air quality impacts, a boiler option was analyzed because it would result in more emissions than furnaces or electric heat. The boilers could be used to generate process steam and building heat, and a backup generator would be used to provide emergency electricity. Primary emission sources for criteria pollutants and VOCs would be the boiler and emergency generator. The conversion building stack would release uranium, fluoride, criteria pollutants, and VOCs in minute amounts, while the HF processing building stack would release fluorides into the atmosphere. Although nitrogen would be used as a purge gas in the process, its use would not generate additional NO_X emissions, because of the absence of oxygen in contact with the nitrogen stream at high temperatures. Annual total stack emission rates during operations are given in the Engineering Support Document (Folga 2003), and these emission rates are presented in Table 5.2-14. Other sources during operations would include vehicular traffic to and from the facility, associated with cylinder transfer, commuting, and material delivery. Parking lots and access roads to the facility would be paved with asphalt or concrete to minimize fugitive dust emissions. In addition, fugitive emissions would include those from storage tanks, silos, cooling towers, etc., but in negligible amounts.

TABLE 5.2-14 Annual Point Source Emissions of Criteria Pollutants, Volatile Organic Compounds, Uranium, and Fluoride from Operation of the Conversion Facility at the Paducah Site

	Emission Rate[a]			
Pollutant	Boiler[b]	Backup Generator	Conversion Building Stack	HF Processing Building Stack
SO_2	0.01	0.17	1.3×10^{-3}	–[c]
NO_x	2.09	1.20	3.4×10^{-2}	–
CO	1.25	0.17	5.3×10^{-2}	–
VOC	0.08	0.17	1.5×10^{-2}	–
PM_{10}[d]	0.11	0.07	9.0×10^{-3}	–
Uranium	–	–	< 0.25 g/yr	–
Fluoride	–	–	< 0.05 ppm[e]	< 0.05 ppm[f]

a Tons/yr unless otherwise noted.

b Boiler emissions were estimated on the basis of annual natural gas usage given in Table 5.2-19.

c A dash indicates no or negligible emissions.

d $PM_{2.5}$ emissions are assumed to be the same as PM_{10} emissions.

e Annual emission is about 1.1 kg (2.4 lb) as HF.

f Annual emission is about 70.5 kg (155 lb) as HF.

The modeling results for concentration increments of SO_2, NO_2, CO, PM_{10}, $PM_{2.5}$, and HF due to emissions from operations of the proposed facility are summarized in Table 5.2-15. The results are maximum modeled concentrations at or beyond the conversion facility boundary. The total concentrations (modeled concentration increments plus background concentrations) are also presented in this table for comparison with applicable NAAQS and SAAQS.

Because of the low emissions during facility operations, all air pollutant concentration increments during operations would be well below applicable standards. As shown in Table 5.2-15, the estimated maximum concentration increments due to operation of the proposed facility would amount to about 16% of the applicable standard for 24-hour average SO_2. This concentration increment is primarily due to a backup generator, which is located next to the conversion building and the site boundaries and within the building cavity/wake region. However, the generator would be operating on an intermittent basis, and thus air quality impacts would be limited to the period of its operation. The total concentrations except for annual-average $PM_{2.5}$, would be well below their applicable standards. The total annual average $PM_{2.5}$ concentration is predicted to be about 99% of its standard, but its background concentration would approach its standard (about 98%). As previously mentioned, the annual average $PM_{2.5}$ concentration at most statewide monitoring stations would either approach or exceed the standard.

TABLE 5.2-15 Maximum Air Quality Impacts Due to Emissions from Activities Associated with Operation of the Conversion Facility at the Paducah Site

			Concentration (μg/m^3)					
							Percent of NAAQS/SAAQS[d]	
Location	Pollutant	Averaging Time	Maximum Increment[a]	Background[b]	Total[c]	NAAQS and SAAQS	Increment	Total
A	SO_2	3 hours	178	169	347	1,300	13.7	26.7
		24 hours	57.2	86.0	143	365	15.7	39.2
		Annual	0.2	13.3	13.5	80	0.2	16.8
	NO_2	Annual	1.2	22.6	23.8	100	1.2	23.8
	CO	1 hour	245	6,970	7,220	40,000	0.6	18.0
		8 hours	106	3,220	3,330	10,000	1.1	33.3
	PM_{10}	24 hours	14.8	79.0	93.8	150	9.9	62.6
		Annual	0.07	25.0	25.1	50	0.1	50.1
	$PM_{2.5}$	24 hours	2.2	31.1	33.3	65	3.4	51.3
		Annual	0.07	14.7	14.8	15	0.5	98.5
	HF	12 hours	0.14	1.04	1.18	3.68	3.8	32.1
		24 hours	0.09	0.86	0.95	2.86	3.1	33.2
		1 week	0.04[e]	0.50	0.54	1.64	2.5	33.1
		1 month	0.02	0.34	0.35	0.82	1.9	42.8
		Annual	0.01	0.17	0.18	400	0.002	0.04
B	SO_2	3 hours	162	169	331	1,300	12.5	25.5
		24 hours	48.8	86	135	365	13.4	36.9
		Annual	0.1	13.3	13.4	80	0.2	16.8
	NO_2	Annual	1.0	22.6	23.6	100	1.0	23.6
	CO	1 hour	252	6,970	7,220	40,000	0.6	18.1
		8 hours	97.3	3,220	3,320	10,000	1.0	33.2
	PM_{10}	24 hours	14.9	79.0	93.9	150	9.9	62.6
		Annual	0.06	25.0	25.1	50	0.1	50.1
	$PM_{2.5}$	24 hours	1.9	31.1	33.0	65	2.9	50.8
		Annual	0.06	14.7	14.8	15	0.4	98.4
	HF	12 hours	0.07	1.04	1.12	3.68	2.0	30.3
		24 hours	0.06	0.86	0.92	2.86	2.0	32.1
		1 week	0.03[e]	0.50	0.53	1.64	1.6	32.2
		1 month	0.01	0.34	0.35	0.82	1.4	42.3
		Annual	0.007	0.17	0.17	400	0.002	0.04
C	SO_2	3 hours	86.6	169	256	1,300	6.7	19.7
		24 hours	32.4	86	118	365	8.9	32.4
		Annual	0.06	13.3	13.4	80	0.1	16.7

TABLE 5.2-15 (Cont.)

		Concentration (µg/m³)						
							Percent of NAAQS/SAAQS[d]	
Location	Pollutant	Averaging Time	Maximum Increment[a]	Background[b]	Total[c]	NAAQS and SAAQS	Increment	Total
	NO_2	Annual	0.5	22.6	23.1	100	0.5	23.1
	CO	1 hour	206	6,970	7,180	40,000	0.5	17.9
		8 hours	54.7	3,220	3,270	10,000	0.5	32.7
	PM_{10}	24 hours	7.7	79.0	86.7	150	5.1	57.8
		Annual	0.03	25.0	25.0	50	0.1	50.1
	$PM_{2.5}$	24 hours	1.0	31.1	32.1	65	1.6	49.4
		Annual	0.03	14.7	14.7	15	0.2	98.2
	HF	12 hours	0.07	1.04	1.11	3.68	1.8	30.1
		24 hours	0.05	0.86	0.91	2.86	1.7	31.8
		1 week	0.02[e]	0.50	0.52	1.64	1.3	31.9
		1 month	0.01	0.34	0.34	0.82	1.1	42.1
		Annual	0.006	0.17	0.17	400	0.001	0.04

a Data represent the maximum concentration increments estimated, except that the fourth- and eighth-highest concentration increments estimated are listed for 24-hour PM_{10} and $PM_{2.5}$.

b See Table 3.1-3 for criteria pollutants and ANL (1991a) for highest weekly and annual HF. Background HF for other averaging times was estimated based on highest weekly and annual background concentrations.

c Total equals the maximum modeled concentration increment plus background concentration.

d The values in the next-to-last column are maximum concentration increments as a percent of NAAQS and SAAQS. The values presented in the last column are total concentration as a percent of NAAQS and SAAQS.

e Estimated by interpolation.

The air quality impacts would be limited to the immediate vicinity of site boundaries. For example, the maximum predicted concentration at the nearest residence on McCall Road would be less than 3% of the highest concentration. Accordingly, it is expected that potential impacts from the proposed facility operations on the air quality of nearby communities would be negligible.[4]

The maximum 3-hour, 24-hour, and annual SO_2 concentration increments predicted to result from the proposed facility operations would be about 63% of the applicable PSD increments (Table 3.1-3). The maximum predicted increments in annual-average NO_2 concentrations due to the proposed facility operations would be about 5% of the applicable PSD.

4 Formerly, the general public had access to the existing fenced gaseous diffusion plant boundaries. However, since the September 11, 2001, terrorist attack, site access for the general public has been restricted indefinitely to the DOE property boundaries.

The 24-hour and annual PM_{10} concentration increases predicted to result from the proposed operations would be about 50% of the applicable PSD increments. As mentioned earlier, this is due to a backup generator, only when it is in operation. The predicted concentration increment at a receptor located 30 mi (50 km) from the proposed facility (the maximum distance for which the Industrial Source Complex 3 [ISC3] short-term model [EPA 1995] could reliably estimate concentrations) in the direction of the nearest Class I PSD area (Mingo National Wildlife Refuge, Missouri) would be less than 0.5% of the applicable PSD increments. Concentration increments at this refuge, which is located about 70 mi (113 km) west of Paducah, would be much lower.

Concentration increments for the two remaining criteria pollutants, Pb and O_3, were not modeled. As a direct result of the phase-out of leaded gasoline in automobiles, average Pb concentrations in urban areas throughout the country have decreased dramatically. It is expected that emissions of Pb from the proposed facility operations would be negligible and would therefore have no adverse impacts on Pb concentrations in surrounding areas. Contributions to the production of O_3, a secondary pollutant formed from complex photochemical reactions involving O_3 precursors, including NO_x and VOCs, cannot be accurately quantified. As discussed in Section 3.1.3, McCracken County, including the Paducah site, is currently in attainment for O_3 (40 CFR 81.318). The O_3 precursor emissions from the proposed facility operations would be insignificant, making up less than 0.01% and 0.08% of 1999 McCracken County emissions of NO_x and VOCs, respectively. As a consequence, the cumulative impacts of potential releases from Paducah GDP operations on regional O_3 concentrations would not be of concern.

Maximum HF air quality impacts are also listed in Table 5.2-15. The estimated maximum short-term (≤1 month) HF concentration increment and total concentration would be about 3.8% and 42.8% of the state standard, respectively, which are still well below the standards. The annual average concentration increment and total concentration would be several orders of magnitude lower than any applicable HF air quality standard.

In summary, except for annual average $PM_{2.5}$, total concentrations would be below their applicable standards. Total maximum estimated concentrations, except for annual average $PM_{2.5}$, would be less than 63% of NAAQS and SAAQS. Total maximum estimated concentrations for $PM_{2.5}$ would approach NAAQS and SAAQS; however, their concentration increments associated with site operations would account for about only 0.5% of the standards. In particular, the annual average $PM_{2.5}$ concentrations at most sitewide monitoring stations would either approach or exceed the standard.

Accidents. Among chemicals released as a result of accidents, HF would be the only one subject to an ambient air quality standard (the Commonwealth of Kentucky HF standard). Most accidental releases would occur over a short duration, about 2 hours at most. The passage time of a plume with an elevated concentration for any receptor location would be a little longer than its release duration. The HF concentration in the plume's path would exceed the 12-hour or 24-hour state ambient standard for the HF tank rupture accident scenario; however, when concentrations are averaged over a year, the annual ambient air quality standard would not be exceeded. Therefore, potential impacts of accidental releases on ambient air quality would be short-term and limited to along the plume path, and long-term impacts would be negligible.

5.2.2.3.2 Noise Impacts. Many noise sources associated with operation would be inside the buildings. The highest noise levels are expected inside the conversion facility in the area of the powder receiver vessels, with measured readings at 77 to 79 dB(A), and in the area of dry conversion, with a reading of 72 to 74 dB(A) (UDS 2003b). Ambient facility noise levels, measured in various processing areas (inside buildings) for continuous operations of a similar facility at Richland, Washington, ranged from 70 to 79 dB(A). Major outdoor noise sources associated with operation would include the cooling tower, trucks and heavy equipment for moving cylinders, and traffic moving to and from the facility, which are typical industrial noise sources. Heavy equipment and truck traffic would be intermittent; thus, noise levels would be low except when equipment was moving or operating. For noise impact analysis, a continuous noise source during operation was assumed to be 79 dB(A) at a distance of 15 m (50 ft),[5] on the basis of the highest noise level measured inside buildings at the Richland facility (UDS 2003b).

The nearest residence, located about 1.3 km (0.8 mi) southeast of Location C and just off DOE's eastern boundary on McCall Road, was selected as the receptor for the analysis of potential noise impacts. Noise levels decrease about 6 dB per doubling of distance from the point source because of the way sound spreads geometrically over increasing distance. The estimated noise level would result in about 40 dB(A) at the nearest residence. This level would be about 46 dB(A) as DNL, if 24-hour continuous operation is assumed. This level is below the EPA guideline of 55 dB(A) as DNL for residential zones (see Section 3.1.3.4), which was established to prevent interference with activity, annoyance, and hearing impairment. If other attenuation mechanisms, such as ground effects or air absorption, are considered, noise levels at the nearest residence would decrease to below background levels of about 44 to 47 dB(A) (see Section 3.1.3.4).

Most trains would blow their whistles loud enough to ensure that all motorists and pedestrians nearby would be aware of an approaching train. These excessive noises could disturb those who live or work near the train tracks. Typical noise levels of train whistles would range from 95 to 115 dB(A) at a distance of 30 m (100 ft), comparable to those of low-flying aircraft or emergency vehicle sirens (DOT 2003b). Associated with facility operations, the total number of shipments (railcars) would be less than 10,000 railcars. It would be equivalent to about two trains per week, assuming five railcars per train. Accordingly, the noise level from train operations would be high along the rail tracks and, in particular, near the crossings. However, noise impacts would be infrequent and of short duration.

In general, facility and infrequent rail traffic operations produce less noise than construction activities. For all three alternative locations, except for intermittent vehicular traffic, the noise level at the nearest residence would be comparable to the ambient background level

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[5] Noise level from one of the continuous outdoor noise sources, a cooling tower, to be used at this size of a facility, would be less than 79 dB(a) at a distance of 15 m (50 ft).

discussed in Section 3.1.3.4, and it would be barely or not distinguishable from the background level, depending on the time of day. In conclusion, noise levels generated by facility operation would have negligible impacts on the residence located nearest to the proposed facility and would be well below the EPA guideline limits for residential areas.

5.2.2.4 Water and Soil

Operation of a conversion facility at Paducah would disturb land, use water, and produce liquid wastes. The following sections discuss impacts to surface water, groundwater, and soil resources during operations. Because no site-specific impacts to water and soil were identified, impacts at alternative Locations A, B, and C would be the same.

5.2.2.4.1 Surface Water. All of the water needed for a conversion facility at Paducah would be withdrawn from the Ohio River. Potable water consumption would be 3 million gal/yr (11.4 million L/yr). An additional 37 million gal/yr (140 million L/yr would be needed for nonpotable uses (e.g., cooling tower makeup). The total water needed would be about 0.00004% of the average flow in the Ohio River. Impacts of this withdrawal would be negligible.

About 4,000 to 8,000 gal/d (15,100 to 30,200 L/d) of sanitary wastewater would be produced by the conversion facility. If sanitary wastewater were released at a constant rate of 2.8 to 5.6 gal/min (11 to 22 L/min) after treatment in the wastewater treatment plant, impacts to the receiving water (Bayou Creek) would not be measurable.

There would be about 4,000 gal/d (15,000 L/min) of process wastewater produced during normal operations. This water would not contain any radionuclides. About 31,000 gal/d (117,000 L/d) (11.3 million gal/yr [42.8 million L/yr]) of wastewater would be produced by cooling tower blowdown. These wastewaters would not contain any radionuclides and could be disposed of to the existing process wastewater treatment system at Paducah, or discharged under a KPDES permit, or treated and reused at the conversion facility. Disposition of these wastewaters is under evaluation.

Accidents. An earthquake could rupture an aboveground pipeline carrying liquid HF from the conversion building to the storage building at a rate of 10 gal/min (38 L/min). For assessing potential surface water or groundwater impacts of this accident scenario, it was assumed that 100% of the HF would drain onto the ground during a 10-minute release period. Approximately 910 lb (410 kg) of liquid HF would be released. Because response and cleanup would occur within a relatively short time after the release (i.e., days or weeks), the HF would have little time to migrate into the soil. Removal of the contaminated soil would prevent any problems of contamination of either surface or groundwater resources. Therefore, there would be no impacts to surface water or groundwater from this type of accident. A similar quick response and cleanup would minimize the impacts of an HF spill to the ground during transfer to railcars.

5.2.2.4.2 Groundwater. Because all water used at the Paducah site would be obtained from the Ohio River and there would be no direct discharges to the underlying aquifers, there would be no impacts to groundwater recharge, depth, or flow direction from operation of a conversion plant at Paducah. However, the quality of groundwater beneath the selected site could be affected by infiltration of contaminated surface water from spills. Indirect contamination could result from the dissolution and mobilization of exposed chemicals by precipitation and subsequent infiltration of the contaminated runoff into the surficial aquifers. Again, following good engineering and operating practices would minimize impacts to groundwater quality.

Accidents. An earthquake could rupture an aboveground HF pipeline that would carry liquid HF from the conversion building to the storage building, or HF could be spilled during transfer to a railcar. Rapid removal of the contaminated soil would prevent any problems of contamination to underlying groundwater resources. Therefore, there would be no impacts to groundwater from these accidents.

5.2.2.4.3 Soils. Normal operations of a conversion facility at the Paducah site would have no direct impacts to soil at all three alternative locations.

Accidents. The only accidents identified that could potentially affect soil would be an HF pipeline rupture and an HF spill during transfer to railcars. Because mitigation would be rapidly initiated and because the volume of HF released would be small (910 lb [410 kg]), impacts to soil would be negligible.

5.2.2.5 Socioeconomics

The socioeconomic analysis covers the effects on population, employment, income, regional growth, housing, and community resources in the ROI around the Paducah site. Impacts from operations, which are the same for all three alternative locations, are summarized in Table 5.2-16.

The potential socioeconomic impacts from operating a conversion facility at Paducah would be relatively small. It is estimated that operational activities would create about 160 direct jobs annually, and about 170 more indirect jobs in the ROI. A conversion facility would produce approximately $13 million in personal income annually during operations.

It is estimated that about 220 people would move to the area at the beginning of operations. However, in-migration would have only a marginal effect on population growth and would require about 1% of vacant owner-occupied housing during facility operations. No significant impact on public finances would occur as a result of in-migration. Fewer than five new local public service employees would be required to maintain existing levels of service in the various local public service jurisdictions in McCracken County.

5.2.2.6 Ecology

5.2.2.6.1 Vegetation. A portion of the conversion product released from the process stack of the conversion facility would become deposited on the soils surrounding the site at Locations A, B, or C. Uptake of uranium-containing compounds can cause adverse effects to vegetation. Deposition of uranium compounds on soils, resulting from atmospheric emissions, would result in soil uranium concentrations considerably below the lowest concentration known to produce toxic effects in plants. Because there would not be a release of process effluent from the facility to surface waters, impacts to vegetation along nearby streams would not occur. Therefore, toxic effects on vegetation from uranium uptake would be expected to be negligible.

TABLE 5.2-16 Socioeconomic Impacts from Operation of the Conversion Facility at the Paducah Site

Impact Area	Operation Impacts[a]
Employment	
Direct	160
Total	330
Income (millions of 2002 $)	
Direct	5.8
Total	13.2
Population (no. of new ROI residents)	220
Housing (no. of units required)	80
Public finances (% impact on fiscal balance)	
Cities in McCracken County[b]	0.2
McCracken County	0.1
Schools in McCracken County[c]	0.2
Public service employment (no. of new employees in McCracken County)	
Police	0
Firefighters	0
General	1
Physicians	0
Teachers	1
No. of new staffed hospital beds (McCracken County)	1

[a] Impacts are shown for the first year of operations (2006).

[b] Includes impacts that would occur in the City of Paducah.

[c] Includes impacts that would occur in the McCracken County school district.

5.2.2.6.2 Wildlife. Noise generated by the operation of a conversion facility at Location A and disturbance from human presence would likely result in a minor disturbance to wildlife in the vicinity. Movement of railcars along the new rail line southwest of the facility might potentially cause the adjacent mature deciduous forest habitat to be unsuitable for some species.

During operations, ecological resources in the vicinity of the conversion facility would be exposed to atmospheric emissions from the boiler stack, cooling towers, and process stack; however, emission levels are expected to be extremely low. The highest average air concentration of uranium compounds would result in a radiation exposure to the general public (nearly 100% due to inhalation) of 3.9×10^{-5} mrem/yr, well below the DOE guideline of 100 mrem/yr. Wildlife species are less sensitive to radiation than humans. (DOE guidelines require an absorbed dose limit to terrestrial animals of less than 0.1 rad/d [DOE 2002d].) Therefore, impacts to wildlife from radiation are expected to be negligible. Toxic effect levels of chronic inhalation of uranium are many orders of magnitude greater than expected emissions from the conversion facility. Therefore, toxic effects on wildlife as a result of inhalation of uranium compounds are also expected to be negligible.

The maximum annual average air concentration of HF due to operation of a conversion facility would be 0.01 μg/m^3. Toxic effect levels of chronic inhalation of HF are many orders of magnitude greater than expected emissions. Therefore, toxic effects to wildlife from HF emissions would be expected to be negligible.

Impacts to wildlife from the operation of a conversion facility at Locations B or C would be similar to impacts at Location A. Noise and human presence would likely result in a minor disturbance to wildlife in the vicinity.

5.2.2.6.3 Wetlands. Liquid process effluents would not be discharged to surface waters during the operation of the conversion facility (Section 5.2.2.4). In addition, water level changes in the Ohio River because of water withdrawal for operations would be negligible. Regional groundwater changes due to the increase in impermeable surface related to the presence of the facility would also be negligible. Therefore, except for potential local indirect impacts near the facility, impacts to regional wetlands due to changes in groundwater or surface water levels or flow patterns would be expected to be negligible. As a result, adverse effects on wetlands or aquatic communities from effluent discharges or water use are not expected.

Storm water runoff from conversion facility parking areas and other paved surfaces might carry contaminants commonly found on these surfaces to local streams. Biota in receiving streams might be affected by these contaminants, resulting in reduced species diversity or changes in community composition. Storm water discharges from the conversion facility would be addressed under a new or existing KPDES Permit for industrial facility storm water discharge. The streams near Locations A, B, and C currently receive runoff and associated contaminants from various roadways and storage yards on the Paducah site, and their biotic communities are likely indicative of developed areas.

5.2.2.6.4 Threatened and Endangered Species. Direct impacts to federal- or state-listed species during operation of a conversion facility at Location A are not expected. The wooded area at Location A has not been identified as summer roosting habitat for the Indiana bat (federal- and state-listed as endangered). Disturbances from increased noise, lighting, and human presence due to facility operation, and the movement of railcars along the new rail line south of the facility might decrease the quality of the adjacent forest habitat for use by Indiana bats. However, Indiana bats that might currently be using habitat near the Paducah site would already be exposed to noise and other effects of human disturbance due to operation of the site, including vehicle traffic. Consequently, disturbance effects related to conversion facility operation would be expected to be minor.

In addition, noise from railcar movement along the new rail line may result in a disturbance to Indiana bats that may use habitat, identified as fair potential and poor potential, west of the Entrance Highway, where existing levels of disturbance are relatively low. Indiana bats have been observed to tolerate increased noise levels (U.S. Fish and Wildlife Service [USFWS] 2002). Consequently, disturbances from rail traffic are not expected to result in loss of suitability of these habitat areas. The operation of a conversion facility at Locations B and C might similarly decrease the quality of wooded areas at those locations for Indiana bat summer habitat, although these locations have not been identified as containing Indiana bat habitat.

5.2.2.7 Waste Management

Operations at the conversion facility would generate radioactive, hazardous, and nonhazardous wastes. The annual waste volumes generated by conversion would be the same for all three alternative locations and are presented in Table 5.2-17. The total volumes of wastes that would be generated during the 25 years of operations would be 1,440 yd^3 (1,100 m^3) of LLW and 180 yd^3 (140 m^3) of hazardous waste. These volumes would result in low impacts on site annual projected volumes.

If ETTP cylinders are processed for conversion at Paducah, an additional 26 yd^3 (20 m^3) of LLW and 5 yd^3 (4 m^3) of hazardous waste would be generated. These volumes constitute negligible impacts on site annual generation volumes.

CaF_2 would be produced in the U_3O_8 conversion and is assumed to have a low uranium content. It is currently unknown whether this CaF_2 could be sold (e.g., as feedstock for commercial production of anhydrous HF) or whether the low uranium content would force disposal. If CaF_2 disposal is necessary, it could be either as a nonhazardous solid waste (provided that authorized limits have been established in accordance with DOE Order 5400.5 [DOE 1990] and its associated guidance) or as LLW. It is currently unknown whether it would require disposal as either a nonhazardous solid waste or as LLW because of its low uranium content. The nonhazardous solid waste generation estimates for conversion to U_3O_8 in Table 5.2-17 are based on the assumption that CaF_2 would be disposed of as nonhazardous solid waste, generating approximately 17 yd^3/yr (13 m^3/yr) of nonhazardous solid waste. This represents a negligible impact (less than 1%) to the projected annual nonhazardous solid waste volume at Paducah. If CaF_2 was disposed of as LLW, it would represent less than 1% of the projected annual LLW load and constitute negligible impact.

TABLE 5.2-17 Wastes Generated from Operation of the Conversion Facility at the Paducah Site

Waste Category	Annual Volume
LLW	
Combustible waste	34 m^3
Noncombustible	8.5 m^3
Others	1.0 m^3
Total[a]	44 m^3
Hazardous waste	5.5 m^3
Nonhazardous waste	
Solids[b]	180 m^3
Sanitary wastewater	5.5×10^6 L

[a] Includes LLW from high-efficiency particulate air (HEPA) filters and laboratory acids and residues.

[b] Includes volumes of CaF_2 generated from the conversion process.

Source: UDS (2003b).

If the HF was not marketable, it would be converted to CaF_2. Neutralization of HF to CaF_2 would produce approximately 4,900 yd^3/yr (3,780 m^3/yr) of CaF_2. This volume represents approximately 20% and 53% of nonhazardous solid waste and LLW, respectively, of projected annual generation volumes for Paducah. These potential waste volumes would result in a moderate to large impact relative to site annual waste generation volumes and on-site waste management capacities. It is also unknown whether CaF_2 LLW would be considered DOE waste if the conversion was performed by a private commercial enterprise. If CaF_2 could be sold, the nonhazardous solid waste or LLW management impacts would be lower.

The U_3O_8 produced from the conversion process would generate about 7,850 yd^3/yr (6,000 m^3/yr) of LLW. This volume is about 83% of the annual site-projected LLW volume and constitutes a relatively large impact on site LLW management. However, plans for off-site (to Envirocare or NTS) disposal of this potential volume of LLW are considered in the proposed action.

Current UDS plans are to leave the heels in the emptied cylinders, fill them with the depleted U_3O_8 product, and dispose of them at either Envirocare or NTS. This approach is expected to meet the waste acceptance criteria of the disposal facilities and eliminate the potential for generating TRU waste (see Appendix B for additional information concerning TRU and PCB contamination). However, it is possible that the heels could be washed from the emptied cylinders if, instead, it was decided to reuse the cylinders for other purposes. In this case, the TRU in the heels of some cylinders at the maximum postulated concentrations could also result in the generation of some TRU waste at the conversion facility. It is estimated that up to 30% (or 244 drums) of the heels could contain enough TRU to qualify this material as TRU waste if it was disposed of as waste. In this case, it is estimated that a volume of about 2.6 yd^3/yr (2.0 m^3/yr) of TRU and 6.0 yd^3/yr (4.4 m^3/yr) of LLW would be generated.

In addition, a small quantity of TRU could be entrained in the gaseous DUF_6 during the cylinder emptying operations and carried out of the cylinders. These contaminants would be captured in the filters between the cylinders and the conversion equipment. The filters would be monitored and replaced routinely to prevent buildup of TRU. The spent filters would be disposed of as LLW. It is estimated that the amount of LLW generated in the form of spent filters would be about 1 drum per year for a total of 25 drums (drums are 55 gal [208 L] in size) for the duration of the conversion operations (see Appendix B). This converts to a total volume of 6.8 yd^3 (5.2 m^3) of LLW. Current site projections include the generation of a small amount of TRU waste (about 0.8 yd^3/yr [0.6 m^3/yr]). In the unlikely event that small amounts of TRU waste are generated from the conversion facility, the wastes would be managed in accordance with DOE's policy for TRU waste, which includes the packaging and transport of these wastes to the Waste Isolation Pilot Plant (WIPP) in New Mexico for disposal.

5.2.2.8 Resource Requirements

Resource requirements during operation would not depend on the location of the conversion facility. Facility operations would consume electricity, fuel, and miscellaneous chemicals that are generally irretrievable resources. Estimated annual consumption rates for operating materials are given in Table 5.2-18. The total quantity of commonly used materials is not expected to be significant and would not affect their local, regional, or national availability. In general, facility operational resources required are not considered rare or unique.

Operation of the proposed conversion facility could include the consumption of fossil fuels used to generate steam and heat and electricity (Table 5.2-19). Energy also would be expended in the form of diesel fuel and gasoline for cylinder transport equipment and transportation vehicles. The existing infrastructure at the site appears to be sufficient to supply the required utilities.

TABLE 5.2-18 Materials Consumed Annually during Normal Conversion Facility Operations at the Paducah Site[a]

Chemical	Quantity (tons/yr)
Solid	
Lime (CaO)[b]	19
Liquid	
Ammonia (99.95% minimum NH_3)	670
Potassium hydroxide (45% KOH)	8
Gas	
Nitrogen (N_2)	10,000

[a] Material estimates are based on facility conceptual-design-status data (UDS 2003b). A number of studies are planned to evaluate design alternatives, the results of which may affect the above materials needs.

[b] Assuming lime is used only for potassium hydroxide regeneration. If HF neutralization is required, the annual lime requirement would be approximately 9,300 tons/yr (8,437 t/yr).

5.2.2.9 Land Use

Because the preferred location (Location A) consists primarily of a previously disturbed grassy field with a wooded area in the southeastern section of the tract, the proposed action would involve a change from current land use. Despite this localized change, operating the facility would be consistent with the activity currently found at the heavily industrialized Paducah site — a result of producing enriched uranium and its DUF_6 by-product. As a consequence, only negligible land use impacts are anticipated.

Impacts of operations on land use for a conversion facility at Location B or Location C would be similar to those of a facility placed at Location A. Although localized changes in land use would occur in both cases, activities would be consistent with those currently found at the heavily industrialized site. Once again, only negligible impacts are expected as a consequence of operating the facility at either of these localities.

5.2.2.10 Cultural Resources

The routine operation of a DUF_6 conversion facility at Paducah is unlikely to adversely affect cultural resources at all three alternative locations because no ground-disturbing activities are associated with facility operation.

Air emissions or chemical releases from the facility were evaluated to determine their potential to affect significant cultural resources in the surrounding area. On the basis of the analysis of air emissions in Section 5.2.2.3 and the secondary standards given in Section 3.1.3, no secondary standards would be exceeded during the operation phase beyond the facility itself.

TABLE 5.2-19 Utilities Consumed during Conversion Facility Operations at the Paducah Site[a]

Utility	Annual Average Consumption	Unit	Peak Demand[b]	Unit
Electricity	37,269	MWh	7.1	MW
Liquid fuel	4,000	gal	NA[c]	NA
Natural gas[d,e]	4.4×10^7	scf[f]	190	scfm[f]
Process water	37×10^6	gal	215	gal/min
Potable water	3×10^6	gal	350	gal/min

[a] Utility estimates are based on facility conceptual-design-status data (UDS 2003b). A number of studies are planned to evaluate design alternatives, the results of which may affect the above utility needs.

[b] Peak demand is the maximum rate expected during any hour.

[c] NA = not applicable.

[d] Standard cubic feet measured at 14.7 psia and 60°F (17°C).

[e] The current facility design (UDS 2003b) uses electrical heating. An option of using natural gas is being evaluated.

[f] scf = standard cubic feet; scfm = standard cubic feet per minute.

Thus, emissions from operation of the facility would not have any adverse effect on cultural resources.

Accidental radiological and chemical releases, including HF, uranium compounds, and NH_3, would be possible, although unlikely, during the operation of the plant (see Section 5.2.2.2). It is projected that HF emissions would not exceed secondary standards beyond site boundaries and would have no effect on cultural resources. Any release of uranium compounds would be as PM and would affect only the surfaces of buildings in close proximity to the facility. NH_3 releases would be gaseous and quickly disperse, although some surface deposits could occur. Careful washing of building surfaces could be required to remove such deposits if any contamination was detected following an accidental release.

5.2.2.11 Environmental Justice

The evaluation of environmental justice impacts is predicated on the identification of high and adverse impacts in other impact areas considered in this EIS, followed by a determination if those impacts would affect minority and low-income populations disproportionately. Analyses of impacts from operating the proposed facility do not indicate high and adverse impacts for any of the other impact areas considered in this EIS (see Section 5.2.2). Despite the presence of disproportionately high percentages of both minority and low-income populations within 50 mi (80 km) of the Paducah site, no environmental justice impacts are anticipated at any of the three alternative locations because of the lack of high and adverse impacts. Similarly, no evidence exists indicating that minority or low-income populations would experience high and adverse impacts from operating the proposed facility in the absence of such impacts in the population as a whole.

5.2.3 Transportation

The action alternatives involve transportation of the conversion products to a disposal site or to commercial users. All products are proposed to be shipped primarily by rail. However, a viable option is to ship some material by truck. For purposes of this EIS, transportation of all cargo is considered for both truck and rail modes of transport. In a similar fashion, conversion products declared to be wastes are expected to be sent to Envirocare in Utah for disposal; another viable option is to send the wastes to the NTS. Thus, both options are evaluated. The emptied heel cylinders, if not used as disposal containers for the U_3O_8 product, would be crushed and shipped in 20-ft (6-m) cargo containers, approximately 10 to a container. However, up to 10% of these cylinders might not meet Envirocare acceptance criteria and would be shipped “as is” to NTS for disposal (UDS 2003b). The HF is expected to be produced in concentrations of both 49% and 70%. Thus, the total impacts for HF transportation are the sum of the impacts presented for each concentration.

As discussed in Appendix F, Section F.3, the impacts of transportation were calculated in three areas: (1) collective population risks during routine conditions and accidents (Section 5.2.3.1), (2) radiological risks to MEIs during routine conditions (Section 5.2.3.2), and (3) consequences to individuals and populations after the most severe accidents involving a release of radioactive or hazardous chemical material (Section 5.2.3.3).

5.2.3.1 Collective Population Risk

The collective population risk is a measure of the total risk posed to society as a whole by the actions being considered. For a collective population risk assessment, the persons exposed are considered as a group, without specifying individual receptors. The collective population risk is used as the primary means of comparing various options. Collective population risks are calculated for both vehicle- and cargo-related causes for routine transportation and accidents. Vehicle-related risks are independent of the cargo in the shipment and include risks from vehicular exhaust emissions and traffic accidents (fatalities caused by physical trauma).

Under the action alternatives, anhydrous NH_3 would be transported to the conversion facility for generation of hydrogen, which would be used in the conversion process. Collective population risks associated with the transport of NH_3 to the site are shown in Table 5.2-20 for three different distances between the origin of NH_3 and the site. By assuming a distance of 620 mi (1,000 km) from the site and using average accident rates and population densities, the number of adverse effects that would be expected among the crew and the population along the transportation route would be about 10 for the truck option and about 2 for the rail option. For the same distance, it is expected that there would be about 1 irreversible adverse effect for the

TABLE 5.2-20 Collective Population Transportation Risks for Shipment of Anhydrous NH_3 to the Paducah Conversion Facility

	Distance to Conversion Facility (km)		
Mode	250	1,000	5,000
Truck Option			
Shipment summary			
Number of shipments	1,300	1,300	1,300
Total distance (km)	324,000	1,296,000	6,480,000
Cargo-related[a]			
Chemical impacts			
Adverse effects	2.4	9.7	49
Irreversible adverse effects	0.36	1.4	7.1
Vehicle-related[b]			
Emission fatalities	0.03	0.1	0.6
Accident fatalities	0.0048	0.019	0.097
Rail Option			
Shipment summary			
Number of shipments	648	648	648
Total distance (km)	162,000	648,000	3,240,000
Cargo-related[a]			
Chemical impacts			
Adverse effects	0.53	2.1	11
Irreversible adverse effects	0.076	0.3	1.5
Vehicle-related[b]			
Emission fatalities	0.002	0.007	0.03
Accident fatalities	0.013	0.051	0.25

[a] Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

[b] Vehicle-related impacts are impacts independent of the cargo in the shipment.

truck option and less than 1 irreversible adverse effect for the rail option. No fatalities would be expected for either transportation mode. As indicated on Table 5.2-20, the risks would be smaller for distances less than 620 mi (1,000 km) and higher for greater distances.

The transportation assessment for the shipment of depleted uranium conversion products for disposal considers several options. The proposed disposal site is the Envirocare facility. (A small number of empty cylinders may require disposal at NTS.) For shipments to Envirocare, rail is evaluated as the proposed mode and truck is evaluated as an alternative. In addition, NTS is considered as an alternative disposal site. For this alternative, both truck and rail modes are evaluated, although neither is currently proposed.

For assessment of the rail option to NTS, it is assumed that a rail spur that would be built in the future would provide rail access to NTS. Currently, the nearest rail terminal is about 70 mi (113 km) from NTS. If a rail spur was not available in the future and if NTS was selected as the disposal site, shipments could be made by truck, or rail could be used with an intermodal transfer to trucks at some place near NTS. (Transportation impacts for the intermodal option would be slightly greater than those presented for rail assuming NTS rail access, but less than those presented for the truck alternative.) If a rail spur was built to NTS, the impacts would require additional NEPA review.

Estimates of the collective population risks for shipment of the U_3O_8 product, emptied cylinders, and CaF_2 to Envirocare over the entire 25-year operational period are presented in Table 5.2-21, assuming the U_3O_8 was shipped in bulk bags. As an option, risks for the shipment of these materials to NTS are provided in Table 5.2-22. No radiological LCFs, traffic fatalities, or emission fatalities are expected for rail transport under either option. No radiological LCFs would be expected for the truck option either. However, approximately 1 traffic fatality might occur, and up to 11 fatalities from vehicle emissions might occur over the project period if the truck option was used.

If the emptied DUF_6 cylinders were refilled with the U_3O_8 product and used to transport the product to the disposal facility, as proposed, the risks shown in Tables 5.2-21 and 5.2-22 for transportation of emptied cylinders would not be applicable, and the risks associated with transportation of CaF_2 would be the same. The risks of transporting the U_3O_8 product in cylinders would be about the same as the sum of risks for transporting the product in bulk bags and the risk of shipping the crushed cylinders for the truck option (Table 5.2-23) with two refilled cylinders per truck. If one cylinder per truck were shipped, routine risks to the crew and vehicle-related risks would be approximately double, because the number of shipments would double. If the rail option was used, the risks would be slightly higher for the cylinder refill option primarily because the quantity of U_3O_8 shipped in a single railcar would be less under the cylinder refill option than under the use of the bulk bag option, and the number of shipments would be proportionally higher.

The risks for shipping the HF co-product are presented in Table 5.2-24 for representative shipment distances of 250, 1,000, and 5,000 km (155, 620, and 3,100 mi), by using U.S. average accident rates and population densities. For shipment distances up to 5,000 km (3,107 mi), 1 traffic fatality is expected for shipment of the HF by either truck or rail; however, up to 7 emission fatalities could occur for shipment by truck, with none expected for rail shipments. For chemical risks, approximately 2 irreversible adverse effects are estimated for either truck or rail transport. Thus, no chemical fatalities are expected because approximately 1% of the cases with irreversible adverse effects are expected to result in fatality (Policastro et al. 1997). Table 5.2-25 presents the risks associated with the shipment of CaF_2 to either Envirocare or NTS should the HF be neutralized and disposed of as waste, as discussed in Section 5.2.4. Shipment of the CaF_2 to either Envirocare or NTS would have similar impacts; approximately 10 emission fatalities for truck and 0 for rail, and about 2 traffic fatalities for shipment by truck.

TABLE 5.2-21 Collective Population Transportation Risks for Shipment of Conversion Products to Envirocare as the Primary Disposal Site, Assuming the U_3O_8 Is Disposed of in Bulk Bags

	U_3O_8		Emptied Cylinders				CaF_2	
	Paducah to Envirocare		Paducah to Envirocare[a]		Paducah to NTS[b]		Paducah to Envirocare	
Mode	Truck (option)	Rail (proposed)[c]	Truck (option)	Rail (proposed)[c]	Truck (proposed)	Rail (option)[c]	Truck (option)	Rail (proposed)[c]
Shipment summary								
Number of shipments	16,420	4,105	3,715	1,858	4,150	1,038	28	7
Total distance (km)	41,710,000	11,010,000	9,436,000	4,985,000	11,690,000	3,559,000	71,120	18,780
Cargo-related[d]								
Radiological impacts								
Dose risk (person-rem)								
Routine crew	240	560	55	140	120	270	NA[e]	NA
Routine public								
Off-link	4.3	11	1.1	2.7	1.7	4.6	NA	NA
On-link	12	0.35	3.1	0.085	4.4	0.16	NA	NA
Stops	97	9.5	26	2.3	36	4.6	NA	NA
Total	110	21	30	5.1	42	9.4	NA	NA
Accident[f]	35	9.9	0.35	0.076	0.02	0.0085	NA	NA
Latent cancer fatalities[g]								
Crew fatalities	0.1	0.2	0.02	0.06	0.05	0.1	NA	NA
Public fatalities	0.07	0.02	0.02	0.003	0.02	0.005	NA	NA
Chemical impacts								
Adverse effects	0.002	0.0004	NA	NA	NA	NA	NA	NA
Irreversible adverse effects	0.0002	0.0001	NA	NA	NA	NA	NA	NA
Vehicle-related[h]								
Emission fatalities	8	0.2	2	0.1	2	0.06	0.01	0.0004
Accident fatalities	1.0	0.24	0.23	0.11	0.27	0.08	0.0018	0.00041

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TABLE 5.2-21 (Cont.)

[a] Emptied cylinders are crushed and shipped 10 per cargo container, with 1 container per truck or 2 containers per railcar.

[b] Cylinders assumed not to meet the waste acceptance criteria for Envirocare. Shipped “as is,” one per truck or four per railcar.

[c] Risks are presented on a railcar basis. One shipment is equivalent to one railcar. For assessment purposes, it was assumed that rail access to NTS would be available in the future.

[d] Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

[e] NA = not applicable.

[f] Dose risk is a societal risk and is the product of accident probability and accident consequence.

[g] Latent cancer fatalities were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public (ICRP 1991).

[h] Vehicle-related impacts are impacts independent of the cargo in the shipment.

TABLE 5.2-22 Collective Population Transportation Risks for Shipment of Conversion Products to NTS as an Optional Disposal Site, Assuming the U_3O_8 Is Disposed of in Bulk Bags

	U_3O_8		Emptied Cylinders				CaF_2	
	Paducah to NTS		Paducah to NTS[a]		Paducah to NTS[b]		Paducah to Envirocare	
Mode	Truck (option)	Rail (option)[c]	Truck (option)	Rail (option)[c]	Truck (option)	Rail (option)[c]	Truck (option)	Rail (option)[c]
Shipment summary								
Number of shipments	16,420	4,105	3,715	1,858	4,150	1,038	28	7
Total distance (km)	46,240,000	14,080,000	10,460,000	6,371,000	11,690,000	3,559,000	71,120	18,780
Cargo-related[d]								
Radiological impacts								
Dose risk (person-rem)								
Routine crew	270	670	61	170	120	270	NA[e]	NA
Routine public								
Off-link	5.2	11	1.4	2.7	1.7	4.6	NA	NA
On-link	13	0.39	3.6	0.094	4.4	0.16	NA	NA
Stops	110	11	29	2.7	36	4.6	NA	NA
Total	130	22	34	5.4	42	9.4	NA	NA
Accident[f]	14	9.9	0.18	0.076	0.02	0.0085	NA	NA
Latent cancer fatalities[g]								
Crew fatalities	0.1	0.3	0.02	0.07	0.05	0.1	NA	NA
Public fatalities	0.07	0.02	0.02	0.003	0.02	0.005	NA	NA
Chemical impacts								
Adverse effects	0.002	0.0006	NA	NA	NA	NA	NA	NA
Irreversible adverse effects	0.0002	0.0002	NA	NA	NA	NA	NA	NA
Vehicle-related[h]								
Emission fatalities	9	0.2	2	0.1	2	0.06	0.01	0.0004
Accident fatalities	1.1	0.32	0.24	0.14	0.27	0.08	0.0018	0.00041

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TABLE 5.2-22 (Cont.)

[a] Emptied cylinders are crushed and shipped 10 per cargo container, with 1 container per truck or 2 containers per railcar.

[b] Cylinders shipped "as is." One cylinder per truck or four cylinders per railcar.

[c] Risks are presented on a railcar basis. One shipment is equivalent to one railcar. For assessment purposes, it was assumed that rail access to NTS would be available in the future.

[d] Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

[e] NA = not applicable.

[f] Dose risk is a societal risk and is the product of accident probability and accident consequence.

[g] Latent cancer fatalities were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-4} for the public (ICRP 1991).

[h] Vehicle-related impacts are impacts independent of the cargo in the shipment.

TABLE 5.2-23 Collective Population Transportation Risks for Shipment of U_3O_8 Conversion Products in Emptied Cylinders

	Paducah to Envirocare (proposed)			Paducah to NTS (option)		
	Truck (option)			Truck (option)		
Mode	1 Cylinder	2 Cylinders	Rail (proposed)	1 Cylinder	2 Cylinders	Rail (option)[a]
Shipment summary						
Number of shipments	36,200	18,100	7,240	36,200	18,100	7,240
Total distance (km)	91,950,000	45,970,000	19,420,000	101,900,000	50,970,000	24,830,000
Cargo-related[b]						
Radiological impacts						
Dose risk (person-rem)						
Routine crew	490	260	770	540	290	930
Routine public						
Off-link	6.8	6.9	17	8.1	8.3	17
On-link	18	18	0.53	21	21	0.59
Stops	150	150	14	170	170	17
Total	180	180	31	200	200	34
Accident	35	35	9.8	14	14	9.8
Latent cancer fatalities						
Crew fatalities	0.2	0.1	0.3	0.2	0.1	0.4
Public fatalities	0.1	0.1	0.02	0.1	0.1	0.02
Chemical impacts						
Adverse effects	0.001	0.001	0.0005	0.001	0.001	0.0007
Irreversible adverse effects	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Vehicle-related[c]						
Emission fatalities	20	8	0.4	20	10	0.4
Accident fatalities	2.3	1.1	0.42	2.4	1.2	0.56

[a] For assessment purposes, it was assumed that rail access to NTS would be available in the future.

[b] Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

[c] Vehicle-related impacts are impacts independent of the cargo in the shipment.

The results of the transportation analysis discussed above indicate that the largest impact during normal transportation conditions would be associated with vehicle exhaust and fugitive dust emissions (unrelated to the cargo). Health risks from cardiovascular and pulmonary diseases have been linked to incremental increases in particulate concentrations in air. However, estimating the health risks associated with vehicle emissions is subject to a great deal of uncertainty. The estimates presented in this EIS were based on very conservative health risk factors presented in Biwer and Butler (1999) and should be considered an upper bound. For perspective, in a recently published EIS for a geologic repository at Yucca Mountain, Nevada (DOE 2002g), the same risk factors were used for vehicle emissions; however, they were adjusted to reduce the amount of conservatism in the estimated health impacts. As reported in the

TABLE 5.2-24 Collective Population Transportation Risks for Shipment of the HF Conversion Co-Product from the Paducah Site to Commercial Users

	49% HF			70% HF		
Mode	250 km	1,000 km	5,000 km	250 km	1,000 km	5,000 km
Truck Option						
Shipment summary						
Number of shipments	10,867	10,867	10,867	4,430	4,430	4,430
Total distance (km)	2,716,750	10,867,000	54,335,000	1,107,500	4,430,000	22,150,000
Cargo-related[a]						
Chemical impacts						
Adverse effects	0.25	1.0	5.0	0.92	3.7	18
Irreversible adverse effects	0.021	0.085	0.43	0.074	0.30	1.5
Vehicle-related[b]						
Emission fatalities	0.3	1	5	0.1	0.4	2
Accident fatalities	0.04	0.16	0.81	0.017	0.066	0.33
Rail Option						
Shipment summary						
Number of shipments	2,174	2,174	2,174	886	886	886
Total distance (km)	543,500	2,174,000	10,870,000	221,500	886,000	4,430,000
Cargo-related[a]						
Chemical impacts						
Adverse effects	0.35	1.4	7.0	0.89	3.5	18
Irreversible adverse effects	0.022	0.088	0.44	0.073	0.29	1.5
Vehicle-related[b]						
Emission fatalities	0.005	0.02	0.1	0.002	0.009	0.04
Accident fatalities	0.043	0.17	0.85	0.017	0.069	0.35

[a] Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

[b] Vehicle-related impacts are impacts independent of the cargo in the shipment.

TABLE 5.2-25 Collective Population Transportation Risks for Shipment of CaF_2 for the Neutralization Option

Parameter	Truck (option)	Rail (proposed)
Number of shipments	25,262	6,316
Paducah to Envirocare Option		
Total distance (km)	64,170,000	16,950,000
Emission fatalities	10	0.4
Accident fatalities	1.6	0.37
Paducah to NTS Option		
Total distance (km)	71,140,000	21,660,000
Emission fatalities	10	0.4
Accident fatalities	1.6	0.49

Yucca Mountain EIS, the adjustments resulted in a reduction in the emission risks by a factor of about 30.

5.2.3.2 Maximally Exposed Individuals during Routine Conditions

During the routine transportation of radioactive material, specific individuals may be exposed to radiation in the vicinity of a shipment. RISKIND (Yuan et al. 1995) has been used to estimate the risk to these individuals for a number of hypothetical exposure-causing events. The receptors include transportation crew members, inspectors, and members of the public exposed during traffic delays, while working at a service station, or while living near an origin or a destination site. The assumptions about exposure are given in Biwer et al. (2001). The scenarios for exposure are not meant to be exhaustive; they were selected to provide a range of representative potential exposures. Doses were assessed and are presented in Table 5.2-26 on a per-event basis for the shipments of U_3O_8 and emptied cylinders with heels.

The highest potential routine radiological exposure to an MEI, with an LCF risk of 2×10^{-7}, would be for a person stopped in traffic near a rail shipment of 4 heel cylinders for 30 minutes at a distance of 3 ft (1 m). There is also the possibility for multiple exposures. For example, if an individual lived near the Paducah site and all shipments of U_3O_8 were made by rail in bulk bags, the resident could receive a combined dose of approximately 4.5×10^{-5} rem if present for all shipments (calculated as the product of 4,105 shipments and an estimated exposure per shipment of 1.1×10^{-8} rem). The individual's dose would increase by approximately a factor of 2 if the U_3O_8 product would be shipped in refilled cylinders. However, this dose is still very low, more than 3,000 times lower than the individual average annual exposure of 0.3 rem from natural background radiation.

5.2.3.3 Accident Consequence Assessment

Whereas the collective accident risk assessment considers the entire range of accident severities and their related probabilities, the accident consequence assessment assumes that an accident of the highest severity category has occurred. The consequences, in terms of committed dose (rem) and LCFs for radiological impacts and in terms of adverse affects and irreversible adverse effects for chemical impacts, were calculated for both exposed populations and individuals in the vicinity of an accident. Tables 5.2-27 and 5.2-28 present the radiological and chemical consequences, respectively, to the population from severe accidents involving shipment of depleted U_3O_8, emptied heel cylinders, anhydrous NH_3, and aqueous HF. No LCFs would be expected for accidents involving heel cylinders; however, up to 3 LCFs might occur following a severe urban rail accident involving a railcar of U_3O_8. Severe rail accidents could have higher consequences than truck accidents because each railcar would carry more material than each truck.

A comparison of Tables 5.2-27 and 5.2-28 indicates that severe accidents involving chemicals transported to and from the conversion facility site could have higher consequences

TABLE 5.2-26 Estimated Radiological Impacts to the MEI from Routine Shipment of Radioactive Materials from the Paducah Conversion Facility

Material	Mode	Inspector	Resident	Person in Traffic	Person at Gas Station	Person near Rail Stop
Routine Radiological Dose from a Single Shipment (rem)						
Depleted U_3O_8 (in bulk bags)[a]	Truck	4.0×10^{-5}	3.1×10^{-9}	1.6×10^{-4}	4.4×10^{-6}	NA[b]
	Rail	9.3×10^{-5}	1.1×10^{-8}	2.7×10^{-4}	NA	6.9×10^{-7}
Crushed heel cylinders[c]	Truck	5.3×10^{-5}	5.7×10^{-9}	1.6×10^{-4}	7.7×10^{-6}	NA
	Rail	6.6×10^{-5}	9.4×10^{-9}	1.7×10^{-4}	NA	6.1×10^{-7}
Heel cylinders[d]	Truck	6.8×10^{-5}	5.4×10^{-9}	2.7×10^{-4}	7.5×10^{-6}	NA
	Rail	1.5×10^{-4}	2.0×10^{-8}	4.0×10^{-4}	NA	1.3×10^{-6}
Routine Radiological Risk from a Single Shipment (lifetime risk of a LCF)[e]						
Depleted U_3O_8 (in bulk bags)	Truck	2×10^{-8}	2×10^{-12}	8×10^{-8}	2×10^{-9}	NA
	Rail	5×10^{-8}	6×10^{-12}	1×10^{-7}	NA	4×10^{-10}
Crushed heel cylinders[c]	Truck	3×10^{-8}	3×10^{-12}	8×10^{-8}	4×10^{-9}	NA
	Rail	3×10^{-8}	5×10^{-12}	8×10^{-8}	NA	3×10^{-10}
Heel cylinders[d]	Truck	3×10^{-8}	3×10^{-12}	1×10^{-7}	4×10^{-9}	NA
	Rail	7×10^{-8}	1×10^{-11}	2×10^{-7}	NA	6×10^{-10}

[a] Per-shipment doses and LCFs would be approximately the same as for the cylinder refill option.

[b] NA = not applicable.

[c] Crushed heel cylinders are shipped 10 cylinders per cargo container, with 1 container per truck or 2 containers per railcar.

[d] Shipped "as is," one cylinder per truck or four cylinders per railcar.

[e] LCFs were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

than radiological accidents. For example, a severe rail accident involving transportation of anhydrous NH_3 to a site in an urban area under stable weather conditions could lead to 5,000 irreversible adverse effects. Among the individuals experiencing these irreversible effects, there could be close to 100 fatalities (about 2% of the irreversible adverse effects [Policastro et al. 1997]). Similarly, a 70% aqueous HF rail accident under the same conservative assumptions could result in approximately 1,800 irreversible adverse effects and 18 fatalities (about 1% of the irreversible adverse effects [Policastro et al. 1997]). As indicated in Table 5.2-28, the consequences would be considerably less if the accident occurred in a less populated area under neutral meteorological conditions. Consequences would also be less if a truck was involved in the accident rather than a railcar because the truck would carry less material than a railcar.

TABLE 5.2-27 Potential Radiological Consequences to the Population from Severe Transportation Accidents[a]

		Neutral Meteorological Conditions			Stable Meteorological Conditions		
Material	Mode	Rural	Suburban	Urban[b]	Rural	Suburban	Urban[b]
Radiological Dose (person-rem)							
Depleted U_3O_8 (in bulk bags)	Truck	250	250	550	630	610	1,400
	Rail	1,000	990	2,200	2,500	2,400	5,400
Depleted U_3O_8 (1 cylinder)	Truck	120	110	250	280	280	620
	Rail	290	280	630	710	690	1,500
Depleted U_3O_8 (2 cylinders)	Truck	230	230	500	570	550	1,200
	Rail	580	560	1,300	1,400	1,400	3,100
Crushed heel cylinders[c]	Truck	2.5	0.67	1.5	4.4	1.2	2.6
	Rail	5	1.3	3	8.7	2.3	5.2
Heel cylinders[d]	Truck	0.25	0.067	0.15	0.44	0.12	0.26
	Rail	1	0.27	0.6	1.7	0.47	1
Radiological Risk (LCF)[e]							
Depleted U_3O_8 (in bulk bags)	Truck	0.1	0.1	0.3	0.3	0.3	0.7
	Rail	0.5	0.5	1	1	1	3
Depleted U_3O_8 (1 cylinder)	Truck	0.06	0.06	0.1	0.1	0.1	0.3
	Rail	0.1	0.1	0.3	0.4	0.3	0.8
Depleted U_3O_8 (2 cylinders)	Truck	0.1	0.1	0.3	0.3	0.3	0.6
	Rail	0.3	0.3	0.6	0.7	0.7	2
Crushed heel cylinders[c]	Truck	0.001	0.0003	0.0007	0.002	0.0006	0.001
	Rail	0.002	0.0007	0.001	0.004	0.001	0.003
Heel cylinders[d]	Truck	0.0001	3×10^{-5}	7×10^{-5}	0.0002	6×10^{-5}	0.0001
	Rail	0.0005	0.0001	0.0003	0.0009	0.0002	0.0005

[a] National average population densities were used for the accident consequence assessment, corresponding to densities of 6 persons/km^2, 719 persons/km^2, and 1,600 persons/km^2 for rural, suburban, and urban zones, respectively. Potential impacts were estimated for the population within a 50-mi (80-km) radius, assuming a uniform population density for each zone.

[b] It is important to note that the urban population density generally applies to a relatively small urbanized area; very few, if any, urban areas have a population density as high as 1,600 persons/km^2, extending as far as 50 mi (80-km). The urban population density corresponds to approximately 32 million people within the 50-mi (80-km) radius, well in excess of the total populations along the routes considered in this assessment.

[c] Crushed heel cylinders are shipped 10 cylinders per cargo container, with 1 container per truck or 2 containers per railcar.

[d] Shipped “as is,” one cylinder per truck or four cylinders per railcar.

[e] LCFs were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

TABLE 5.2-28 Potential Chemical Consequences to the Population from Severe Transportation Accidents[a]

Chemical Effect	Mode	Neutral Meteorological Conditions			Stable Meteorological Conditions		
		Rural	Suburban	Urban[b]	Rural	Suburban	Urban[b]
Number of Persons with the Potential for Adverse Health Effects							
Depleted U_3O_8 (in bulk bags)	Truck	0	1	1	0	12	28
	Rail	0	3	9	0	47	103
Depleted U_3O_8 (in cylinders)	Truck (1 cylinder)	0	0	1	0	6	13
	Truck (2 cylinders)	0	1	1	0	11	26
	Rail	0	2	5	0	27	58
Anhydrous NH_3	Truck	6	710	1,600	55	6,600	15,000
	Rail	10	1,100	2,500	90	11,000	24,000
49% HF	Truck	0.35	42	93	3.4	400	900
	Rail	0.99	120	270	7.3	880	1,900
70% HF	Truck	2.8	340	760	44	5,200	12,000
	Rail	9.3	1,100	2,500	110	14,000	30,000
Number of Persons with the Potential for Irreversible Adverse Health Effects[c]							
Depleted U_3O_8 (in bulk bags)	Truck	0	0	0	0	5	10
	Rail	0	0	0	0	17	38
Depleted U_3O_8 (in cylinders)	Truck (1 cylinder)	0	0	0	0	2	5
	Truck (2 cylinders)	0	0	0	0	4	8
	Rail	0	1	1	0	10	22
Anhydrous NH_3	Truck	0.8	100	200	10	1,000	3,000
	Rail	1	200	400	20	2,000	5,000
49% HF	Truck	0.025	3.0	6.6	0.25	30	66
	Rail	0.081	9.7	22	0.62	74	160
70% HF	Truck	0.23	27	60	2.0	240	540
	Rail	0.77	92	210	6.7	800	1,800

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TABLE 5.2-28 (Cont.)

[a] National average population densities were used for the accident consequence assessment, corresponding to densities of 6 persons/km^2, 719 persons/km^2, and 1,600 persons/km^2 for rural, suburban, and urban zones, respectively. Potential impacts were estimated for the population within a 50-mi (80-km) radius, assuming a uniform population density for each zone.

[b] It is important to note that the urban population density generally applies to a relatively small urbanized area — very few, if any, urban areas have a population density as high as 1,600 persons/km^2 extending as far as 50 mi (80 km). The urban population density corresponds to approximately 32 million people within the 50-mi (80-km) radius, well in excess of the total populations along the routes considered in this assessment.

[c] The potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in fatality to approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997). Exposure to anhydrous NH_3 is estimated to result in fatality to approximately 2% of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

Accidents for which consequences are provided in Tables 5.2-27 and 5.2-28 are extremely rare. For example, the average accident rate for interstate-registered heavy combination trucks is approximately 3.0×10^{-7} per kilometer (Saricks and Tompkins 1999). The conditional probability that a given accident would be a severe accident is on the order of 0.06 in rural and suburban areas and about 0.007 in urban areas (NRC 1977). Therefore, the frequency of a severe accident per kilometer of travel in an urban area is about 2×10^{-9}. For shipment of NH_3 to the site, the total distance traveled is estimated to be about 808,000 mi (1,300,000 km) if the NH_3 was transported from a location 620 mi (1,000 km) away from the conversion site (Table 5.2-20). The fraction of the distance traveled in urban areas is generally less than 5% (DOE 2002f, Table 6.10). If 5% is assumed, the total distance traveled in urban areas would be about 40,000 mi (65,000 km). On the basis of these assumptions, over the life of the project, the probability of a severe NH_3 truck accident occurring in an urban area is about 1×10^{-4} (1 chance in 10,000). In general, stable weather conditions occur only about one-third of the time, resulting in a probability for the most severe anhydrous NH_3 accident listed in Table 5.2-28 of about 4×10^{-5} (or a 1-in-25,000 chance of occurrence) during the 25-year operational period. Similarly, for shipment of 70% HF 620 mi (1,000 km) from the site, the total distance traveled is estimated to be 3,000,000 mi (4,430,000 km) (Table 5.2-24). The average distance traveled in urban areas would be about 137,000 mi (220,000 km [4,430,000 × 0.05]). Therefore, the probability of a severe 70% HF truck accident occurring in an urban area under stable meteorological conditions is about 1×10^{-4} (or a 1-in-10,000 chance of occurrence) over the 25-year operational period.

The probability of a rail accident involving anhydrous NH_3 or 70% HF of the kind listed in Table 5.2-28 is even less than 4×10^{-5} and 1×10^{-4}, respectively, over the 25-year operational period, because the accident rates for railcars are lower and the total distance travelled by train is less. In fact, the probabilities of severe rail accidents for the same origin-destination pairs and for transportation of the same cargo are approximately 10 to 20 times less than the probabilities for severe truck accidents. As stated above, this can be attributed to train accident rates being about

5 times less (see Table 6 in Saricks and Tompkins 1999), and the total distance traveled by train being generally about 2 to 4 times shorter.

Conservative estimates of consequences to the MEI located 100 ft (30 m) away from the accident site along the transportation route are also made for shipment of depleted U_3O_8, emptied heel cylinders (assuming they are not used as containers for depleted U_3O_8), anhydrous NH_3, and aqueous HF. The results for radiological impacts are shown in Table 5.2-29. Under the conservative assumptions described above for consequences to the population, it is estimated that the MEI could receive up to 1.3 rem from accidents involving emptied cylinders. However, for shipment of the depleted U_3O_8 product by train, the MEI could receive a dose as high as 670 rem if the product was shipped in bulk bags, and 380 rem if it was shipped in emptied DUF_6 cylinders. For shipment by truck, the MEI dose would be 170 rem with bulk bags and 150 rem with refilled cylinders, assuming 2 cylinders per truck. The dose received by the individual would decrease quickly as the person's distance from the accident site increased. For example, at a distance of 330 ft (100 m), the dose would be reduced by about a factor of 6 (to about 110 rem and 60 rem for train accidents with bulk bags and refilled cylinders, respectively, and to about 28 rem and 25 rem for truck accidents with bulk bags and refilled cylinders, respectively.) If the person was located at a distance of 100 ft (30 m) and if the accident occurred under the most severe conditions described above, the individual could suffer acute and potentially lethal consequences from both radiation exposure and the chemical effects of uranium. However, if the MEI was 330 ft (100 m) or farther from the accident, the individual would not be expected to suffer acute effects. However, the chance of the MEI developing a latent cancer would increase by about 10% for the train accident and about 3% for the truck accident. For accidents involving anhydrous NH_3 and aqueous HF, the MEI would likely experience an irreversible health effect or death depending on the severity of the accident, weather conditions, and distance at the time of the accident.

Even though the risks are relatively low (because of low probability of occurrence), the consequences of a few of the transportation accidents considered would be high if they did occur. These high-consequence accidents are generally associated with the transportation of anhydrous NH_3 to the site and aqueous HF from the site. The consequences could be reduced or mitigated through design (e.g., limiting the quantity of material per vehicle), operational procedures (e.g., judicial selection of routes and times of travel, increased protection and tracking of transport vehicles), and emergency response actions (e.g., sheltering, evacuation, and interdiction of contaminated food materials following an accident).

5.2.3.4 Historical Safety Record of Anhydrous NH_3 and HF Transportation in the United States

Anhydrous NH_3 is routinely shipped commercially in the United States for industrial and agricultural applications. Information provided in the DOT *Hazardous Material Incident System (HMIS) Database* (DOT 2003b) for 1990 through 2002 indicates that 2 fatalities and 19 major injuries to the public or to transportation or emergency response personnel occurred as a result of

TABLE 5.2-29 Potential Radiological Consequences to the MEI from Severe Transportation Accidents Involving Shipment of Radioactive Materials

	Neutral Weather Conditions		Stable Weather Conditions	
Mode	Dose (rem)	Radiological Risk (LCF)[a]	Dose (rem)	Radiological Risk (LCF)[a]
Depleted U_3O_8 (in bulk bags)				
Truck	11	0.005	170[b]	0.08
Rail	42	0.02	670[b]	0.3
Depleted U_3O_8 (1 cylinder)				
Truck	4.8	0.002	76	0.04
Rail	12	0.006	190	0.09
Depleted U_3O_8 (2 cylinders)				
Truck	9.6	0.005	150[b]	0.08
Rail	24	0.01	380[b]	0.2
Crushed heel cylinders[c]				
Truck	0.28	0.0001	0.63	0.0003
Rail	0.55	0.0003	1.3	0.0006
Heel cylinders[d]				
Truck	0.028	1×10^{-5}	0.063	3×10^{-5}
Rail	0.11	6×10^{-5}	0.25	0.0001

a LCFs were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

b See text for discussion. Because of the conservative assumptions made in deriving the numbers in this table, the MEI is likely to receive a dose that is less than that shown here. However, if the doses were as high as those shown in the table, the MEI could develop acute radiation effects. The individual might also suffer from chemical effects due to uranium intake.

c Crushed heel cylinders are shipped 10 cylinders per cargo container, with 1 container per truck or 2 containers per railcar.

d Shipped "as is," one cylinder per truck or four cylinders per railcar.

anhydrous NH_3 releases during truck and rail operations. These fatalities and injuries occurred during transportation or loading and unloading operations. Over that period, truck and rail NH_3 spills resulted in more than 1,000 and 6,000 evacuations, respectively. Five very large spills, greater than 10,000 gal (38,000 L), occurred; however, these spills were en route derailments from large rail tank cars. The two largest spills, both around 20,000 gal (76,000 L), occurred in rural or lightly populated areas of Texas and Idaho and resulted in 1 major injury. The Idaho spill in 1990 required the evacuation of 200 people. For highway shipments, one truck transport and 3 loading/unloading accidents occurred that involved large anhydrous NH_3 spills of between 4,000 and 8,000 gal (15,000 and 30,000 L). The 1 en route truck accident involving the largest truck spill (in Iowa on May 3, 1996) resulted in 1 fatality and the evacuation of 40 people. The other 3 large truck shipment spills occurred during loading/unloading operations but did not result in any fatalities. However, one of the spills involved a major injury and required the evacuation of 14 people in addition to the treatment of 26 with minor injuries.

Over the past 30 years, the safety record for transporting anhydrous NH_3 has significantly improved as a result of several factors. Hazardous compressed gas truck shipment loading and unloading operations require strict conformance with DOT standards for safety valve design and specifications in addition to requirements on the installation of measuring and sampling devices. Federal rules governing the transportation of hazardous materials (49 CFR 173) require that valves installed for tank venting, loading, and unloading operations must be "of approved design, made of metal not subject to rapid deterioration by the lading, and must withstand the tank test pressure without leakage." The MC331 compressed gas tanker trucks, which would most likely be used to ship anhydrous NH_3 to the DUF_6 conversion facility, must be equipped with check valves to prevent the occurrence of a large spill (e.g., a spill from a feed line disconnection during a loading operation). These valves are typically located near the front end of a MC331 tanker truck and close to the driver's cab. Although not specifically required by DOT regulations, excess flow valves may be installed to prevent a catastrophic spill in the event that the driver is unable to reach the manual check valve to cut off flow from a failed feed line or loading tank valve. Safety measures contributing to the improved safety record over the past 30 years include the installation of protective devices on railcars, fewer derailments, closer manufacturer supervision of container inspections, and participation of shippers in the Chemical Transportation Emergency Center.

Most of the HF transported in the United States is anhydrous HF, which is more hazardous than the aqueous HF. Since 1971, which is the period covered by DOT records (DOT 2003b), no fatal or serious injuries to the public or to transportation or emergency response personnel have occurred as a result of anhydrous HF releases during transportation. Over the period 1971 to 2003, 11 releases from railcars were reported to have no evacuations or injuries associated with them. The only major release (estimated at 6,400 lb [29,000 kg] of HF) occurred in 1985 and resulted in approximately 100 minor injuries. Another minor HF release during transportation occurred in 1990. The safety record for transporting HF has improved in the past 10 years for the same reasons discussed above for NH_3.

5.2.4 Impacts Associated with HF and CaF_2 Conversion Product Sale and Use

During the conversion of the DUF_6 inventory to depleted uranium oxide, products having some potential for reuse would be produced. These products would include HF and CaF_2, which are commonly used as commercial materials. An analysis of impacts associated with the potential reuse of HF and CaF_2 has been included as part of this EIS. Areas examined include the characteristics of these materials as produced within the conversion process, the current markets for these products, and the potential socioeconomic impacts within the United States if the products were sold. Because there would be some residual radioactivity associated with these materials, a description of the DOE process for authorizing the release of contaminated materials for unrestricted use (referred to as "free release") and a bounding estimate of the potential human health effects of such free release have also been included in the analysis. Details on the analysis are presented in Appendix E and are summarized below.

One of the chemicals produced during conversion would be an aqueous HF-water solution of approximately 55% strength. The predominate markets for HF acid call for 49% and 70% HF solutions; thus, this product would be further processed to yield these strengths. In the preferred design, a small amount of solid CaF_2 would also be produced.

Table 5.2-30 gives the approximate quantities of HF and CaF_2 that would be produced annually in the preferred designs. The quantities in Table 5.2-30 are based on the assumption that there would be a viable economic market for the aqueous HF produced. If such a market did not exist, UDS proposes that it would convert all of the HF to CaF_2 and then either sell this product or dispose of it as LLW or as solid waste. The approximate quantity of CaF_2 produced in this scenario would be 11,800 t (13,000 tons).

Because it is expected that the UDS-produced HF and CaF_2 would contain small amounts of volumetrically distributed residual radioactive material, neither could be sold for unrestricted use, and CaF_2 could not be disposed of as solid waste unless DOE established authorized limits for radiological contamination in HF and CaF_2. UDS will be required to apply for appropriate authorized limits, according to whether the HF and CaF_2 were sold or CaF_2 was disposed of as solid waste. In this context, authorized limits would be the maximum concentrations of radioactive contaminants allowed to remain volumetrically distributed within the HF and CaF_2 being sold. The dose analysis presented in this EIS was not conducted to establish authorized limits.

TABLE 5.2-30 Products from DUF_6 Conversion (t/yr)

Product	Portsmouth	Paducah	Total
Depleted uranium oxide	10,700	14,300	25,000
HF acid (55% solution)	8,200	11,000	19,300
CaF_2	18	24	42

Estimates of the potential, bounding exposure for a hypothetical worker working in close proximity to an HF storage tank were made under very conservative assumptions. The estimated annual exposure under such extreme conditions is 0.034 mrem/yr. Similar bounding estimates of the exposure to a worker in close proximity to a CaF_2 handling process yielded an estimate of 0.23 mrem/yr. The bounding exposure to HF resulted from external radiation and inhalation. For CaF_2, in addition to external radiation and inhalation, the bounding exposure also resulted from an assumed incidental ingestion. Given more realistic exposure conditions, the potential dose would be much smaller than the bounding estimates. Potential exposures to product users would be much smaller than those to workers. Detailed discussions on the assumptions for bounding exposures are provided in Appendix E.

Socioeconomic impact analyses were conducted to evaluate the impacts of the introduction of the UDS-produced HF or CaF_2 into the commercial marketplace. The current aqueous HF acid producers have been identified as a potential market for the aqueous HF (UDS 2003a), with UDS-produced aqueous HF replacing some or all of current U.S. production. The impact of HF sales on the local economy in which the existing producers were located and on the U.S. economy as a whole would likely be minimal.

No market for the 22,000 t (24,251 tons) of CaF_2 that might be produced in the proposed conversion facilities at Paducah and Portsmouth has been identified (UDS 2003a). Should such a market be found, the impact of CaF_2 sales on the U.S. economy is likely to be minimal.

In the event that no market for either HF or CaF_2 is established, the HF would be neutralized in a process that would produce additional CaF_2. It is likely that the CaF_2 would be disposed of as waste. This would require shipping it to an approved solid waste or LLW disposal facility. While disposal activities would produce a small number of transportation jobs and might lead to additional jobs at the waste disposal facility, the impact of these activities in the transportation corridors, at the waste disposal site(s), and on the U.S. economy would be minimal.

5.2.5 Impacts If ETTP Cylinders Are Shipped to Paducah Rather Than to Portsmouth

Current DOE plans call for the cylinders stored at ETTP to be shipped to Portsmouth. However, the option of sending the ETTP cylinders to Paducah for conversion is considered in this section. If the ETTP DUF_6 cylinders were converted at Paducah, the Paducah facility would have to operate an additional 3 years, resulting in a total operational period of 28 years. Potential environmental impacts associated with conversion facility operations, cylinder preparation activities at ETTP, and transportation of the cylinders to Paducah are discussed below.

5.2.5.1 Construction and Operation Impacts

If the ETTP cylinders were shipped to Paducah rather than to Portsmouth, the Paducah facility would have to operate an additional 3 years, resulting in a total operational period of 28 years. Facility construction impacts would be the same as those discussed in Section 5.2.1.

The annual operational impacts would be the same as those described in Section 5.2.2 because the facility throughput would be the same; however, impacts would occur over the additional 3 years necessary to process the ETTP DUF_6 cylinders. The shipment of the cylinders to Paducah would result in some incremental increase in the annual radiation dose to workers, as described below.

The involved workers in the cylinder yards would need to unload the cylinders arriving from ETTP, inspect them, transfer them to cylinder yards, and put them into storage. Regular cylinder maintenance activities would be performed until they are transferred to the conversion facility. The shipment of ETTP cylinders to Paducah could last up to 6 years (from 2004 up to December 2009, when all the cylinders need to be removed from ETTP). However, for the purpose of analysis and to provide bounding estimates of annual impacts, it is assumed that the duration of the shipment campaign would be 2 years. Worker exposure at the cylinder yards would increase significantly for the first 2 years because of the handling of ETTP cylinders. It then would decrease steadily but would be slightly greater than that presented in Section 5.2.1.1 because of maintaining the additional ETTP cylinders.

Potential radiation exposures for handling the arriving cylinders were estimated using the following assumptions: (1) unloading a cylinder would require 2 workers to each work half an hour at a distance of 3 ft (1 m) from the cylinder; (2) inspecting a cylinder would require 2 workers to each work half an hour at a distance of 1 ft (0.30 m) from the cylinder; (3) each shipment to the cylinder yard would require 2 workers for about half an hour at a distance of 6 ft (2 m) from the cylinders; and (4) placing each cylinder to its storage position would require 2 workers to each work half an hour at a distance of 3 ft (1 m) from the cylinder. These assumptions were developed for the purpose of modeling potential radiation exposures; in actuality, the number of workers required and the exposure duration of each activity could be less. The collective exposure from handling all the ETTP cylinders was estimated to be about 12.3 person-rem. Distributing it evenly among the 8 workers for 2 years would result in an extra exposure of 770 mrem/yr for each worker.

Because the number of ETTP cylinders is about 12% of the number of Paducah cylinders, potential radiation exposure from routine maintenance activities was assumed to increase by the same percentage. Annual radiation exposure from preparing and transferring cylinders to the conversion facility would not be affected because the cylinder processing rate would stay the same.

Combining the above assumptions, the potential average radiation exposure of the cylinder yard workers would be about 1,460 mrem/yr for the first 2 years. It then would drop from 720 mrem/yr to 430 mrem/yr steadily for the rest of the 26 years. The maximum average cancer risk for individual workers would be less than 6×10^{-4}/yr (1 chance in 1,600 of developing 1 LCF each year). Considering the conservative assumptions used to estimate the potential exposures, actual worker exposures are expected to be less than the estimated values. In reality, worker exposures would be monitored by a dosimetry program and would be kept ALARA.

No on-the-job fatalities are predicted with an additional 3 years during the conversion facility operational phase; it is estimated, however, that a total of about 221 injuries would occur, compared with 197 injuries over 25 years (Table 5.2-1).

It might be necessary to construct a new cylinder yard at Paducah if it was decided to transport the ETTP cylinders to Paducah. If such a decision was made in the future, an additional environmental or NEPA review would be required for construction of a new yard.

5.2.5.2 Cylinder Preparation Impacts at ETTP

Transporting the cylinders at ETTP to Paducah could result in potential environmental impacts at ETTP from the preparation of the cylinders for shipment. As described in Chapter 2, some of the DUF_6 cylinders in storage no longer meet DOT requirements for the shipment of radioactive materials. It is currently unknown exactly how many cylinders do not meet DOT requirements, although current estimates are that 1,700 cylinders are DOT-compliant. Before transportation, cylinders would have to be prepared to meet the requirements. As described in Chapter 2, for the purposes of this EIS, environmental impacts were evaluated for three options for preparing cylinders for shipment: use of cylinder overpacks, cylinder transfer, and obtaining a DOT exemption.

An overpack is a container into which a cylinder would be placed for shipment. The metal overpack would be designed, tested, and certified to meet all DOT shipping requirements. The overpack would be suitable to contain, transport, and store the cylinder contents regardless of cylinder condition. According to UDS (2003b), the use of cylinder overpacks is considered the most likely approach for shipping noncompliant cylinders.

The cylinder transfer option would involve the transfer of the DUF_6 from noncompliant cylinders to cylinders that meet all DOT requirements. If selected, this option would likely require the construction of a cylinder transfer facility at ETTP. Currently, there are no plans or proposals to build or use a cylinder transfer facility to prepare DUF_6 cylinders for shipment. If such a decision were made, additional NEPA review would be conducted. The use of a cylinder transfer facility for cylinder preparation is considered much less likely than the use of overpacks, because the former approach would be more resource intensive and costly and would generate additional contaminated emptied cylinders requiring treatment and disposal.

The third option is to obtain an exemption from DOT that would allow the DUF_6 cylinders to be transported either "as is" or following repairs. The primary finding that DOT would have to make to justify granting an exemption is this: the proposed alternative would have to achieve a safety level that would be at least equal to the level required by the otherwise applicable regulation or, if the otherwise applicable regulation did not establish a required safety level, would be consistent with the public interest and adequately protect against the risks to life and property that are inherent when transporting hazardous materials in commerce. It is likely that some type of compensatory measures during the transportation would have to be employed to justify the granting of an exemption. No specific measures were evaluated in this EIS. However, because the granting of an exemption would be based on a demonstration of equivalent safety, the transportation impacts for this option would be similar to those presented for the overpack and cylinder transfer options. Therefore, transportation impacts for the exemption option are not presented separately in this section.

The site-specific impacts of preparing both compliant and noncompliant cylinders (using overpacks and cylinder transfer) for shipment at ETTP were evaluated in Appendix E of the DUF_6 PEIS (DOE 1999a). In that evaluation, it was assumed for ETTP that the total number of cylinders not meeting DOT requirements ranged from 2,342 to 4,683 (50% to 100% of the ETTP DUF_6 inventory); correspondingly, from 0 to 2,342 compliant cylinders would require preparation for shipment.

The following paragraphs summarize the impacts from the cylinder preparation activities at ETTP as presented in Appendix E of the DUF_6 PEIS (DOE 1999a). The site-specific impacts from operation of a transfer facility at ETTP were evaluated on the basis of the assumption that the facility would be located at the center of the site, since no proposal exists for such a facility and no specific location has been proposed. For the same reasons, the site-specific impacts from construction were not evaluated. Therefore, an additional NEPA review might be required to construct a cylinder transfer facility if a decision was made to do so in the future.

5.2.5.2.1 Cylinder Overpack Option. For normal operations, the PEIS analysis concluded that the potential on-site impacts from preparing compliant cylinders and from placing noncompliant cylinders into overpacks would be small and limited to involved workers. No impacts to the off-site public or the environment would occur, since no releases are expected and no construction activities would be required. The only equipment required would be similar to the equipment currently used during routine cylinder handling and maintenance activities.

It is estimated that at ETTP, the total collective dose to involved workers would range from 42 to 85 person-rem (resulting in less than 0.03 LCF) for overpacking operations and from 0 to 27 person-rem (resulting in less than 0.01 LCF) for preparation of compliant cylinders. The total collective dose to workers preparing all the ETTP cylinders would range from 69 to 85 person-rem (resulting in less than 0.03 LCF). This dose to workers would be incurred over the duration of the cylinder preparation operations (annual doses can be estimated by dividing the total dose by the duration of the operation in years). It should be noted that the assumptions used in the PEIS for estimating worker exposure were very conservative, with the purpose of bounding potential exposures. In practice, cylinder preparation activities, such as inspecting, unstacking, and loading cylinders, would involve fewer workers and be of shorter duration, resulting in significantly lower worker exposures than the estimates presented here.

The PEIS also evaluated the potential for accidents during cylinder preparation operations. The types of accident considered were the same as those considered for the continued storage of cylinders under the no action alternative in this EIS, such as spills from corroded cylinders during wet and dry conditions and vehicle accidents causing cylinders to be involved in fires. The consequences of such accidents are described under the no action alternative in Section 5.1.

5.2.5.2.2 Cylinder Transfer Option. A summary of environmental parameters associated with the construction and operation of a cylinder transfer facility with various throughputs is presented in Table 5.2-31. In the PEIS, it was assumed that the ETTP transfer facility would process 320 cylinders per year, requiring about 15 years to transfer 4,683 cylinders. Although the three facility sizes shown in Table 5.2-31 have vastly different throughputs (ranging over a factor of 5), the differences in the environmental parameters among them are relatively small because of economies of scale. If transfer operations at ETTP occurred over a shorter period of time than 15 years, a larger facility would be required, with environmental parameters similar to those listed for the 1,600-cylinder/yr facility or the 960-cylinder/yr facility.

For the cylinder transfer option, impacts during construction and normal operations would generally be small and limited primarily to involved workers. It is estimated that at ETTP, the total collective dose to involved workers would range from 410 to 480 person-rem (resulting in less than 0.2 LCF) for cylinder transfer operations, and it would range from 0 to 27 person-rem (resulting in less than 0.01 LCF) for preparing compliant cylinders. The total collective dose to workers preparing all the ETTP cylinders would range from 437 to 480 person-rem (resulting in less than 0.2 LCF). This dose to workers would be incurred over the duration of the cylinder preparation operations (annual doses can be estimated by dividing the total dose by the duration of the operation in years).

In the PEIS, the size of the transfer facility was estimated to be less than about 20 acres (8 ha); such a facility would likely be constructed in a previously disturbed area. Some small off-site releases of hazardous and nonhazardous materials could occur, although such releases would have negligible impacts on the off-site public and the environment. Construction activities could temporarily impact air quality, but all criteria pollutant concentrations would be within applicable standards.

TABLE 5.2-31 Summary of Environmental Parameters for a Cylinder Transfer Facility

	Annual Facility Throughput		
Affected Parameter	1,600 Cylinders	960 Cylinders	320 Cylinders
Disturbed land area (acres)	21	14	12
Paved area (acres)	15	10	8
Construction water (million gal/yr)	10	8	6.5
Construction wastewater (million gal/yr)	5	4	3.3
Operations water (million gal/yr)	9	7	6
Operations wastewater (million gal/yr)	7.1	5.7	4.4
Radioactive release (Ci/yr)	0.00078	0.00063	0.00049

Source: Appendix E in DOE (1999a).

Impacts on cultural resources would be possible if a transfer facility was built at ETTP. Depending on the location chosen, the K-25 Main Plant Historical District, significant archaeological resources, or traditional cultural properties could be adversely affected. The ORR CRMP has been approved by the Tennessee SHPO. It includes procedures for determining the effect of an undertaking on cultural resources, consulting with the Tennessee SHPO and Native American groups, and mitigating adverse effects (Souza et al. 2001). These procedures, including additional surveys and any necessary mitigation, would have to be completed before any ground-disturbing activities for construction of a new facility could begin.

5.2.5.3 Transportation of Cylinders from ETTP to Paducah

The estimated potential environmental impacts from transportation of UF_6 cylinders are presented in this section for shipments from ETTP to the Paducah site. Potential impacts for the shipment of DUF_6 cylinders are presented in Section 5.2.5.3.1; potential impacts for the shipment of non-DUF_6 cylinders are presented in Section 5.2.5.3.2. The impacts of transportation were calculated in three areas: (1) collective population risks during routine conditions and accidents, (2) radiological risks to MEIs during routine conditions, and (3) consequences to individuals and populations after the most severe accidents involving a release of UF_6. Shipments of cylinders by both truck and rail were assessed.

5.2.5.3.1 DUF_6 Cylinder Shipments

Collective Population Risk. The total collective population risks for shipment of the entire ETTP inventory to Paducah are presented in Table 5.2-32 for the DUF_6 and non-DUF_6 cylinders. Annual impacts would depend on the duration of the shipping campaign and can be computed by dividing the total risk by the campaign duration. No fatalities are expected as a result of the shipping campaign because all estimated collective fatality risks are much less than 0.5. The estimated radiation doses from the shipments are much less than levels expected to cause an appreciable increase in the risk of cancer in crew members and the public. The highest fatality risks are from vehicle-related causes; the risks for truck shipments are higher than for rail.

The highest radiological risks are for routine transport by general train (0.04 crew LCFs) followed by truck (0.008 crew LCFs). In RADTRAN, rail crew risks are calculated for railcar inspectors in rail yards. During transport, members of the rail crew are assumed to be shielded completely by the locomotive(s) and any intervening railcars. The radiological risks from accidents are approximately 10 times lower than those for routine transport. No chemical impacts would occur under normal transport conditions because the package contents are assumed to remain confined. Chemical accident risks for the entire shipping campaign would be negligible for any transport option. No adverse effects (1.7×10^{-6} or less) or irreversible adverse effects (1.2×10^{-6} or less) are expected.

TABLE 5.2-32 ETTP UF_6 Cylinder Shipments to Paducah

	DUF_6		Non-DUF_6	
Mode	Truck	Rail[a]	Truck	Rail[a]
Shipment summary				
Number of shipments	4,900	1,225	503	181
Total distance traveled (km)	2,370,000	1,010,000	243,000	149,000
Cargo-related[b]				
Radiological impacts				
Dose risk (person-rem)				
Routine crew	21	88	2.8	18
Routine public				
Off-link	0.26	0.89	0.1	0.18
On-link	0.72	0.036	0.28	0.0074
Stops	6.5	1.2	2.6	0.25
Total	7.4	2.2	3.0	0.44
Accident[c]	0.11	0.015	0.00053	3.7×10^{-5}
Latent cancer fatalities[d]				
Crew fatalities	0.008	0.04	0.001	0.007
Public fatalities	0.004	0.001	0.001	0.0002
Chemical impacts				
Adverse effects	1.7×10^{-6}	6.1×10^{-8}	0	0
Irreversible adverse effects	1.2×10^{-6}	4.8×10^{-8}	0	0
Vehicle-related[e]				
Emission fatalities	0.2	0.01	0.02	0.002
Accident fatalities	0.054	0.031	0.0055	0.0047

[a] Risks are presented on a railcar basis. One shipment is equivalent to one railcar.

[b] Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

[c] Dose risk is a societal risk and is the product of accident probability and accident consequence.

[d] LCFs were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

[e] Vehicle-related impacts are impacts independent of the cargo in the shipment.

Maximally Exposed Individuals during Routine Conditions. During the routine transportation of radioactive material, specific individuals may be exposed to radiation in the vicinity of a shipment. RISKIND (Yuan et al. 1995) has been used to estimate the risk to these individuals for a number of hypothetical exposure-causing events. The receptors include transportation crew members, inspectors, and members of the public exposed during traffic delays, while working at a service station, or while living near an origin or destination site. The assumptions about exposure are given in DOE (1999a) and Biwer et al. (2001). The scenarios for exposure are not meant to be exhaustive; they were selected to provide a range of representative potential exposures. Doses were assessed and are presented in Table 5.2-33 on a per-event basis — no attempt was made to estimate the frequency of exposure-causing events. The highest potential routine radiological exposure to an MEI, with an LCF risk of 1×10^{-7}, would be for a person stopped in traffic near a shipment for 30 minutes at a distance of 3.3 ft (1 m). There is also the possibility for multiple exposures. For example, if an individual lived near either the ETTP or Paducah sites and all shipments were made by truck, the resident could receive a combined dose of less than 0.03 mrem if present for all shipments (calculated as the product of 4,900 shipments and an estimated exposure per truck shipment of 5.4×10^{-9} rem). However, this dose is very low, approximately 10,000 times lower than the individual average annual exposure of 0.3 rem from natural background radiation. Truck inspectors would receive a higher dose per shipment (6.3×10^{-5} rem/event) than the hypothetical resident and might also be exposed to multiple shipments. If the same inspector were present for all shipments, that person would receive a combined dose of approximately 300 mrem distributed over the duration of the shipping campaign, about the same as would be received from an average annual exposure to natural background radiation.

Accident Consequence Assessment. Whereas the collective accident risk assessment considers the entire range of accident severities and their related probabilities, the accident consequence assessment assumes that an accident of the highest severity category has occurred. The consequences, in terms of committed dose (rem) and LCFs for radiological impacts and in terms of adverse affects and irreversible adverse effects for chemical impacts, were calculated for both exposed populations and individuals in the vicinity of an accident. Tables 5.2-34 and 5.2-35 present the radiological and chemical consequences, respectively, to the population from severe accidents involving shipment of DUF_6. Tables 5.2-36 and 5.2-37 present the radiological

TABLE 5.2-33 Estimated Radiological Impacts to the MEI from Routine Shipment of DUF_6 Cylinders

Mode	Inspector	Resident	Person in Traffic	Person at Gas Station	Person near Rail Stop
Routine Radiological Dose from a Single Shipment (rem)					
Truck	6.3×10^{-5}	5.4×10^{-9}	2.3×10^{-4}	7.5×10^{-6}	NA[a]
Rail	1.1×10^{-4}	1.5×10^{-8}	2.6×10^{-4}	NA	9.3×10^{-7}
Routine Radiological Risk from a Single Shipment (lifetime risk of an LCF)[b]					
Truck	3×10^{-8}	3×10^{-12}	1×10^{-7}	4×10^{-9}	NA
Rail	6×10^{-8}	8×10^{-12}	1×10^{-7}	NA	5×10^{-10}

[a] NA = not applicable.

[b] LCFs were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

TABLE 5.2-34 Potential Radiological Consequences to the Population from Severe Transportation Accidents Involving Shipment of DUF_6 Cylinders[a]

	Neutral Meteorological Conditions			Stable Meteorological Conditions		
Mode	Rural	Suburban	Urban[b]	Rural	Suburban	Urban[b]
Radiological Dose (person-rem)						
Truck	590	580	1,300	15,000	15,000	32,000
Rail	2,400	2,300	5,200	60,000	58,000	130,000
Radiological Risk (LCF)[c]						
Truck	0.3	0.3	0.6	7	7	20
Rail	1	1	3	30	30	60

[a] National average population densities were used for the accident consequence assessment, corresponding to densities of 6 persons/km^2, 719 persons/km^2, and 1,600 persons/km^2 for rural, suburban, and urban zones, respectively. Potential impacts were estimated for the population within a 50-mi (80-km) radius, assuming a uniform population density for each zone.

[b] It is important to note that the urban population density generally applies to a relatively small urbanized area — very few, if any, urban areas have a population density as high as 1,600 persons/km^2, extending as far as 50 mi (80 km). That urban population density corresponds to approximately 32 million people within the 50-mi (80-km) radius, well in excess of the total populations along the routes considered in this assessment.

[c] LCFs were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

Source: DOE (1999b).

and chemical consequences, respectively, to the MEI from severe accidents involving shipment of DUF_6.

The potential consequences of severe cylinder accidents were estimated for rail shipments on the basis of the assumption that the accident occurred in an urban area under stable weather conditions (such as at nighttime). In such a case, it was estimated that approximately four persons might experience irreversible adverse effects (such as lung or kidney damage) from exposure to HF and uranium. The number of fatalities expected following an HF or uranium chemical exposure is expected to be somewhat less than 1% of the potential irreversible adverse effects. Thus, no fatalities would be expected (1% of 4).

TABLE 5.2-35 Potential Chemical Consequences to the Population from Severe Transportation Accidents Involving Shipment of DUF_6 Cylinders[a]

	Neutral Weather Conditions			Stable Weather Conditions		
Mode	Rural	Suburban	Urban[b]	Rural	Suburban	Urban[b]
Number of Persons with the Potential for Adverse Health Effects						
Truck	0	2	4	6	760	1,700
Rail	4	420	940	110	13,000	28,000
Number of Persons with the Potential for Irreversible Adverse Health Effects[c]						
Truck	0	1	2	0	1	3
Rail	0	1	3	0	2	4

[a] National average population densities were used for the accident consequence assessment, corresponding to densities of 6 persons/km^2, 719 persons/km^2, and 1,600 persons/km^2 for rural, suburban, and urban zones, respectively. Potential impacts were estimated for the population within a 50-mi (80-km) radius, assuming a uniform population density for each zone.

[b] It is important to note that the urban population density generally applies to a relatively small urbanized area — very few, if any, urban areas have a population density as high as 1,600 persons/km^2, extending as far as 50 mi (80 km). That urban population density corresponds to approximately 32 million people within the 50-mi (80-km) radius, well in excess of the total populations along the routes considered in this assessment.

[c] Potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in fatality of approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

Source: DOE (1999b).

Over the long term, radiation effects are possible from exposure to the uranium released. In a highly populated urban area, it was estimated that about 3 million people could be exposed to small amounts of uranium as it was dispersed by the wind. Among those exposed, it was estimated that approximately 60 LCFs could occur in the urban population in addition to those occurring from all other causes. For comparison, in a population of 3 million people, approximately 700,000 would be expected to die of cancer from all causes. The occurrence of a severe rail accident in an urban area under stable weather conditions would be expected to be rare. The consequences of cylinder accidents occurring in rural environments during unstable weather conditions (typical of daytime) or involving a truck shipment were also assessed. The consequences of all other accident conditions were estimated to be considerably less than those described above for the severe urban rail accident.

TABLE 5.2-36 Potential Radiological Consequences to the MEI from Severe Transportation Accidents Involving Shipment of DUF_6 Cylinders

	Neutral Weather Conditions		Stable Weather Conditions	
Mode	Dose (mrem)	Radiological Risk of LCF[a]	Dose (mrem)	Radiological Risk of LCF[a]
Truck	0.43	2×10^{-4}	0.91	5×10^{-4}
Rail	1.7	9×10^{-4}	3.7	2×10^{-3}

[a] LCFs were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

Source: DOE (1999b).

TABLE 5.2-37 Potential Chemical Consequences to the MEI from Severe Transportation Accidents Involving Shipment of DUF_6 Cylinders

	Neutral Weather Conditions		Stable Weather Conditions	
Mode	Adverse Effects	Irreversible Adverse Effects[a]	Adverse Effects	Irreversible Adverse Effects[a]
Truck	Yes	Yes	Yes	Yes
Rail	Yes	Yes	Yes	Yes

[a] Potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in fatality of approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

Source: DOE (1999b).

5.2.5.3.2 Non-DUF_6 Cylinder Shipments

Collective Population Risk. The total collective population risks for shipment of the non-DUF_6 cylinders to Paducah are presented earlier in Table 5.2-32. Annual impacts would depend on the duration of the shipping campaign and can be computed by dividing the total risk by the campaign duration. On a per-shipment basis, the radiological risks during routine transportation would be slightly higher for non-DUF_6 shipments than for DUF_6 cylinder shipments because a higher external dose rate was assumed for the non-DUF_6 shipments. Conversely, radiological accident risks per shipment would be much less for the non-DUF_6 shipments than for the DUF_6 cylinder shipments. This is because the average uranium content per non-DUF_6 cylinder shipment is much less than that for a DUF_6 cylinder shipment: the *total* amount of UF_6 in the non-DUF_6 cylinders is approximately 25 t (28 tons), compared with approximately 12 t (13 tons) in *each* DUF_6 cylinder.

In general, the total potential impacts from radiological and vehicular causes would be small for the shipment of non-DUF_6 cylinders; no fatalities are expected as a result of the shipping campaign because all estimated collective fatality risks are much less than 0.5. Overall, the estimated total impacts from non-DUF_6 shipments are about a factor of 10 less than the total impacts from DUF_6 cylinder shipments (primarily because of the difference in the numbers of shipments).

Maximally Exposed Individuals during Routine Conditions. For MEIs, radiological doses and risks were assessed and are presented in Table 5.2-38 on a per-event basis for the shipment of non-DUF_6 cylinders — no attempt was made to estimate the frequency of

TABLE 5.2-38 Estimated Radiological Impacts to the MEI from Routine Shipment of Non-DUF_6 Cylinders

Mode	Inspector	Resident	Person in Traffic	Person at Gas Station	Person near Rail Stop
Routine Radiological Dose from a Single Shipment (rem)					
Truck	1.4×10^{-4}	2.0×10^{-8}	5.0×10^{-4}	2.7×10^{-5}	NA[a]
Rail	1.8×10^{-4}	2.5×10^{-8}	5.0×10^{-4}	NA	1.6×10^{-6}
Routine Radiological Risk from a Single Shipment (lifetime risk of an LCF)[b]					
Truck	9×10^{-8}	1×10^{-11}	3×10^{-7}	1×10^{-8}	NA
Rail	9×10^{-8}	1×10^{-11}	3×10^{-7}	NA	8×10^{-10}

[a] NA = not applicable.

[b] LCFs were calculated by multiplying the dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

exposure-causing events. On a per-shipment basis, the radiological risks to an MEI during routine transportation would be slightly higher for non-DUF_6 shipments than for DUF_6 cylinder shipments because a higher external dose rate was assumed. The highest potential routine radiological exposure to an MEI, with a LCF risk of 3×10^{-7}, would be for a person stopped in traffic near a shipment for 30 minutes at a distance of 3 ft (1 m).

There is also the possibility for multiple exposures. For example, if an individual lived near either the ETTP or Paducah sites and all non-DUF_6 shipments were made by truck, that person could receive a combined dose of approximately 0.01 mrem if present for all shipments (calculated as the product of 500 shipments and an estimated exposure per shipment of 2.0×10^{-8} rem). However, this dose is still very low, approximately 10,000 times lower than the individual average annual exposure of 0.3 rem from natural background radiation. Truck inspectors would receive a higher dose per shipment (1.4×10^{-4} rem/event) than the hypothetical resident and might also be exposed to multiple shipments. If the same inspector were present for all shipments, that person would receive a combined dose of approximately 70 mrem distributed over the duration of the shipping campaign, much less than the average annual exposure to natural background radiation.

Accident Consequence Assessment. Because the average uranium content of each non-DUF_6 cylinder shipment is much less than that for a DUF_6 cylinder shipment (the *total* amount of UF_6 in the non-DUF_6 cylinders is approximately 25 t [28 tons], compared with approximately 12 t [13 tons] in *each* DUF_6 cylinder), a separate accident consequence assessment was not conducted for non-DUF_6 cylinder shipments. The potential impacts of the highest consequence accidents for non-DUF_6 cylinder shipments would be much less than those presented in Tables 5.2-34 through 5.2-37 for DUF_6 shipments.

The nuclear properties of DUF_6 are such that the occurrence of a nuclear criticality is not a concern, regardless of the amount of DUF_6 present. However, criticality is a concern for the handling, packaging, and shipping of enriched UF_6. For enriched UF_6, criticality control is accomplished by employing, individually or collectively, specific limits on uranium-235 enrichment, mass, volume, geometry, moderation, and spacing for each type of cylinder. The amount of UF_6 that may be contained in an individual cylinder and the total number of cylinders that may be transported together are determined by the nuclear properties of enriched UF_6. Spacing of cylinders of enriched UF_6 in transit during routine and accident conditions is ensured by use of regulatory approval packages that provide protection against impact and fire. Consequently, because of these controls and the relatively small number of shipments containing enriched UF_6, the occurrence of an inadvertent criticality is not considered to be credible and therefore is not analyzed in the accident consequence assessment conducted in this EIS.

5.2.6 Potential Impacts Associated with the Option of Expanding Conversion Facility Operations

As discussed in Section 2.2.5, several reasonably foreseeable activities could result in a future decision to increase the conversion facility throughput or extend the operational period at one or both of the conversion facility sites. Specifically, the throughput of the facility could be increased through process improvements at Paducah. The facility also could be operated beyond the currently planned 25-year period in order to process additional DUF_6 that might be transferred to DOE at some time in the future (such as DUF_6 generated by USEC or another commercial enrichment facility). In addition, it is possible that DUF_6 cylinders could be transferred from Paducah to Portsmouth to facilitate conversion of the entire inventory, particularly if DOE assumes responsibility for additional DUF_6 at Paducah.

To account for these future possibilities and provide future planning flexibility, this section includes an evaluation of the environmental impacts associated with expanding conversion facility operations at Paducah, either by increasing throughput or by extending operations. In addition, potential environmental impacts associated with possible Paducah-to-Portsmouth cylinder shipments are also evaluated in this section.

5.2.6.1 Potential Impacts Associated with Increasing Plant Throughput

DOE believes that higher throughput rates can be achieved by improving the efficiency of the planned equipment (DOE 2004b). The conversion contract provides significant incentives to the conversion contractor to improve efficiency. For example, the current facility designs are based on an assumption that the conversion plant would have an 84% on-line availability (percent of time system is on line and operational). However, on the basis of Framatome's experience at the Richland plant, the on-line availability is expected to be at least 90%. Therefore, there is additional capacity expected to be realized in the current design.

If the plant throughput was marginally increased by process improvements, the environmental impacts during operations could increase for some areas but still would be similar to those discussed in Section 5.2.2 for the base design. For example, annual radiation doses to workers and the public from site emissions might increase in proportion to throughput. Slight variations in plant throughput are not unusual from year to year because of operational factors (e.g., equipment maintenance or replacement) and are generally accounted for by the conservative nature of the impact calculations. As discussed in Section 5.2.2, the estimated annual impacts during operations are well within applicable guidelines and regulations, with collective and cumulative impacts being quite low.

5.2.6.2 Potential Impacts Associated with Extending the Plant Operational Period

As noted above, the Paducah conversion facility is currently being designed to process the Paducah cylinder inventory over 25 years. There are no current plans to operate the conversion facilities beyond this period. However, with routine facility and equipment maintenance and periodic equipment replacements or upgrades, it is believed that the conversion facility could be operated safely beyond this time period to process any additional DUF_6 for which DOE might assume responsibility.

The estimated annual environmental impacts during conversion facility operations are presented and discussed in Section 5.2.2; these impacts are expected to continue each year for the planned 25 years of operations at Paducah. If operations were extended beyond 25 years and if the operational characteristics (e.g., estimated releases of contaminants to air and water) of the facility remained unchanged, it is expected that the annual impacts would be essentially the same as those presented in Section 5.2.2. However, continued operations would result in the impacts being incurred over a greater number of years. The total radiation dose to the workers and the public would increase in proportion to the number of additional years that the facility operated. Although the annual frequency of accidents would remain unchanged, the overall probability of a severe accident would increase proportionately with the additional operational time period. In addition, the total quantities of depleted uranium and secondary waste products requiring disposal would increase proportionately, as would the amount of HF or CaF_2 produced. As discussed in Section 5.2.2, the estimated annual impacts during operations are within applicable guidelines and regulations, with collective and cumulative impacts being quite low. This would also be expected during extended operations.

5.2.6.3 Potential Impacts Associated with Possible Future Paducah-to-Portsmouth Cylinder Shipments

As noted above, it is possible that in the future, DUF_6 cylinders could be transferred from Paducah to Portsmouth to facilitate conversion of the entire inventory, particularly if DOE assumed responsibility for additional DUF_6 at Paducah. At this time, it is uncertain whether such transfers would take place and how many cylinders would be transferred if such a decision was made. Therefore, for comparative purposes, this section provides estimates of the potential impacts from transporting 1,000 DUF_6 cylinders from Paducah to Portsmouth by either truck or rail. Shipment of 1,000 cylinders per year roughly corresponds to the annual base design throughput of the Portsmouth conversion facility.

The transportation assessment methodology discussed in Appendix F, Section F.3, was used to estimate the collective population risk for shipment of 1,000 cylinders between Paducah and Portsmouth by both truck and rail. It was assumed that only compliant cylinders that met DOT requirements would be shipped between the sites. The estimated highway and rail route distances between the sites are 395 mi (636 km) and 478 mi (769 km), respectively. The estimated collective risks are provided in Table 5.2-39. No cargo-related or vehicle-related fatalities are expected for the shipment of 1,000 cylinders per year between the sites.

The estimated consequences of severe accidents and the potential impacts to MEIs would be the same as presented and described in Section 5.2.5 for the shipment of ETTP cylinders.

TABLE 5.2-39 Annual Transportation Impacts for the Shipment of DUF_6 Cylinders from Paducah to Portsmouth, Assuming 1,000 DUF_6 Cylinders Shipped per Year

				Cargo-Related			Vehicle-Related	
			Total	Radiological Risk (LCF)[a]		Irreversible	Latent	
		No. of	Distance			Adverse	Emission	Accident
Route	Mode	Shipments	(10^6 mi)	Crew	Public	Effects	Fatalities	Fatalities
Paducah to Portsmouth	Truck	1,000	0.395	0.002	0.001	5×10^{-7}	0.1	0.01
	Rail[b]	250	0.12	0.007	0.0003	2×10^{-8}	0.008	0.006

[a] The lifetime risk of an LCF for an individual was estimated from the calculated doses by using a dose-to-risk conversion factor of 0.0005 fatality per person-rem for members of the general public, as recommended in ICRP Publication 60 (ICRP 1991). The approximate corresponding dose received for each radiological fatality risk listed in this table may be obtained by multiplying the fatality risk by 2,000 (i.e., 1 ÷ 0.0005).

[b] Assumes four DUF_6 cylinders per railcar.

5.3 CUMULATIVE IMPACTS

5.3.1 Issues and Assumptions

The CEQ guidelines for implementing NEPA define cumulative effects as the impacts on the environment resulting from the incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). Cumulative effects include other actions regardless of what agency (federal or nonfederal), organization, or person undertakes them. Noteworthy cumulative impacts can result from individually minor, but collectively significant, effects of all actions.

The activities considered in this cumulative analysis include those that might affect environmental conditions at or near the Paducah site; they also include activities occurring on the site itself and activities occurring nearby that would have similar effects. Tabular summaries of impacts associated with various actions are presented in Table 5.3-1 for impacts associated with the various technical areas assessed in this EIS. When possible, these summaries are quantitative; however, some are, by necessity, qualitative. For technical areas without data that can be aggregated, this analysis evaluates potential cumulative impacts in a qualitative manner as systematically as possible. When it is not appropriate for estimates of impacts to be accumulated, they are not included in the table. For example, it is not appropriate to accumulate chemical impacts (anticipated to be extremely small under the alternatives considered in this EIS) because hazard index estimates are not expected to be additive for different materials and conditions.

TABLE 5.3-1 Cumulative Impacts of DUF_6 Activities and Other Past, Present, or Reasonably Foreseeable Future Actions at the Paducah Site

		Impacts of DUF_6 Management[a]			Cumulative Impacts[c]	
Impact Category	Existing Conditions	No Action	Action Alternatives	Impacts of Other Actions[b]	No Action	Action Alternatives
Radiological, off-site population						
Public, collective dose (person-rem)[d]	4.8	< 0.19	1.2×10^{-3}	21.3	26.3	26.1
Public, number of LCFs[e]	0.002	$< 1 \times 10^{-4}$	6×10^{-7}	0.01	0.01	0.01
Off-site MEI, annual dose (mrem/yr)[f]	1.9	0.1	$<3.9 \times 10^{-5}$	0.42	2.4	2.3
Radiological, worker population						
Worker, collective dose (person-rem)[g]	35	813[h]	380	0.25	848	415
Worker, number of LCFs[i]	0.01	0.3	0.1	1×10^{-4}	0.3	0.4
Transportation[j]						
Number of truck shipments	6,000	< 1/yr	4,200	8,400	14,400	18,600
Number of rail shipments	0	0	6,000	0	0	6,000
Annual dose, truck, MEI (mrem/yr)	0.01	Negligible	9.1×10^{-4}	0.034	0.04	0.04
Annual dose, rail, MEI (mrem/yr)	0	0	2.5×10^{-3}	0	0	2.5×10^{-3}
Air quality (nonattainment)[k]	None	None	None	None	None	24-h PM_{10} and annual $PM_{2.5}$ above their standards during construction
Water and soil[l,m]						
Surface water quality (exceedance)	Aquatic toxicity	None	None	None	Aquatic toxicity	Aquatic toxicity
Groundwater quality (exceedance)	4 Parameters	None	None	None	4 Parameters	4 Parameters
Soil (exceedance)	None	None	None	None	None	None
Ecology (adverse impacts)	Negligible	Negligible	Negligible to minor	Negligible	Negligible	Negligible to minor
Land use (changes from current)	None	None	None	None	None	None

TABLE 5.3-1 (Cont.)

Impact Category	Existing Conditions	Impacts of DUF_6 Management[a]: No Action	Impacts of DUF_6 Management[a]: Action Alternatives	Impacts of Other Actions[b]	Cumulative Impacts[c]: No Action	Cumulative Impacts[c]: Action Alternatives
Cultural resources (adverse impacts)	None	Unlikely	Low to high archeological sensitivity; impacts mitigated	Unlikely	Unlikely	Low to high archeological sensitivity; impacts mitigated
Environmental justice (impacts)	None	None	None	None	None	None

[a] Based on the results in Chapter 5 of this EIS.

[b] Includes impacts related to the worst-case LLW management at the Paducah site (DOE 1997; see also DOE 2002b); continued enrichment of uranium and storage of DUF_6 by USEC and DOE (management only) (DOE 1999a); continued conversion of uranium ore into UF_6 at the Honeywell International, Inc., plant at Metropolis, Illinois (NRC 1995). Future actions would also include construction and operation of a uranium enrichment facility at the Paducah site, per the 2002 agreement between USEC and DOE that would place such a facility at the Paducah or Portsmouth site (U.S. Energy Research and Development Administration [ERDA] 1977; Platts Nuclear Fuel 2002). Other actions assume that air quality impacts from the TVA's Shawnee power plant and the Joppa Electric Energy, Inc., power plant (see DOE 1999d) would continue.

[c] Cumulative impacts equal the sum of the impacts of the DUF_6 management alternative and other past, present, and reasonably foreseeable future actions.

[d] Total collective dose, assuming a 25-year period.

[e] Assumes 0.0005 LCF/person-rem.

[f] Off-site MEI includes exposures resulting from airborne and waterborne emissions. Cumulative impacts assume all facilities operate simultaneously and are located at the same point.

[g] No worker dose given for possible enrichment facility, thus cumulative figures will be slightly low; the individual dose would still be monitored to remain under 5 rem/person annually.

[h] Estimated for 25 years to enable comparison with proposed action.

[i] Includes both facility workers and noninvolved workers; assumes 0.0004 LCF/person-rem.

[j] The following assumptions were made to estimate the transportation impacts under the DUF_6 management alternatives: (1) number of shipments includes all radiological shipments to and from the site (rounded to the nearest hundred); (2) number of truck or rail shipments is for the mode proposed; there may be other shipments by the other mode.

[k] Air impacts not discussed for the enrichment facility (see ERDA 1977).

[l] Exceedance of the EPA MCL for drinking water; the exceedance is temporary for certain conversion options and involves local, small waterways.

[m] Beta activity, chromium, nitrate as nitrogen, and TCE were evaluated in terms of maximum contaminant levels adopted by the Commonwealth of Kentucky.

Sources: DOE (1997, 1999a,d, 2001b, 2002b); NRC (1995).

5.3.2 Paducah Site

Past, ongoing, and future actions at the Paducah site include uranium enrichment operations (under management of USEC), waste management activities, waste disposal activities (DOE 1997, 2002b), environmental restoration activities (DOE 2001b), and continued management of DUF_6 cylinders by USEC. Other actions occurring near the Paducah site that could contribute to past, present, or future impacts near the Paducah site (because of their diffuse nature) include continued operation of the TVA's Shawnee Power Plant; the Joppa Electric Energy, Inc., power plant in Joppa, Illinois (see DOE 1999d); and the Honeywell International, Inc., uranium conversion plant in Metropolis, Illinois (NRC 1995).

One action that is considered in this analysis and that deserves special mention is the future development of a uranium enrichment facility at the Paducah site. In January 2004, USEC announced that it had selected Portsmouth as the site of its American Centrifuge Facility. However, this cumulative assessment assumes that the facility could be sited at Paducah and would use existing gas centrifuge technology; the assessment further assumes that the impacts of such a facility would be the same as those outlined in a 1977 analysis of environmental consequences for such an action (Energy Research and Development Administration [ERDA] 1977). (The facility proposed in 1977 was never completed.)

Together with the alternatives assessed in Sections 5.1 and 5.2 of this EIS, the cumulative analysis (data columns 4 through 6 of Table 5.3-1) includes the following:

- *No Action Alternative*: The cumulative impacts of no action include the impacts of UF_6 generation and management activities by USEC and DOE (management only) (DOE 1999a) and continued storage of cylinders under the no action alternative; waste management activities (DOE 1997); conversion of uranium ore into UF_6 at the Honeywell International, Inc., plant in Metropolis, Illinois (NRC 1995); electrical power generation at the TVA's Shawnee power plant and at the Joppa Electric Energy, Inc., power plant (DOE 1999d); and environmental restoration activities that have proceeded to a point that their consequences can be defined (DOE 2001b). Future actions could also include construction, operation, and D&D of a uranium enrichment facility at the Paducah site.

- *Proposed Action Alternatives*: The cumulative impacts of the proposed action alternatives include impacts related to the preferred alternative for waste management at the Paducah site (DOE 1997; see also DOE 2002b); continued enrichment of uranium and storage of DUF_6 by USEC and DOE (management, only) (DOE 1999a), conversion of DUF_6 without or with cylinders from ETTP (proposed action alternatives in this EIS); continued conversion of uranium ore into UF_6 at the Honeywell International, Inc., plant at Metropolis, Illinois (NRC 1995), electrical power generation at the TVA's Shawnee power plant and at the Joppa Electric Energy, Inc., power plant (DOE 1999d); and environmental restoration activities that have proceeded to a point that their consequences can be defined (DOE 2001b). Future actions could also include construction, operation, and D&D of a uranium enrichment facility at the Paducah site.

5.3.3 Results

The results of the cumulative analysis are summarized in Table 5.3.1. The first two data columns of the table summarize the results of the assessment of impacts of alternatives presented in Sections 5.1 and 5.2 of this EIS. The second two data columns identify the anticipated cumulative impacts of the alternatives when added to other actions.

5.3.3.1 Radiological Releases — Normal Operations

For the no action and the proposed action alternatives, impacts to human health and safety could result from radiological facility operations. As shown in Table 5.3-1, the cumulative collective radiological exposure to the off-site population would be well below the maximum DOE dose limit of 100 mrem/yr to the off-site MEI for both alternatives and below the limit of 25 mrem/yr specified in 40 CFR 190 for uranium fuel cycle facilities. Annual individual doses to involved workers at radiological facilities would be monitored to maintain exposure below the regulatory limits.

5.3.3.2 Accidental Releases — Radiological and Chemical Materials

For the no action and the proposed action alternatives, doses and consequences of releases of radiological materials were considered for a range of accidents from likely (occurring an average of 1 or more times in 100 years) to extremely rare (occurring an average of less than once in a million years). Because of the low probability of two accidents happening at the same time, the consequences of these accidents are not considered to be cumulative. The probability of likely accidents occurring at the same time is very low, even for the most frequently expected accidents, because this risk is the product of their fractional probabilities (1 in 100 years multiplied by 1 in 100 years equals both occurring 1 in 10,000 years [$0.01 \times 0.01 = 0.0001$]). In the unlikely event that two facility accidents from the “likely” category occurred at the same time, the consequences for the public would be low. The additive impacts would be for no chemical effects and for no LCFs.

5.3.3.3 Transportation

The number of shipments of wastes with a radiological component and of empty cylinders, from the conversion facility and from the option of transportation of ETTP cylinders to the Paducah site, would involve about 4,000 truck shipments of intact heel cylinders to NTS and about 6,000 rail shipments of U_3O_8 and crushed heel cylinders to Envirocare. Since none of the other actions have shipped or would ship by rail, the annual dose to the MEI is determined by the dose from the proposed action alternatives. For truck transportation, other actions have a larger dose than any DUF_6 management alternative, and annual cumulative dose to the MEI is determined by other actions. All cumulative doses are less than 0.1 mrem/yr.

5.3.3.4 Chemical Exposure — Normal Operations

Impacts associated with chemical exposure are expected to be very small under the no action alternative and the proposed action alternative considered in this EIS. As noted above, the calculation of cumulative impacts is not possible because of the absence of necessary measures (hazard indices) for other actions and the difficulty of aggregating these measures across the different chemicals used in different industries.

5.3.3.5 Air Quality

The Paducah site is currently located in an attainment region where criteria air pollutants do not exceed regulatory standards. During construction at the site for on-site conversion, continued storage, or cylinder preparation, total pollutant concentrations for SO_2, NO_2, and CO would be well below their applicable air quality standards. However, total concentrations of PM (PM_{10} and $PM_{2.5}$) are predicted to approach or exceed air quality standards during yard construction or during facility construction. These impacts would be temporary and could be minimized by using good engineering and construction practices and standard dust suppression methods. During the operational period, total annual average $PM_{2.5}$ concentrations would approach (99%) their applicable standards, primarily because of high background concentrations.

5.3.3.6 Noise

No cumulative noise impacts are expected because noise energy dissipates within short distances from the sources and because significant noise impacts are not expected in the vicinity of the conversion facility under all alternatives.

5.3.3.7 Water and Soil

Local impacts on surface water would not exceed the 20 µg/L of uranium used for comparison in discharges to Little Bayou Creek under low-flow conditions for the no action alternative. Impacts on water and soils would be localized and temporary, with adequate dilution occurring once the creek entered nearby larger waterways. Past impacts from the site included aquatic toxicity at KPDES Outfall 017 during cylinder painting/refurbishment. Under the no action alternative, care would be taken during cylinder painting to prevent a further toxicity effect. For the proposed action alternatives, no radioactive contamination would be released to surface water.

Data from the 2000 annual groundwater monitoring results showed that four pollutants exceeded primary drinking water standards in groundwater at the Paducah site: beta activity (seven wells), chromium (all wells), nitrogen as nitrate (one well), and TCE (trichloroethene) (two wells) (DOE 2001b). The groundwater analysis indicates that current cylinder maintenance programs would control cylinder corrosion under the no action alternative, and that the maximum uranium concentration in groundwater (from cylinder breaches) would be 6 µg/L, considerably below the 20 µg/L guideline level used for comparison (EPA 1996). Direct contamination of groundwater could occur during the construction and operation of a conversion facility — for example, from the dissolution and infiltration of stockpiled chemicals into aquifers. However, good engineering and construction practices should ensure that indirect impacts associated with either a conversion or treatment facility would be minimal and would not change existing groundwater conditions.

Because impacts to soils during construction and operation would be local, there would be no cumulative soil impacts.

5.3.3.8 Ecology

Cumulative ecological impacts should be negligible to minor under any alternative considered in this EIS in conjunction with the effects of other activities. At all three alternative locations, construction of a conversion facility could remove trees that are of a type preferred by the Indiana bat; however, this federally endangered species is not known to utilize these areas. No impacts on individuals or populations of Indiana bat are expected.

5.3.3.9 Land Use

All DUF_6 activities under all alternatives would be confined to the Paducah site, which is already used for similar activities. No land use impacts are expected.

5.3.3.10 Cultural Resources

The probability of encountering significant archaeological resources would vary, depending on the proposed location. Further cultural resource surveys would be required. Consultation with the SHPO and Native Americans has been initiated. If significant cultural resources were encountered, adverse effects would need to be mitigated. If any structures at the Paducah GDP were determined to be historically significant and there was a potential for a short-term adverse effect from the deposit of particulate matter on building surfaces, these adverse effects would be mitigated. All additional survey and mitigation would be conducted in consultation with the Kentucky SHPO.

5.3.3.11 Environmental Justice

No environmental justice cumulative impacts are anticipated for the Paducah site despite the presence of disproportionately high percentages of minority and low-income populations in the vicinity. This is because cumulative impacts in the vicinity of the Paducah site are not both high and adverse.

5.3.3.12 Socioeconomics

Socioeconomic impacts under any of the alternatives considered are anticipated to be generally positive, often temporary, and relatively small. Growth in population would not place demands on existing housing or public services that could not be met by existing capabilities. Cumulative socioeconomic impacts are expected to be similarly small and positive, although some would be more long-lived than others.

5.4 MITIGATION

In general, the impacts presented in this chapter are conservative estimates of impacts expected for each alternative. Factors such as flexibility in siting at and within the three alternative locations at Paducah and facility design and construction options could be used to reduce impacts from these conservative levels. This section identifies what impacts could be mitigated to reduce adverse impacts. On the basis of the analyses conducted for this EIS, the following recommendations can be made:

- Potential future impacts on site air and groundwater could be avoided by inspecting cylinders, carrying out cylinder maintenance activities (such as painting), and promptly cleaning up releases from any breached DUF_6 cylinders. In addition, runoff from cylinder yards should be collected and sampled so that contaminants can be detected and their release to surface water or groundwater can be avoided. If future cylinder painting results in KPDES Permit violations, treating cylinder yard runoff prior to release may be required.

- Temporary impacts on air quality from fugitive dust emissions during reconstruction of cylinder yards or construction of any new facility should be controlled by the best available practices to avoid temporary exceedances of the PM_{10} and $PM_{2.5}$ standard. Technologies that will be used to mitigate air quality impacts during construction include using water sprays on dirt roadways and on bare soils in work areas for dust control; covering open-bodied trucks transporting materials likely to become airborne when full and at all times when in motion; water spraying and covering bunkered or staged excavated and replacement soils; maintaining paved roadways in good repair and in a clean condition; using barriers and windbreaks around construction areas such as soil banks, temporary screening, and/or vegetative cover; mulching or covering exposed bare soil areas until vegetation has time to recover or paving has been installed; and prohibiting any open burning.

- During construction, impacts to water quality and soil can be minimized through implementing storm water management, sediment and erosion controls (e.g., temporary and permanent seeding; mulching and matting; sediment barriers, traps, and basins; silt fences; runoff and earth diversion dikes), and good construction practices (e.g., covering chemicals with tarps to prevent interaction with rain; promptly cleaning up any spills).

- Potential impacts to wetlands at the Paducah site could be minimized or eliminated by maintaining a buffer near adjacent wetlands during construction. Mitigation for unavoidable impacts may be developed in coordination with the appropriate regulatory agencies.

- If trees (either live or dead) with exfoliating bark are encountered on construction areas, they should be saved if possible to avoid destroying potential habitat for the Indiana bat. If necessary, the trees should be cut only before March 31 or after October 15, according to recommendations of the USFWS (Andrews 2004).

- The quantity of radioactive and hazardous materials stored on site, including the products of the conversion process, should be minimized.

- The construction of a DUF_6 conversion facility at Paducah would have the potential to impact cultural resources. Neither an archaeological nor an architectural survey has been completed for the Paducah site as a whole or for any of the alternative locations, although an archaeological sensitivity study has been conducted. In accordance with Section 106 of the NHPA, the adverse effects of this undertaking must be evaluated once a location is chosen.

- Testing should be conducted either prior to or during the conversion facility startup operations to determine if the air vented from the autoclaves should be monitored or if any alternative measures would need to be taken to ensure that worker exposures to PCBs above allowable OSHA limits do not occur.

- The nuclear properties of DUF_6 are such that the occurrence of a nuclear criticality is not a concern, regardless of the amount of DUF_6 present. However, criticality is a concern for the handling, packaging, and shipping of enriched UF_6. For enriched UF_6, criticality control is accomplished by employing, individually or collectively, specific limits on uranium-235 enrichment, mass, volume, geometry, moderation, and spacing for each type of cylinder. The amount of enriched UF_6 that may be contained in an individual cylinder and the total number of cylinders that may be transported together are determined by the nuclear properties of enriched UF_6. Spacing of cylinders of enriched UF_6 in transit during routine and accident conditions is ensured by use of regulatory approval packages that provide protection against impact and fire.

- Because of the relatively high consequences estimated for some accidents, special attention will be given to the design and operational procedures for components that may be involved in such accidents. For example, the tanks holding hazardous chemicals, such as anhydrous NH_3 and aqueous HF, on site would be designed to meet all applicable codes and standards, and special procedures would be in place for gaining access to the tanks and for filling the tanks. In addition, although the probabilities of occurrence for a high-consequence accident are extremely low, emergency response plans and procedures would be in place to respond to any emergencies should an accident occur. Additional details are discussed below.

Although the probability of transportation accidents involving hazardous chemicals such as HF and NH_3 is very low, the consequences could be severe. For this EIS, the assessment of transportation accidents involving HF and NH_3 assumed conservative conditions. Currently, a number of industry practices are commonly employed to minimize the potential for large releases, as discussed below.

HF is usually shipped in 100-ton (91-t), 23,000-gal (87,000-L) shell, full, noncoiled, noninsulated tank cars. Most HF railcars today meet DOT Classification 112S500W, which represents the current state of the art. To minimize the potential for accidental releases, these railcars have head protection and employ shelf couplers, which help prevent punctures during an accident. The use of these improved tank cars has led to an improved safety record with respect to HF accidents over the last several years. In fact, the HF transportation accident rate has steadily decreased since 1985. Industry recommendations for the new tank car guideline appear in *Recommended Practices for the Hydrogen Fluoride Industry* (Hydrogen Fluoride Industry Practices Institute 1995b).

Accidents involving HF and NH_3 at a conversion facility could have potentially serious consequences. However, a wide variety of good engineering and mitigative practices are available that are related to siting, design, and accident mitigation for HF and NH_3 storage tanks, which might be present at a conversion facility. Many are summarized in the *Guideline for the Bulk Storage of Anhydrous Hydrogen Fluoride* (Hydrogen Fluoride Industry Practices Institute 1995a). There is an advanced set of accident prevention and mitigative measures that is recommended by industry for HF storage tanks, including storage tank siting principles (e.g., evaluating seismic, high wind, and drainage conditions), design recommendations, and tank appurtenances, as well as spill detection, containment, and mitigation. Measures to mitigate the consequences of an accident include HF detection systems, spill containment systems such as dikes, remote storage tank isolation valves, water spray systems, and rapid acid deinventory systems (that rapidly remove acid from a leaking vessel). Details on these mitigative strategies are also provided in the Hydrogen Fluoride Industry Practices Institute (1995a) guidelines.

5.5 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are those impacts that cannot be mitigated by choices associated with siting and facility design options. They are impacts that would be unavoidable, no matter which options were selected.

The cylinders currently in storage would require continued monitoring and maintenance under all alternatives. These activities would result in the exposure of workers in the vicinity of the cylinders to low levels of radiation. The radiation exposure of workers could be minimized, but some level of exposure would be unavoidable. The radiation doses to workers are estimated to be well within public health standards under all alternatives. Radiation exposures of workers would be monitored at each facility and would be kept ALARA. Cylinder monitoring and maintenance activities would also emit air pollutants, such as vehicle exhaust and dust (PM_{10}), and produce small amounts of sanitary waste and LLW. Concentrations of air emissions during operations are estimated to be within applicable standards and guidelines, and waste generation would not appreciably affect waste management operations.

Under all alternatives, workers would have a potential for accidental on-the-job injuries and fatalities that would be unrelated to radiation or chemical exposures. These would be a consequence of unanticipated events in the work environment, typical of all workplaces. On the basis of statistics in similar industries, it is estimated that less than 1 fatality and on the order of several hundred injuries would occur under the alternatives, including the required transportation among sites associated with the alternatives. The chance of fatalities and injuries occurring would be minimized by conducting all work activities in as safe a manner as possible, in accordance with occupational health and safety rules and regulations. However, the chance of these types of impacts cannot be completely avoided.

Conversion would require the construction of a new facility at the Paducah site. Up to 45 acres (18 ha) of land could be disturbed during construction, with approximately 10 acres (4 ha) required for the facility footprint. Construction of the facility could result in losses of terrestrial and aquatic habitats. Dispersal of wildlife and temporary elimination of habitats would result from land clearing and construction activities involving movement of construction personnel and equipment. The construction of the facility could cause both short-term and long-term disturbances of some biological habitats. Although some destruction would be inevitable during and after construction, these losses could be minimized by careful site selection and construction practices.

5.6 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The major irreversible and irretrievable commitments of natural and man-made resources related to the alternatives analyzed in this EIS are discussed below. A commitment of a resource is considered *irreversible* when the primary or secondary impacts from its use limit the future options for its use. An *irretrievable* commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for later use by future generations.

The decisions to be made in the ROD following the publication of this EIS would commit resources required for implementing the selected alternative. Three major resource categories would be committed irreversibly or irretrievably under the alternatives considered in this EIS: land, materials, and energy.

5.6.1 Land

Land that is currently occupied by cylinder storage or selected for the conversion facility could ultimately be returned to open space if the yards, buildings, roads, and other structures were removed, the areas were cleaned up, and the land was revegetated. Future use of these tracts of land, although beyond the scope of this EIS, could include restoring them for unrestricted use. Therefore, the commitment of this land would not necessarily be irreversible. However, the land used to dispose of any conversion products or construction or D&D wastes would represent an irretrievable commitment, because wastes in belowground disposal areas could not be completely removed, the land could not be restored to its original condition, and the site could not feasibly be used for other purposes following the closure of the disposal facility. All disposal activities associated with the alternatives analyzed in this EIS would take place at DOE or commercial disposal facilities that would be permitted or licensed to accept such wastes.

5.6.2 Materials

The irreversible and irretrievable commitment of material resources for the various EIS alternatives would include construction materials that could not be recovered or recycled, materials rendered radioactive that could not be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Materials related to construction could include wood, concrete, sand, gravel, steel, aluminum, and other metals (Table 5.6-1). At this time, no unusual construction material requirements have been identified. The construction resources, except for those that could be recovered and recycled with current technology, would be irretrievably lost. None of the identified construction resources is in short supply, and all should be readily available in the local region.

Strategic and critical materials (e.g., Monel and Inconel) would not be required in quantities that would seriously reduce the national or world supply. This material would be used throughout the facilities and would be used in the generation of HF in the conversion process. The autoclaves and conversion units (process reactors) are long-lead-time procurements with few qualified bidders. Many suppliers are available for the remainder of the equipment.

Estimated annual consumption rates of raw materials are provided in Table 5.6-2. Consumption of operating supplies (e.g., miscellaneous chemicals such as lime and potassium hydroxide, and gases such as nitrogen), although irretrievable, would not constitute a permanent drain on local sources or involve any material in critically short supply in the United States as a whole.

TABLE 5.6-1 Materials/Resources Consumed during Conversion Facility Construction at the Paducah Site

Materials/Resources	Total Consumption	Unit	Peak Demand	Unit
Utilities				
Water	4×10^6	gal	1,500	gal/h
Electricity	1,500	MWh	7.2	MWh/d
Solids				
Concrete	9,139	yd^3	NA[a]	NA
Steel	511	tons	NA	NA
Inconel/Monel	33	tons	NA	NA
Liquids				
Fuel	73,000	gal	250	gal/d
Gases				
Industrial gases (propane)	15,000	gal	50	gal/d

[a] NA = not applicable.

5.6.3 Energy

The irretrievable commitment of energy resources during the operation of the various facilities considered under the alternatives would include the consumption of fossil fuels used to generate steam and heat and electricity for the facilities (Table 5.6-3). Energy would also be expended in the form of diesel fuel and gasoline for cylinder transport equipment and transportation vehicles. Consumption of these utilities, although irretrievable, would not constitute a permanent drain on local sources or involve any utility in critically short supply in the United States as a whole.

TABLE 5.6-2 Materials Consumed Annually during Conversion Facility Operations at the Paducah Site[a]

Chemical	Quantity (tons/yr)
Solid	
Lime (CaO)[b]	19
Liquid	
Ammonia (99.95% minimum NH_3)	670
Potassium hydroxide (45% KOH)	8
Gas	
Nitrogen (N_2)	10,000

[a] Material estimates are based on conceptual-design-status data (UDS 2003b). A number of studies are planned to evaluate design alternatives, the results of which may affect the above materials needs.

[b] Assuming lime is used only for potassium hydroxide regeneration. If HF neutralization is required, the annual lime requirement would be approximately 9,300 tons/yr (8,437 t/yr).

TABLE 5.6-3 Utilities Consumed during Conversion Facility Operations at the Paducah Site[a]

Utility	Annual Average Consumption	Unit	Peak Demand[b]	Unit
Electricity	37,269	MWh	7.1	MW
Liquid fuel	4,000	gal	NA[c]	NA
Natural gas[d,e]	4.4×10^7	scf[f]	190	scfm[f]
Process water	37×10^6	gal	215	gal/min
Potable water	3×10^6	gal	350	gal/min

a Utility estimates are based on conceptual design status data (UDS 2003b). A number of studies are planned to evaluate design alternatives, the results of which may affect the above utility needs.

b Peak demand is the maximum rate expected during any hour.

c NA = not applicable.

d Standard cubic feet measured at 14.7 psia and 60°F (16°C).

e The current facility design (UDS 2003b) uses electrical heating. An option of using natural gas is being evaluated.

f scf = standard cubic feet; scfm = standard cubic feet per minute.

5.7 RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

For this EIS, *short term* is considered the period of construction activities for the alternatives analyzed — the time when most short-term (or temporary) environmental impacts would occur. Disposal of solid nonhazardous waste resulting from new facility construction, operations, and D&D would require additional land at a sanitary landfill site, which would be unavailable for other uses in the long term. Any radioactive or hazardous waste generated by the various alternatives would involve the commitment of associated land, transportation, and disposal resources, and resources associated with the processing facilities for waste management.

For the construction and operation of the conversion facility, the associated construction activities would result in both short- and long-term losses of terrestrial and aquatic habitats from natural productivity. Dispersal of wildlife and temporary elimination of habitats would result from land clearing and construction activities involving movement and staging of construction personnel and equipment. The building of new facilities could cause long-term disturbances of some biological habitats, potentially causing long-term reductions in the biological activity of an area. Although some habitat loss would be inevitable during and after construction, these losses would be minimized by careful site selection and by thorough environmental reviews of specific proposals. Short-term impacts would be reduced and mitigated as necessary. After closure of the new facilities, they would be decommissioned and could be reused, recycled, or remediated.

5.8 POLLUTION PREVENTION AND WASTE MINIMIZATION

Implementation of the EIS alternatives would be conducted in accordance with all applicable pollution prevention and waste minimization guidelines. Pollution prevention is designed to reduce risk to public health, safety, welfare, and the environment through source reduction techniques and environmentally acceptable recycling processes. The Pollution Prevention Act of 1990 (42 USC 11001–11050) established a national policy that pollution should be prevented or reduced at the source, whenever feasible. The act indicates that when pollution cannot be prevented, polluted products should be recycled in an environmentally safe manner. Disposal or other releases into the environment should be employed only as a last resort. Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements* (U.S. President 1993), and DOE Order 5400.1, *General Environmental Protection Program* (DOE 1988), implement the provisions of the Pollution Prevention Act of 1990. Pollution prevention measures could include source reduction, recycling, treatment, and disposal. The emphasis would be on source reduction and recycling to prevent the creation of wastes (i.e., waste minimization).

Waste minimization is the reduction, to the extent feasible, of the generation of radioactive and hazardous waste. Source reduction and waste minimization techniques include good operating practices, technology modifications, changes in input material, and product changes. An example of waste minimization would be to substitute nonhazardous materials, when possible, for materials that contribute to the generation of hazardous or mixed waste.

A consideration of opportunities for reducing waste generation at the source, as well as for recycling and reusing material, will be incorporated to the extent possible into the engineering and design process for the conversion facility. Pollution prevention and waste minimization will be major factors in determining the final design of any facility to be constructed. Specific pollution prevention and waste minimization measures will be considered in designing and operating the final conversion facility.

5.9 DECONTAMINATION AND DECOMMISSIONING OF THE CONVERSION FACILITY

When operations at the conversion facility are complete, D&D would be performed to protect both public health and safety and the environment from accidental releases of any remaining radioactivity and hazardous materials. The conversion facility is being designed to facilitate D&D activities. This analysis assumes that the D&D activity would provide for the disassembly and removal of all radioactive and hazardous components, equipment, and structures associated with the conversion facilities. The objective assumed in this EIS would be to completely dismantle the various buildings and achieve “greenfield” (unrestricted use) conditions. The design requirements for the D&D of these facilities can be found in two DOE Directives from 1999: DOE Guide 430.1-3, *Deactivation Implementation Guide*, and DOE Guide 430.1-4, *Decommissioning Implementation Guide* (DOE 1999e,f).

Because the D&D of the proposed facility is not expected to occur for at least 25 years, it is likely that an additional environmental review would need to be performed before it occurred. It is also expected that such a review would be based on the actual condition of the facilities and a more definite identification of the resulting waste materials.

5.9.1 Human Health and Safety — Off-Site Public

It is expected that D&D of the DUF_6 conversion facility would result in low radiation doses to members of the public and would be accomplished with no significant adverse environmental impacts.

DOE has established a primary dose limit for any member of the public of 0.1 rem (1 mSv) total effective dose equivalent (TEDE) per year for protection of public health and safety. Compliance with the limit is based not just on an individual DOE source or practice but on the sum of internal and external doses resulting from all modes of exposure to all radiation sources other than background and medical sources (DOE 1993). However, it could be very difficult to determine doses from all radiation sources for the purpose of demonstrating compliance. Therefore, DOE elements are instructed to apply a public dose constraint of 0.025 rem (0.25 mSv) of TEDE per year to each DOE source or practice (DOE 2002g). Also, DOE elements are required to implement a process to ensure, on a case-specific basis, that public radiation exposures will be ALARA below the dose constraint (DOE 1993).

To be consistent with DOE's general approach to protecting the public from radiation exposure explained above, the release of radioactive material from D&D activities at a DOE-controlled site, such as a DUF_6 conversion or cylinder treatment facility, would be limited to an amount determined on a case-specific basis through the ALARA process to be ALARA but, in any event, less than 0.025 rem/yr (0.25 mSv/yr). This would ensure that doses to the public from DOE real property releases following D&D are consistent with NRC requirements for commercial nuclear facilities, as stated in 10 CFR 20, Subpart E, "Radiological Criteria for License Termination."

In its final generic EIS for decommissioning of NRC-licensed nuclear facilities (NRC 1994), the NRC concluded that at any site where the 0.025-rem/yr (0.25-mSv/yr) dose criterion established in 10 CFR 20, Subpart E is met, the likelihood that individuals who use the site would be exposed to multiple sources with cumulative doses approaching 0.1 rem/yr (1 mSv/yr) would be very low. Accordingly, the likelihood would also be very low that a member of the public would be exposed in excess of the DOE primary dose limit after D&D of the DUF_6 conversion and cylinder treatment facilities to meet site-specific limits that are ALARA below the dose constraint of 0.025 mrem/yr (0.25 mSv/yr).

The total public dose from D&D of the DUF_6 conversion facility is estimated to range from 4 to 5 person-rem. This estimate was scaled from data on public exposure doses found in NRC (1988) to account for the capacity of the conversion facility and the effort required for its D&D. Because of the low specific activity of uranium, the estimate is very small and primarily would result from the transportation of D&D wastes for ultimate disposition (NRC 1988).

Radiation doses to the public resulting from accidents during D&D activities would be low enough to be considered insignificant (NRC 1988).

5.9.2 Human Health and Safety — On-Site Workforce

Radiological impacts to involved workers during D&D of the conversion facility would result primarily from external radiation due to the handling of depleted uranium materials. Because of the low radiation exposures from depleted uranium, one of the initial D&D activities would be removal of any residual uranium from the process equipment, significantly reducing radiation exposure to the involved workforce.

Radiation exposure estimates for the involved workforce during D&D activities involving nuclear facilities licensed by the NRC are provided in NRC (1988) and NRC (1994). These nuclear facilities include UF_6 production plants and uranium fuel fabrication plants that are similar to the conversion facilities considered in this EIS. Average radiation dose rates in the conversion facility during the initial cleaning are expected to be much less than 2 mrem/h, which is the radiation dose rate from bulk quantities of uranium (NRC 1988).

Table 5.9-1 lists the estimated LCFs of the involved workforce during decontamination and cleanup activities at the facility as a function of the residual dose rate (NRC 1994). The radiological impacts in Table 5.9-1 were estimated on the basis of the dose rates to which the workers are subjected and the collective effort required to reduce the residual contamination levels.

One of the most critical parameters in developing the decommissioning plan would be the release criterion applicable for the project. Subpart E of 10 CFR Part 20 addresses release criteria for NRC licensees, while DOE Order 5400.5 (DOE 1990) governs the development of authorized release limits for DOE facilities. On the basis of a residual dose rate of 25 mrem/yr, the estimated LCFs of the involved workforce would be much lower than unity (i.e., no radiation-related fatalities), since the radiation dose to involved workers would be a small fraction of the exposure experienced over the operating lifetime of the facility and well within the occupational exposure limits imposed

TABLE 5.9-1 Estimated Latent Cancer Fatalities from Radiation Exposure Resulting from Conversion Facility D&D Activities at the Paducah Site[a]

Residual Dose Rate (mrem/yr)	Low[b]	High[c]
100	2.12×10^{-3}	3.61×10^{-3}
60	2.12×10^{-3}	3.63×10^{-3}
30	2.12×10^{-3}	3.65×10^{-3}
15	2.14×10^{-3}	3.66×10^{-3}
10	2.16×10^{-3}	3.67×10^{-3}
3	2.18×10^{-3}	3.68×10^{-3}
1	2.19×10^{-3}	3.69×10^{-3}
0.3	2.19×10^{-3}	3.70×10^{-3}
0.1	2.20×10^{-3}	3.71×10^{-3}
0.03	2.20×10^{-3}	3.72×10^{-3}

[a] Values in this table are unscaled values taken directly from NRC (1994).

[b] Based on the D&D of a uranium fuel fabrication plant that converts enriched UF_6 into UO_2 for production of light-water reactor fuel (DOE 1999g).

[c] Based on the D&D of a UF_6 production plant where yellowcake is converted to UF_6.

by regulatory requirements. Radiation exposure of the involved D&D workers would be monitored by a dosimetry program and maintained below regulatory limits.

The risk of on-the-job fatalities and injuries to conversion facility D&D workers was calculated by using industry-specific statistics from the BLS, as reported by the National Safety Council (2002). Annual fatality and injury rates from the BLS construction industry division were used for the D&D phase. On the basis of D&D cost information provided in Elayat et al. (1997), it is assumed that the D&D workforce would be approximately 10% of the construction workforce. On the basis of these assumptions and information provided in UDS (2003b), the estimated incidences of fatalities and injuries for the D&D of the conversion facilities are 0.01 and 5, respectively.

5.9.3 Air Quality

Before structural dismantlement, all contaminated surfaces would be cleaned manually. Best construction management practices, such as dust control measures, would be used to protect air quality and to mitigate any airborne releases during the D&D process. As discussed in Section 5.9.1, it is anticipated that the D&D activities would not produce any significant radiological emissions that would affect the off-site public.

D&D can be considered to be the reverse of the construction of buildings and structures. Available information (Elayat et al. 1997) indicates that the level of construction-related activities during D&D would be an order of magnitude lower than during conversion facility construction. Air quality during D&D activities would thus be bounded by the results presented in Sections 5.2.1.3 and 5.2.2.3 for construction activities, if it is assumed that the existing emission control systems were efficiently maintained.

5.9.4 Socioeconomics

The potential consequences from D&D of the conversion facilities would be lower than those discussed in Section 5.2.1.5 for conversion facility construction, because the total D&D workforce would be smaller for facility D&D than for facility construction.

To decommission the conversion facility, many of the same people who operated the facility could do the cleaning; however, the dismantling and moving of equipment would have to be performed by electricians, plumbers, mechanics, and equipment operators, most of whom would be hired or contracted (NRC 1988) specifically for this purpose.

5.9.5 Waste Management

The major challenge of the D&D activity would be to remove and dispose of radioactive and hazardous wastes while keeping occupational and other exposures ALARA. Section 3.7 of DOE Guide 420.1-1 (DOE 2000c) requires facilities where radioactive or other hazardous contaminating materials will be used to be designed so as to simplify periodic decontamination and ultimate decommissioning. For example, if necessary, all cracks, crevices, and joints would have to be caulked or sealed and finished smooth to prevent the accumulation of contaminated material in inaccessible areas. These design features should minimize the generation of radioactive and/or hazardous materials during D&D activities.

There are three major classes of D&D waste, based on the composition and radioactivity of the materials involved: LLW, mixed LLW, and hazardous waste. It is assumed that TRU waste would not be present (any TRU waste generated during facility operations would be removed prior to D&D activities). A fourth class is “clean” material; this is any material resulting from D&D activities, including metal, which can be safely reused or recycled without any further radiological or hazardous controls. If no further need is established for these clean materials, they can be disposed of at sanitary landfills without requiring any further radiological or hazardous controls.

D&D-related waste can also be categorized into two general groups: contaminated materials and other wastes. Contaminated materials are standard materials such as steel and concrete that contain or have embedded trace amounts of radioactivity. In general, contamination is caused by the settling or adherence of uranium and its progeny products on internal surfaces such as piping. The average concentrations of the radionuclides contaminating the conversion facility are expected to be generally low enough to rank these materials as Class-A LLW.

Other wastes, the second general group of D&D-related wastes, are composed of materials that can become radioactively contaminated when plant workers use them. They include gloves, rags, tools, plastic sheeting, and chemical decontaminants. These wastes are also expected to have an average radioactivity low enough to be ranked as Class-A LLW. This analysis assumes that the quantities of other wastes would be much lower than those generated during facility deconstruction.

It is assumed that the soil within the conversion facility perimeters would not be contaminated with radiological or hazardous materials as a result of normal facility operations and therefore would not require excavation and subsequent treatment and disposition. If soil was contaminated due to an accidental release, it would be cleaned up as quickly as possible after the release occurred and would not be part of the D&D wastes.

The methodology outlined in Forward et al. (1994) was used to estimate the volumes and types of wastes that would be generated from the D&D of the conversion facility. Because contaminant inventories for these facilities are unavailable, reference data on the contaminant inventory data compiled by the NRC were applied. Facilities are categorized in Forward et al. (1994) into different types on the basis of their function, structure, design, and degree of D&D difficulty. This analysis assumes that the conversion facilities could be considered to be “radioactively contaminated buildings” with a “low” degree of D&D difficulty.

On the basis of the above assumptions and information provided in UDS (2003a), the annual and total waste generation rates from the D&D of the conversion facility were estimated and are provided in Table 5.9-2. Of the total materials generated during the D&D of the conversion facility, both LLMW and hazardous wastes would make up 2% to 3% of the total, and LLW would constitute about 6% to 7%. The majority of the D&D materials (approximately 88% of the total) would be "clean."

The "clean" waste would be sent to a landfill that accepts construction debris. LLW would be sent to a licensed disposal facility where it would likely be buried in accordance with the waste acceptance criteria and other requirements in effect at that time. Hazardous and mixed waste would be disposed of in a licensed facility in accordance with applicable regulatory requirements.

TABLE 5.9-2 Annual and Total Waste Volume Estimates from Conversion Facility D&D Activities at the Paducah Site

Waste Type	Annual D&D Waste (m^3/yr)[a]	Total D&D Waste (m^3)
LLMW	40	110
Hazardous waste	40	110
LLW	70	200
Clean	1,200	4,000

[a] Annual rates based on 3-year D&D.

6 ENVIRONMENTAL AND OCCUPATIONAL SAFETY AND HEALTH PERMITS AND COMPLIANCE REQUIREMENTS

6.1 DUF_6 CYLINDER MANAGEMENT AND CONSTRUCTION AND OPERATION OF A DUF_6 CONVERSION FACILITY

DUF_6 cylinder management as well as construction and operation of the proposed DUF_6 conversion facility would be subject to many federal, state, and local requirements. In accordance with such legal requirements, a variety of permits, licenses, and other consents must be obtained. Table 6.1 at the end of this chapter lists those that may be needed. The status of each is indicated on the basis of currently available information. However, because the DUF_6 project is still at an early stage, the information in Table 6.1 should not be considered comprehensive or binding. UDS may determine that additional consents not listed in Table 6.1 apply, or that the DUF_6 cylinder management and/or the conversion facility qualify for exemptions or exclusions from some listed consents.

6.2 TRANSPORTATION OF UF_6

Transportation of UF_6 (depleted, natural, or slightly enriched) is governed by the Hazardous Materials Transportation Act (HMTA), as amended by the Hazardous Materials Transportation Uniform Safety Act of 1990 and other acts (49 USC 5101 et seq.). This law is implemented by the DOT through its hazardous materials regulations (HMRs) (i.e., 49 CFR Parts 171 through 180). Since UF_6 presents hazards because of both its radioactivity and corrosivity, the DOT HMRs impose specific packaging requirements on UF_6 shipments in addition to the otherwise applicable radioactive material transportation requirements. The specific packaging requirements for shipments of UF_6 appear in 49 CFR 173.420 and are summarized below.

- Other than Model 30A cylinders and certain cylinders manufactured before June 30, 1987, DUF_6 packaging must be designed, fabricated, inspected, tested, and marked in accordance with the version of ANSI Standard N14.1, *Uranium Hexafluoride — Packaging for Transport*, that was in effect at the time the packaging was manufactured.

- Each UF_6 packaging must be designed so that it will withstand a hydraulic test at an internal pressure of at least 1.4 megapascals (MPa) (200 lb/in.^{2}) without leakage.

- Each UF_6 packaging must be designed so that it will withstand a free drop test without loss or dispersal of UF_6. The specimen must drop onto a flat, horizontal surface of such a character that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen. The drop must occur so that the specimen will suffer maximum damage in respect to the safety features to be tested. Mandatory drop heights, which must be measured from the lowest point of the specimen to the upper surface of the target, vary depending on the packaging mass from 1 ft (0.3 m) if the packaging mass exceeds 33,000 lb (15,000 kg) to 4 ft (1.2 m) if the packaging mass is less than 11,000 lb (5,000 kg).

- Each UF_6 packaging must be designed so that it will withstand, without rupture of the containment system, a thermal test as follows: Exposure for a period of 30 minutes to a thermal environment that provides a heat flux at least equivalent to that of a hydrocarbon fuel/air fire in sufficiently quiescent ambient conditions to give a minimum average flame emissivity coefficient of 0.9 and an average temperature of at least 800 degrees C (1,475 degrees F), fully engulfing the specimen, with a surface absorptivity coefficient that is the greater of 0.8 or the value the package may be expected to possess if exposed to the fire specified and a convective coefficient that must be the value that the package may be demonstrated to have if exposed to the fire specified.

- The UF_6 must be in solid form.

- The volume of solid DUF_6 must not exceed 62% of the certified capacity of the package at 20°C (68°F). For natural and slightly enriched UF_6, this requirement is 61%.

- The pressure in the package at 20°C (68°F) must be less than 101.3 kPa (14.8 lb/psia).

- Before initial filling and during periodic inspection and tests, UF_6 packaging must be cleaned in accordance with ANSI N14.1.

- UF_6 packaging must be periodically inspected, tested, marked, and otherwise conform to ANSI N14.1.

- Each repair to UF_6 packaging must be performed in accordance with ANSI N14.1.

If, at the time transportation occurs, the DUF_6 is being stored in a cylinder for which compliance with the then-applicable transportation requirements in 49 CFR 173.420 cannot be verified, UDS may implement one of the following options before shipping the DUF_6:

- Obtain an exception, pursuant to 49 CFR 173.3(b), to allow the cylinder to be transported either "as is" or following repairs, or

- Transfer the DUF_6 from its noncompliant cylinder into a compliant cylinder.

- Ship the noncompliant cylinder in a compliant overpack.

A detailed discussion of regulatory considerations associated with transporting UF_6 is presented in Biwer et al. (2001).

6.3 WORKER SAFETY AND HEALTH

The Occupational Safety and Health Act of 1970 (P.L. 91-596) gives OSHA the authority to prescribe and enforce standards and regulations affecting the occupational safety and health of private-sector employees. However, at facilities where another federal agency has exercised its statutory authority to prescribe or enforce occupational safety and health standards, Section 4(b)(1) of the act waives OSHA's jurisdiction. Relying on this section of the act, in 1974, OSHA explicitly recognized the authority of the AEC to establish and enforce occupational safety and health standards at AEC-sponsored, contractor-operated facilities covered by the AEA. Since then, the AEC and its successor agencies, including DOE, have regulated worker health and safety at most of their own facilities. This approach will be used to regulate worker safety at DUF_6 cylinder management and conversion facilities.

DOE exercises its authority over working conditions at its facilities through an extensive program of internal oversight and a system of DOE regulations and directives that require DOE contractors to comply with relevant worker protection standards and regulations (e.g., 29 CFR Part 1910, *Occupational Safety and Health Standards*, and 29 CFR Part 1926, *Safety and Health Regulations for Construction*) and impose additional radiation and chemical exposure standards developed by DOE (DOE Order 440.1A). DOE enforces its regulations, which have the power of law, by levying fines or by referring the offending contractor to the Department of Justice for other punishment. Most of DOE's worker radiation protection regulations are located in 10 CFR Part 835, *Occupational Radiation Protection*. Pertinent DOE directives are listed in site-specific contract provisions and are enforced by invoking contractual remedies such as contract cancellation. Accordingly, UDS is required by its contract to comply with applicable health, safety, and environmental laws, orders, regulations, and national consensus standards and to develop and execute a radiation protection plan and an integrated safety management plan (DOE 2000d).

TABLE 6.1 Potentially Applicable Consents for the Construction and Operation of a DUF_6 Conversion Facility

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Air Quality Protection			
Title V Operating Permit: Required for sources that are not exempt and are major sources, affected sources subject to the Acid Rain Program, sources subject to new source performance standards (NSPS), or sources subject to National Emission Standards for Hazardous Air Pollutants (NESHAPs).	Kentucky Department of Environmental Protection (KDEP); U.S. Environmental Protection Agency (EPA)	Clean Air Act (CAA), Title V, Sections 501–507 (*U.S. Code*, Title 42, Sections 7661–7661f [42 USC 7661–7661f]); 401 *Kentucky Administrative Regulation* (KAR) 52:020	Uranium Disposition Services, LLC (UDS), has determined that the DUF_6 conversion facility is not an affected source subject to the Acid Rain Program and is not a source subject to NSPS. However, UDS has not yet confirmed whether the DUF_6 conversion facility would be a major source of hazardous air pollutants (HAPs). Also, the facility is subject to *Code of Federal Regulations*, Title 40, Part 61, Subpart H (40 CFR Part 61, Subpart H), "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities" (NESHAPs), although emissions are expected to result in an effective dose equivalent to the maximally exposed individual (MEI) of well below the standard (i.e., 10 mrem/yr). Accordingly, UDS is seeking official verification from the KDEP as to whether a Title V Operating Permit is needed. KDEP representatives have verbally stated that no Title V Operating Permit will be required.
Kentucky Federally Enforceable State Origin Permit for Air Quality (FE SOP): Required for sources that accept permit conditions that are legally and practically enforceable to limit their potential to emit (PTE) to below the major source thresholds that would make them subject to the requirement to obtain a Title V Operating Permit. *— OR —* **Kentucky State Origin Permit for Air Quality (SOP):** Required for (1) sources that emit or have the PTE (a) more than 25 tons (28 t)/yr and less than 100 tons (110 t)/yr of a nonhazardous regulated air pollutant and (b) less than 10 tons (28 t)/yr of a HAP and less than 25 tons (110 t)/yr of combined HAPS; or (2) certain minor source incinerators, unless the source is exempt. Among others, a source required to obtain a Title V Operating Permit or a Federally Enforceable Permit for a Non-Major Source is exempt.	KDEP	*Kentucky Revised Statute* (KRS) 224.10–100 and 224.20–100; 401 KAR 52.030; 401 KAR 52:040	Assuming that a Title V Operating Permit will not be required, UDS expects that the DUF_6 conversion facility will be required to obtain either a Kentucky FE SOP or a Kentucky SOP for Air Quality. UDS is seeking verification from the KDEP concerning which of these permits is needed and has plans to submit a timely application for the appropriate permit.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Air Quality Protection (Cont.)			
Risk Management Plan (RMP): Required for any stationary source that has a regulated substance (e.g., hydrogen fluoride, anhydrous ammonia, ammonia, nitric acid) in any process (including storage) in a quantity that is over the threshold level.	EPA; KDEP	CAA, Title 1, Section 112(r)(7) (42 USC 7412); 40 CFR Part 68; 401 KAR, Chapter 68	UDS has determined that certain regulated substances would be stored at the DUF_6 conversion facility in quantities that could potentially exceed the threshold levels. Accordingly, an RMP may be required. UDS will verify this with the KDEP and, if necessary, prepare an RMP.
CAA Conformity Determination: Required for each criteria pollutant (i.e., sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead) where the total of direct and indirect emissions in a nonattainment or maintenance area caused by a federal action would equal or exceed threshold rates.	DOE; KDEP; Tennessee Department of Environment and Conservation (TDEC)	CAA, Title 1, Section 176(c) (42 USC 7506); 40 CFR 93; 401 KAR 50:065; TDEC Regulations 1200-3-34-.02	McCracken County, Kentucky, and Roane County, Tennessee, have both been designated as "Cannot be Classified or Better Than Standard" for all criteria pollutants. Because these counties are in attainment with National Ambient Air Quality Standards for all criteria pollutants and contain no maintenance areas, no CAA conformity determination is required for any criteria pollutant that would be emitted as a result of the proposed federal action.
Water Resources Protection			
Kentucky Pollutant Discharge Elimination System (KPDES) Permit – Construction Site Storm Water: Required before making point source discharges into waters of the state of storm water from a construction project that disturbs more than 5 acres (2 ha) of land.	KDEP	Clean Water Act (CWA) (33 USC 1251 et seq.); 40 CFR Part 122; 401 KAR 5:055 and 5:060	UDS has determined that a KPDES Permit for construction site storm water would be required. However, storm water from the DUF_6 conversion facility construction area could be managed such that discharge would occur through an existing outfall covered by KPDES Permit No. 0004049, which was issued to the U.S. Department of Energy (DOE) for surface water discharges from the Paducah Gaseous Diffusion Plant (GDP). Accordingly, UDS plans to coordinate with DOE and the KDEP to determine whether a separate KPDES Permit is needed for storm water discharges from the DUF_6 conversion facility construction site. If a separate permit is needed, UDS will, at the appropriate time, either submit a Notice of Intent (NOI) to discharge under the General KPDES Permit No. KYR10 for storm water discharges from construction activities or submit an application for an individual KPDES Permit to the KDEP.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Water Resources Protection (Cont.)			
Kentucky Pollutant Discharge Elimination System (KPDES) Permit – Industrial Facility Storm Water: Required before making point source discharges into waters of the state of storm water from an industrial site.	KDEP	CWA (33 USC 1251 et seq.); 40 CFR Part 122; 401 KAR 5:055 and 5:060	UDS has determined that storm water would be discharged from the DUF_6 conversion facility site during operations. Therefore, a KPDES Permit for Industrial Facility Storm Water discharge may be required, unless arrangements can be made to discharge such storm water through an existing outfall covered by KPDES Permit No. 0004049, already held by DOE for the Paducah GDP. UDS plans to consult with DOE and the KDEP concerning discharges of storm water during operations through an existing outfall. If this cannot be arranged and a separate KPDES Permit is needed, UDS will, at the appropriate time, submit an application for an individual KPDES Permit to the KDEP.
Kentucky Pollutant Discharge Elimination System (KPDES) Permit – Process Water Discharge: Required before making point source discharges into waters of the state of industrial process wastewater.	KDEP	CWA (33 USC 1251 et seq.); 40 CFR Part 122; 401 KAR 5:055 and 5:060	UDS is studying options for management of process water/blowdown discharges. The need for a KPDES permit for such discharges will be determined based on the outcome of the study. If it is determined that a KPDES permit is required, UDS will apply for the permit at the appropriate time.
Construction Permit for Sewer Line Extension: Required before beginning construction of sewer line extensions, pump stations, and force mains, or before modification of existing facilities.	KDEP	401 KAR 5:0005	UDS has determined that a Construction Permit for Sewer Line Extension would be required before beginning construction of sewer lines and pump stations at the DUF_6 conversion facility site. Accordingly, UDS plans to submit an application to the KDEP at the appropriate time.
Approval of Plans and Specifications for Water Line Extension: Required before altering any existing facilities in a public or semipublic water system.	KDEP	401 KAR 8:100	UDS will submit the information required to obtain approval for a water line extension at the appropriate time.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Water Resources Protection (Cont.)			
CWA Section 404 (Dredge and Fill) Permit: Required to place dredged or fill material into waters of the United States, including areas designated as wetlands, unless such placement is exempt or authorized by a nationwide permit or a regional permit; a notice must be filed if a nationwide or regional permit applies.	U.S. Army Corps of Engineers (USACE)	CWA (33 USC 1251 et seq.); 33 CFR Parts 323 and 330	UDS believes that construction of the DUF_6 conversion facility would not result in dredging or placement of fill material into wetlands within the jurisdiction of the USACE. However, construction of a rail crossing at Big Bayou Creek may require a Section 404 Permit. Accordingly, UDS plans to consult with the USACE concerning the project and, if appropriate, submit either a preconstruction notification about activities covered by a nationwide permit or an application for an individual Section 404 Permit.
Floodplain Construction Permit: Required prior to beginning construction of an obstruction across or along any stream or in the floodway of any stream.	KDEP	401 KAR 4:020 and 4:060	Construction of a rail crossing at Big Bayou Creek may require a Floodplain Construction Permit. UDS plans to consult with the KDEP to verify the need for this permit and will submit an application, as appropriate.
Groundwater Protection Plan: Required for conducting specified activities that may result in the pollution of groundwater.	KDEP	40 1 KAR 5:037	Certain activities at the DUF_6 conversion facility, such as storage of wastes in tanks and/or drums and storage of bulk quantities of potential pollutants in tanks, may require development of a Groundwater Protection Plan. UDS will consult with the KDEP to verify the need for such a plan and will develop the plan, if required.
Spill Prevention Control and Countermeasures (SPCC) Plan: Required for any facility that could discharge oil in harmful quantities into navigable waters or onto adjoining shorelines.	EPA	CWA (33 USC 1251 et seq.); 40 CFR Part 112	If it is determined that a SPCC plan would be required, UDS will submit the plan to the EPA and KDEP at the appropriate time.
CWA Section 401 Water Quality Certification: Required to be submitted to the agency responsible for issuing any federal license or permit to conduct an activity that may result in a discharge of pollutants into waters of a state.	KDEP	CWA, Section 401 (33 USC 1341); KRS 224.70	UDS would be required to obtain a CWA Section 401 Water Quality Certification if construction or operation associated with the DUF_6 conversion facility, such as construction of a rail spur, requires a federal license or permit. If it is determined that a federal license or permit is required (e.g., a CWA Section 404 Permit), UDS will request a CWA Section 401 Water Quality Certification from the KDEP at the appropriate time.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Waste Management and Pollution Prevention			
Registration and Hazardous Waste Generator Identification Number: Required before a person who generates over 220 lb (100 kg) per calendar month of hazardous waste ships the hazardous waste off site.	EPA; KDEP	Resource Conservation and Recovery Act (RCRA), as amended (42 USC 6901 et seq.), Subtitle C; 401 KAR 32:010	At the appropriate time, UDS plans to apply to the KDEP for an EPA Hazardous Waste Generator Identification Number.
Hazardous Waste Treatment, Storage, or Disposal Facility Permit: Required if hazardous or mixed waste will undergo nonexempt treatment by the generator, be stored on site by the generator of 2,205 lb (1,000 kg) or more of hazardous waste per month for longer than 90 days, be stored on site by the generator of between 220 and 2,205 lb (100 and 1,000 kg) of hazardous waste per month for longer than 180 days, be disposed of on site, or be received from off site for treatment or disposal.	EPA; KDEP	RCRA, as amended (42 USC 6901 et seq.), Subtitle C; 401 KAR 38:010, Section 4	Hazardous waste would not be disposed of on site at the DUF_6 conversion facility, nor would nonexempt treatment be conducted. Also, UDS does not plan to store any hazardous wastes that are generated on site for more than 90 days. Accordingly, UDS believes that no Hazardous Waste Treatment, Storage, or Disposal Facility Permit would be required. UDS plans to verify this determination with the KDEP.
Solid Waste Site or Facility Permit: Required to establish, construct, operate, and maintain a solid waste site or facility in Kentucky.	KDEP	401 KAR 47:080 and 47:100	Solid waste would not be disposed of on site at the DUF_6 conversion facility. Therefore, no Solid Waste Site or Facility Permit would be required.
Notification for Underground Storage Tank (UST) System: Required within 30 days of bringing a new UST system into service.	EPA; KDEP	RCRA, as amended, Subtitle I (42 USC 6991a–6991i); 40 CFR 280.22; 401 KAR 42:020	No UST systems would be installed at the DUF_6 conversion facility. Therefore, no Notification for UST System form would be submitted.
Notification of PCB Waste Activity	EPA	Toxic Substances Control Act (TSCA), as amended (15 USC 2601 et seq.); 40 CFR Part 761	UDS would be required to notify EPA of PCB waste activities at the time that DUF_6 cylinders to which paints containing PCBs have been applied are designated for disposal, either alone or as containers for depleted uranium oxide. At the appropriate time, UDS will notify the EPA by filing the required form.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Emergency Planning and Response			
List of Material Safety Data Sheets: Submission of a list of Material Safety Data Sheets is required for hazardous chemicals (as defined in 29 CFR Part 1910) that are stored on site in excess of their threshold quantities.	Local Emergency Planning Commission (LEPC); Kentucky Emergency Response Commission	Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), Section 311 (42 USC 11021); 40 CFR 370.20	UDS will prepare and submit a List of Material Safety Data Sheets at the appropriate time.
Annual Hazardous Chemical Inventory Report: Submission of the report is required when hazardous chemicals have been stored at a facility during the preceding year in amounts that exceed threshold quantities.	LEPC; Kentucky Emergency Response Commission; local fire department	EPCRA, Section 312 (42 USC 11022); 40 CFR 370.25; 106 KAR 1:081	UDS will cooperate with other DOE tenants at the Paducah Gaseous Diffusion Plant (PGDF) site regarding submission of a site-wide Annual Hazardous Chemical Inventory Report each year. For the purpose of preparing the site-wide report, the total quantities of hazardous chemicals stored by all tenants at the PGDP site, including those stored at the depleted UF_6 conversion facility, will be considered.
Notification of On-Site Storage of an Extremely Hazardous Substance: Submission of the notification is required within 60 days after on-site storage begins of an extremely hazardous substance in a quantity greater than the threshold planning quantity.	Kentucky Emergency Response Commission	EPCRA, Section 304 (42 USC 11004); 40 CFR 355.30; 106 KAR 1:081	UDS will prepare and submit the Notification of On-Site Storage of an Extremely Hazardous Substance at the appropriate time, if such substances are determined to be stored in a quantity greater than the threshold planning quantity at the DUF_6 conversion facility.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Transportation of Radioactive Wastes and Conversion Products			
Certificate of Registration: Required to authorize the registrant to transport hazardous material or cause a hazardous material to be transported or shipped.	U.S. Department of Transportation (DOT)	Hazardous Materials Transportation Act (HMTA), as amended by the Hazardous Materials Transportation Uniform Safety Act of 1990 and other acts (49 USC 1501 et seq.); 49 CFR 107.608(b)	UDS will obtain a Certificate of Registration at the appropriate time.
Packaging, Labeling, and Routing Requirements for Radioactive Materials: Required for packages containing radioactive materials that will be shipped by truck or rail.	DOT	HMTA (49 USC 1501 et seq.); Atomic Energy Act (AEA), as amended (42 USC 2011 et seq.); 49 CFR Parts 172, 173, 174, 177, and 397	When shipments of radioactive materials are made, UDS will comply with DOT packaging, labeling, and routing requirements.
Biotic Resources			
Threatened and Endangered Species Consultation: Required between the responsible federal agencies and affected states to ensure that the project is not likely to (1) jeopardize the continued existence of any species listed at the federal or state level as endangered or threatened or (2) result in destruction of critical habitat of such species.	DOE; U.S. Fish and Wildlife Service; Kentucky Department of Fish and Wildlife Resources	Endangered Species Act of 1973, as amended (16 USC 1531 et seq.); KRS 150.183, 150.990, and 146.600–619	No species listed at the federal or state level as endangered or threatened or the critical habitat of such a species has been identified that would be affected by construction or operation of the DUF_6 conversion facility.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Nuclear Facility Operations			
Approval to Start Up a Nuclear Facility: Required before start-up of new nuclear facilities, which are activities or operations that involve radioactive and/or fissionable materials in such form or quantity that a nuclear hazard potentially exists to the employees or the general public.	DOE	AEA, as amended (42 USC 2011 et seq.); DOE Order 425.1B	UDS will obtain approval from DOE to start up the DUF_6 conversion facility at the appropriate time.
Approval to Release Materials Containing Residual Radioactive Contamination: Required before releasing (1) nonuranium products from the DUF_6 conversion process (such as hydrogen fluoride [HF] or calcium fluoride [CaF_2]) for unregulated use and (2) decontaminated DUF_6 cylinders for unregulated use as scrap metal.	DOE	AEA, as amended (42 USC 2011 et seq.); DOE Order 5400.5	UDS will obtain approval from DOE before releasing HF, CaF_2, or decontaminated cylinders for unregulated use.
Cultural Resources			
Archaeological and Historical Resources Consultation: Required before a federal agency approves a project in an area where archaeological or historic resources might be located.	DOE; Advisory Council on Historic Preservation; Kentucky State Historic Preservation Officer (SHPO)	National Historic Preservation Act of 1966, as amended (16 USC 470 et seq.); Archaeological and Historical Preservation Act of 1974 (16 USC 469–469c-2); Antiquities Act of 1906 (16 USC 431 et seq.); Archaeo-logical Resources Protection Act of 1979, as amended (16 USC 470aa–mm)	DOE has coordinated with the Advisory Council on Historic Preservation and the Kentucky SHPO. A programmatic agreement (PA) calling for a complete cultural resource survey of the Paducah GDP, as well as development and implementation of a Cultural Resource Management Plan (CRMP), has been negotiated. The survey will proceed when the PA has been finalized; the CRMP will include any cultural resources found on the area to be occupied by the DUF_6 conversion facility.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Cultural Resources (Cont.)			
Government-to-Government Tribal Consultation: Required to ensure that project activities have been designed to protect access to, physical integrity of, and confidentiality of traditional cultural and religious sites.	DOE	American Indian Religious Freedom Act of 1978 (42 USC 1996 and 1996a); Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001 et seq.); National Historic Preservation Act of 1966, as amended (16 USC 470f); 36 CFR Part 800, Subpart B; 43 CFR Part 10	DOE has initiated government-to-government consultations with Native American tribes in the area of the DUF_6 conversion facility. No religious or sacred sites, burial sites, or resources significant to Native Americans have been identified to date.
Other			
Environmental Impact Statement (EIS): Required to evaluate the potential environmental impacts of a proposed major federal action that may significantly affect the quality of the human environment and to consider alternatives to the proposed action.	DOE	National Environmental Policy Act of 1969, as amended (NEPA) (42 USC 4321 et seq.); 40 CFR Parts 1500–1508; 10 CFR Part 1021	The requirements of NEPA are satisfied by publication of this EIS for the DUF_6 conversion facility.
Annual Toxic Release Inventory (TRI) Report: Required for facilities that have 10 or more full-time employees and are assigned certain Standard Industrial Classification (SIC) codes.	EPA	EPCRA, Section 313 (42 USC 11023); 40 CFR Part 372	UDS will prepare and submit a TRI report to the EPA each year.

TABLE 6.1 (Cont.)

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Other (Cont.)			
Tennessee Department of Environment and Conservation Consent Order (issued February 2, 1999): Establishes requirements for management, surveillance, testing, maintenance, and disposition of the UF_6 cylinders at the East Tennessee Technology Park.	DOE; Tennessee Department of Environment and Conservation (TDEC)		UDS will implement the requirements of the TDEC Consent Order.
Kentucky Natural Resources and Environmental Protection Cabinet Agreed Order (entered October 2, 2003: Establishes requirements for management, surveillance, testing, and maintenance of the DUF_6 storage yards and cylinders for which DOE accepts and exercises regulatory authority and responsibility at the Paducah Gaseous Diffusion Plant site.	DOE; KDEP	KRS 224	UDS will implement the requirements of the Kentucky Natural Resources and Environmental Protection Cabinet Agreed Order.
Federal Aviation Administration (FAA) Notice of Construction: Required prior to constructing a structure that could affect navigable airspace.	FAA	49 USC 44718; 14 CFR 77.11	UDS has notified the FAA that construction of the air emissions vent will occur within approximately 4 miles of the Barkley Regional Airport.

7 REFERENCES

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9 GLOSSARY

Accident: An unplanned sequence of events resulting in undesirable consequences, such as the release of radioactive or hazardous material to the environment.

Accident consequence assessment: An assessment of the impacts following the occurrence of an accident, independent of the probability of that accident. The environmental impact statement (EIS) provides estimates of the consequences of a number of possible accidents, ranging from those with low probability (rare) to those with relatively high probability (frequent).

Accident frequency: The likelihood that a specific accident will occur, that is, the probability of occurrence. If an accident is estimated to happen once every 50 years, the accident frequency is generally reported as 0.02 per year (1 occurrence divided by 50 years = 0.02 occurrence per year). For the EIS, accident frequencies were grouped as follows:

- I, likely (L) — The average frequency of occurrence is estimated to be greater than or equal to 1 in 100 years.
- II, unlikely (U) — The average frequency of occurrence is estimated to be 1 in 100 to 1 in 10,000 years.
- III, extremely unlikely (EU) — The average frequency of occurrence is estimated to be 1 in 10,000 to 1 in 1 million years.
- IV, incredible (I) — The average frequency of occurrence is estimated to be less than 1 in 1 million years.

Accident risk: Risk based on both the severity of an accident (consequence) and the probability that the accident will occur. High-consequence accidents that are unlikely to occur (low probability) may pose a low overall risk. For purposes of comparison, accident risk is typically calculated by multiplying the accident consequence (e.g., dose or expected fatalities) by the accident probability.

Accident risk assessment: An assessment that considers the probabilities and consequences of a range of possible accidents, including low-probability accidents that have high consequences and high-probability accidents that have low consequences. The overall *risk* associated with an accident is generally estimated by multiplying the accident consequence by the probability of occurrence.

Accident source term: The amount of radioactive or hazardous material released to the environment in dispersible form following an accident.

Adsorption: Process in which solid surfaces attract and retain a layer of ions from a water solution.

Advection: The process by which material is transported by the bulk motion of flowing water.

Air quality: Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances. Air quality standards are the prescribed level of constituents in the outside air that cannot be exceeded during a specific time in a specified area.

Air Quality Control Region (AQCR): An interstate or intrastate area designated by the U.S. Environmental Protection Agency (EPA) for the attainment and maintenance of National Ambient Air Quality Standards (NAAQS).

Alpha particle (α): A positively charged particle consisting of two protons and two neutrons that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

Ambient air: The surrounding atmosphere as it exists around people, plants, and structures.

American Indian Religious Freedom Act of 1978: The Act that established national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and freedom to worship through traditional ceremonies and rites.

Aquifer: A saturated subsurface geologic formation that can transmit significant quantities of water.

Archaeological and Historic Preservation Act: Act directed at the preservation of historic and archaeological data that would otherwise be lost as a result of federal construction. It authorizes the U.S. Department of the Interior to undertake recovery, protection, and preservation of archaeological and historic data.

As low as reasonably achievable (ALARA): An approach to control or manage radiation exposures (both individual and collective to the workforce and the public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit; it is a practice that has as its objective the attainment of dose levels as far below applicable limits as possible.

Atomic Energy Act of 1954 (AEA): The Act that, along with other related legislation, provided the Atomic Energy Commission (a predecessor of the U.S. Department of Energy) with authority to develop generally applicable standards for protecting the environment from radioactive materials.

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

Bald and Golden Eagle Protection Act, as amended: The Act making it unlawful to take, pursue, molest, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere in the United States.

Beta particle (β): An elementary particle emitted from a nucleus during radioactive decay; it is negatively or positively charged, identical in mass to an electron, and in most cases easily stopped, as by a thin sheet of metal or plastic.

Biota: The plant and animal life of a region.

Bounding: In the case of accident analysis, bounding is a condition, consequence, or risk that provides an upper limit that is not exceeded by other conditions, consequences, or risks. This term is also used to identify conservative assumptions that will likely overestimate actual risks or consequences.

Breach: A general term referring to a hole in a cylinder or container. A breach may be caused by corrosion or by mechanical forces, such as those caused by a drop or contact with handling equipment.

Cancer: A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation.

Candidate species: Plant or animal species that are not yet officially listed as threatened or endangered but are undergoing status review by the U.S. Fish and Wildlife Service (USFWS). These species are candidates for possible addition to the list of threatened and endangered species.

Carbon monoxide (CO): A colorless, odorless gas that is toxic if breathed in high concentration over a period of time. Carbon monoxide is one of six criteria air pollutants specified under Title I of the CAA.

Cascade: The process system that is used to separate the isotopic streams of uranium-235 and uranium-238 in gaseous diffusion plants.

Cask: A heavily shielded, typically robust container for shipping or storing spent nuclear fuel. Spent nuclear fuel casks are usually cylindrical containers with radiation shielding provided by steel, lead, concrete, or depleted uranium.

Census tract: An area usually containing between 2,500 and 8,000 persons that is used for organizing and monitoring census data. The geographic dimensions of census tracts vary widely, depending on population settlement density. Census tracts do not cross county borders.

Clean Air Act (CAA): The Act that mandates the issuance and enforcement of air pollution control standards for stationary sources and motor vehicles.

Clean Air Act Amendments of 1990: An Act that expanded the enforcement powers of the EPA and added restrictions on air toxins, ozone-depleting chemicals, stationary and mobile emissions sources, and emissions implicated in acid rain and global warming.

Clean Water Act of 1972, 1987: The Act that regulates the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit. Also regulates discharges to or dredging of wetlands.

Code of Federal Regulations (CFR): The codified form in which all federal regulations in force are published.

Collective dose: Summation of individual radiation doses received by all those exposed to the source or event being considered. The collective radiation dose received by a population group is usually measured in units of person-rem.

Collective population risk: A measure of possible loss in a group of people that takes into account the probability that the hazard will cause harm and the consequences of that event. The collective population risk does not express the risk to specific individual members of the population.

Committed effective dose equivalent: The sum of the committed dose equivalents to various tissues of the body, each multiplied by its weighting factor. It does not include contributions from external doses. Committed effective dose equivalent is expressed in units of rem and provides an estimate of the lifetime radiation dose to an individual from radioactive material taken into the body through either inhalation or ingestion.

Convection: Process by which heat is transferred between a surface and a moving fluid when they are at different temperatures.

Criteria pollutants: Six air pollutants for which national ambient air quality standards are established by the EPA under Title I of the CAA. The six pollutants are sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), ozone (O_3), particulate matter (PM_{10}, particles with a mean diameter of 10 micrometers [μm] or less), and lead (Pb).

Critical habitat: Air, land, or water area and constituent elements, the loss of which would appreciably decrease the likelihood of survival and recovery of a species listed as threatened or endangered or a distinct segment of the population of that species.

Cultural resources: Archaeological sites, architectural structures or features, traditional use areas, and Native American sacred sites or special use areas.

Cumulative impacts: The impacts assessed in an environmental impact statement that could potentially result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal), private industry, or individual undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Curie (Ci): A measure of the radioactivity of a material, equal to 3.7×10^{10} disintegrations per second.

Cylinder: As defined for this EIS, a large steel container used to store depleted uranium hexafluoride (DUF_6). Cylinders are typically about 12 ft long by 4 ft in diameter and weigh about 9 to 13 t (10 to 14 tons) when full of DUF_6.

Cylinder preparation: The activities required to prepare DUF_6 cylinders for transportation. Cylinder preparation would be required if cylinders were transported to a conversion facility.

Decay: see also *radioactive decay*.

Decay products: see also *radioactive decay products*.

Decommissioning: The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

Defluorination: The conversion of uranium hexafluoride to triuranium octaoxide (U_3O_8 [uranyl uranate]) accomplished by using steam. UF_6 is chemically decomposed with steam and heat to produce U_3O_8 and HF, with concentrated HF as the direct by-product.

Depleted uranium hexafluoride (DUF_6): A compound of uranium and fluorine from which most of the uranium-235 isotope has been removed. Isotope separation results in two product "streams." The stream containing the additional uranium-235 is said to be "enriched" and is collected for further processing into other forms of enriched uranium. The remaining UF_6 stream is said to be "depleted" and is now stored at the Paducah, Portsmouth, and ETTP sites.

Disposal: The emplacement of material in a manner designed to ensure isolation for the foreseeable future. Disposal is considered to be permanent, with no intent to retrieve the material for future use.

Disposal facility: A facility or part of a facility into which hazardous, radioactive, or solid waste is intentionally placed and at which waste is intended to permanently remain after closure of the facility.

Disproportionately high and adverse environmental impact: An adverse environmental impact determined to be unacceptable or above generally accepted norms. A disproportionately high impact refers to an environmental hazard with a risk or rate of exposure for a low-income or minority population that exceeds the risk or rate of exposure for the general population.

Disproportionately high and adverse human health effect: Any effect on human health from exposure to environmental hazards that exceeds generally accepted levels of risk and affects low-income and minority populations at a rate that appreciably exceeds the rate for the general population. Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts to human health.

Dose: The amount of energy deposited in body tissue due to radiation exposure. Various technical terms — such as dose equivalent, effective dose equivalent, and collective dose — are used to evaluate the amount of radiation received by an exposed individual or population.

Dose rate: Radiation dose delivered per unit of time and measured in rem per hour.

Drain: A device (e.g., a channel or pipe) used to carry away or to empty liquid from a liquid source.

Effective dose equivalent: The sum of the products of the dose equivalent to various organs or tissues and the weighting factors applicable to each of the body organs or tissues that are irradiated. The effective dose equivalent includes the dose from radiation sources internal and/or external to the body and is expressed in units of rem.

Emergency Planning and Community Right-to-Know Act of 1986: The Act that established programs to provide the public with important information on the hazardous and toxic chemicals in their communities and established emergency planning and notification requirements to protect the public in the event of a release of hazardous substances.

Emergency Response Planning Guideline (ERPG): A hazardous-material personnel exposure level or range which, when exceeded by a short-term or acute exposure, will cause adverse reproductive, developmental, or carcinogenic effects in humans. ERPGs are approved by a committee of the American Industrial Hygiene Association.

Endangered species: Any species that is in danger of extinction throughout all or a significant portion of its geographic range.

Endangered Species Act, as amended: The Act intended to prevent the further decline of endangered and threatened species and to restore these species and their habitats. Consultation with the USFWS is necessary to determine whether endangered and threatened species or their critical habitats are known to be in the vicinity of the proposed action.

Engineering analysis: A comprehensive technical analysis of DUF_6 technology options, including conversion, use, transportation, storage, and disposal.

Enrichment: An isotopic separation process that increases the portion of the uranium-235 isotope in relation to uranium-238 in natural uranium. In addition to the enriched uranium, this process also produces uranium depleted in uranium-235. Enrichment is accomplished in the United States through a process called gaseous diffusion.

Environmental impact statement (EIS): A document prepared in accordance with the requirements of the National Environmental Policy Act (NEPA).

Environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or environmental hazards as a result of their lack of political or economic strength.

Evapotranspiration: Loss of water from the soil by both evaporation and transpiration from plants growing in the soil.

Exposure: The condition of being made subject to the action of radiation, chemicals, or physical hazards. Exposure is sometimes used as a generic term to refer to the dose of radiation or chemicals absorbed by an individual or population.

External exposure: Exposure to radiation, principally gamma radiation, that originates from sources outside of the body.

Farmland Protection Policy Act of 1981: An Act that requires federal agencies to take steps to ensure that federal actions do not contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses in cases in which other national interests do not override the importance of protecting the farmland resources.

Fault: A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Federal Facilities Compliance Act of 1992: An Act that amended the Resource Conservation and Recovery Act (RCRA) with the objectives of bringing all federal facilities into compliance with applicable federal and state hazardous waste laws, of waiving federal sovereign immunity under those laws, and of allowing the imposition of fines and penalties. The law also requires the U.S. Department of Energy (DOE) to submit an inventory of all its mixed waste and to develop a treatment plan for mixed waste.

Federal listed species: see also *threatened, endangered,* and *candidate species*.

Fission: The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

Floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas, including at a minimum that area inundated by a 1% or greater chance flood in any given year. The base floodplain is defined as the 100-year (1%) floodplain. The critical action floodplain is defined as the 500-year (0.2%) floodplain.

Food chain: The scheme of feeding relationships between trophic levels that unites the member species of a biological community.

Fugitive dust: The dust released from activities associated with construction, manufacturing, or transportation.

Fugitive emissions: Uncontrolled emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

Gamma radiation (γ): High-energy, short-wavelength electromagnetic radiation (a packet of energy) emitted from a radioactive nucleus during decay. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials such as lead or uranium. Gamma rays are similar to X-rays, but are usually more energetic.

Gaseous diffusion: The uranium enrichment process first developed in the 1940s as part of the Manhattan Project. In gaseous diffusion, gaseous UF_6 is allowed to flow irreversibly through a membrane or diffusion barrier. With holes just large enough to allow the passage of individual molecules without passage of the bulk gas through the membrane or diffusion barrier, more of the lighter molecules (i.e., those containing uranium-235 atoms) will flow through the barrier than the heavier molecules (i.e., those containing uranium-238 atoms), thus effecting partial separation. Gaseous diffusion results in two streams of UF_6: one enriched in the uranium-235 isotope and one depleted in the uranium-235 isotope.

General public: For purposes of analyses in this EIS, anyone outside the boundary of a site at the time of an accident or during normal facility operations, as well as people along transportation routes used to ship hazardous chemicals or radioactive materials.

Glove box: An airtight box used to work with hazardous material, vented to a closed filtering system, having gloves attached inside the box to protect the worker.

Greater-than-Class-C waste: Low-level radioactive waste generated by the commercial sector that exceeds U.S. Nuclear Regulatory Commission (NRC) concentration limits for Class-C low-level waste, as specified in Title 10, Part 61, *Code of Federal Regulations* (10 CFR Part 61).

Green salt: see *uranium tetrafluoride*.

Groundshine: Gamma radiation emitted from radioactive materials deposited on the ground.

Groundwater: Generally, all water contained in the ground; water held below the water table available to freely enter wells.

Grout: A cementing or sealing mixture of cement and water to which sand, sawdust, or other fillers (additives — e.g., waste) may be added.

Grouted waste: Refers to the solid material obtained by mixing waste material with cement and repackaging it in drums. Grouting is intended to reduce the mobility of the waste material.

Habitat: Area where a plant or animal lives.

Hazard index: A summation of the hazard quotients for all chemicals to which an individual is exposed. A hazard index value of 1.0 or less than 1.0 indicates that no adverse human health effects (noncancer) are expected to occur.

Hazard quotient: A comparison of an estimated chemical intake (dose) with a reference dose level below which adverse health effects are unlikely. The hazard quotient is expressed as the ratio of the estimated intake to the reference dose. The value is used to evaluate the potential for noncancer health effects, such as organ damage, from chemical exposures.

Hazardous air pollutants: The 189 chemicals and chemical classes — such as asbestos, beryllium, mercury, benzene, and radionuclides — whose emissions are specially regulated by the CAA.

Hazardous material: A material that poses a potential risk to health, safety, and property when transported or handled.

Hazardous waste: Under RCRA, a solid waste, or combination of solid waste, which — because of its quantity, concentration, or physical, chemical, or infectious characteristics — may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source material (including UF_6), special nuclear material, and by-product material, as defined by the AEA, are specifically excluded from the definition of solid waste.

Health risk conversion factors: Estimates of the expected number of health effects (i.e., cancer cases, cancer fatalities, or genetic effects) caused by exposure to a given amount of radiation. Health risk conversion factors are multiplied by the estimated radiation dose received by a given population (such as workers or members of the public) in order to estimate the number of health effects expected to occur as a result of the exposure. Health risk conversion factors are derived from data collected from Japanese atomic bomb survivors, historical medical and industrial exposures, and animal experimentation.

Heels: Residual amounts of nonvolatile material left in a cylinder following the removal of DUF_6.

High-efficiency particulate air (HEPA) filter: A filter with an efficiency of at least 99.95% used to separate particles from air exhaust streams prior to releasing that air into the atmosphere.

Hydrocarbons (HC): Chemical compounds containing carbon and hydrogen as the principal elements.

Hydrogen fluoride (HF): A colorless, toxic, fuming, corrosive liquid or gas miscible with cold water and very soluble in hot water. HF is produced when UF_6 comes in contact with water, such as humidity in the air, and is often a by-product produced when UF_6 is converted to another chemical form.

Hygroscopic: A chemical substance with an affinity for water; one that will absorb moisture, usually from the air.

Inconel: A metal alloy containing nickel, chromium, and iron, which exhibits good resistance to corrosion in aqueous environments.

Internal exposure: The ingestion or inhalation of radioactive contaminants in air, water, food, or soil, and the subsequent radiation dose to internal organs and tissues of the body.

Involved worker: A worker directly involved in the handling or processing of radioactive or hazardous materials.

Ion: An atom, molecule, or molecular fragment carrying a positive or negative electrical charge.

Ionizing radiation: Radiation that has enough energy to remove electrons from substances that it passes through, forming ions.

Isotope: One of two or more species of an element that have the same atomic number but different masses. The difference in mass is due to the presence of one or more extra neutrons in the nucleus. The number of protons for different isotopes of the same element is the same. Uranium-235 and uranium-238 are examples of isotopes of the element uranium.

Land disposal restrictions: Restrictions on the disposal of waste that is hazardous under RCRA. The land disposal restrictions include technology-based or performance-based treatment standards that must be met before hazardous waste can be disposed of on land.

Latent cancer fatality (LCF): Term used to indicate the estimated number of cancer fatalities that may result from exposure to a cancer-causing element. Latent cancer fatalities are similar to naturally occurring cancers and may be expressed at any time after the initial exposure.

Lead (Pb): A toxic metal in air, food, water, and soil. Overexposure to this metal can cause damage to the circulatory, digestive, and central nervous systems. Lead is one of six criteria air pollutants specified under Title I of the CAA.

Long-term storage: The containment of material on a temporary basis or for a period of years, in such a manner as not to constitute disposal of such material. Long-term storage would preserve access to the material until a future use is identified or until a decision is made to dispose of the material.

Low-income population: Persons of low-income status. This status is based on U.S. Bureau of the Census definitions of individuals living below the poverty line, as defined by a statistical threshold that considers family size and income. For 1990, the poverty line threshold for a family unit of four individuals was $12,674 (based on 1989 income). In this EIS, low-income population was defined as consisting of any census tract located within a 50-mi (80-km) radius of a storage site that has a proportion of low-income population that is greater than the respective state average.

Low-level mixed waste (LLMW): Waste that contains both hazardous waste under RCRA and radioactive material, including source, special nuclear, or by-product material subject to the AEA. Such waste has to be handled, processed, and disposed of in a manner that considers its chemical as well as its radioactive components.

Low-level radioactive waste (LLW): Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or “11e(2) by-product material” as defined by DOE Order 5820.2A. Low-level waste is typically disposed of using shallow land burial.

Low-Level Radioactive Waste Policy Act: The Act, as amended, that established procedures for the implementation of compacts providing for the establishment and operation of regional disposal facilities for LLW that made the federal government responsible for ultimate disposal of commercially generated waste with a classification of greater-than-Class-C (see also *greater-than-Class-C waste*).

Maximally exposed individual (MEI): A hypothetical individual who — because of proximity, activities, or living habits — could potentially receive the maximum possible dose of radiation or of a hazardous chemical from a given event or process.

Migratory Bird Treaty Act, as amended: Act intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia.

Millirem: A unit of radiation exposure equal to one-thousandth of a rem.

Minority population: Persons classified by the U.S. Bureau of the Census as Negro/ Black/African-American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, or other nonwhite; based on self-classification by individuals according to the race with which they most closely identify. For this EIS, a minority population was defined as any census tract located within a 50-mi (80-km) radius of a storage site that has a proportion of minority population that is greater than the respective state average.

Mixed waste: see also *low-level mixed waste*.

Model: A conceptual, mathematical, or physical system obeying certain specified conditions, whose behavior is used to understand the physical system to which it is analogous. Models are often used to predict the behavior or outcome of future events.

Modified Mercalli Intensity: A level on the Modified Mercalli scale. A measure of the perceived intensity of earthquake ground-shaking with 12 divisions, from I (not felt by people) to XII (damage nearly total).

Monel: Trade name for a white copper-nickel alloy that is acid- and corrosion-resistant.

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the CAA, as amended. The primary NAAQS are intended to protect the public health with an adequate margin of safety; the secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants (NESHAPs): A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These standards were implemented in the CAA Amendments of 1977.

National Environmental Policy Act (NEPA) of 1969: The Act that established the national policy to protect humans and the environment, requiring environmental reviews of federal actions that have the potential for significant impact on the environment. It also established the Council on Environmental Quality (CEQ).

National Historic Preservation Act of 1966, as amended: The Act directing federal agencies to consider the effects of their programs and projects on properties listed on or eligible for the National Register of Historic Places. It does not require any permits, but pursuant to federal code, if a proposed action might impact any archaeological, historical, or architectural resource, this Act mandates consultation with the proper agencies.

National Pollutant Discharge Elimination System (NPDES): Federal permitting system required for hazardous effluents regulated through the CWA, as amended.

National Register of Historic Places: A list maintained by the Secretary of the Interior as the official list of historic properties (districts, sites, buildings, structures, and objects) deserving preservation because of their local, state, or national significance in American history, architecture, archaeology, engineering, and culture. Properties listed on or eligible for the National Register are protected by the National Historic Preservation Act of 1966, as amended.

NEPA document: A document prepared pursuant to requirements of the National Environmental Policy Act or CEQ regulations, including the following: environmental assessment, environmental impact statement, Notice of Intent, Record of Decision, and Finding of No Significant Impact.

Nitrogen oxides (NO_x): The oxides of nitrogen, primarily nitrogen oxide (NO) and nitrogen dioxide (NO_2), that are produced in the combustion of fossil fuels and can constitute an air pollution problem. When NO_2 combines with volatile organic compounds in sunlight, ozone is produced. Nitrogen oxides are one of six criteria air pollutants specified under Title I of the CAA.

Nonattainment area: An AQCR (or a portion thereof) for which the EPA has determined that ambient air concentrations exceed NAAQS for one or more criteria pollutants (see also *attainment area* and *criteria pollutants*).

Nonhazardous waste: Routinely generated waste, including general facility refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, dirt, and rubble. Nonhazardous waste is segregated and recycled whenever possible.

Noninvolved worker: A worker employed at a site who is not directly involved in the handling of radioactive or hazardous materials.

Normal operations: Conditions during which facilities and processes operate as expected or designed. In general, the evaluation of normal operations includes the occurrence of some infrequent events that, although not considered routine, are not classified as accidents. For example, the identification and repair of breached cylinders, expected to occur infrequently, was considered to be normal operations.

Nuclear weapon: The general name given to any weapon in which the explosion results from energy released by reactions involving atomic nuclei — either fission or fusion, or both.

Occupational Safety and Health Administration (OSHA): The agency that oversees and regulates workplace health and safety, created by the Occupational Safety and Health Act of 1970.

Overpack: Container used for transporting cylinders not meeting U.S. Department of Transportation (DOT) requirements. An overpack is a container into which a cylinder would be placed for shipment. The overpack would be designed, tested, and certified to meet all DOT shipping requirements and would be suitable to contain, transport, and store the cylinder contents regardless of cylinder condition.

Ozone (O_3): The triatomic form of oxygen. In the stratosphere, ozone protects the earth from the sun's ultraviolet rays, but in lower levels of the atmosphere, ozone is considered an air pollutant and can cause irritation of the eyes and respiratory tract. Ozone is one of six criteria air pollutants specified under Title I of the CAA.

Palustrine: Nontidal wetlands dominated by trees, shrubs, or persistent emergent vegetation or small shallow wetlands.

Particulate matter, particulates: Particles in an aerosol stream, the larger of which usually can be removed by filtration.

Pasquill stability categories: Classification scheme that describes the degree of atmospheric turbulence. Categories range from extremely unstable (A) to extremely stable (F). Unstable conditions promote the rapid dispersion of atmospheric contaminants and result in lower air concentrations compared with stable conditions.

Pathway: A route or sequence of processes by which radioactive or hazardous material may move through the environment to humans or other organisms. For example, one potential exposure pathway involves the contamination and subsequent use of surface water or groundwater.

Permeability: In hydrology, the capacity of a medium (rock, sediment, or soil) to transmit groundwater. Permeability depends on the size and shape of the pores in the medium and how they are interconnected.

Permissible exposure limits (PELs): Occupational exposure limits established for worker exposures to various chemicals, endorsed by the OSHA. Permissible exposure limits are defined so as to protect worker health and may be for short-term or 8-hour duration exposure.

Plume: The spatial distribution of a release of airborne or waterborne material as it disperses in the environment.

Plutonium (Pu): A heavy, radioactive, metallic element with the atomic number 94. Plutonium is produced artificially in a reactor by bombardment of uranium with neutrons and is used primarily in the production of nuclear weapons.

PM_{10}: Particulate matter with a mean aerodynamic diameter of 10 micrometers (μm) or less. PM_{10} is one of six criteria air pollutants specified under Title I of the CAA.

Pollution Prevention Act of 1990: The Act establishing the national policy that pollution should be prevented or reduced at the source or recycled in an environmentally safe manner and that pollution that cannot be prevented or recycled should be, as a last resort, treated and disposed of in an environmentally safe manner.

Polychlorinated biphenyls (PCBs): A class of chemical substances formerly manufactured as an insulating fluid in electrical equipment. PCBs are highly toxic to aquatic life and, in the environment, exhibit many of the characteristics of dichloro diphenyl trichloroethane (DDT). PCBs persist in the environment for a long time and accumulate in animals.

Polycyclic aromatic hydrocarbons (PAHs): A group of organic compounds, some of which are known to be potent human carcinogens.

Population dose: see also *collective dose*.

Programmatic environmental impact statement (PEIS): A type of EIS that deals with broad strategies and decisions, such as those that are regional or national in scope.

Proposed action: The term used in an EIS to refer to the activity planned by a federal agency that generates the need to prepare an EIS.

Public: see also *general public*.

Radiation: The particles (alpha and beta particles) or photons (gamma rays) emitted from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation, such as that from uranium, is indistinguishable from induced radiation.

Radiation absorbed dose (rad): The basic unit of absorbed dose equal to the absorption of 0.01 joule per kilogram (J/kg) of absorbing material.

Radioactivity: The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

Radioactive decay: Natural process by which a radioactive atom is physically transformed into another form by the release of energy in the form of subatomic particles such as alpha or beta particles, or electromagnetic radiation such as gamma rays.

Radioactive decay products: The isotopes produced when another isotope undergoes radioactive decay. The decay products are also typically radioactive.

Radionuclide: An atom that exhibits radioactive properties. Standard practice for naming a radionuclide is to use the name or atomic symbol of the element followed by its atomic weight (e.g., cobalt-60 [Co-60], a radionuclide of cobalt with an atomic weight of 60).

Recharge: Replenishment of water to an aquifer.

Record of Decision (ROD): A document prepared in accordance with the requirements of 40 CFR 1505.2 that provides a concise public record of the DOE's decision on a proposed action for which an EIS was prepared. A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative(s), and the factors balanced by the DOE in making the decision. The ROD also identifies whether all practicable means of avoiding or minimizing environmental harm have been adopted and, if not, why they were not.

Region of influence (ROI): The physical area that bounds the environmental, sociological, economic, or cultural feature of interest for the purpose of analysis.

Rem: The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of X-ray or gamma-ray exposure.

Resource Conservation and Recovery Act (RCRA), as amended: An act that provides a "cradle-to-grave" regulatory program for hazardous waste that established, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

Retardation: The process by which dissolved material moves more slowly through the soil than the velocity of the bulk fluid (i.e., water).

Risk: A quantitative or qualitative expression of possible loss that considers both the probability that a hazard will cause harm and the consequences of that event.

Safe Drinking Water Act, as amended: An act that protects the quality of public water supplies and all sources of drinking water.

Sanitary waste: Waste generated by normal housekeeping activities, liquid or solid (includes sludge), that is not hazardous or radioactive.

Scope: The range of actions, alternatives, and impacts to be considered in a document prepared pursuant to NEPA of 1969.

Scoping: The process of inviting public comment on what should be considered prior to preparation of an EIS.

Severe accident: An accident with a frequency of less than 1 in 1 million (10^{-6}) per year that would have more severe consequences than a design-basis accident in terms of damage to the facility, off-site consequences, or both.

Shielding: Any material that is placed between a source of radiation and people, equipment, or other objects, in order to absorb the radiation and thereby reduce radiation exposure. Common shielding materials include concrete, steel, water, and lead. In general, for shielding gamma radiation sources, the denser a material is, the more effective it is as a shield.

Sinter: To form a homogenous mass by heating without melting.

Socioeconomic analysis: Analysis of those parts of the human environment in a particular location that are related to existing and potential future economic and social conditions.

Socioeconomic impacts: For this EIS, impacts expressed in terms of regional economic impacts (notably changes in local employment, income, and economic output [sales]), impacts to public services and finance in local jurisdictions, and impacts to local housing markets.

Soil and Water Conservation Act of 1977: An Act to establish a program administered by the Secretary of Agriculture to further the conservation of soil, water, and related resources consistent with the roles and responsibilities of other federal agencies and state and local governments.

Solid Waste Disposal Act: An Act that regulates the treatment, storage, or disposal of solid, both nonhazardous and hazardous, waste, as amended by RCRA and the Hazardous and Solid Waste Amendments of 1984.

Source: Any physical entity that may cause radiation exposure, for example, by emitting ionizing radiation or releasing radioactive material. Examples of radiation sources include X-ray machines and radionuclides such as uranium.

Source term: The amount of radioactive or hazardous material released to the environment following an accident.

Stability class: see *Pasquill stability categories*.

Stakeholder: Any person or organization interested in or potentially affected by activities and decisions of the DOE.

Storage: The temporary holding of material in a controlled and monitored facility.

Sulfur dioxide (SO_2): A compound of sulfur produced by the burning of sulfur-containing compounds and considered to be a major air pollutant. Sulfur dioxide is one of six criteria air pollutants specified under Title I of the CAA.

Sulfur oxides (SO_X): A general term used to describe the oxides of sulfur — pungent, colorless gases formed primarily by the combustion of fossil fuels. Sulfur oxides, which are considered major air pollutants, may damage the respiratory tract as well as vegetation.

Technetium: A radioactive element with the atomic number 43. It is derived from uranium and plutonium fission products. Its isotope Tc-99 is used to absorb slow neutrons in reactor technology.

Terrestrial: Pertaining to plants or animals living on land rather than in the water.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Throughput: A general term that refers to the amount of material handled or processed by a facility in a year.

Tiering: The process of first addressing general (programmatic) matters in a broad PEIS, followed by more narrowly focused (project-level) environmental documentation that incorporates by reference the more general document.

Topography: Physical shape of the ground surface.

Total effective dose equivalent: The sum of the effective dose equivalent from external exposure and the 50-year committed effective dose equivalent from internal exposure.

Toxic Substances Control Act of 1976 (TSCA): The act authorizing the EPA to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the EPA before they are manufactured for commercial purposes.

Transuranic (TRU) waste: Waste contaminated by alpha-emitting transuranic radionuclides (i.e., radionuclides with atomic numbers greater than 92) with half-lives of more than 20 years and concentrations higher than 100 nanocuries per gram (nCi/g) at the time of assay.

Triuranium octaoxide (U_3O_8): An oxide form of uranium that is the most common chemical form found in nature. U_3O8 is very stable and has a low solubility in water.

Uranium: A heavy, silvery-white, naturally radioactive, metallic element (atomic number 92). Its two principally occurring isotopes are uranium-235 and uranium-238. Uranium-235 is indispensable to the nuclear industry because it is the only isotope existing in nature to any appreciable extent that is fissionable by thermal neutrons. Uranium-238 is also important because it absorbs neutrons to produce a radioactive isotope that subsequently decays to plutonium-239, an isotope that also is fissionable by thermal neutrons.

Uranium dioxide (UO_2): A black crystalline powder that is widely used in the manufacture of fuel pellets for nuclear reactors. Pressed and sintered, it is stable when exposed to water or air below 300°C (572°F).

Uranium hexafluoride (UF_6): A chemical composed of one atom of uranium combined with 6 atoms of fluorine. UF_6 is a volatile white crystalline solid at ambient conditions. This form of uranium is used as feed for gaseous diffusion enrichment plants.

Uranium metal: A heavy, silvery-white, malleable, ductile, softer-than-steel metallic element. One of the densest materials known, it is 1.6 times more dense than lead and slightly less toxic. Uranium metal is not as stable as U_3O_8 or UF_4 because it is subject to surface oxidation. It tarnishes in air, with the oxide film preventing further oxidation of massive metal at room temperature.

Uranium tetrafluoride (UF_4): A green crystalline solid that melts at about 960°C (1,652°F) and has an insignificant vapor pressure. It is very slightly soluble in water; generally an intermediate in the conversion of UF_6 to either uranium oxide (U_3O_8 or UO_2) or uranium metal. Also known as green salt.

Uranyl fluoride (UO_2F_2): A yellow hygroscopic (i.e., moisture-retaining) solid that is very soluble in water. In accidental releases of UF_6, UO_2F_2 is a solid particulate compound that may deposit on the ground over a large area.

Vacuum: A pressure less than atmospheric. Depleted uranium hexafluoride (DUF_6) is stored in a vacuum in cylinders.

Volatile organic compounds (VOCs): A broad range of organic compounds (such as benzene, chloroform, and methyl alcohol), often halogenated, that vaporize at ambient or relatively low temperatures.

Waste management: The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated pollution prevention and surveillance and maintenance activities.

Waste minimization: An action that economically avoids or reduces the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling.

Wastewater: Water that typically contains less than a 1% concentration of organic hazardous waste materials.

Water Quality Act of 1987: An act amending the Federal Water Pollution Control Act to make NPDES requirements applicable to storm water discharges.

Web site: A collection of information — possibly including text, figures, pictures, audio, and video — that can be accessed by computer through the Internet computer network. These sites are intended to communicate and distribute information to anyone having access to the Internet.

Wetlands: Lands or areas exhibiting hydric soils, saturated or inundated soil during some portion of the plant growing season, and plant species tolerant of such conditions (includes swamps, marshes, and bogs).

Wild and Scenic Rivers Act: An Act providing for protection of the free-flowing, scenic, and natural values of rivers designated as components or potential components of the National Wild and Scenic Rivers System.

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